E-Scooter / E-Bike Charger — Waterproof Test Report

Reference Standards: GB/T 4208-2017 (IP Protection) · IEC 60529:2013 · ISO 20653:2013 (Road Vehicles) · QC/T 1088-2017 (E-Bike Chargers)

Test Item	Test Group (PC + Sealed Design)	Control Group (ABS + Standard Design)	Unit	Notes / Design Basis
1. Basic Test Parameters				
Sample Specification	Complete charger + cables (production unit)	Complete charger + cables (production unit)	-	Same as shipping state
Sample Quantity	5	5	pcs	5 samples per group
Sample Condition	Powered on and charging	Powered on and charging	-	Most severe condition testing
Test Voltage	AC 220V / DC 42V × 2A (rated)	AC 220V / DC 42V × 2A (rated)	V/A	Simulating real user usage
Test Temperature	25 ± 2	25 ± 2	℃	Room temperature
Test Water Temperature	23 ± 2	23 ± 2	℃	Standard water temperature
Housing Material	PC + silicone sealing ring + IP67 connector	ABS + standard snap-fit + no sealing ring	-	Test group has sealed design
Housing Seam Treatment	Ultrasonic welding + sealing ring	Snap-fit + screws	-	Structural design difference
Lab Power Supply	Stabilized AC 220V / 50Hz	Stabilized AC 220V / 50Hz	-	Same power source
Safety Monitoring	RCD (30mA sensitivity) + IR thermal imager	RCD (30mA sensitivity) + IR thermal imager	-	Personnel + equipment dual protection
Data Acquisition	Online insulation monitor + leakage current monitor + high-speed camera	Online insulation monitor + leakage current monitor + high-speed camera	-	Full process monitoring
2. IPX4 Splash Test (Simulating Heavy Rain, IEC 60529 §14.2.4)				
Test Method	Oscillating tube rain method (tube radius 200mm)	Oscillating tube rain method (tube radius 200mm)	-	GB/T 4208 IPX4 standard method
Water Flow Rate	10 ± 0.5	10 ± 0.5	L/min	Standard specification
Water Pressure	50 — 150	50 — 150	kPa	Standard specification
Tube Oscillation Angle	±60° (covering 180°)	±60° (covering 180°)	°	Standard specification
Oscillation Speed	60°/s (one full cycle 4s)	60°/s (one full cycle 4s)	°/s	Standard specification
Sample-to-Sprayer Distance	≈ 200	≈ 200	mm	Tube radius
Test Duration	10	10	min	GB/T 4208 §14.2.4
Charger Status During Test	Charging (DC port connected to battery)	Charging (DC port connected to battery)	-	Most severe condition
Anomaly During Test	No leakage, no short circuit, charging normal	Leakage current instantly spikes to 25mA (RCD trips)	-	Control group triggered RCD protection
Immediate Post-Test Check	Charging function normal, indicator normal	Cannot continue test, internal short circuit	-	Power on immediately after test
IPX4 Grade Verdict	Pass (IPX4)	Fail (below IPX4)	-	GB/T 4208 grade
3. IPX7 Immersion Test (Simulating Water Submersion, IEC 60529 §14.2.7)				
Test Method	Water tank immersion method	Water tank immersion method	-	GB/T 4208 IPX7 standard method
Water Depth (lowest point of sample to water surface)	1000 ± 10	1000 ± 0	mm	Standard 1 meter
Sample Orientation	Worst-case pose (DC connector facing down)	Worst-case pose (DC connector facing down)	-	Most severe condition
Test Duration	30	30	min	Standard specification
Charger Status During Test	Charging (DC port connected to battery)	Charging (DC port connected to battery)	-	Live test in water
Leakage Current During Test	< 0.1 (within safety threshold)	Instantly spikes to 30mA (RCD trips), internal PCB smokes	mA	RCD threshold 30mA
Charging Status During Test	Charging current stable 2.0±0.1A	Charging current 0A (charging interrupted), after 5min housing heats up	-	Real-time monitoring
Immediate Post-Test Check	Insulation 200 MΩ, leakage 0.05mA	Insulation 0.5 MΩ (failed), obvious burnt smell inside	MΩ	500V DC megohmmeter
Function After Removing from Water	Powers on and resumes normal charging immediately	Completely damaged, cannot power on	-	Power on immediately after test
Function After 24h Drying	100% normal, insulation recovered to 500 MΩ	Still damaged, internal PCB corroded and shorted	-	Room temperature natural drying
IPX7 Grade Verdict	Pass (IPX7)	Fail (below IPX7)	-	GB/T 4208 grade
4. Acceptance Criteria				
Target IP Protection Level	IPX4 + IPX7 (dual certification)	IPX4 (minimum requirement)	-	Test group design target, control group basic requirement
Leakage Current During Test	< 0.5 mA (safety threshold)	< 0.5 mA	mA	GB 4943.1-2022 safety standard
Insulation Resistance After Test	≥ 100 MΩ (500V DC)	≥ 100 MΩ	MΩ	Test group requires recovery to initial value
Charging Function After Test	Current stable at 2.0±0.2A	Current stable at 2.0±0.2A	A	Normal function after test
Short Circuit Determination	No short circuit (leakage current < 0.5mA)	No short circuit	-	Baseline requirement
Water Ingress Determination	No visible water trace in live parts	No visible water trace in live parts	-	Disassemble and visually inspect after test
Function After 24h Drying	Fully recovered, same as before test	Fully recovered, same as before test	-	Post-test stability
Housing Structure	Sealing ring not detached, no weld cracks	Snap-fit not loosened, screws not loose	-	Structural integrity
Electrical Safety	Pass withstand voltage test 1500VAC / 1min	Pass withstand voltage test 1500VAC / 1min	-	Post-test withstand voltage

Sample No.	Test Group (PC)	Control Group (ABS)	Pass/Fail	Failure Description
Sample-Level Test Results				
#01	Pass	Fail	✓	ABS IPX4 phase: RCD trips on leakage
#02	Pass	Fail	✓	ABS IPX7 phase: internal short circuit, PCB burned
#03	Pass	Fail	✓	ABS IPX7 phase: charging interrupted, housing heats up
#04	Pass	Fail	✓	ABS still cannot power on after drying
#05	Pass	Fail	✓	ABS visible water traces + corrosion marks inside
Pass Rate	5/5	0/5	Passed / Total	5/5 vs 0/5
Overall Conclusion	**Test group with PC passed 5/5 in IPX4 + IPX7 dual waterproof testing, operating stably under both heavy rain and 1m water immersion for 30 min, with full function recovery after drying; ABS control group 0/5 passed — RCD trips on leakage during IPX4 phase, internal short circuit and burnout during IPX7 phase, still damaged after drying, unable to meet outdoor use requirements.**			