

# **Kelly KEB Brushless Motor Controller User's Manual**

## **Devices Supported:**

**KEB48220 KEB48221**  
**KEB48300 KEB48301**  
**KEB48400 KEB48401**  
**KEB48600 KEB48601**  
**KEB72330 KEB72331**  
**KEB72450 KEB72451**  
**KEB72600 KEB72601**  
**KEB72800 KEB72801X**

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# Chapter 1 Introduction

## 1.1 Overview

The manual introduces Kelly ebike brushless DC motor controllers' features, installation and maintenance. Read the manual carefully and thoroughly before using the controller. If you have any questions, please contact the support center of Kelly Controls, LLC.

Kelly's programmable KEB motor controllers provide efficient, smooth and quite controls for electric bicycle, electric motorcycle, scooter, etc. It outputs high taking off current, and strictly limit battery current. It can work with relative small battery, but provide good acceleration and hill climbing. It uses high power MOSFET, PWM to achieve efficiency 99%.

In most cases, Powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to set parameters, conduct tests, and obtain diagnostic information quickly and easily.

## Chapter 2 Main Features and Specifications

### 2.1 General functions

- (1) Extended fault detection and protection. LED flashing code indicates fault sources.
- (2) Monitoring battery voltage. It will stop driving if battery voltage is too high. It will cut back then stop driving if voltage is going too low.
- (3) Built-in current loop and over current protection.
- (4) Motor temperature input and protection. Configurable range.
- (5) Cutting back current at low temperature and high temperature to protect battery and controller. The current will ramp down quickly if controller temperature is higher than 90°C, and shut down at 100°C. Low temperature current ramping down usually starts at 0°C.
- (6) The controller keeps monitoring voltage during regen. It will cut back current or stop regen if voltage is too high.
- (7) Configurable to limit max reverse speed to half of max forward speed
- (8) Configurable and programmable with RS-232. Software upgradeable. Windows GUI provided.
- (9) Provide power supply (5V) for hall sensors and other sensors.
- (10) 3 switch inputs: Default to throttle switch, brake switch and reverse switch. Closing to ground is to activate.
- (11) 3 analog inputs, 0-5V: Default to throttle input, brake input and motor temperature input.
- (12) Configurable boost switch. Output can arrive at the maximum current if the switch is enabled and turned on.
- (13) Configurable turbo switch. Limit max power to half if the switch is enabled and turned on.
- (14) Configurable max reverse power to half.
- (15) Enhanced regen brake function. Novel ABS technique provides powerful and smooth regen.
- (16) Configurable 12V brake signal input, instead of motor temperature sensor.
- (17) Optional joystick throttle. Single 0-5V signal for both forwarding and reversing.
- (18) Thermal overload detection and protection to safeguard the motor from over temperature, with recommended Silicon temperature sensors KTY83-122 .
- (19) 3 hall position sensor inputs. Open collector, pull up provided.
- (20) Optional supply voltage 8V-30V.

**Caution!** Regeneration has braking effect, but can't replace mechanical brake. Mechanical brake is required to stop your vehicle. Regen isn't a safety feature! Controller may stop regen to protect itself (not you!).

## 2.2 Features

- Specially designed for electric bicycle and scooter.
  - Intelligence with powerful microprocessor.
  - Synchronous rectification, ultra low drop, fast PWM to achieve very high efficiency.
  - Electronic reversing.
  - Voltage monitoring on 3 motor phases, bus, and power supply.
  - Voltage monitoring on voltage source 12V and 5V.
  - Current sense on all 3 motor phases.
  - Current control loop.
  - Hardware over current protection.
  - Hardware over voltage protection.
  - Support torque mode, speed mode, and balanced mode operation.
  - Configurable limit for motor current and battery current.
  - Battery current limiting available, doesn't affect taking off performance.
  - More startup current ,can get more startup speed.
  - Low EMC.
  - LED fault code.
  - Battery protection: current cutback, warning and shutdown at configurable high and low battery voltage.
  - Rugged aluminum housing for maximum heat dissipation and harsh environment.
  - Rugged high current terminals, and rugged aviation connectors for small signal.
  - Thermal protection: current cut back, warning and shutdown on high temperature.
  - Configurable 60 degree or 120 degree hall position sensors.
  - Support motors with any number of poles.
  - Up to 40,000 electric RPM standard. Optional high speed 70,000 ERPM and ultra high speed 100,000ERPM (Electric RPM = mechanical RPM \* motor pole pairs).
  - Brake switch is used to start regen.
  - 0-5V brake signal is used to command regen current.
  - Support three modes of regenerative braking: brake switch regen, release throttle regen, 0-5V analog signal variable regen.
  - Configurable high pedal protection: Disable operation if power up with high throttle.
  - Current multiplication: Take less current from battery, output more current to motor.
  - Easy installation: 3-wire potentiometer will work.
- Current meter output.
- Standard PC/Laptop computer to do programming. No special tools needed.
  - User program provided. Easy to use. No cost to customers.

## 2.3 Specifications

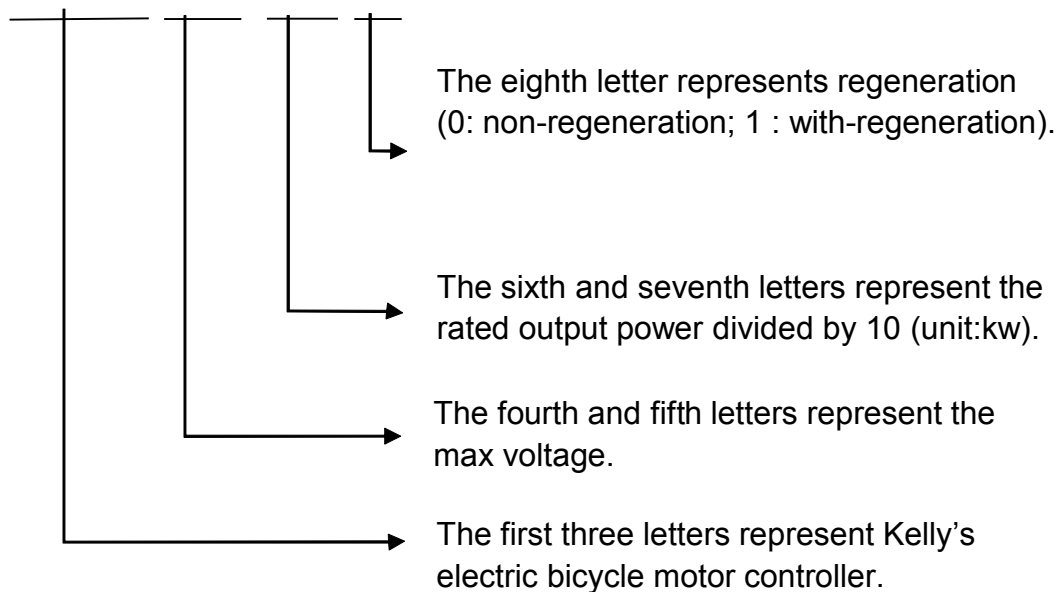
- Frequency of Operation: 16.6kHz.
- Standby Battery Current: < 0.5mA.
- 5V Sensor Supply Current: 40mA.
- Controller supply voltage range, PWR, 18V to 90V.

- Supply Current, PWR, 150mA.
- Configurable battery voltage range, B+. Max operating range: 18V to 1.25\*Nominal.
- Standard Throttle Input: 0-5 Volts(3-wire resistive pot), 1-4 Volts(hall active throttle).
- Analog Brake and Throttle Input: 0-5 Volts. Producing 0-5V signal with 3-wire pot.
- Full Power Operating Temperature Range: 0°C to 50°C (controller case temperature).
- Operating Temperature Range: -30°C to 90°C, 100°C shutdown (controller case temperature).
- Peak Phase Current, 30 seconds: 100-350A, depending on the model.
- Continuous Phase Current Limit: 50A-150A, depending on the model.
- Maximum Battery Current: Configurable

## 2.4 Models

The naming regulations of the Kelly KEB motor controller model:

**KEB72 330**



# Chapter 3 Wiring and Installation

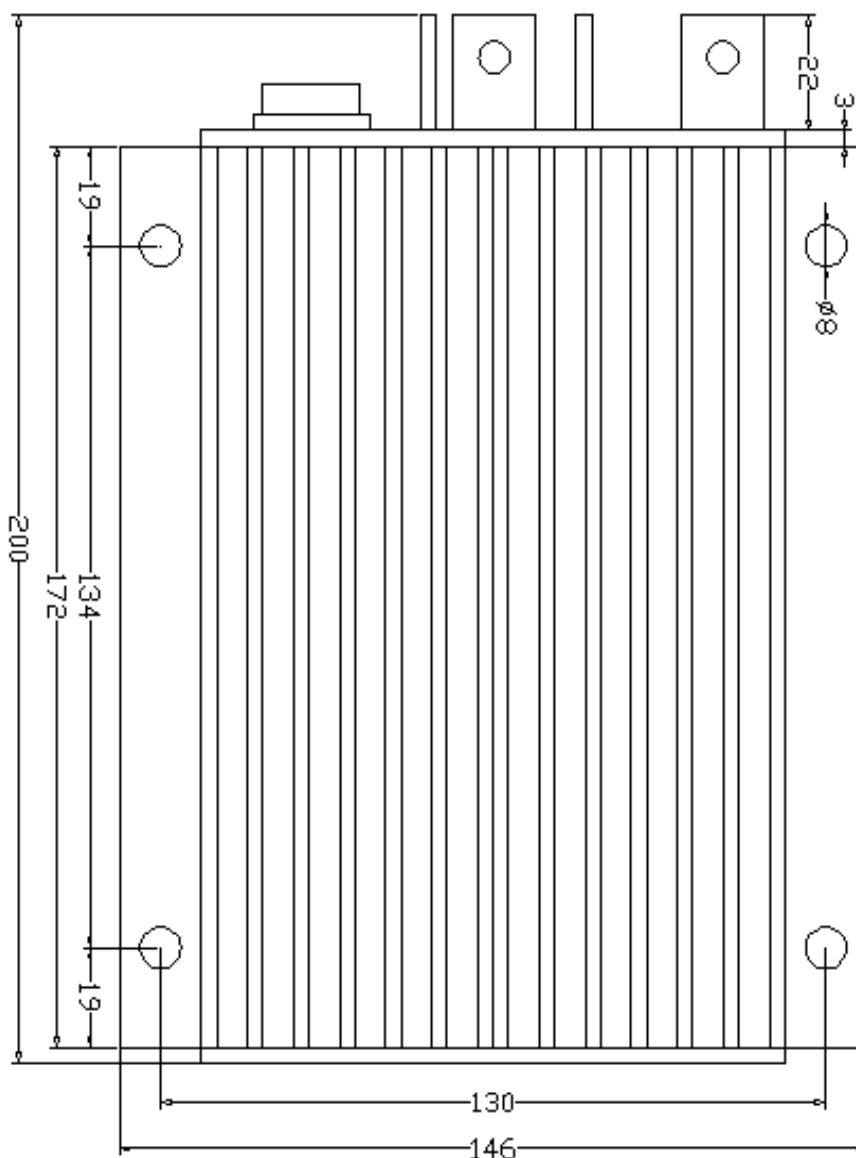
## 3.1 Mounting the Controller

The controller can be oriented in any position as clean and dry as possible, or shield with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with four screws. Applying silicon gel or other thermal conductive material to contact surface will enhance thermal performance.

Sufficient heat sink and airflow are required for high power application.

The case outline and mounting holes' dimensions are shown in Figure 1.



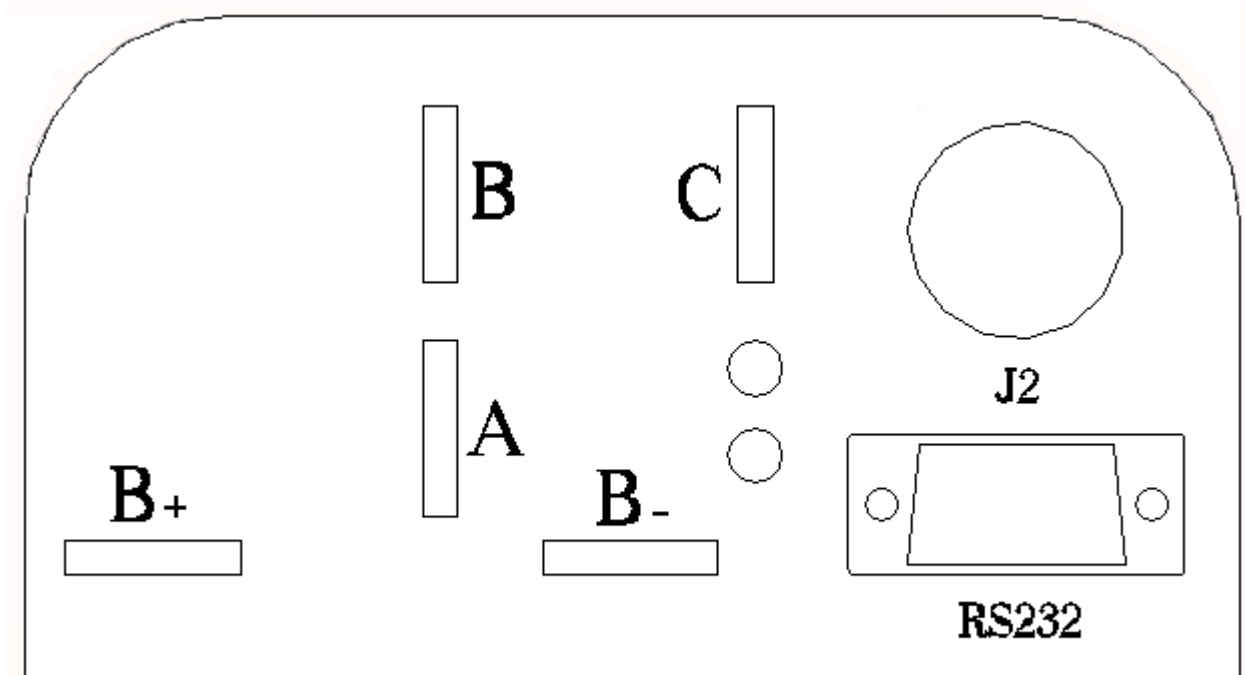
Height: 62 millimeters

**Figure 1:** mounting holes' dimensions (dimensions in millimeters)

### 3.2 Connections

#### 3.2.1 Front Panel of KEB Motor Controller:

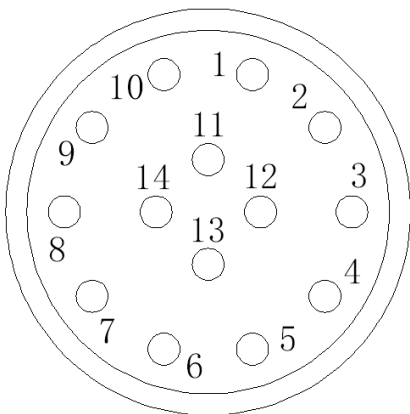
Five metal bars and a 14pin rugged connector are provided for connecting to the battery, motor and control signals in the front of the controller shown as Figure 2.



**Figure 2:** Front panel of KEB motor controller

- B+:** battery positive
- B-:** battery negative
- A:** Output U/1/A phase
- B:** Output V/2/B phase
- C:** Output W/3/C phase

**Figure 3:** The connecting diagram of J2



#### J2 Pin Definition

- 1- PWR:** Controller power supply
- 2- RTN:** Signal return, or power supply ground
- 3- RTN:** Signal return
- 4- Motor temperature Input or 12V brake input.**
- 5- Throttle analog input, 0-5V**
- 6- Brake analog input, 0-5V**
- 7- 5V:** 5V supply output, <40mA
- 8- Micro\_SW:** Throttle switch input.

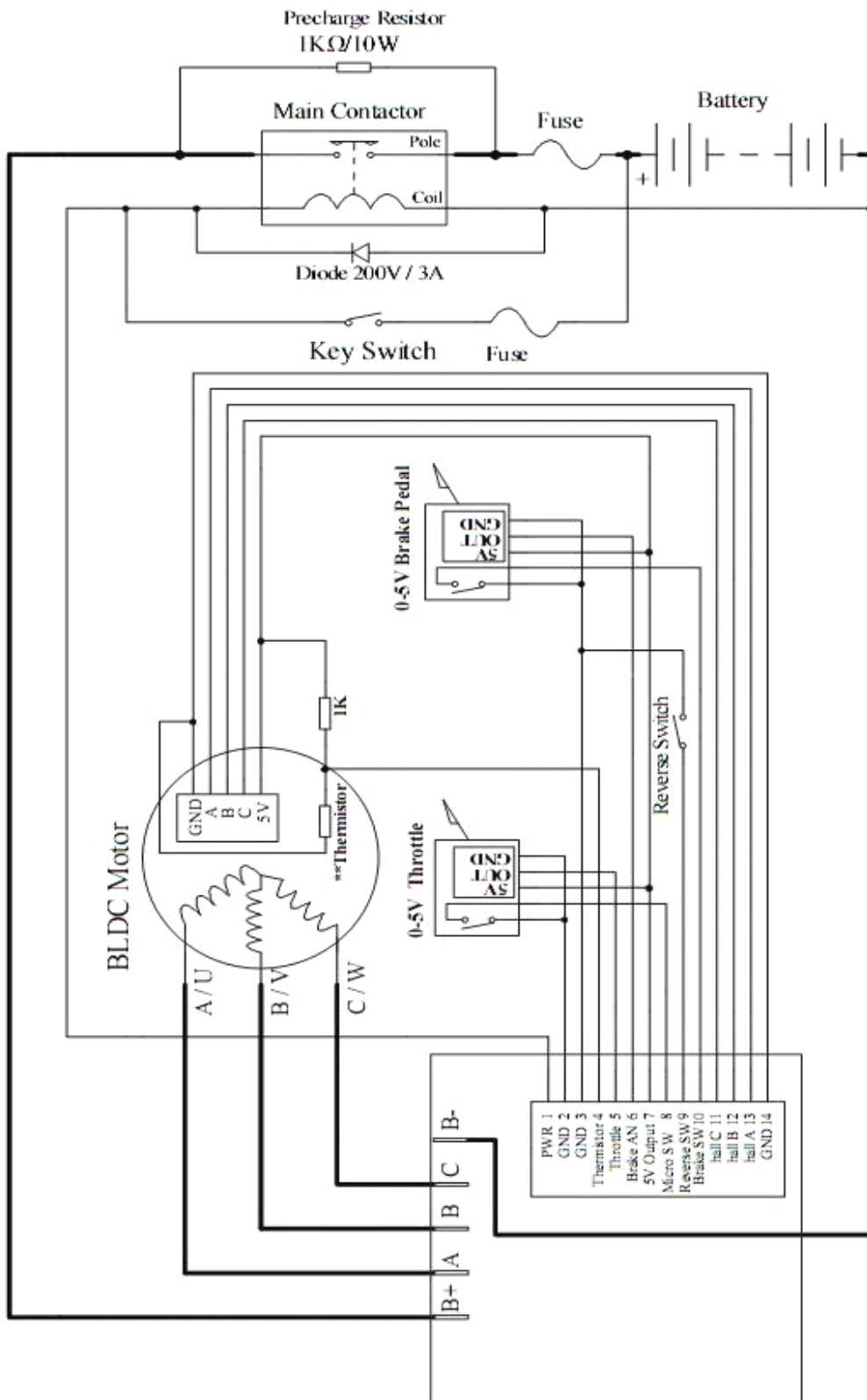
- 9- Reverse switch input
- 10- Brake switch input
- 11- Hall phase C
- 12- Hall phase B
- 13- Hall phase A
- 14- RTN: Signal return

**Notes:**

1. All RTN pins are internally connected. RTN is internally connected to B-.
2. Switch to ground is active. Open switch is inactive

**Caution: Make sure all connections are correct before applying power. Otherwise it may damage the controller! Please securely wire B- before applying power. It's preferred to place contactor or breaker on B+. Please place precharge resistor on any breaker! It can cause damage without it!!!**

3.2.2 Standard Wiring of KEB Motor Controller

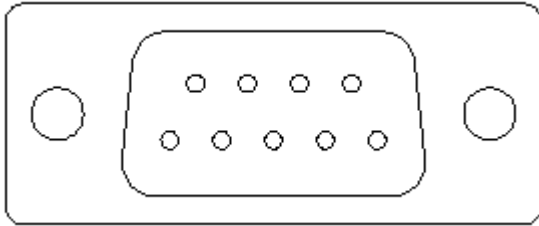


NOTE: Potentialmeter can be used to output 0-5V.  
 Please securely wire B- before any other wiring. Never put contactor or break on B-.  
 \*\* Thermistor is optional item. default to KTY83-122.

Figure 4: KEB controller standard wiring  
 (Battery voltage can be used for controller supply)

### 3.2.3 Communication Port

A RS232 port of controller is provided to communicate with host computer for calibration and configuration.



**Figure 5:** standard RS232 interface

## 3.3 Installation Check List

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference. The LED codes are listed in Table 1.

#### **Caution:**

- Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.
- Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.
- Make sure both the PWR switch and the brake are off
- Use well-insulated tools.

- Make sure the wire is connected correctly
- Turn the PWR switch on. The LED should blink, then keep on when the controller operates normally. If this does not happen, check continuity of the PWR and controller ground.
- The fault code will be detected automatically at restarting.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Please verify wiring and voltage if it doesn't operate. Also check fuse. The motor should run faster with increasing throttle. If not, refer to Table 1 LED code, and correct the fault according to the code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good top speed.

## Chapter 4 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller, or you will damage it. However, clearing the controller exterior periodically should be necessary.

The controller is inherently a high power device. When working with any battery powered vehicle, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, avoiding loose clothing and jewelry, and using insulated tools.

### 4.1 Cleaning

Although the controller requires virtually no maintenance after properly installation, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped down with a moist rag. Be sure it is dry before reconnecting the battery.
- Make sure the connections to the bus bars are tight. Use two wrenches for this task in order to avoid stressing the bus bars; the wrenches should be well insulated.

### 4.2 Configuration

You can configure the controller with a host computer through RS232.

- Use straight RS232 cable connecting the 9pin connector on face penal to a host computer  
Provide 18V to 90V to PWR. Wire power supply ground to any RTN pin.
- Do not connect B+, throttle and so on. The controller may display fault code, but it doesn't affect programming or configuration.

**Table 1: LED CODES**

LED Code	Explanation	Solution
Green Off	No power or not operating	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	Normal operation	That's great! You got solution!
Green and Red LED Keep On		1. Software is upgrading. 2. Supply voltage is too low or battery is too high. 3. The controller is damaged. Please contact Kelly for warrantee.

**Red LED Codes**

LED Code	Explanation	Solution
1,2    □    □□	Over voltage error	1. Battery voltage is higher than max operating voltage of the controller. Please check the battery voltage and configuration. 2. Over voltage at regeneration. Controller will cut back or stop regeneration. 3. Please note there could be 2% error with Overvoltage setting.
1,3    □    □□□	Low voltage error	1. The controller will attempt to clear the fault code automatically after 5 second if battery voltage returns to normal. 2. Check the battery voltage. 3. Charge battery if necessary.
1,4    □    □□□□	Over temperature warning	1. The controller temperature is over 90°C. The controller will cut back current in the case. Stop or reduce output to ensure the temperature fall. 2. Improve heat sink or airflow.
2,1    □□    □	Motor fails to start	1. Motor hasn't reached 25 electrical RPM after 2 seconds from starting. Most likely the hall or phase wiring problem.
2,2    □□    □□	Internal voltage fault	1. Check if the B+ and PWR voltage are correct, refer to B- or RTN. Could be PWR voltage low. 2. Please check load on 5V supply. Could be high load on 5V. Incorrect pot wiring can load it heavily. 3. The controller is damaged. Please contact Kelly for warrantee.
2,3    □□    □□□	Over temperature	1. When controller's temperature is over 100°C. it will stop driving in order to protect itself. 2. Stop driving and wait for temperature fall. The controller will restart if temperature drops below 80°C.

2,4	ⓂⓂ ⓂⓂⓂⓂ	Throttle error at power up	<ol style="list-style-type: none"> <li>1. The throttle signal is higher than configured dead zone at power-on</li> <li>2. The fault will disappear if restarts or releases throttle.</li> </ol>
3,1	ⓂⓂⓂ Ⓜ	Frequent reset	<ol style="list-style-type: none"> <li>1. The controller will stop driving after detecting too many resets.</li> <li>2. Mostly because of B- or return wiring. Use the heavier and cleaner return wires. For dual controllers, bond B- of both controllers together with heavy cable or copper strip.</li> <li>3. Could be over current protection. May set max current lower.</li> <li>4. Restarting will clear the error.</li> <li>5. Please contact Kelly if it happens repeatedly.</li> </ol>
3,2	ⓂⓂⓂ ⓂⓂ	Internal reset	Reset caused by over current, high battery voltage or low supply voltage. It is normal if occurs occasionally.
3,4	ⓂⓂⓂ ⓂⓂⓂⓂ	Throttle isn't zero when try to change direction	The controller won't change drive direction if throttle isn't zero. Also it won't change direction at high speed. The controller will wait throttle and speed close to zero before changing direction.
4,1	ⓂⓂⓂⓂ Ⓜ	Over voltage at startup or regeneration	The controller won't drive motor if detects overvoltage at power up. It will cut back regen current or stop regen at overvoltage. You may set max voltage threshold with GUI.
4, 2	ⓂⓂⓂⓂ ⓂⓂ	Hall sensor signal error	<ol style="list-style-type: none"> <li>1. Most likely caused by incorrect hall wiring (to wrong pin or loose wire).</li> <li>2. Intermittent or damaged hall sensor.</li> <li>3. Double check hall angle setting, 60 degree or 120 degree.</li> </ol>
4, 3	ⓂⓂⓂⓂ ⓂⓂⓂ	Motor over temperature	<ol style="list-style-type: none"> <li>1. The motor temperature is higher than configured max temperature. Controller will shut down and wait for motor temperature dropping.</li> <li>2. Change the temperature setting with configuration program.</li> </ol>
4, 4	ⓂⓂⓂⓂ ⓂⓂⓂⓂ	Motor locked rotor	When in locked rotor condition, the max output phase current of the motor will be limited to 90% of previous current. Once the locked rotor disappear, the fault codes will disappear and the max output phase current will return to normal.

The Red LED flashes once at power on, then keeps off for normal operation. "1, 2" means it flashed once, then flashes twice after 1 second. The time between two flashes is 0.5 second. The pause time between one error code and another error code is 2 second.

## Contact Us:

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