

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	KEB72801

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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) Controller temperature measurement and protection
- (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 5V sensor supply.
- (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.
- Current limit and torque control.
- Battery current limiting available, doesn't affect taking off performance.
- More startup current ,can get more startup speed.
- Low EMC.
- LED fault code helps users to debugging.
- Battery protection: current cut back, shutdown and warning at low battery.
- Rugged aluminum housing for maximum heat dissipation.
- Thermal protection: Current cutback at low temperature and high temperature to protect battery and controller.
- Compatible with 60-degree or 120-degree hall position sensor.
- Any number of poles supported.
- Up to 40000 electric RPM. (electric RPM = mechanical RPM * motor pole pairs)
- Brake switch is used to start regen.
- 0-5V brake signal is used to command regen current.
- Three modes of regen: brake switch regen, release throttle regen, 0-5V signal regen.
- High pedal protection: Disable operation if power up with non-zero throttle.
- Current multiplication: Take less current from battery, output more current to motor.
- Easy installation: 3-wire potentiometer will work.

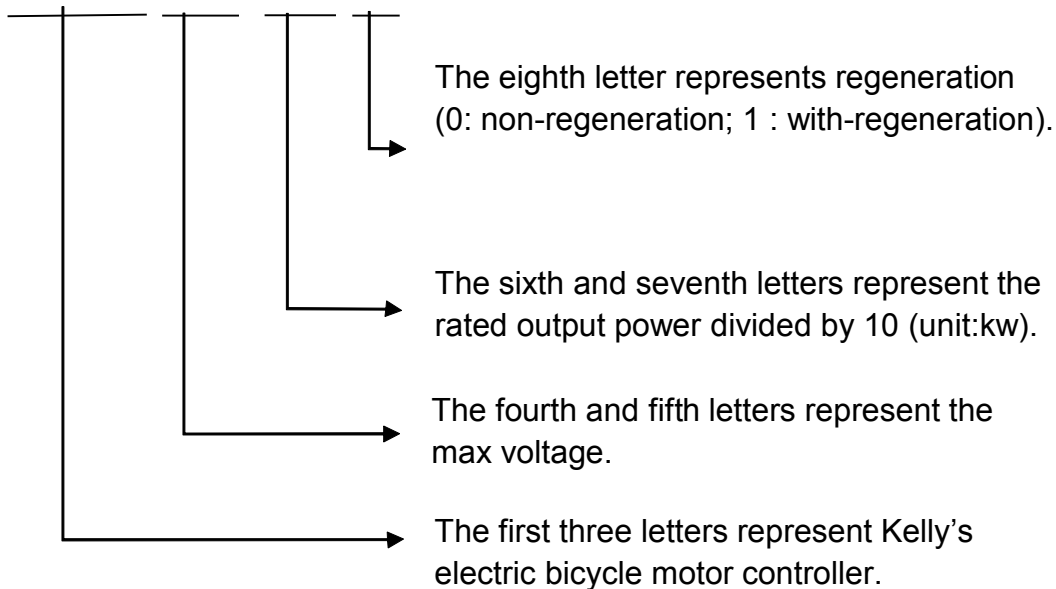
2.3 Specifications

- Frequency of Operation: 16.6kHz.
- Standby Battery Current: < 1mA.
- 5V Sensor Supply Current: 40mA.
- Supply Voltage, PWR, 18V to 90V.
- Supply Current, PWR, 150mA.
- Operating Voltage, B+, 18V to 1.25*Nominal.
- 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: 100-300A, depending on model.
- Continuous Phase Current Limit: 50A-150A, depending on 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

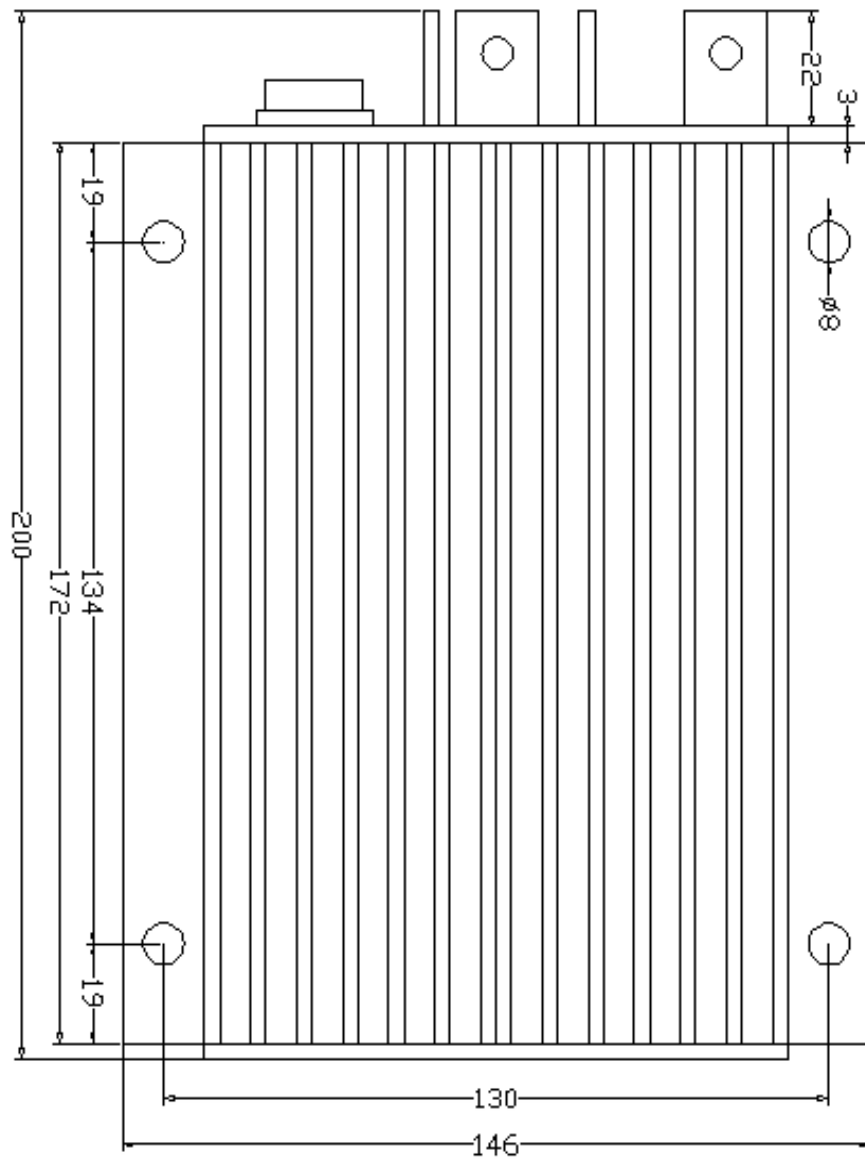
3.1 Mounting the Controller

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.

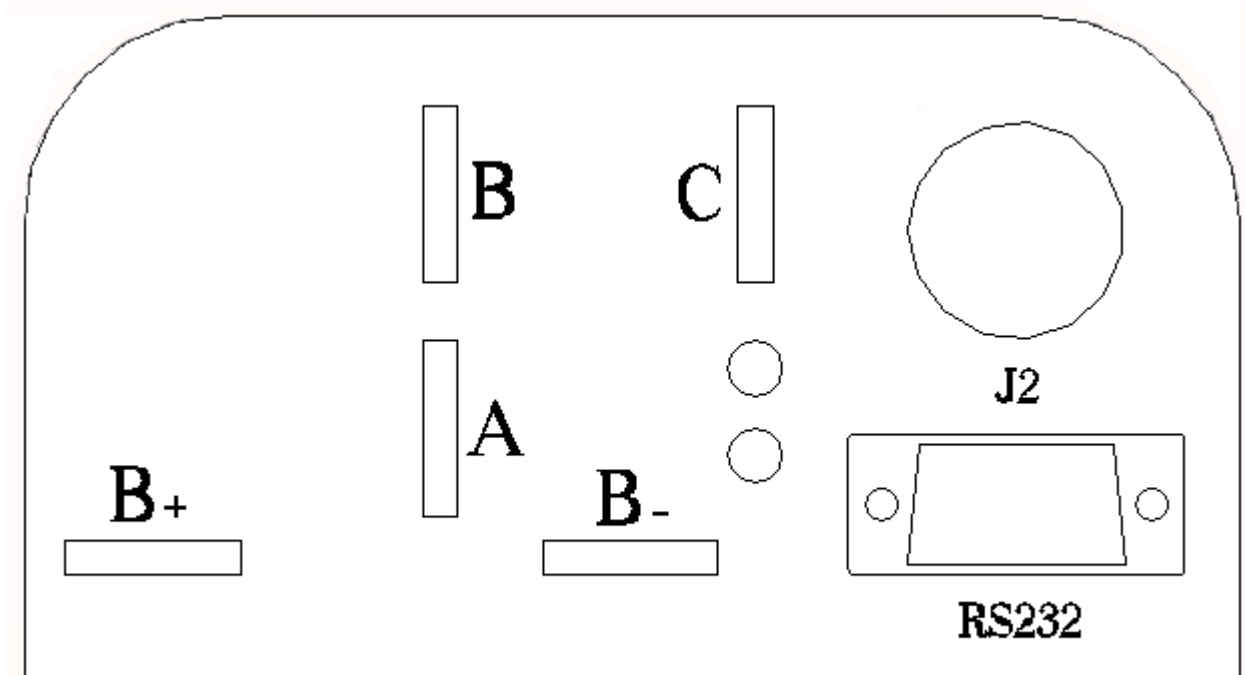
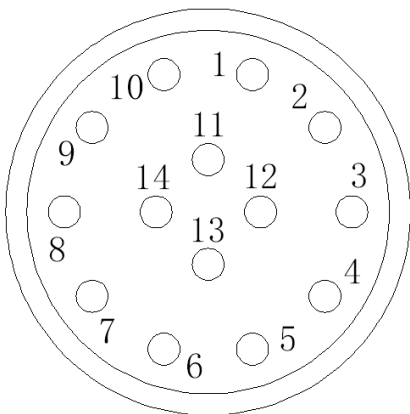


Figure 2: Front panel of KEB motor controller

- 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.

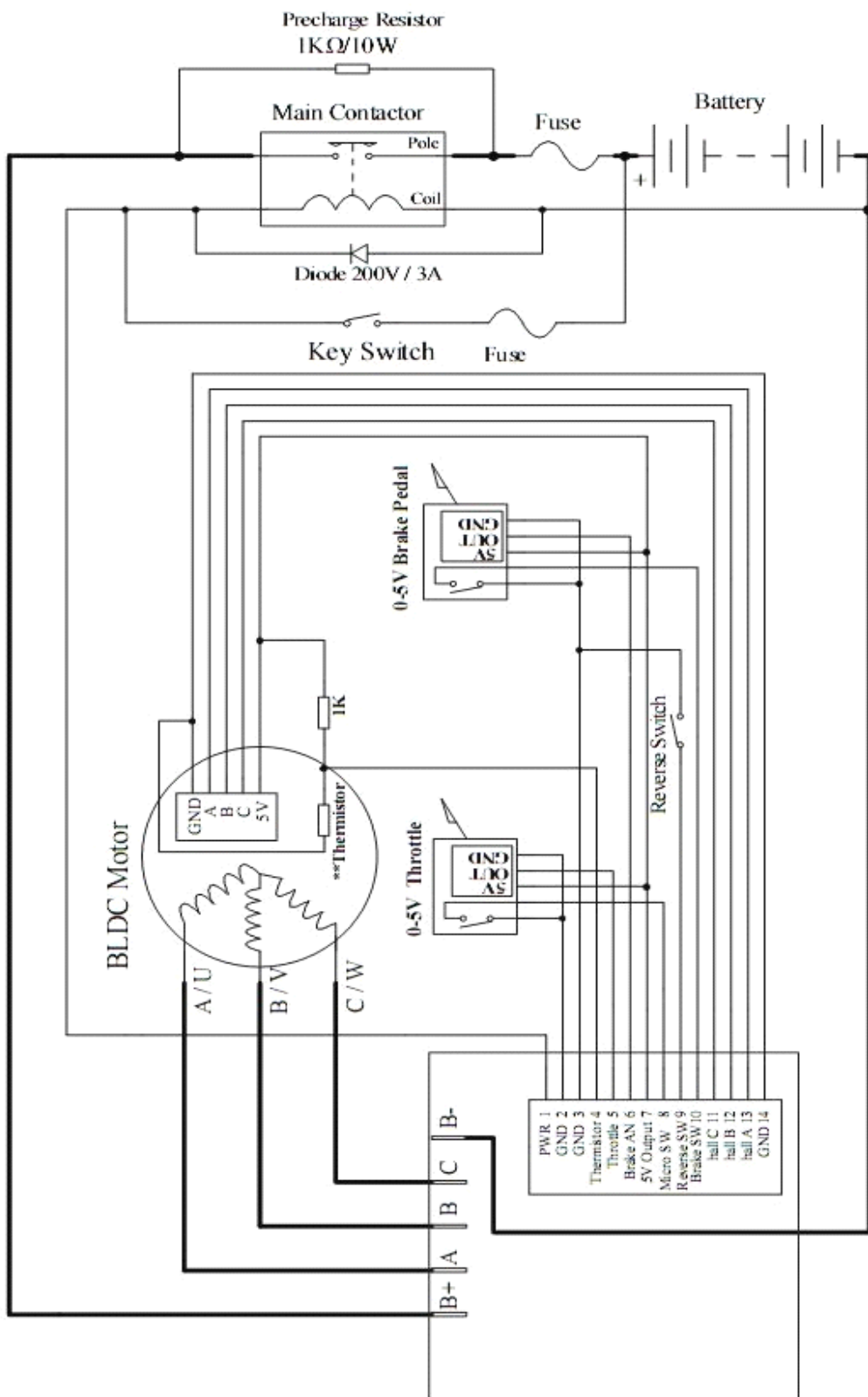
- 9- Reverse switch input
- 10- Brake switch input
- 11- Hall phase C
- 12- Hall phase B
- 13- Hall phase A
- 14- RTN: Signal return

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.

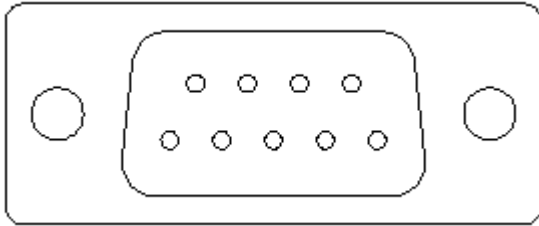


Figure 5: standard RS232 interface

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 panel 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"> 1. The throttle signal is higher than configured dead zone at power-on 2. The fault will disappear if restarts or releases throttle.
3,1	▣▣▣▣ ▣	Frequent reset	<ol style="list-style-type: none"> 1. The controller will stop driving after detecting too many resets. 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. 3. Could be over current protection. May set max current lower. 4. Restarting will clear the error. 5. Please contact Kelly if it happens repeatedly.
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"> 1. Most likely caused by incorrect hall wiring (to wrong pin or loose wire). 2. Intermittent or damaged hall sensor. 3. Double check hall angle setting, 60 degree or 120 degree.
4, 3	▣▣▣▣▣ ▣▣▣▣	Motor over temperature	<ol style="list-style-type: none"> 1. The motor temperature is higher than configured max temperature. Controller will shut down and wait for motor temperature dropping. 2. Change the temperature setting with configuration program.

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.

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