

Kelly KBL Brushless Motor Controller User's Manual

Devices Supported:

KBL24101	KBL36101
KBL24151	KBL36151
KBL24201	KBL36201
KBL24301	KBL36301
KBL48101	KBL72101
KBL48151	KBL72151
KBL48201	KBL72201
KBL48301	KBL72301
KBL48401B	KBL72401B
KBL48501B	KBL72501B
KBL48601B	KBL72601H
KBL12151H	KBL14151H
KBL12221H	KBL14251H
KBL12251H	
KBL12401H	

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Chapter 1 Introduction

1.1 Overview

The manual introduces Kelly BLDC motor controller features, installation and maintenance. Read the manual carefully and thoroughly before use the controller. Should you have any questions, please contact the support center of Kelly Controls, LLC.

Kelly's programmable motor controllers provide efficient, smooth and quiet controls for golf cart, go-cart, electric motorcycle, forklift, hybrid vehicle, electrical vehicle, electric boat, as well as industry motor speed or torque control. 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 Features and Specifications

2.1 General functions

- (1) Extended fault detection and protection. LED flashing for fault code.
- (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) Current cutback at low temperature and high temperature to protect battery and controller. The current will ramp down quickly if controller temperature is higher than 90C, and shutdown at 100C. Low temperature current ramping down usually starts at 0C.
- (6) The controller keeps monitoring voltage during regen. It will cut back current then cut off regen if voltage is going 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. Close to ground to activate. Default to throttle switch, brake switch and reverse switch.
- (11) 3 analog inputs, 0-5V. Default to throttle input, brake input and motor temperature input
- (12) Reverse alarm output. Recirculation diodes provided.
- (13) Main contactor driver. Cut off the power if any fault detected.
- (14) Current meter to display both drive and regen current. Save shunt!
- (15) Configurable boost switch. Output the maximum current achievable if the switch is enabled and turned on.
- (16) Configurable turbo switch. Limiting max power to half if the switch is enabled and turned on.
- (17) Configurable max reverse power to half.
- (18) Enhanced regen brake function. Novel ABS technique provides powerful and smooth regen.
- (19) Configurable 12V brake signal input, in lieu of motor temperature sensor.
- (20) Optional joystick throttle. Single 0-5V signal for both forward and reversing.
- (21) Motor over temperature detection and protection, with recommended thermistor.
- (22) 3 hall position sensor inputs. Open collector, pull up provided.
- (23) Optional CAN bus.
- (24) 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

- 1) Intelligence with powerful microprocessor.
- 2) Synchronous rectification, ultra low drop, fast PWM to achieve very high efficiency.
- 3) Current limit and torque control.
- 4) Battery current limiting available, doesn't affect taking off performance.
- 5) Low EMC.
- 6) LED fault code helps user debugging.
- 7) Battery protection: current cut back, shutdown and warning at high or low battery.
- 8) Thermal enhanced rugged aluminum housing. Rugged connectors.
- 9) Thermal protection: current cut back on low temperature and high temperature to protect battery and controller.
- 10) Configurable 60-degree or 120-degree hall position sensor.
- 11) Support any number of poles.
- 12) Up to 60000 electric RPM. (Electric RPM = mechanical RPM * motor poles)
- 13) Three modes of regen: brake switch regen, release throttle regen, 0-5V signal regen.
- 14) High pedal protection: Disable operation if power up with non-zero throttle.
- 15) Current multiplication: Take less current from battery, output more current to motor!
- 16) Easy installation: 3-wire potentiometer will work.

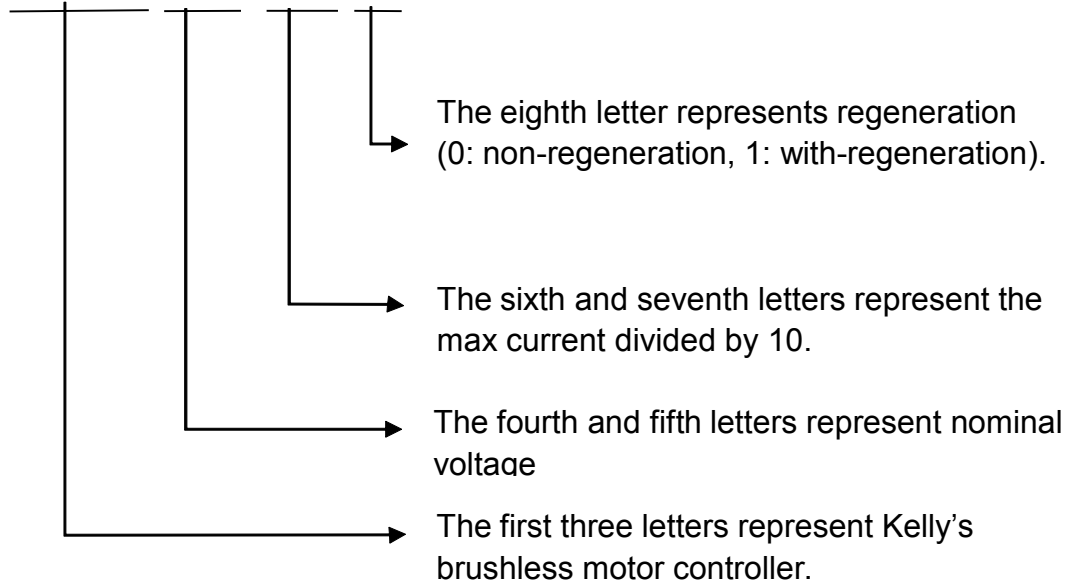
2.3 Specifications

- Frequency of Operation: 16.6kHz.
- Standby Battery Current: < 2mA.
- 5V Sensor Supply Current: 40mA.
- Supply Voltage, PWR, 18V to 90V.
- Supply Current, PWR, 150mA.
- Operating Voltage, B+, 18V to 1.25*Nominal Voltage.
- Analog Brake and Throttle Input: 0-5 Volts. Can use 3-wire pot to produce 0-5V signal.
- Reverse Alarm, Main Contactor Coil Driver, Meter: <200mA.
- Full Power Operating Temperature Range: 0C to 50C (controller case temperature).
- Operating Temperature Range: -30C to 90C, 100C shutdown (controller case temperature).
- Motor Current Limit, 1 minute: 100A / 150A / 200A / 300A, depending on model.
- Motor Current Limit, continuous: 50A / 75A / 100A / 150A, depending on model.
- Max Battery Current :Configurable.
- Supply Voltage, 8-30V for Controllers Rated Higher Than 72V.

2.4 Name Regulation

The name regulation of Kelly BLDC motor controllers:

KBL48101



Chapter 3 Wiring and Installation

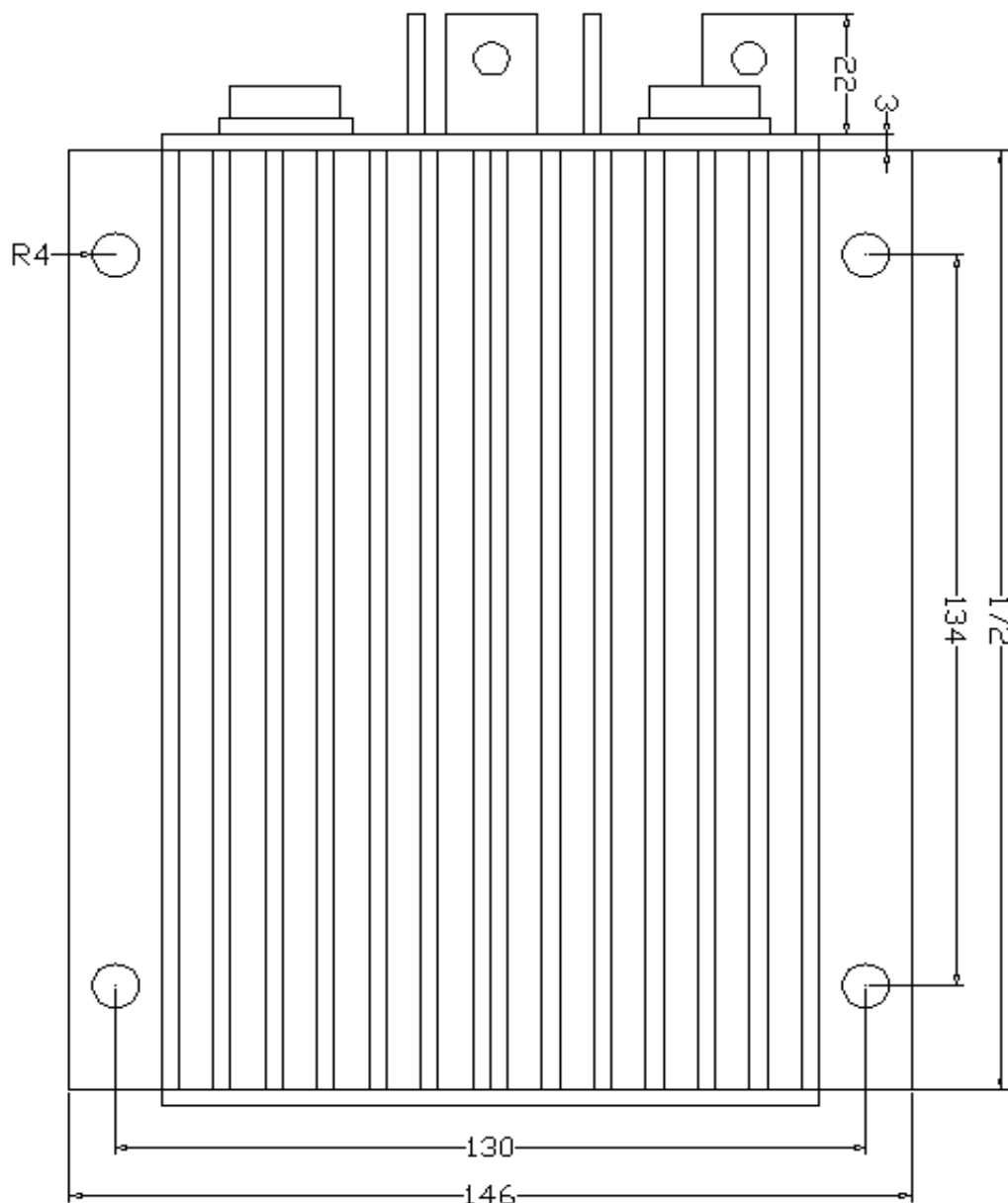
3.1 Mounting the Controller

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 hole dimensions are shown in Figure 1.



Tall: 62 millimeters

Figure 1: mounting hole dimensions (dimensions in millimeters)

3.2 Connections

3.2.1 Front Panel of BLDC Motor Controller:

Five metal bars and two plugs (J1, J2) are provided for connections to the battery, motor and control signals in the front of the controller shown as Figure 2.

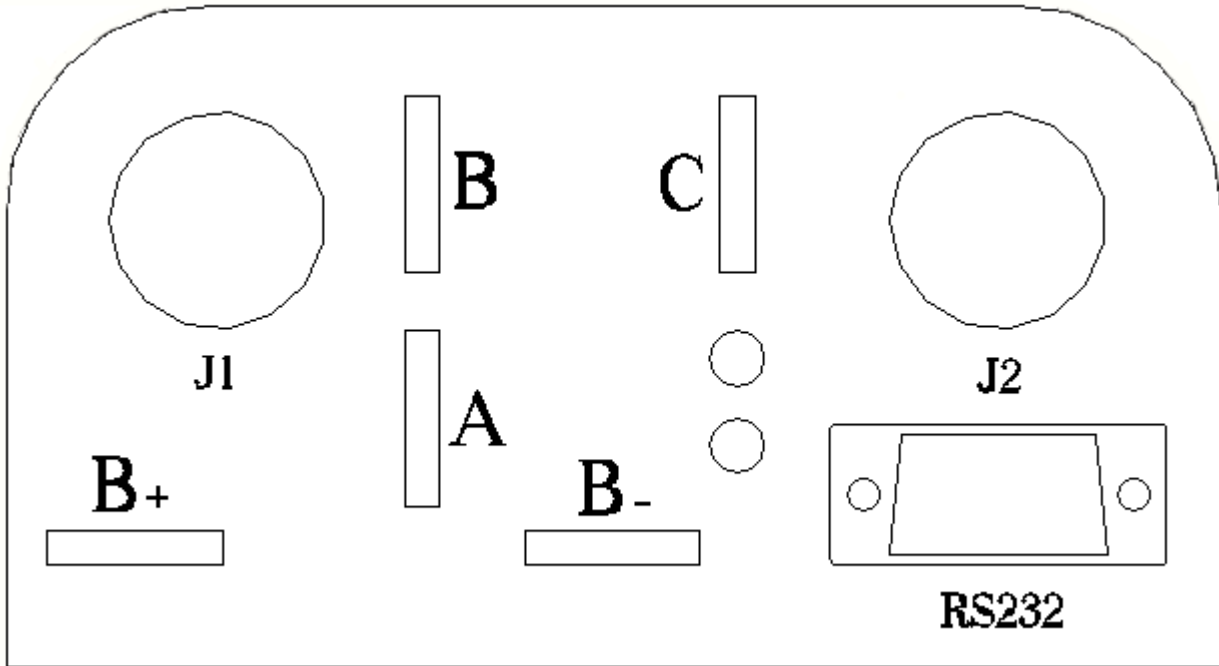


Figure 2: Front panel of BLDC motor controller

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

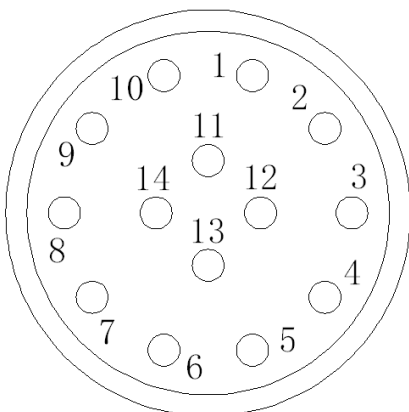


Figure 3: The connecting diagram of J1 and J2

J1 Pin Definition

- 1- **PWR:** Controller power supply (output). The pin is Red LED for S/N less :08XXXXXX.
- 2- **Current meter.** <200mA
- 3- **Main contactor driver.** <200mA
- 4- **Alarm:** To drive reverse beeper. <200mA
- 5- **RTN:** Signal return
- 6- **Green LED:** Running indication
- 7- **RTN:** Signal return
- 8- **RS232 receiver**
- 9- **RS232 transmitter**

- 10- CAN bus high
- 11- CAN bus low
- 12- Reserved
- 13- RTN: Signal return, or power supply return
- 14- Red LED: Fault code. The pin is PWR for S/N less :08XXXXXX.

J2 Pin Definition

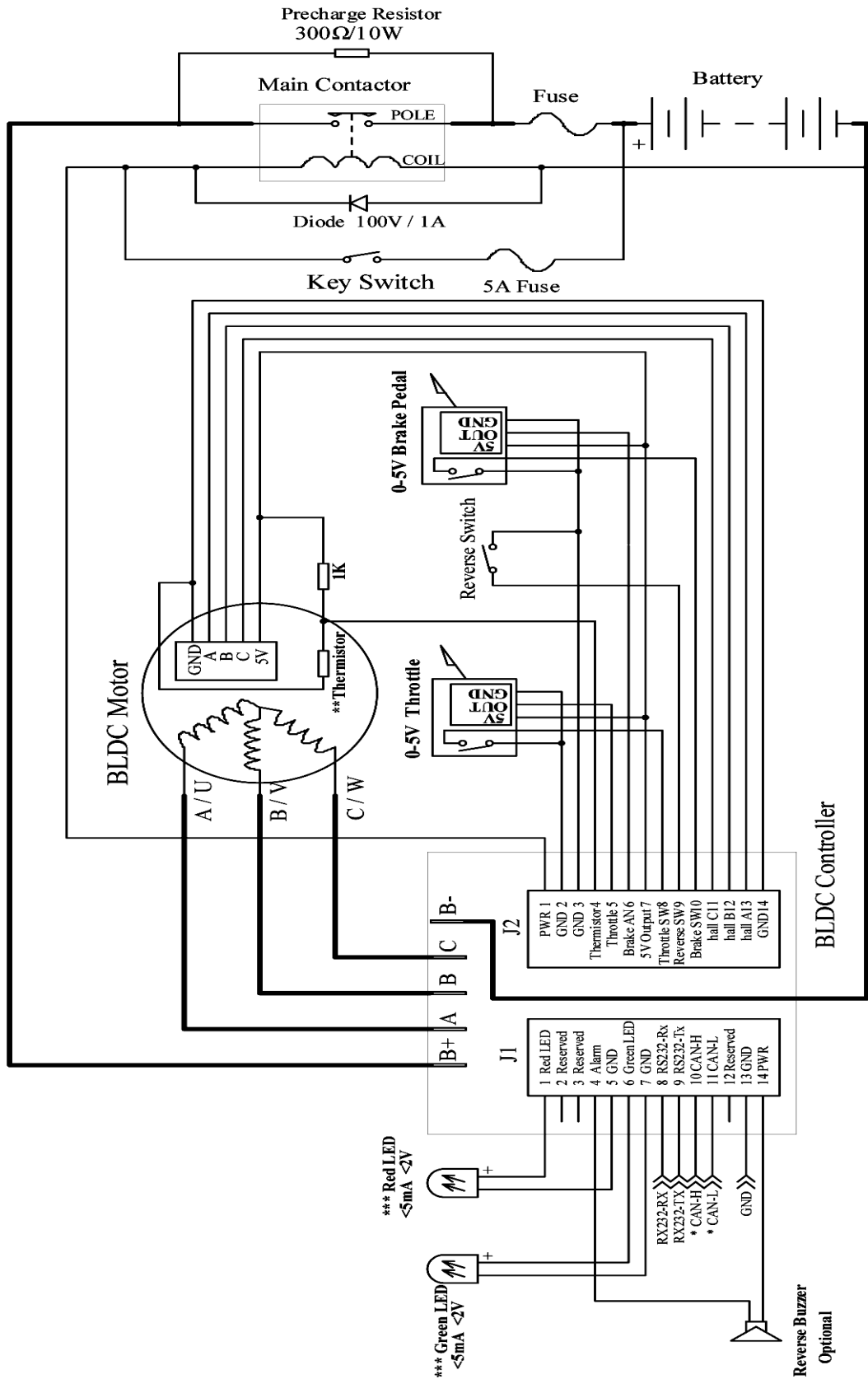
- 1- PWR: Controller power supply (input)
- 2- RTN: Signal return, or power supply return
- 3- RTN: Signal return
- 4- Motor temperature input.
- 5- Throttle analog input, 0-5V
- 6- Brake analog input, 0-5V
- 7- 5V: 5V supply output. <40mA
- 8- Throttle switch input
- 9- Reverse switch input
- 10- Brake 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. Two PWR pins, J1-14 and J2-1, are internally connected. It's recommended to use J1-14 to supply peripherals. Twist peripheral wires with PWR is the best for EMC. Recirculation diodes are provided in the controller for main contactor coil, alarm and meter drivers.
3. Switch to return is active. Open switch is inactive

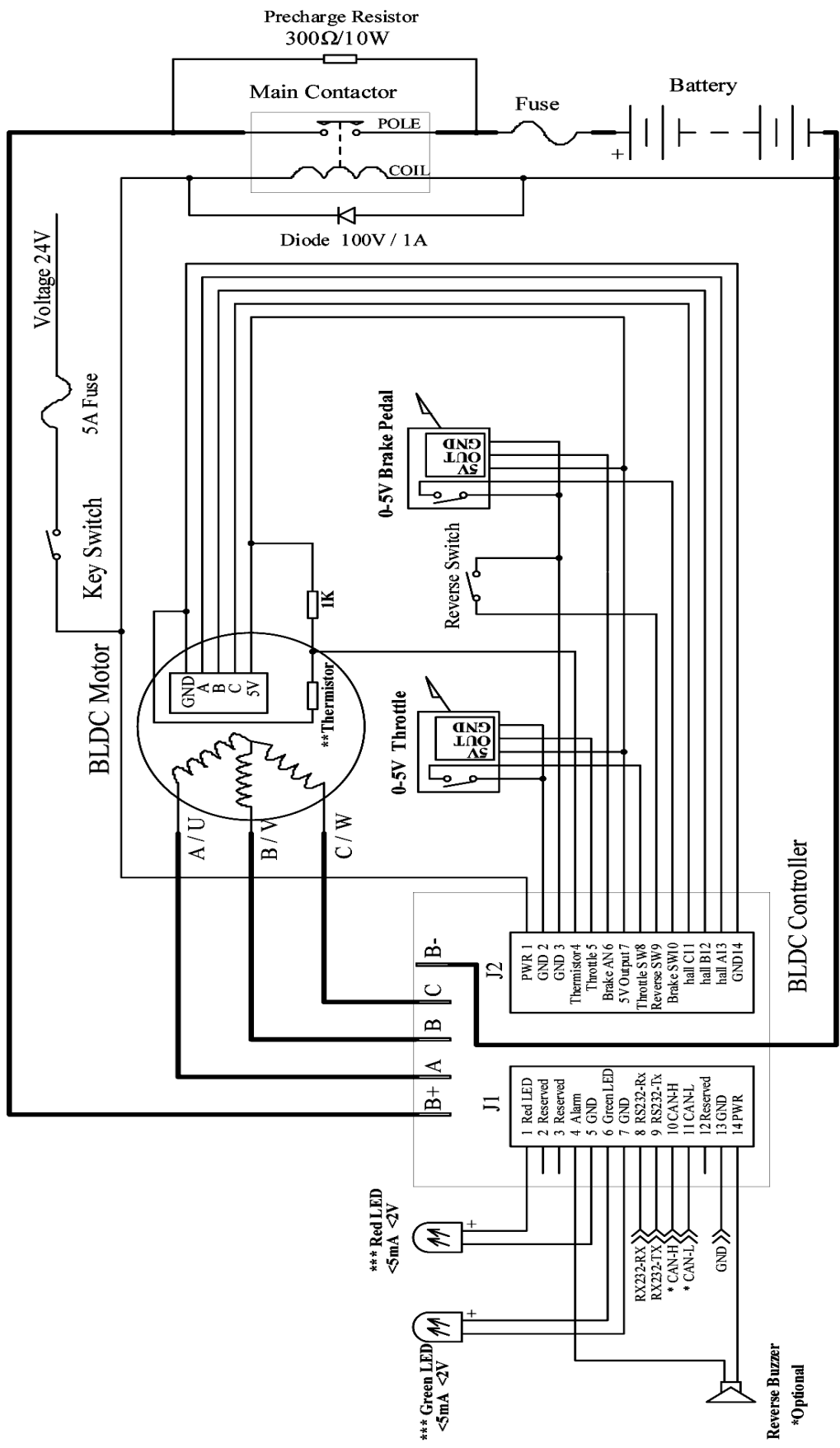
Caution: Make sure all connections are correct before apply power. Otherwise it may damage the controller! Please securely wire B- before applying power. It's preferred to place contactor or breaker on B+. Don't connect GND to B-. Please place precharge resistor on any breaker! It can cause damage without it!!!

3.2.2 Wiring of BLDC 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-. Don't connect GND to B-.
 * CAN bus is deprecated by default.
 ** Thermistor is optional item. default to KTY83-122.
 *** When you connect an external LED, the LED front panel brightness will be reduced.

Figure 4: Standard Wiring for Controllers Rated Equal or Lower Than 72V.



NOTE: Potentialmeter can be used to output 0-5V
 Please securely wire B- before any other wiring. Never put contactor or break on B-. Don't connect GND to B-.
 * CAN bus is depopulated by default.
 ** Thermistor is optional item. default to KIT83-122.
 *** When you connect an external LED, the LED front panel brightness will be reduced.

Figure 5: BLDC controller preferred wiring (24V supply is preferred)

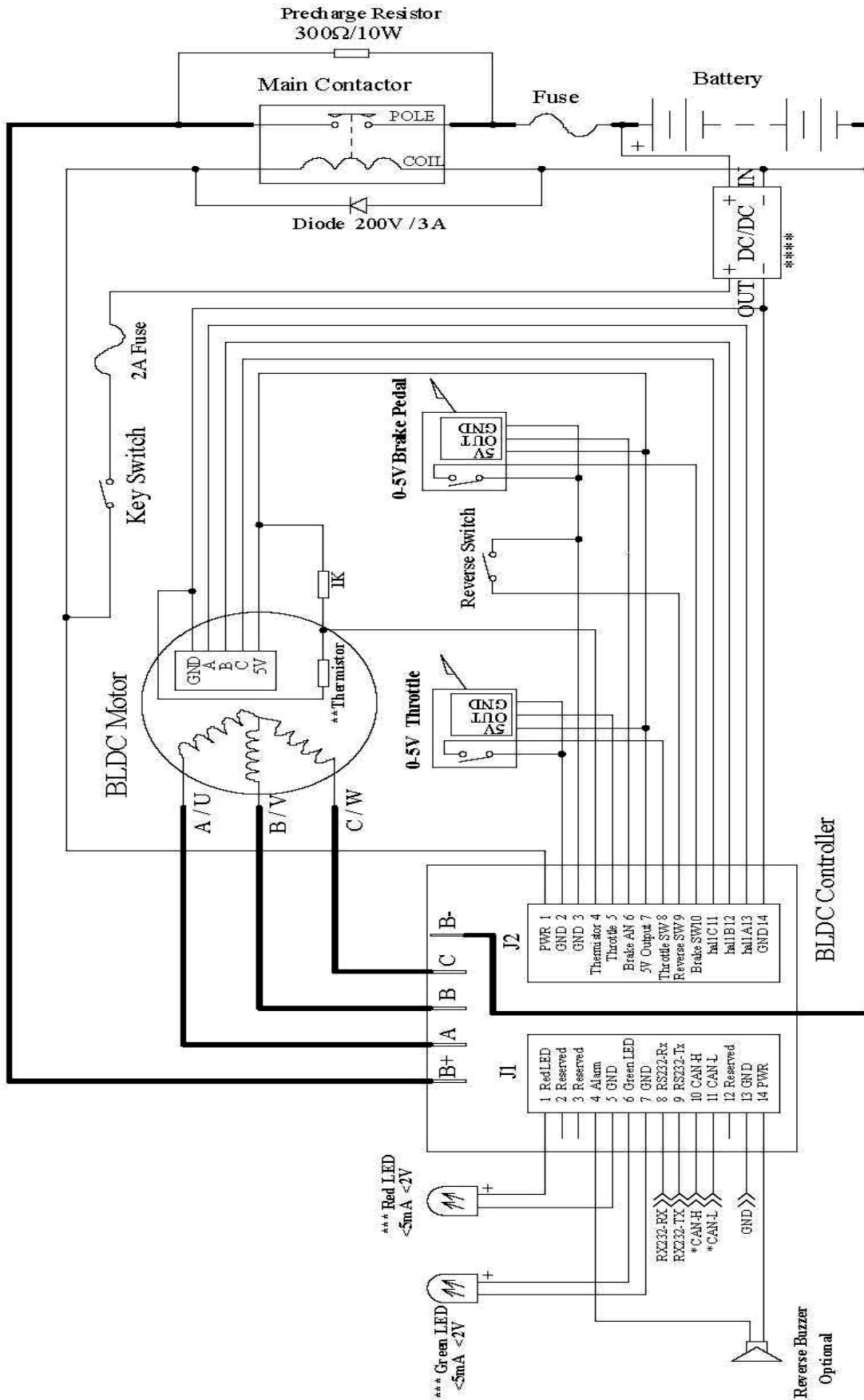


Figure 6: Standard Wiring for Controllers Rated Higher Than 72V (12V or 24V supply is required)

NOTE: Potentialmeter can be used to output 0-5V
 Please securely wire B- before any other wiring. Never put contactor or breaker on B-. Don't connect GND to B-.
 * CAN bus is deprecated by default.
 ** Thermistor is optional item. default to KTY83-122.
 *** When you connect an external LED, the LED front panel brightness will be reduced.

3.2.3 Communication Port

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

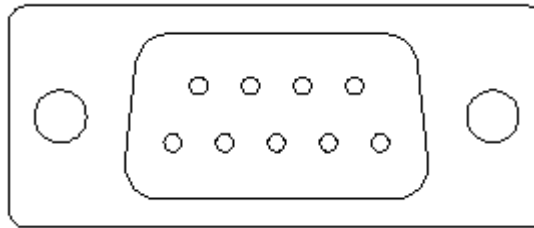


Figure 6: RS232 Interface

3.3 Installation Check List

Before operating the vehicle, complete the following checkout procedure. Use LED code as a reference. 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 the PWR switch and the brake is off
- Use well-insulated tools.

- Make sure the wire is connected correctly
- Turn the PWR switch on. The LED should blink, then keeps on when the controller operates normally. If this does not happen, check continuity of the PWR and return.
- The fault code will be detected automatically at restart.
- 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. 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 power.

Chapter 4 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller. Or will void warranty. However, cleaning 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, starting with battery positive.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil, resistor 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 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 or USB port.

- Use straight through RS232 cable or USB converter provide by Kelly to connect the D9 connector to a host computer. Provide >18V (either J2 pin1 or J1 pin14) to PWR. Wire power supply return 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

Green 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 too low or battery 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.
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. The controller temperature is over 100°C. Controller stops driving in the case. 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 restart or release throttle.
3,1	ⓂⓂⓂ Ⓜ	Frequent reset	<ol style="list-style-type: none"> 1. The controller will stop driving after detect too many resets. 2. Mostly because of B- or return wiring. Use heavier and clean 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. Restart 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 change direction.
4,1	ⓂⓂⓂⓂ Ⓜ	Over voltage at startup or regeneration	The controller won't drive motor if detect 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 higher than configured max temperature. Controller will shutdown and wait for motor temperature drops. 2. Can change the temperature setting with configuration program.
<p>The LED flashes once at power on, then keeps on 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.</p>			

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