Kelly KDHA High Voltage Series/PM Motor Controller User's Manual

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KDH12401A
KDH12500A
KDH12501A
KDH14300A
KDH14301A
KDH14450A
KDH14451A

Rev.3.3
Jan. 2012

Contents

Chapter 1 Introduction

1.1 Overview

This manual introduces the Kelly HIGH VOLTAGE motor controllers' features, their installation and their 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 motor controllers provide efficient, smooth and quiet controls for electric vehicles like golf carts, go-carts, electric motorcycles, forklifts and hybrid vehicles, as well as electric boats and industrial motor speed control. It uses high power MOSFET's and, fast PWM to achieve efficiencies of up to 99% in most cases. A powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to adjust parameters, conduct tests, and obtain diagnostic information quickly and easily.

Chapter 2 Main Features and Specifications

2.1 General functions

- Extended fault detection and protection. The LED flashing pattern indicates the fault sources.
- Monitoring battery voltage. It will stop driving if the battery voltage is too high and it will progressively cut back motor drive power as battery voltage drops until it cuts out altogether at the preset "Low Battery Voltage" setting.
- Built-in current loop and over current protection.
- Configurable motor temperature protection range.
- Current cutback at low temperature and high temperature to protect battery and controller. The current begins to ramp down at 90° C case temperature, shutting down at 100° C.
- The controller keeps monitoring battery recharging voltage during regenerative braking, progressively cutting back current as battery voltage rises then cutting off regen altogether when voltage goes too high.
- Maximum reverse speed is configurable to half of the maximum forward speed.
- Configurable and programmable with a host computer though RS232 or USB. Provide free GUI which can run on Windows XP/2000, Windows 7 and Vista (recommend using Kelly Standard USB To RS232 Converter).
- Provision of a +5 volt output to supply various kinds of sensors, including Hall effect type.
- 3 switch inputs which are activated by connection to Ground. Default to throttle switch, brake switch and reversing switch.
- 3 analog 0-5V inputs that default to throttle input, brake input and motor temperature input.
- Pulsed reverse alarm output.
- Main contactor driver. Cutting off the power if any fault is detected.
- Maximum reverse power is configurable to half power.
- Configurable motor over-temperature detection and protection with the recommended thermistor KTY83-122.Optional CAN bus.
- Supply voltage 8V-30V.

Caution! ***Regeneration has braking effect but does not replace the function of a mechanical brake. A mechanical brake is required to stop your vehicle. Regen IS NOT a safety feature! Controller may stop regen, without warning, to protect itself or the battery(it won't protect you!).***

2.2 Features

•Opto-isolated technology achieve stability.
•Intelligence with powerful microprocessor.
•Synchronous rectification, ultra low drop, and fast PWM to achieve very high efficiency.
•Current limit and torque control.
•Low EMC.
•LED fault code.
•Voltage monitoring on voltage source 12V and 5V.
•Hardware over current protection.
•Hardware over voltage protection.
•Support torque mode, speed mode, and balanced mode operation.
•Configurable limit for motor current
•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 at high temperature.
•Configurable high pedal protection: the controller will not work if high throttle is detected at power on.
•Brake switch is used to start regen.
•0-5V brake signal is used to command regen current.
•Standard PC/Laptop computer is used 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.
•Controller supply voltage range, PWR, 8 to 30V.
•Supply Current, 200mA @ 12V, or 2.5W
•Configurable battery voltage range, B+, Max operating range: 18V to 180V.
•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.
•Reverse Alarm, Main Contactor Coil Driver, Meter.
•Full Power Temperature Range: 0°C to 40°C (controller case temperature).
•Operating Temperature Range: -30°C to 90°C, 100°C shutdown (controller case temperature).
•Motor Current Limit,10 seconds boost: 300A-700A, depending on model.
•Motor Current Limit, 1 minutes: 250A-600A,depending on the model.
•Motor Current Limit, continuous:135A-280A, depending on the model.

Kelly High Voltage DC Motor Controller						
Model	10 seconds boost current	1 minutes current	continuous current	Nominal Voltage Range	Max operating voltage	Regen
KDH07500A	500A	400A	200A	24V-72V	18V-90V	
KDH07501A	500A	400A	200A	24V-72V	18V-90V	*
KDH07700A	700A	600A	280A	24V-72V	18V-90V	
KDH07701A	700A	600A	280A	24V-72V	18V-90V	*
KDH09400A	400A	350A	180A	24V-96V	18V-120V	
KDH09401A	400A	350A	180A	24V-96V	18V-120V	*
KDH09500A	500A	400A	200A	24V-96V	18V-120V	
KDH09501A	500A	400A	200A	24V-96V	18V-120V	*
KDH12400A	400A	300 A	160A	24V-120V	18V-136V	
KDH12401A	400A	300 A	160A	24V-120V	18V-136V	*
KDH12500A	500A	400A	200A	24V-120V	18V-136V	
KDH12501A	500A	400A	200A	24V-120V	18V-136V	*
KDH14300A	300A	250A	135A	24V-156V	18V-168V	
KDH14301A	300A	250A	135A	24V-144V	18V-180V	*
KDH14450A	450A	350A	180A	24V-156V	18V-168V	
KDH14451A	450A	350A	180A	24V-144V	18V-180V	
Supply voltage of all KDHA controllers is 8V-30V.						

Chapter 3 Wiring and Installation

3.1 Mounting the Controller

The controller can be oriented in any position which should be as clean and dry as possible, and if necessary, shielded with a cover to protect it from water and contaminants.

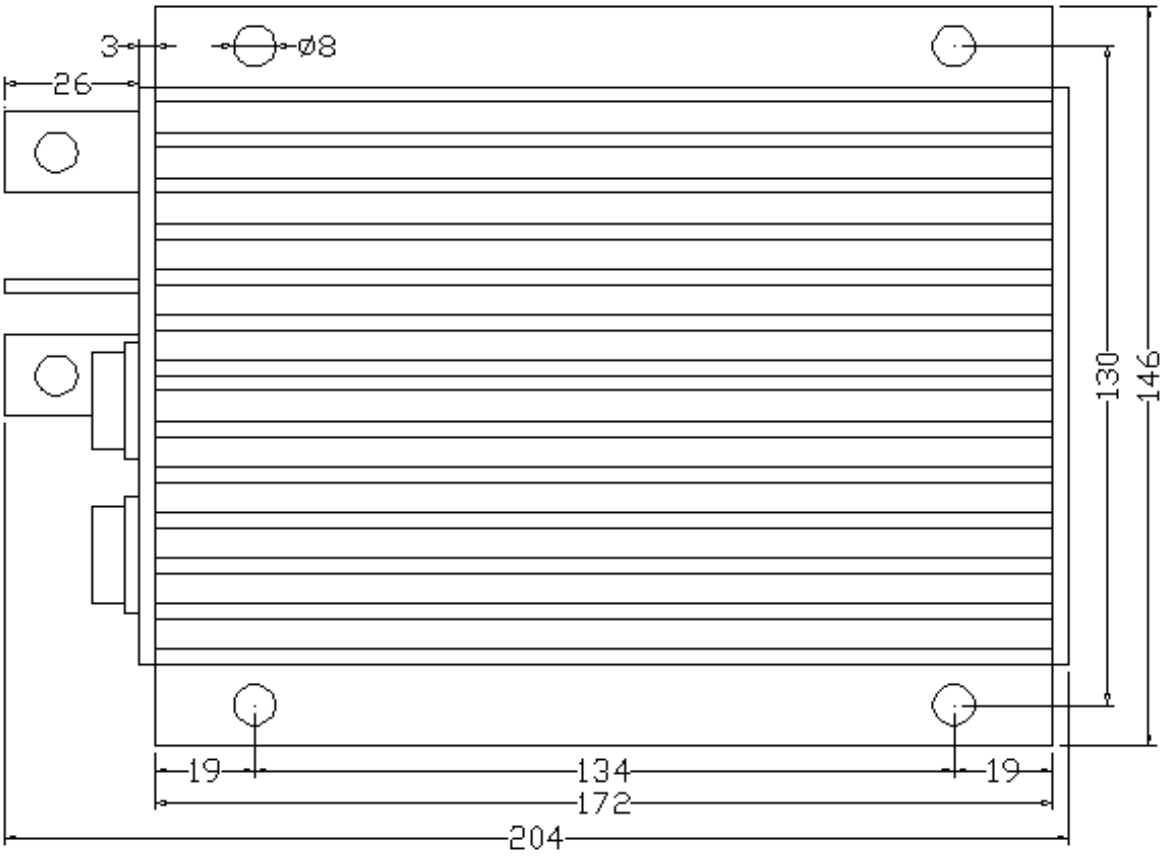
To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with four screws. Applying silicon grease or some other thermal conductive material to contact surface will enhance thermal performance.

Proper heat sinking and airflow are vital to achieve the full power capability of the controller.

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

Caution:

- **RUNAWAYS — Some conditions could cause the vehicle to run out of control. Disconnect the motor, or jack up the vehicle, and get the drive wheels off the ground before attempting any work on the motor control circuitry.**
- **HIGH CURRENT ARCS — Electric vehicle batteries can supply very high power, and arcs can occur if they are short circuit. Always turn off the battery circuit before working on the motor control circuit. Wear safety glasses, and use properly insulated tools to prevent short.**



Height: 62 millimeters

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

3.2 Connections

3.2.1 Front Panel of KDH Motor Controller:

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

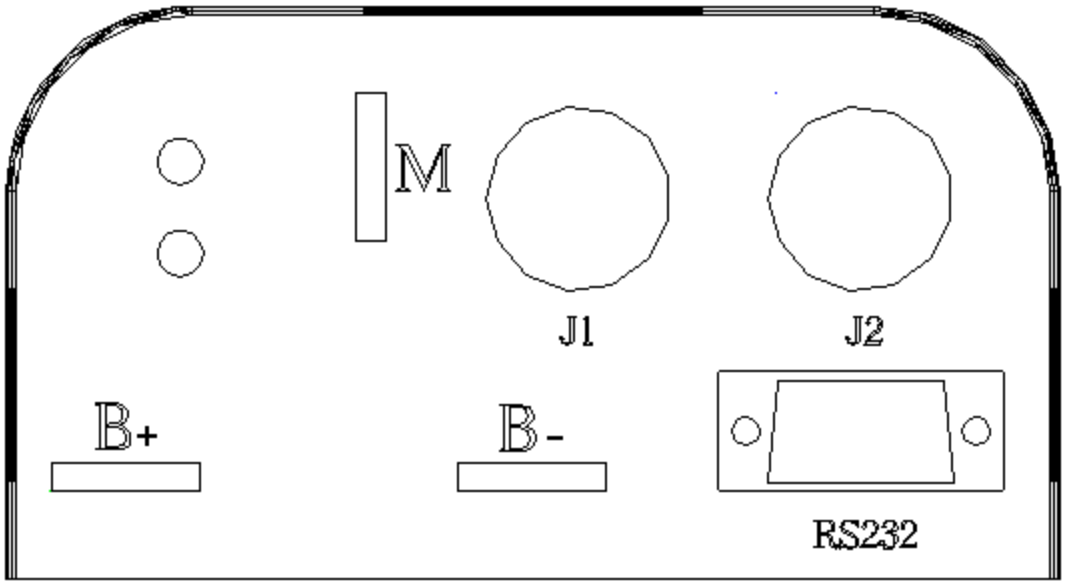
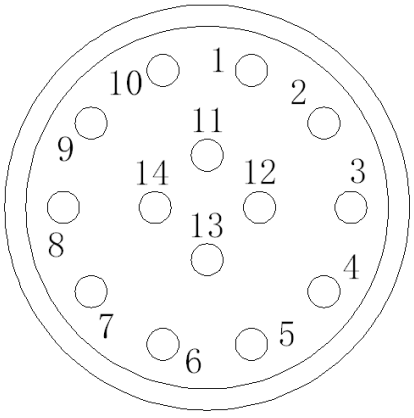


Figure 2: Front panel of KDHA motor controller

B+: battery positive and armature positive
B-: battery negative
M: armature negative

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. <2A**
4- **Alarm: To drive reverse beeper, <200mA.**
5- **GND: Signal return**
6- **Green LED: Running indication**
7- **GND: Signal return**
8- **RS232 receiver**
9- **RS232 transmitter**
10- **CAN bus high. Optional**

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

J2 Pin Definition

1- PWR: Controller power supply (input)
2- GND: Signal return, or power supply ground
3- GND: 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- Micro_SW: Throttle switch input
9- Reversing switch input
10- Brake switch input
11- Reserved
12- Reserved
13- Reserved
14- GND: Signal return

Notes:

1. All RTN pins are internally connected.
2. Two PWR pins, J1-1 and J2-1, are internally connected. It's recommended to use J1-1 to supply peripherals like alarm and contactor. Twist peripheral wires with PWR is the preferred for EMC.
3. Kelly Ammeter positive connect to 5V power supply of controller, negative to J1-2.
4. Switch to ground is active. Open switch is inactive.

Caution:
• RUNAWAYS — Some conditions could cause the vehicle to run out of control. Disconnect the motor, or jack up the vehicle, and get the drive wheels off the ground before attempting any work on the motor control circuitry.
• HIGH CURRENT ARCS — Electric vehicle batteries can supply very high power, and arcs can occur if they are short circuit. Always turn off the battery circuit before working on the motor control circuit. Wear safety glasses, and use properly insulated tools to prevent short.

3.2.2 Standard Wiring of KDHA Motor Controller

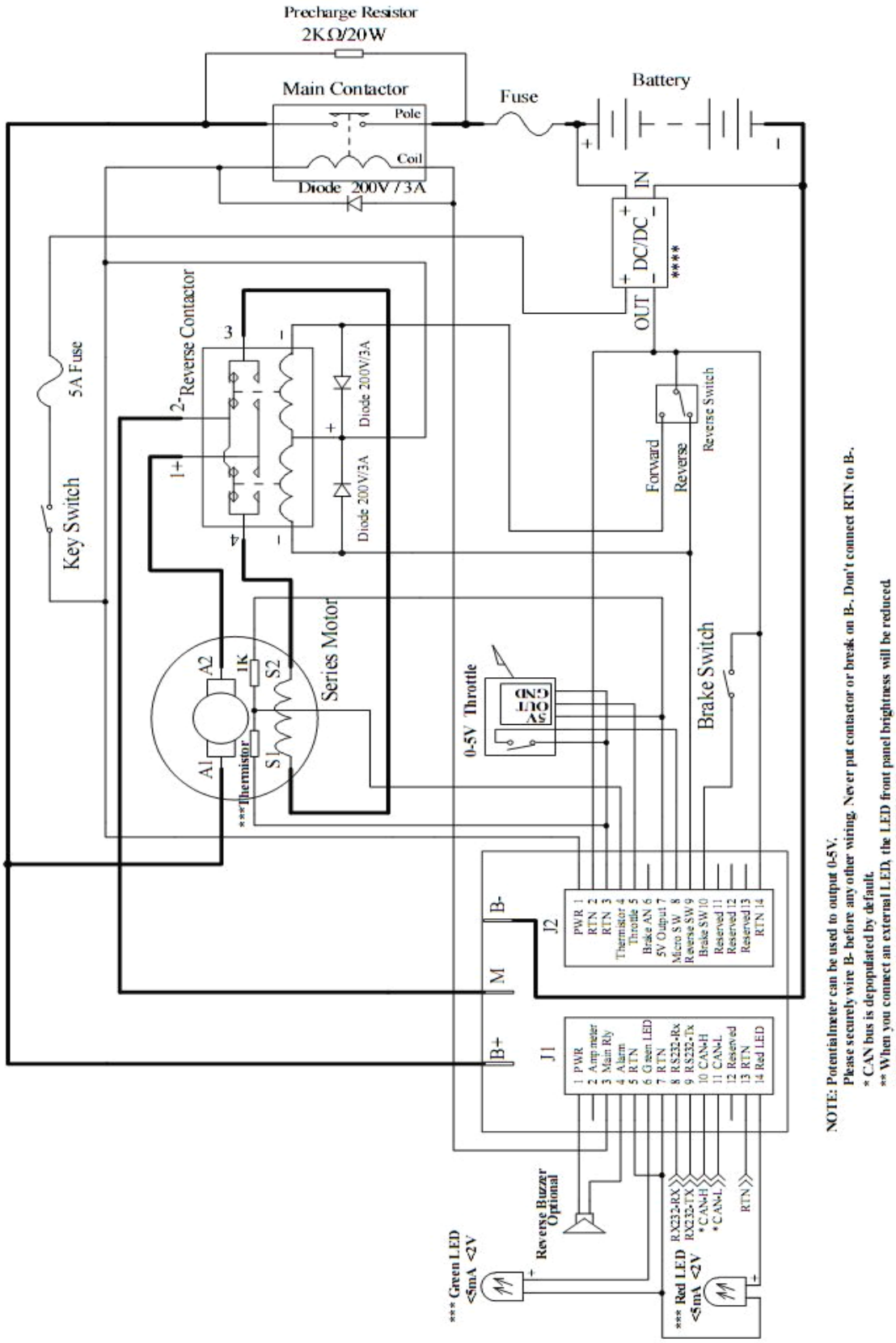


Figure 4: KDHA Series motor controller standard wiring

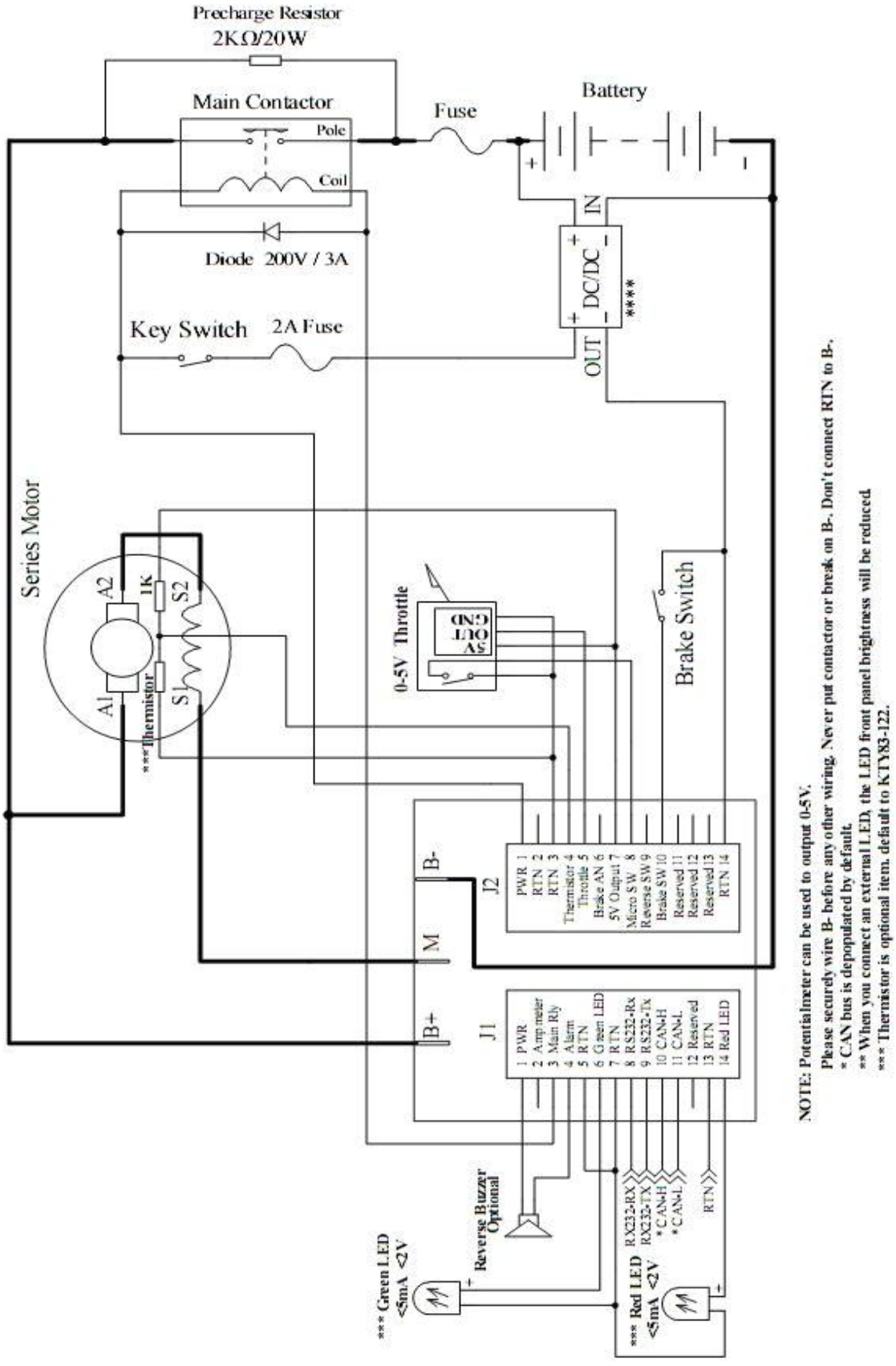


Figure 5: KDHA Series motor controller standard wiring without Reversing Contactor

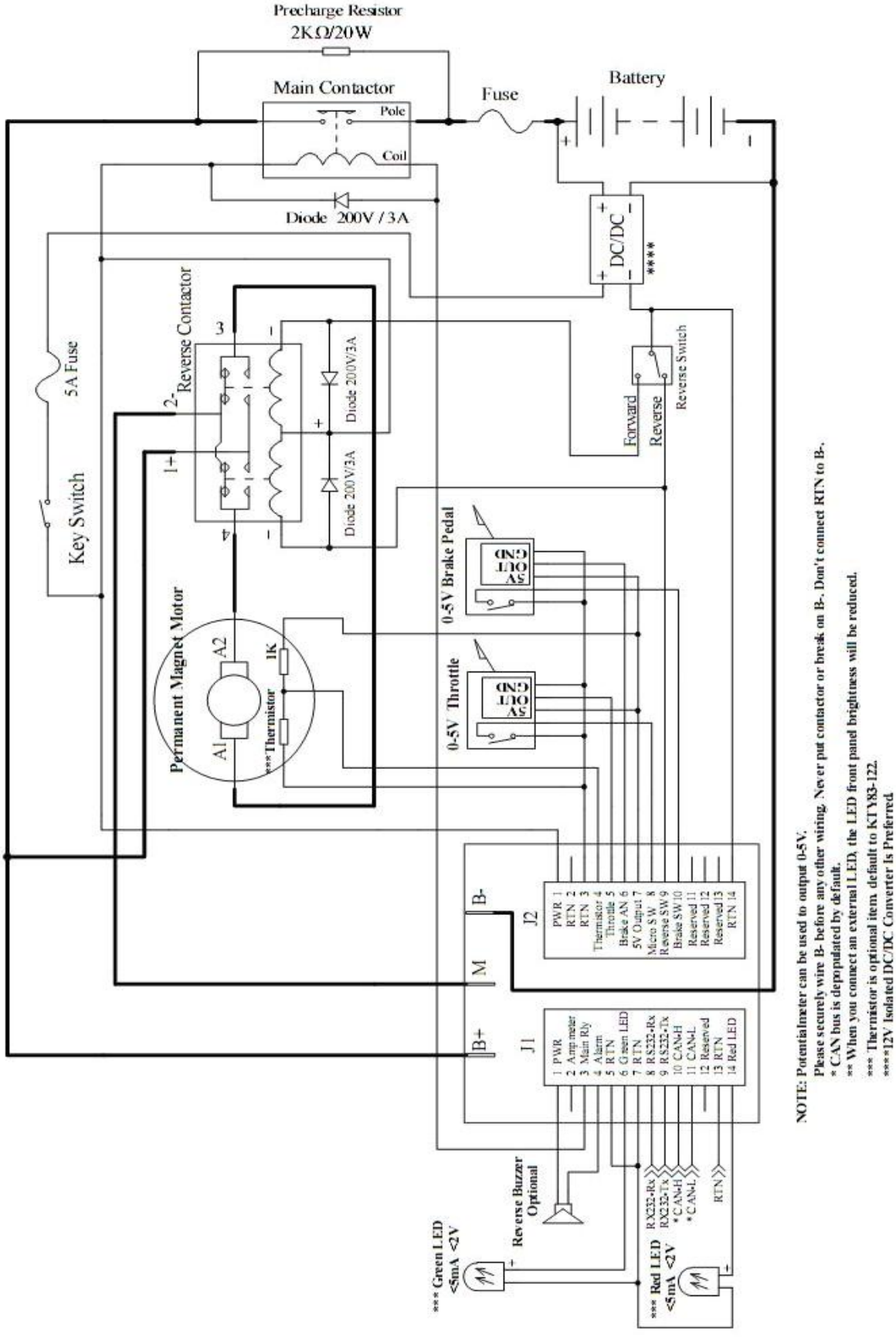


Figure 6: KDHA PM motor controller standard wiring

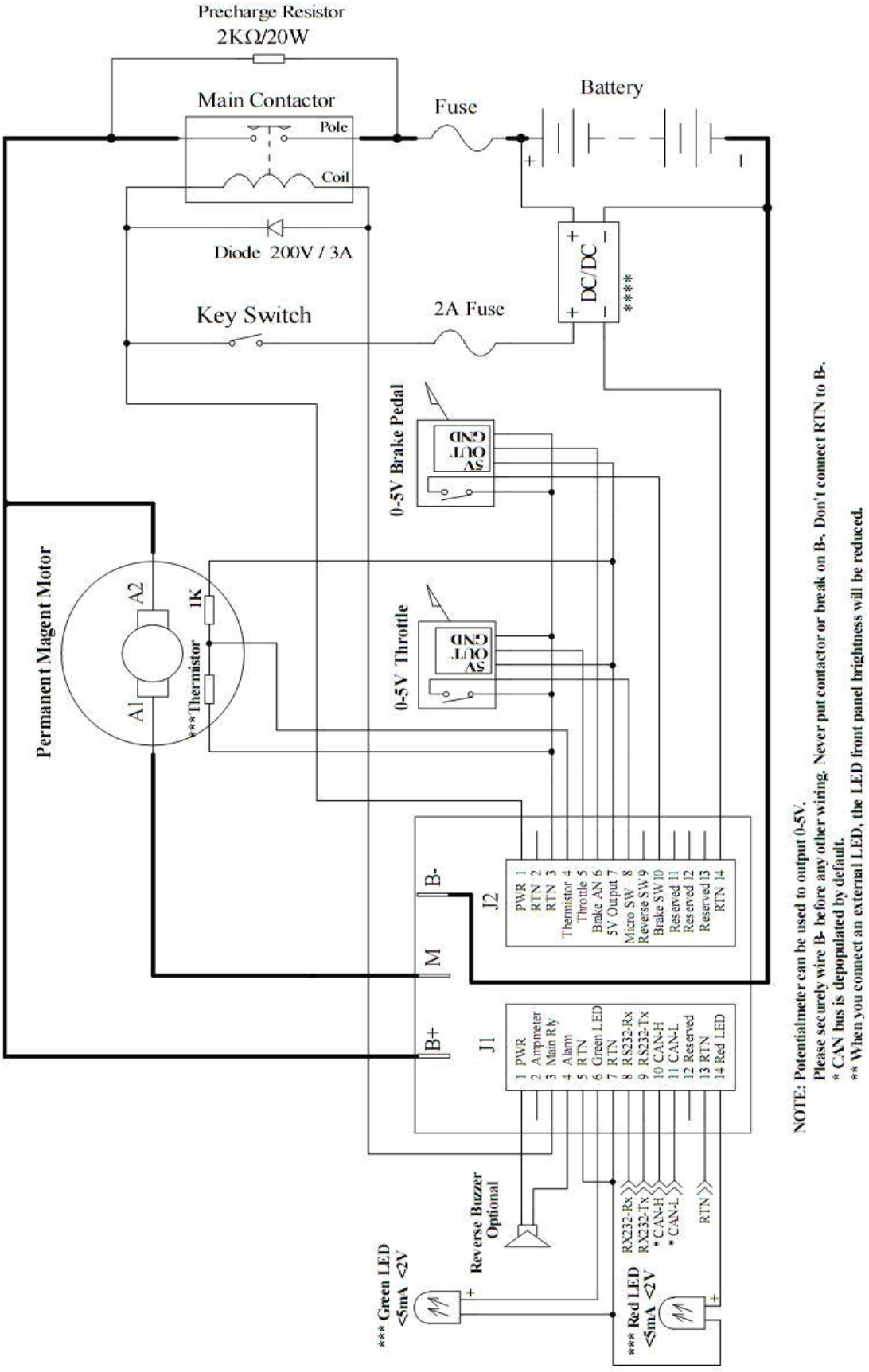


Figure 7: KDHA PM motor controller standard wiring without Reversing Contactor

3.2.3 Communication Port

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

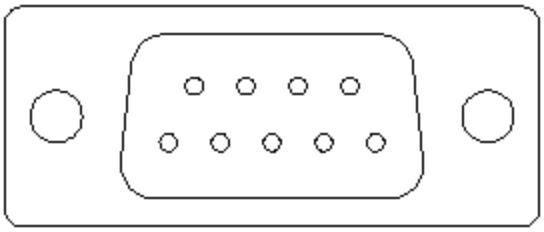


Figure 8: standard RS232 interface

3.3 Installation Checklist

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference as 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 Green LED stay on steadily and Red LED turns off 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 restart.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Verify wiring or voltage and the fuse if it does not. The motor should run faster with increasing throttle. If not, refer to the Table 1 LED code, and correct the fault as determined by the fault 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 as this will void your warranty. However, periodic, exterior cleaning of the controller should be carried out.

The controller is a high powered device. When working with any battery powered vehicle, proper safety precautions should be taken that include, but are not limited to, proper training, wearing eye protection, avoidance of loose clothing, hair and jewelry. Always use 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 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. Make sure that the controller is dry before reconnecting the battery.
- Make sure the connections to the bus bars, if fitted, are tight. To avoid physically stressing the bus bars use two, well-insulated wrenches.

4.2 Configuration

You can configure the controller with a host computer through either an RS232 USB port.

- Disconnect motor wiring from controller.
- Do not connect B+, throttle and so on. The controller may display fault code in some conditions, but it doesn't affect programming or configuration.
- Use a straight through RS232 cable or USB converter provided by Kelly to connect to a host computer.
- Provide 8V to 30V supply to PWR (either J2 pin1 or J1 pin1). Wire power supply return to any GND pin.

Download the free configuration software from:

http://www.kellycontroller.com/support.php

Caution:

•Make certain that the motor is disconnected before trying to run the Configuration Software!

•Configuration software will be regularly updated and published on the website. Please Update your Configuration Software regularly. You must uninstall the older version before updating.

•When setting "Hall Sensor Type" in GUI, do not use "Auto-Check". This has been deleted from the newer configuration software versions.

Table 1: LED CODES

Green LED Code

LED Code	Explanation	Solution
Green Off	No power or switched off	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	Normal operation	That's great! You got solution!
Green & Red are both On		1. Software still upgrading. 2. Supply voltage too low or battery too high 3. The controller is damaged. Contact Kelly about a warranty repair.

Red LED Code

LED Code		Explanation	Solution
1,2	¤ ¤¤	Over voltage error	1. Battery voltage is too high for the controller. Check battery volts and configuration. 2. Regeneration over-voltage. Controller will have cut back or stopped regen. 3. This only accurate to ± 2% upon Overvoltage setting.
1,3	¤ ¤¤¤	Low voltage error	1. The controller will clear after 5 seconds if battery volts returns to normal. 2. Check battery volts & recharge if required.
1,4	¤ ¤¤¤¤	Over temperature warning	1. Controller case temperature is above 90℃. Current will be limited. Reduce controller loading or switch Off until controller cools down. 2. Clean or improve heatsink or fan.
2,2	¤¤ ¤¤	Internal volts fault	1. Measure that B+ & PWR are correct when measured to B- or RTN. 2. There may be excessive load on the +5V supply caused by too low a value of Regen or throttle potentiometers or incorrect wiring. 3. Controller is damaged. Contact Kelly about a warranty repair.
2,3	¤¤ ¤¤¤	Over temperature	The controller temperature has exceeded 100℃. The controller will be stopped but will restart when temperature falls below 80℃.
2,4	¤¤ ¤¤¤¤	Throttle error at power-up	1. Throttle signal is higher than the preset 'dead zone' at Power On. Fault clears when throttle is released. 2. Set throttle model as "Hall Active" throttle if you use that throttle type.

3,1	¤¤¤ ¤	Frequent reset	May be caused by over-voltage, bad motor intermittent earthing problem, bad wiring, etc.
3,2	¤¤¤ ¤¤	Improper throttle model	Set throttle model as "3 Wire" hall if you use that throttle type.
3,3	¤¤¤ ¤¤¤	Brake pedal sensor fault	1. Check and make sure wiring is correct. 2. Check whether connect to the right pedal type.
3,4	¤¤¤ ¤¤¤¤	Non-zero throttle on direction change	Controller won't allow a direction change unless the throttle or speed is at zero. Fault clears when throttle is released.
4,1	¤¤¤¤ ¤	Regen or Start-up over-voltage	The voltage is higher than configured overvoltage value. The controller can resume operation when voltage lowered and brake cycled.
4, 3	¤¤¤¤ ¤¤¤	Motor over temperature	Motor temperature has exceeded the configured maximum. The controller will shut down until the motor temperature cools down.
The Red LED flashes once at power on as a confidence check and then normally stays Off. "1, 2" means the Red flashes once and after a second pause, flashes twice. The time between two flashes is 0.5 second. The pause time between multiple flash code groups is two seconds.			

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