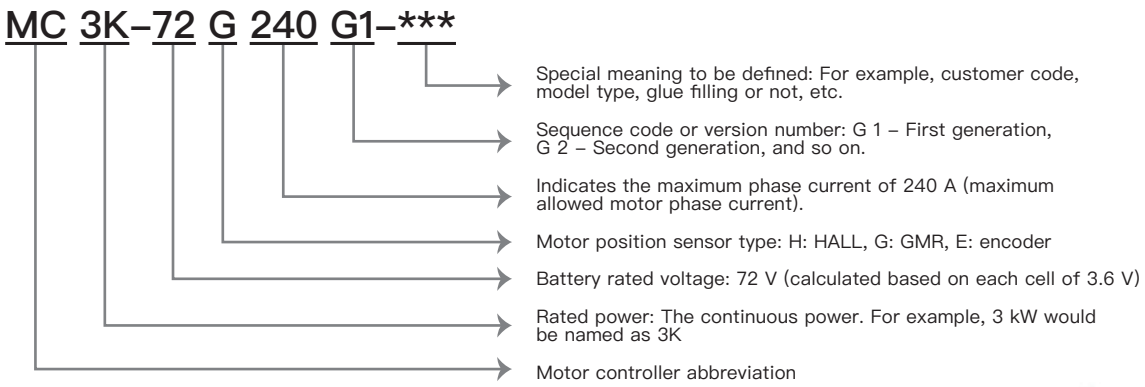
Specification of Motor Controller for Electric Motorcycle

Product model: MC6K-72G450
MC8K-72G550
MC10K-96G550

Contents

1 Product Information

1.1 Product designation



Note:

① Rated power measurement conditions: ambient temperature 23℃ ± 5℃, natural cooling. For example, 5.5 kW would be named 6K, and 15 kW would be named 15K.

② Maximum phase current measurement conditions: Ambient temperature 23°C ± 5°C, natural cooling. 240 A indicates the maximum phase current capability of 240 A sustained for 1 minute. This value may vary depending on the motor and usage scenario.

1.2 Application scope

This specification provides relevant technical information of the electric motorcycle controller made by Hobbywing Technology Co., Ltd. (i.e. HW), including the functional safety descriptions, allowable operating conditions, technical boundary conditions of the Hobbywing electric motorcycle controller, as well as the interface technical conditions of other modules and related installation & operation precautions.

Hobbywing electric motorcycle controller is designed to only operate under the conditions set out in this specification. Hobbywing will assume no responsibility for operation under the conditions beyond this specification. Hobbywing will assume responsibility for controller failure pertaining to problems in design, production and transportation. However, controller failure arising from failure of other components of the motorcycle system is beyond the Hobbywing's responsibility.

Customers are recommended to include the following safety precautions in the manual of the motorcycle using HW controller, as detailed below:

1) Ensure the motorcycle handlebar will not send the incorrect speed regulation signal during operation.

2) Ensure the controller can receive the reliable electric brake signal.

3) Ensure the mechanical brake can function well.

4) The controller may get pretty hot on the surface if the motorcycle runs at high load. Thereby, users shall be aware of taking measures against scald before coming in contact with the pretty hot controller or other mounting areas.

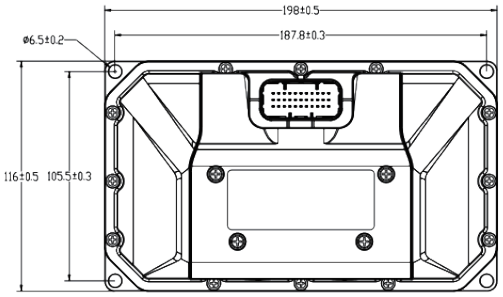
5) In case of the controller operating voltage exceeding the specified 36 V safety voltage, users shall be aware that they shall not come in contact with the live part of the controller (connector)to prevent electric shock.

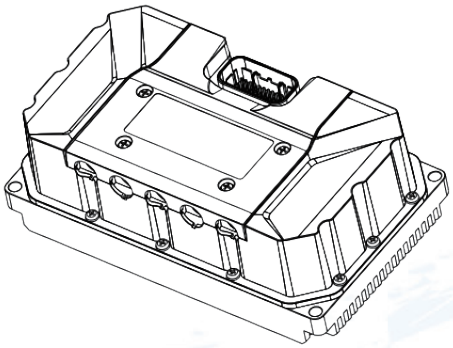
1.3 Product overview

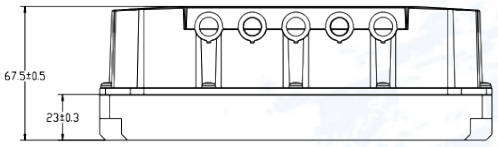
This product utilizes a 32-bit ARM-M4 high-speed MCU as its main control chip, plus a highly reliable automotive-grade software architecture and FOC algorithm. This configuration ensures smooth power delivery, low noise, and powerful acceleration. The appropriately tuned software ensures the high overall power efficiency and long endurance, while also supporting power tuning for a variety of personalized driving experiences. It features the comprehensive protections, such as voltage, current, temperature, short circuit, and locked-rotor protection, along with power-on self-check functionality, and IP67 rating protection, ensuring reliable operation of the power system. It is configured for three-gear operating mode switching, EABS braking, TCS, limp home, cruise control, Boost acceleration, assisted pushing and other functions, which greatly contribute to improved driving experience and safety. It can perform OTA upgrades, black-box troubleshooting, motor self-learning, and allows for multiple communication interfaces and encoder types, giving the controller exhibits excellent compatibility, and rapid troubleshooting capabilities. Founded in 2005, HOBBYWING has been deeply involved in the drone industry for over 20 years, demonstrating reliable aviation-grade quality control capabilities.

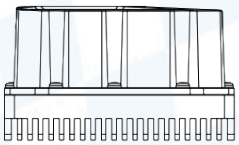
1.4 Product dimensions

Controller dimension (198 × 116 × 67.5) mm.









1.5 Product weight

The controller weighs about 1800 g.

2 Product Function Descriptions

2.1 Motorcycle function

The basic functions of the motorcycle are defined in the table below (the functions can be customized).

Seq. No.	Motorcycle function	Function Descriptions
1	Stepless speed regulation	Check the handlebar input (1.2 V – 3.8 V) for stepless speed regulation on the motorcycle.
2	Gears (three-speed)	Determine whether to switch gears by checking the gear level. Three gear levels are available: high, medium, and low.
3	Parking	Check the parking level fluctuation to see if the parking is working well. If not, the motorcycle must not be started.
4	Braking	Check the brake level fluctuation to see if the brake is working well. The high and low level brakes are available.
5	Reverse	Activate reverse mode via combination key.
6	Pushing	Activate pushing mode via combination key.
7	Side stand	Activate the side stand function by checking the side stand level. It is impossible to start the motorcycle in case of failure of side stand level.
8	Cruise control	Activate cruise mode via combination key, and exit it via accelerator or brake.
9	Seat cushion detecting	Activate the seat cushion function by checking the seat cushion level.
10	Anti-theft	Activate the antitheft mode by checking the antitheft lock signal. The motorcycle can be locked directly when not in motion. When riding, stop the motorcycle before locking.
11	One-click repair	Activate this function via combination key in case of handlebar or brake failure
12	TCS	This function may prevent wheels from slipping and improve motorcycle stability and safety.
13	EPB (Electrical Park Brake)	When parking on a slope, enter the assisted parking mode via combination key.
14	Self-learning	The controller has a self-learning function that adapts to the parameters of the motor it operates.

2.2 Safety protection functions

This product can perform varieties of software-based fault detection, including handlebar fault, brake fault, position sensor fault, overvoltage fault, undervoltage fault, overcurrent fault, locked-rotor fault, controller overtemperature fault, and motor overtemperature fault, etc. (Security functions can be adjusted based on customers' requirements).

Seq. No.	Safety protection functions	Function descriptions
1	Overvoltage protection	The controller may stop its output to the motor in case of battery overvoltage.
2	Soft undervoltage protection	When the battery voltage falls below the soft undervoltage threshold, the battery current limit starts to decrease until it reaches the minimum.
3	Undervoltage protection	The controller may stop its output to the motor in case of battery undervoltage.
4	Over-current protection (Motor phase line shorted)	The controller may remain unaffected despite the motor phase shorting line-to-line. Note: Short-circuit protection is only applies between any two phases of the motor, and between a phase and the positive power source, and does not apply to phase to ground short circuits.
5	Over-temp protection	The controller has the over-temp. protection function in place to prevent damage due to overheating.
6	Open-phase protection	Configured for open-phase detection at zero motorcycle speed.
7	Locked-rotor protection	In response to a locked rotor condition, the controller will cut off its output within 2 seconds.
8	Sensor fault	If the controller detects the loss of more than one motor position signal, it will cut off its output.
9	Throttle fault	In the event of an open circuit in any one of the speed control handlebars or short circuit between any two of these cables, the controller will stop motor operation.
10	Start lock	If the handlebar is not at the zero position (> 1.2 V) at power up, the controller will not drive the motor. The handlebar must be reset and then turned again to start the electric vehicle normally.
11	Black box function	The operational data will be stored from before and after a fault, which can be read via the host computer and WeChat mini-program, and analyzed using host computer software.

3 Product Electrical Specification

3.1 Controller technical parameters

Models / Specifications	MC6K	MC8K	MC10K
Bus max. current	190 A	250 A	230 A
Phase max. current	450 A	550 A	500 A
Rated bus voltage	48 V, 60 V, 72 V	48 V, 60 V, 72 V	96 V
Rated power (72V bus voltage)	6 kW	8 kW	10 kW
Peak power (72V bus voltage)	12 kW	16 kW	20 kW
MOSFET count/ Internal Resistance	18 – MOSFET/1.6 mΩ	24 – MOSFET/1.6 mΩ	24 – MOSFET/2.2 mΩ
Strong and weak power isolation	For 48V, 60V, 72V systems, only CAN/RS485 communication interfaces are isolated; For 96V systems, a full isolation circuit is applied between the high–voltage and low–voltage circuit.		
Motor sensor	H: HALL G: GMR		
Control mode	Sensor–based FOC		
Communication mode	CAN/RS485/TTL TX RX/Bluetooth		
Max. controller efficiency	98%		
Cooling mode	Natural air cooling		
Operating ambient temperature	–25℃ ~ 60℃		
Humidity boundary	0% ~ 95% RH		
IP grade	IP67		

3.2 Power supply boundary

Table 1 Controller power supply boundary conditions (Note: Parameters marked with * in the table may vary depending on the customer's technical specifications.)

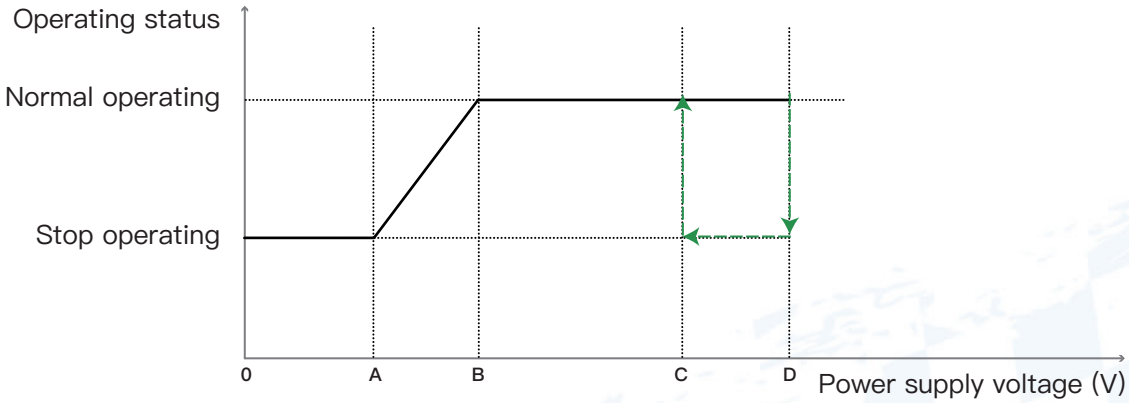


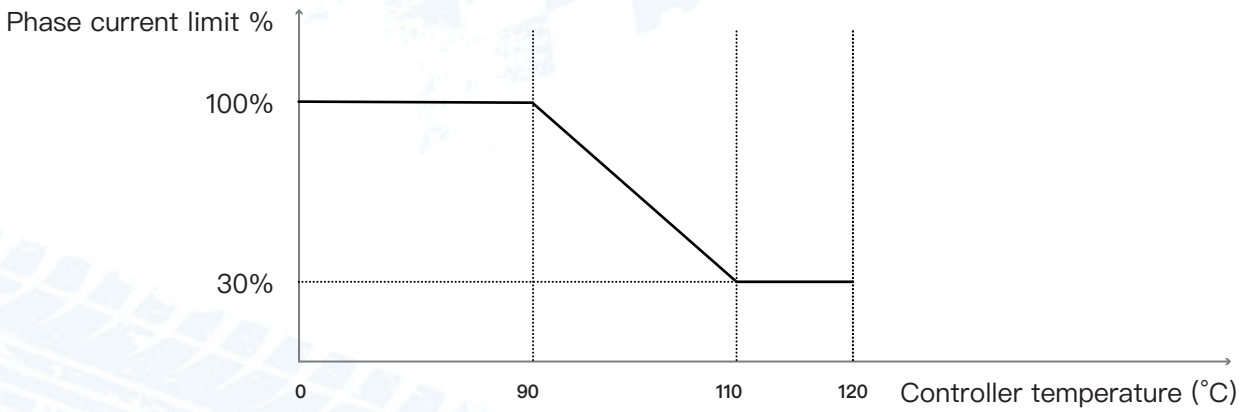
Table 2 Undervoltage/Overvoltage protection boundary conditions (Note: The parameters marked with * in the table may vary depending on the customer's technical specifications.)

Battery voltage	A	B	C	D
48 V	35 V*	40 V*	56 V*	58 V*
60 V	48 V*	53 V*	70 V*	72 V*
72 V	58 V*	62 V*	84 V*	86 V*
96 V	79 V*	84 V*	115 V*	120 V*

Table 3 Rated current/peak current boundary conditions (Note: Parameters marked with * in the table may vary depending on the customer's technical specifications.)

Models	Performance parameters	Boundary descriptions
MC6K	Rated current	Ambient temperature of 23°C ± 5°C, natural air cooling, line current of **95 A** and phase current of **130 A**, continuous operation for **30 min** without derating. (Tested on certain motor models)
	Peak current	Ambient temperature of 23°C ± 5°C, natural air cooling, line current of **190 A** and phase current of **450 A**, continuous operation for **1 min** without derating.
MC8K	Rated current	Ambient temperature of 23°C±5°C, natural air cooling, line current of **125 A** and phase current of **150 A**, continuous operation for **30 min** without derating. (Tested on certain motor models)
	Peak current	Ambient temperature of 23°C±5°C, natural air cooling, line current of **250 A** and phase current of **550 A**, continuous operation for **1 min** without derating.
MC10K	Rated current	Ambient temperature of 23°C±5°C, natural air cooling, line current of **115 A** and phase current of **140 A**, continuous operation for **30 min** without derating. (Tested on certain motor models)
	Peak current	Ambient temperature of 23°C±5°C, natural air cooling, line current of **230 A**, phase current of **500 A**, continuous operation for **1 min** without derating.

Fig. 1 Phase Current Temperature Boundary (Note: Parameters marked with * in the table may vary depending on the customer's technical specifications.)



3.3 Electrical safety

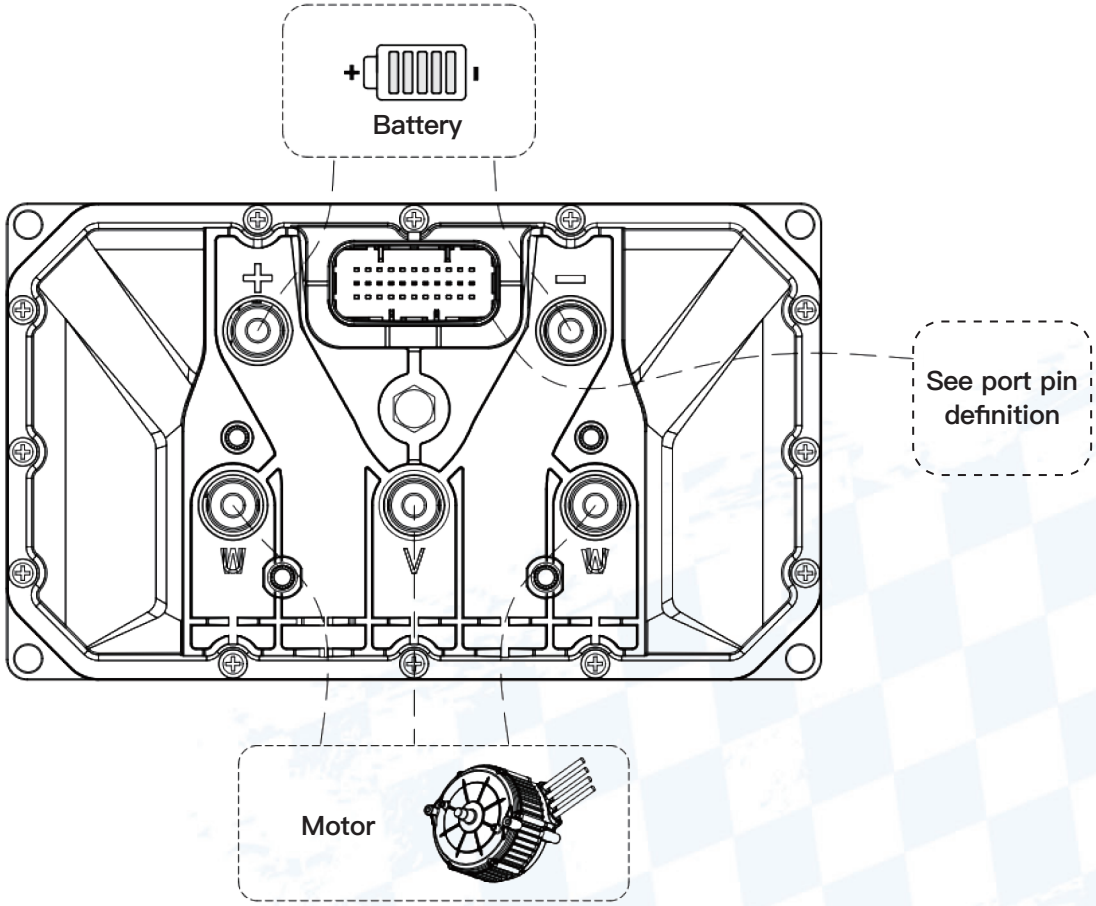
Seq. No.	Test items	Test conditions/requirements
1	Insulation resistance test	The positive output terminal is connected to the power input/output, while the negative terminal is connected to the signal output terminal or ground (housing). Apply DC 500 V to carry out test for 1 min. The insulation resistance between the power terminals and the signal terminal, as well as the housing, must all be greater than 20 MΩ. After test, the controller operates well.
2	Dielectric strength test	DC 1500 V is applied between the wire of the test controller and the protective earth circuit for 1 minute to perform the test. During the test, the leakage current shall be ⩽ 5 mA with no breakdown or flashover detected. After test, the controller operates well.

4 Electrical Connection and Interface Definition

There are two types of wires for controller connection: signal harness and power harness. The signal harness is attached to the controller's control port via its connector to achieve the signal connection.

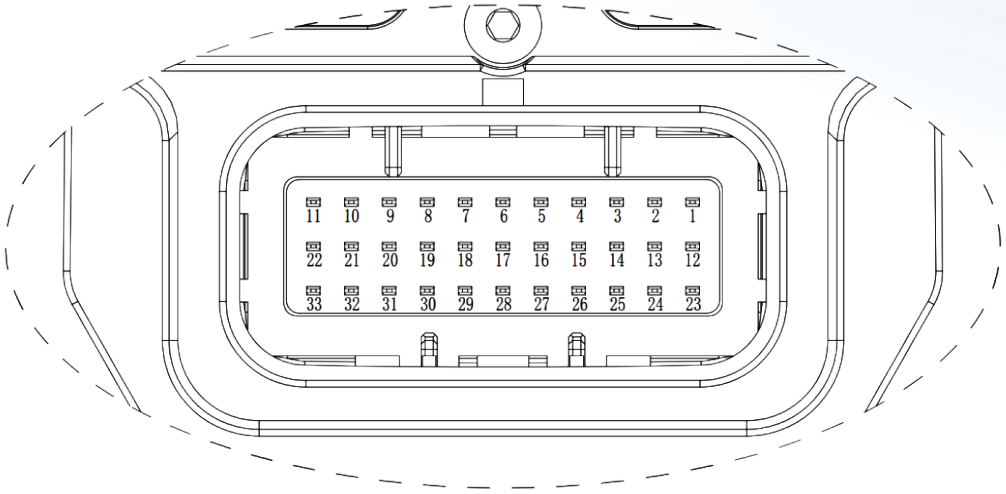
The power harness is connected to the controller's power terminal via the wiring terminal to ensure that the controller receives power from the battery, and to enable the controller to regulate the power output to the motor.

4.1 Electrical structure block diagram



4.2 Control port pin definition

The control port model is a 33-pin connector, which is designed to mate with the following connectors: TE Connectivity 1554461-1.

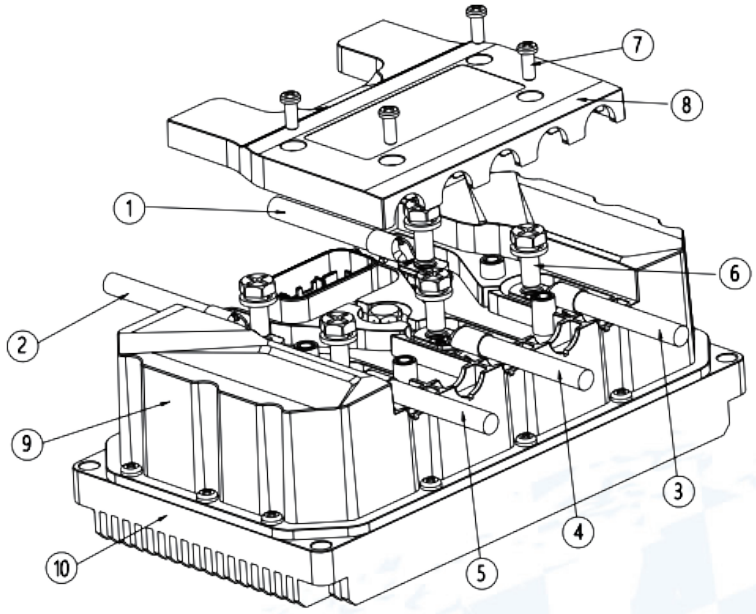


Pin no	Default pin function/function description	Multiplex pin function/function description
1	GMR Signal A	Optional multiplexed differential GMR A+ or HALL A
2	Encoder 5 V Power Supply	/
3	Differential GMR signal A–	Only when pin 1 is multiplexed to the differential GMR A+, A– signal is valid.
4	CANH	The functionality of RS485A can be reused
5	12VEDC	Connected to the relay's positive terminal, which serves as the freewheel
6	DI1	Active low, input 0 to 0.2 V
7	DI2	Active low, input 0 to 0.2 V
8	DI3	Active low, input 0 to 0.2 V
9	DI4	Active low, input 0 to 0.2 V
10	Wheel motion signal	Output Signal
11	ACC	1.Non–isolated version: Key lock, connected to the bus positive terminal 2.Isolated version: Key lock, connected to 12V power supply
12	Differential GMR signal B	Optional multiplexed differential GMR B+ or HALL B
13	TM	KTY84、10K NTC、PT1000 Motor temperature detection, supports KTY83, KTY84, 10K NTC, PT1000

14	Differential GMR signal B–	Only when pin 12 is multiplexed to the differential GMR B+, B– signal is valid.
15	CANL	Multiplexed RS485B
16	GND	Ground
17	DI5	Active low, input 0 to 0.2 V
18	SWD_DIO	Debugging port
19	SWD_CLK	Debugging port
20	DI6	Active low, input 0 to 0.2 V
21	DI7	1.High effective, input 9V to 16 V; 2.Multiplexed DI, active low;
22	UART_TX	1.Multiplexed DO, external Bluetooth TX; 2.Multiplexed DI, active low;
23	GMR Signal Z	Optional multiplexed Z+ or HALL C
24	GND	/
25	Differential GMR signal Z–	Only when pin 23 is multiplexed to the differential GMR Z+, Z– signal is valid.
26	PWM	Magnetic coding PWM
27	Relay negative terminal	OD output, drives relay
28	GND	/
29	Throttle signal 2	AI
30	Throttle signal 1	AI
31	5 V	Throttle power supply
32	Brake	High effective, input 9 V to 16 V;
33	UART_RX	Multiplexed DI, external Bluetooth RX;

4.3 Power terminal wiring definition

The power cable termination definition is illustrated below:



Seq. No.	Terminal wiring	Material	Qty	Mouting torque(N·m)
1	SC25-6 terminal at negative of power source		1	5.5 ~ 6.2
2	SC25-6 terminal at positive of power source		1	5.5 ~ 6.2
3	SC25-6 terminal at U phase line		1	5.5 ~ 6.2
4	SC25-6 terminal at V phase line		1	5.5 ~ 6.2
5	SC25-6 terminal at W phase line		1	5.5 ~ 6.2
6	Terminal fixing screws	35K carbon steel color	5	Triple combination outer hexagonal inner cross M6*12
7	Plastic cover plate locking screws PA4*8	Carbon steel + nickel plating	2	
8	Plastic cover plate	PC-945A/UL-VO	1	
9	Plastic face housing	PC-945A/UL-VO	1	
10	Aluminum bottom housing	AL6063	1	

5 Product Environmental Adaptation Specifications

5.1 Ambient temperature range

Operating ambient temperature range: –25˚C~60˚C

Ambient temperature range for long–term storage: –10˚C~40˚C

Temperature range for storage environment adaptability: –40˚C~85˚C

5.2 Product environment adaptation

Seq. No.	Test items	Test conditions/requirements
1	Low–temp. storage test	The controller is placed in a temperature control box at –40 ℃ for 24 h and can work well at room temperature again.
2	High–temp. storage test	The controller is placed in a temperature control box at 85 ℃ for 48 h and can work well at room temperature again.
3	Constant temperature and humidity test	A constant humid heat test is performed at a temperature of 40 ˚C ± 2 ˚C and relative humidity of 93 % ± 5 % for a period of 48 hourshout significant appearance abnormalities.
4	Vibration test	Sweep frequency vibration: Frequency: 10 ~ 25 Hz; double amplitude of 1.2 mm; frequency of 25 ~ 500 Hz, acceleration of 30 m/s^2. 3 direction: X, Y, and Z, vibration time per direction: 8h. Random vibration: X, Y, and Z directions, vibration time per direction: 8h. After test, no deformation, breakdown (crack) on the shell, and unsecured components and set screws are allowed. The controller shall work well during and after test.

6 Product Packing

6.1 Controller assembly precautions

1) The mounting area must be level and free of foreign objects, burrs and welding residue, etc.

2) The heat dissipation surface must have good air circulation to improve the cooling efficiency of the controller, thereby maximizing its operation performance.

3) Carefully check that the assembled cables do not interfere with the motorcycle to avoid cable wear and short circuits that could cause malfunctions.

4) The controller is secured with bolts (M6 bolts are recommended) at the locking torque of 3.5 N·m ~ 4.5 N·m.

5) The connector mating cycle shall be less than 20 times within the life cycle of the controller; If not, it will increase the contact resistance, which may subsequently result in excessive temperature rise.

6) The power terminals of the controller are secured with screws with appropriate torque to ensure that the terminals are properly tightened. Failure to do so may result in poor electrical contact, which may lead to overheating.

7) The control terminals of the controller must be inserted firmly into the controller sockets, making sure that they are fully inserted in place. Failure to do so may result in loose connections.

6.2 Harness assembly precautions

1) The wiring harness uses different colored wires and tamper-proof connectors to prevent incorrect wiring. Incorrect wiring can cause the controller to malfunction.

2) High-temperature wires must not be bundled with non-high-temperature wires to prevent damage to the insulation layer which could result in short circuits.

3) Ensure proper battery wiring to prevent reverse polarity connections or incorrect connection of battery wires to phase wires.

4) Ensure proper motor wiring to prevent the phase lines from short circuits or open circuits.

5) Ensure that proper controller wiring procedures are followed, with phase lines and power wires connected according to specified instructions. Failure to do so may result in motor.

6) At the end of harness assembly, it is necessary to install silicone dust plugs on the controller.

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