Kelly KDHE High Efficient Series/PM Motor Controller User's Manual

KDH72101E

KDH72121E

KDH12401E

KDH12601E

KDH12801E

KDH12101E

KDH12121E

KDH12151E

KDH14401E

KDH14601E

KDH14801E

Rev.3.4

Dec. 2016

Contents

Chapter 1   Introduction

1.1 Overview

This manual introduces the Kelly KDHE High Efficient 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.

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

(1) Extended fault detection and protection. The LED flashing pattern indicates the fault sources, and Green LED indicates normal operation. Controller will shut down in some fault conditions.

(2) 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.

(3) Built-in current loop and over current protection.

(4) Configurable motor temperature protection range.

(5) Current cutback at low temperature and high temperature to protect battery and controller. The current begins to ramp down at 90 ℃ case temperature, shutting down at 100 ℃.

(6) 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.

(7) Maximum reverse speed is configurable to half of the maximum forward speed.

(8) 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).

(9) Provision of a +5 volt output to supply various kinds of sensors, including Hall effect type.

(10) 3 switch inputs which are activated by connection to Ground. Default to throttle switch, brake switch and reversing switch.

(11) 3 analog 0-5V inputs that default to throttle input, brake input and motor temperature input.

(12) Pulsed reverse alarm output.

(13) Main contactor driver. Cutting off the power if any fault is detected.

(14) Maximum reverse power is configurable to half power.

(15) Configurable motor over-temperature detection and protection with the recommended thermistor KTY84-130.Optional CAN bus.Optional CAN bus.

(16) 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. Support fan or water cooling.

•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.

•Easy installation: 1-4V "Hall Active" throttle or "3 Wire" potentiometer(<100K) can work.

•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 depending on the model: usually less than 2mA.

•Controller supply voltage range, PWR, 8 to 30V(24V is preferred).

•Controller input power, PWR: less than 10W.

• Configurable battery voltage range, B+. Max operating range: 18V-90V for 72V controllers; 18V-136V for 120V controllers;18V to 180V for 144V controllers.

•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℃ to 50℃(controller case temperature).

•Operating Temperature Range: -30℃ to 90℃,100℃ shutdown (controller case temperature).

•Motor Current Limit,1 minutes: 400A - 1800A, depending on the model.

•Motor Current Limit, continuous:200A - 900A, depending on the model.

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 or six 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 and 2.

> **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.**
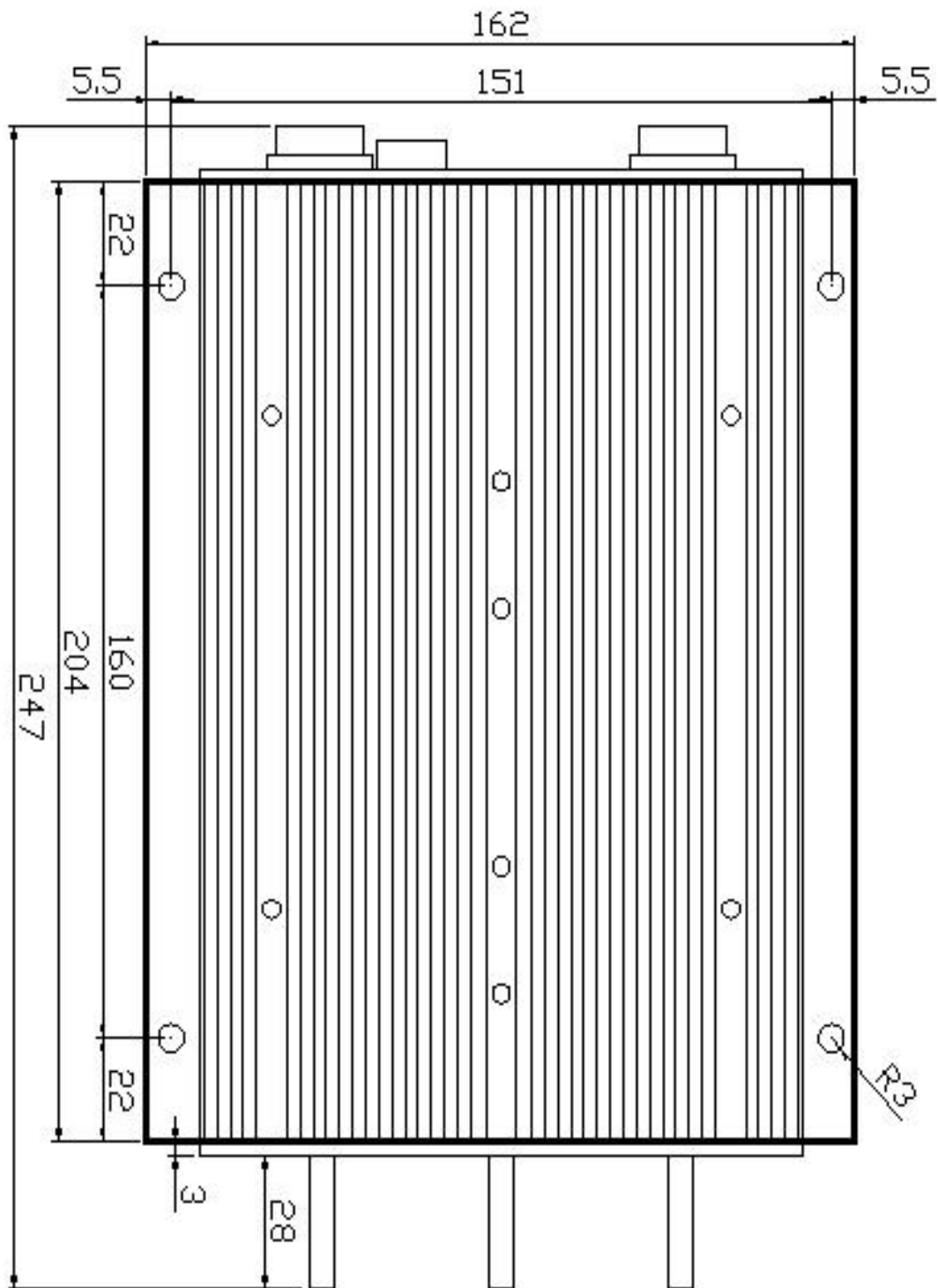
Figure 1: Height: 84 millimeters
Length: 204 millimeters
Controller models with above dimension: KDH72101E,KDH72121E,KDH12401E,
KDH12601E,KDH12801E,KDH12101E,
KDH12121E, KDH14401E,KDH14601E

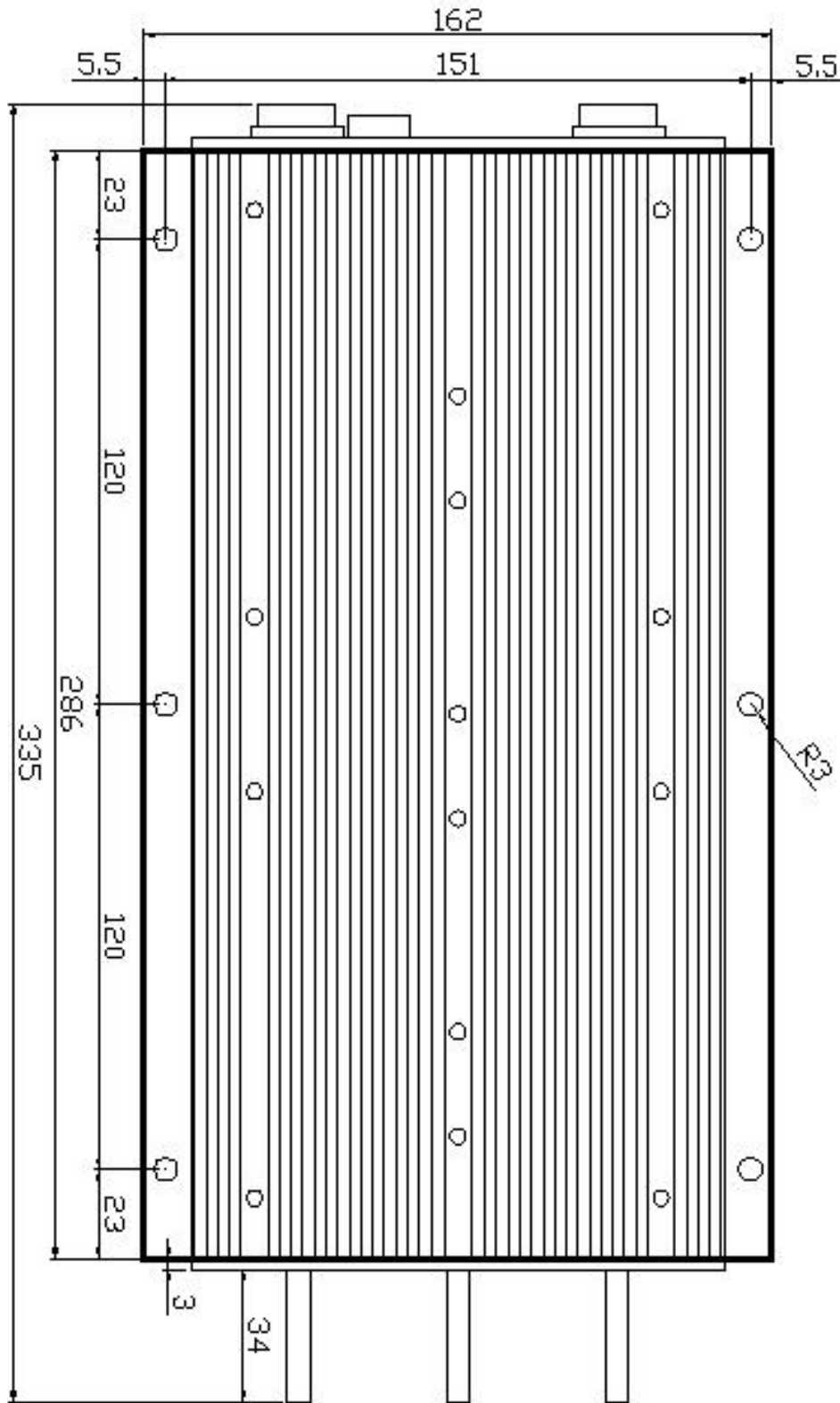**Figure 2:** Height: 84 millimeters
Length: 286 millimeters
Controller models with above dimension: KDH12151E,KDH14801E

3.2 Connections

3.2.1 Panel of KDHE Motor Controller:

Three metal bars and two plugs (J1, J2) are provided for connecting to the battery, motor and control signals shown as Figure 3 and Figure 4.
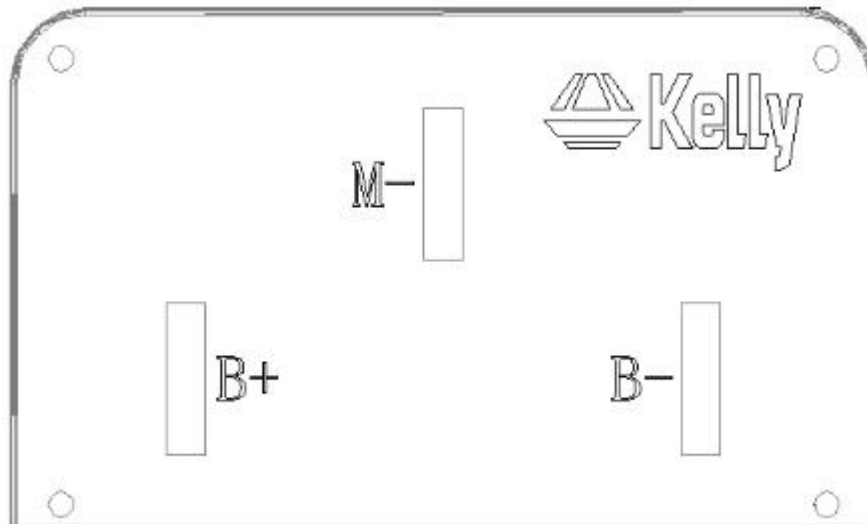

Figure 3: Front panel of KDHE motor controller

B+: battery positive and armature positive

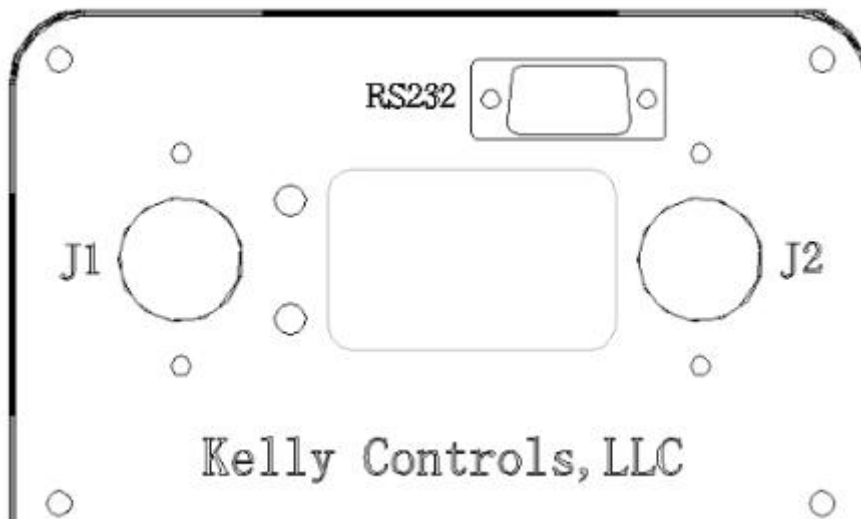**B-: battery negative**

M-: armature negative

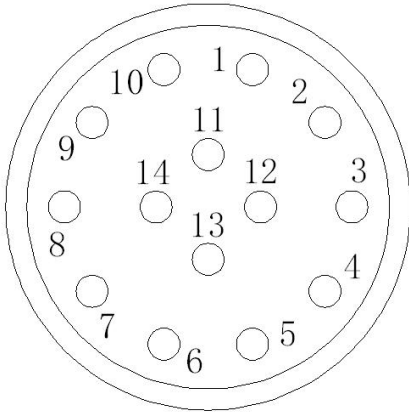**Figure 4:** Back panel of KDHE motor controller

Figure 5: The connecting diagram of **J1** and **J2**

J1 Pin Definition

   1- **PWR: Controller power supply (output).**
   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- **Reserved**
   9- **Reserved**
   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.**

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. <50mA**
   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 and GND 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:

• **Do not apply power until you are certain the controller wiring is correct and has been double checked. Wiring faults will damage the controller.**

• **Ensure that the B- wiring is securely and properly connected before applying power.**

• **The preferred connection of the system contactor or circuit breaker is in series with the B+ line.**

• **All contactors or circuit breakers in the B+ line must have precharge resistors across their contacts. Lack of even one of these precharge resistors may severely damage the controller at switch-on.**

3.2.2 Standard Wiring of KDHE Motor Controller
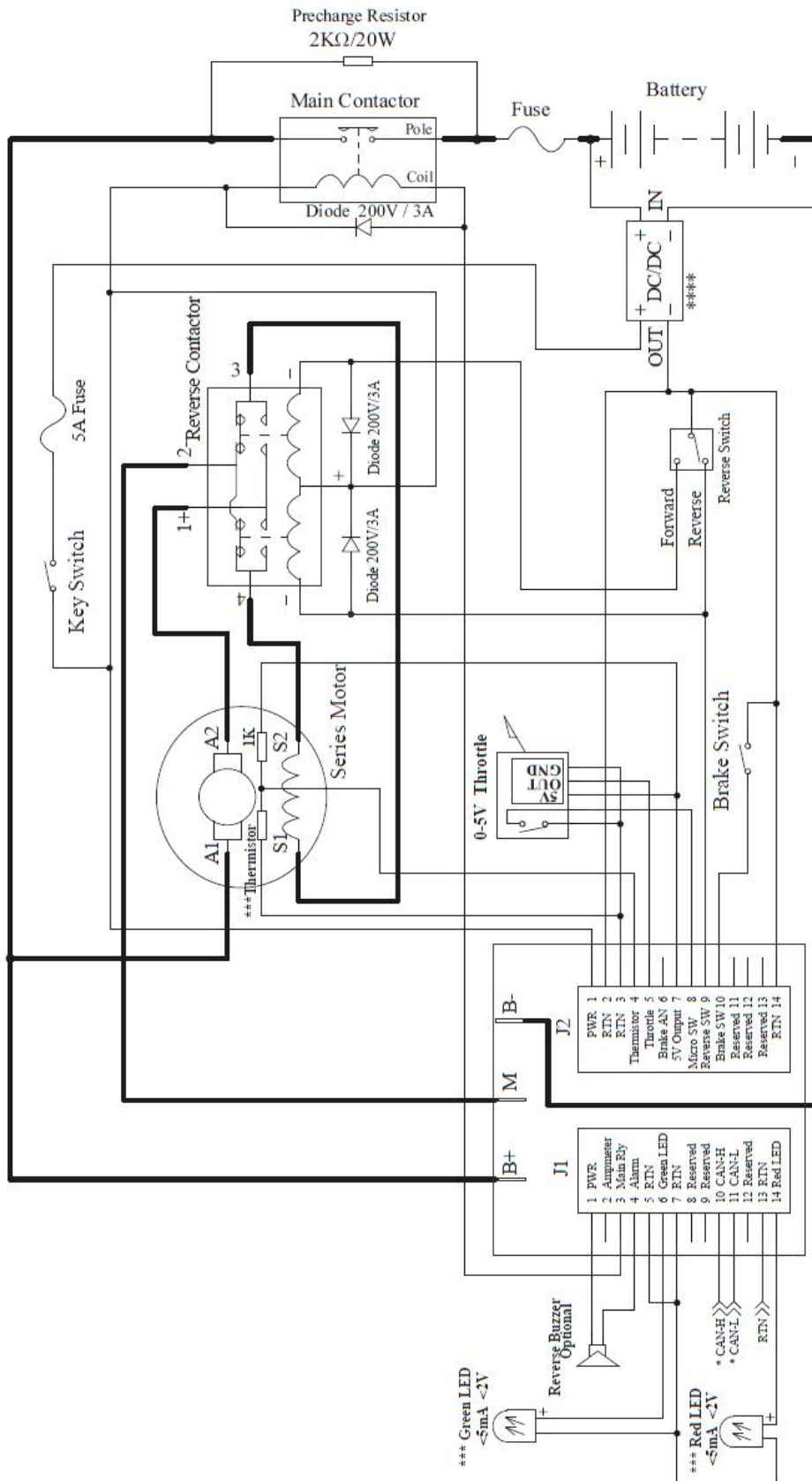
Figure 6: KDHE Series motor controller standard wiring
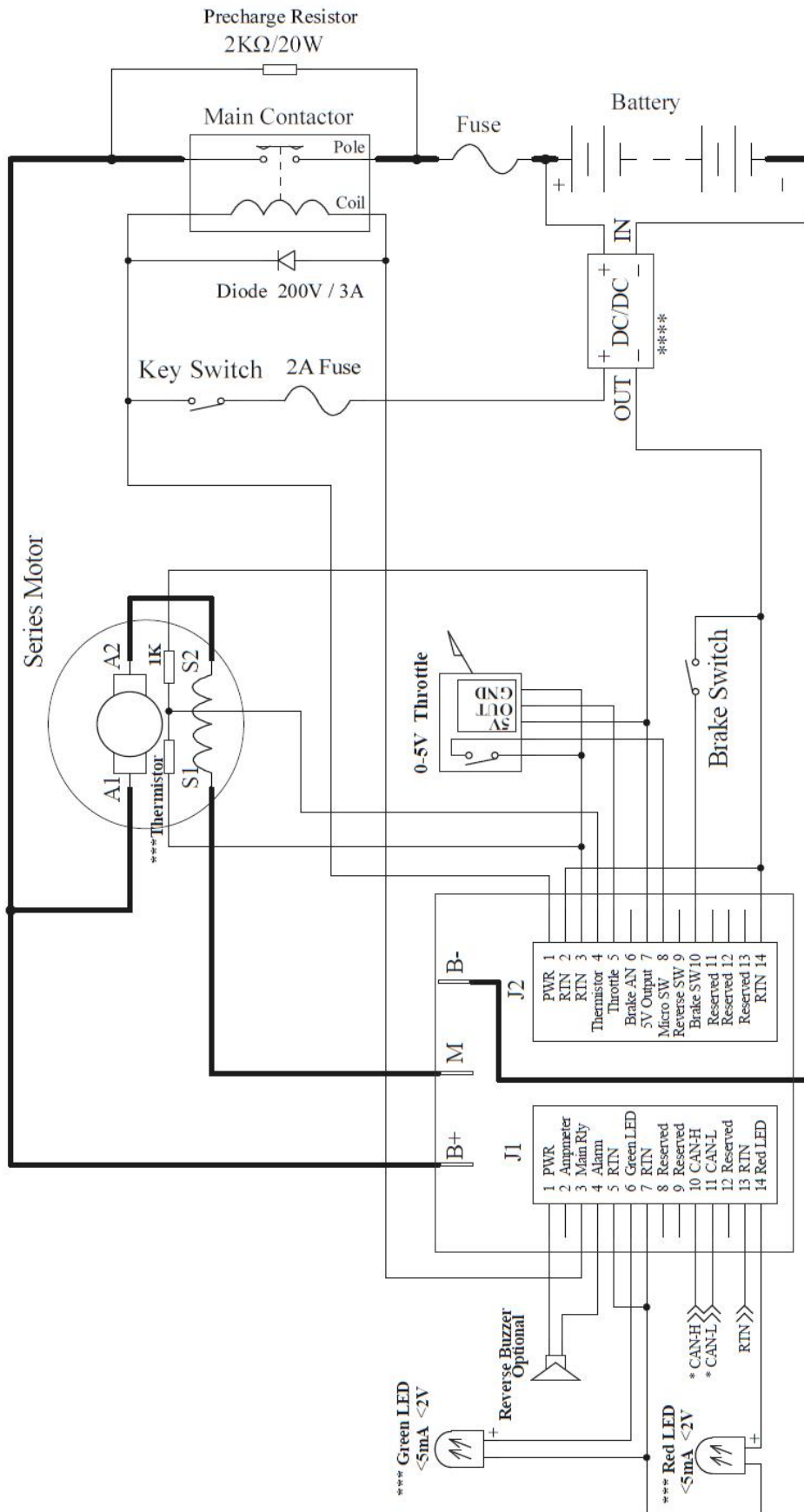
Figure 7: KDHE Series motor controller standard wiring without Reversing Contactor
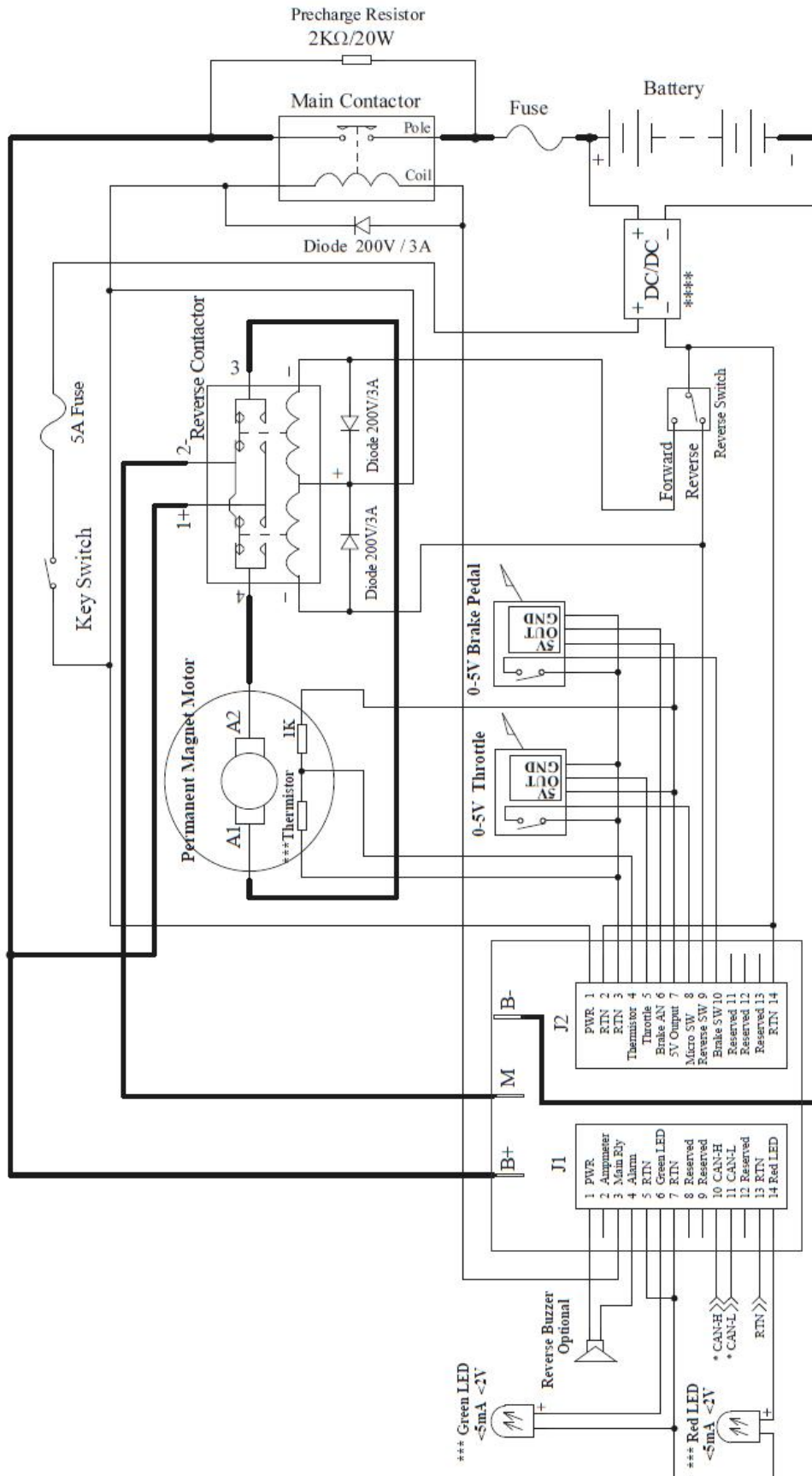
Figure 8: KDHE PM motor controller standard wiring
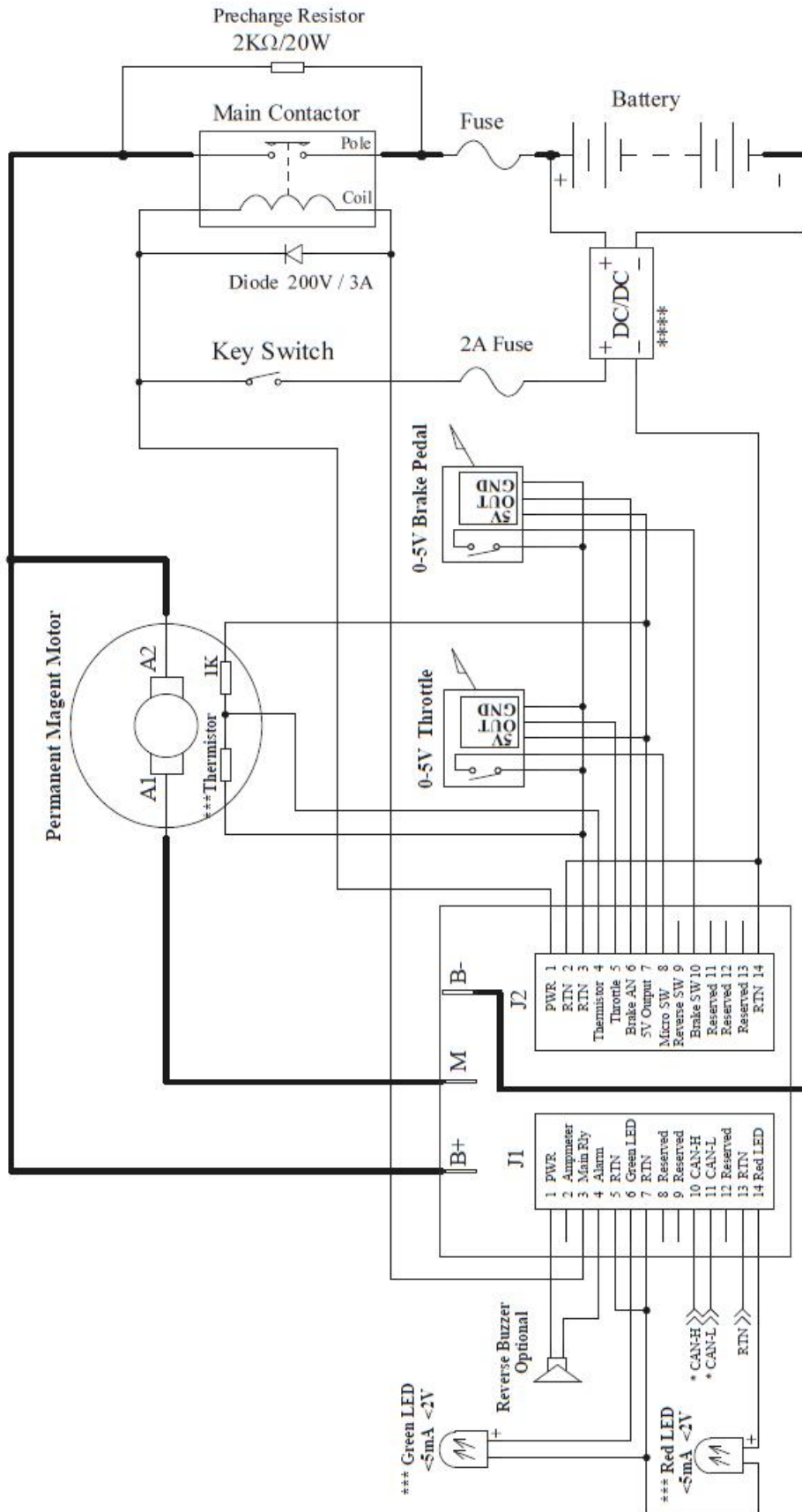
Figure 9: KDHE PM motor controller standard wiring without Reversing Contactor

3.2.3 Communication Port
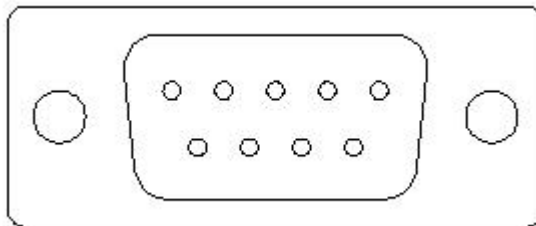
Figure 10: standard RS232 interface

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 wiring is connected correctly
- Turn on the PWR switch, the Red flashes once and the Green is off. After the start-up delay, normally the Red will stay off and the Green will turn on. If there is error, the Red LED will flashes for fault codes.
  If the S/N less: 11xxxxxx: Turn on the PWR switch, the Red flashes once and the Green is on. Normally, the Red will stay off. If there is error, the Red LED will flashes for fault codes.
- 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.
- 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 either an through RS232.

- 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 Kelly USB To RS232 Converter to connect to a host computer. Provide 10V-30V (either J2 pin1 or J1 pin1) to PWR. Wire power supply return to any RTN pin, isolated from B-.

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.**

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 $\pm$ 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 voltage 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 in GUI if you use that throttle model.
3,1	¤¤¤ ¤	Frequent reset	May be caused by over-voltage, bad motor intermittent earthing problem, bad wiring, etc.
3,2	¤¤¤ ¤¤	Internal reset	May be caused by some transient fault condition like a temporary over-current, momentarily high or low battery voltage. This can happen during normal operation.
3,3	¤¤¤ ¤¤¤	Hall throttle is open or short-circuit	When the throttle is repaired, a restart will clear the fault.
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	Motor drive is disabled if an over-voltage is detected at start-up or during regen. The voltage threshold detection level is set during configuration. The max threshold is about 1.25 times of controller rated voltage. I.e. you may set threshold lower than 60V for 48V controller.
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.			

18

Table 2: **Kelly KDHE Controller CAN Commands List**

Version 1.1

You should specify when sending:
    ID: Our default ID is 0x6B, so only the data frame with ID 107 can be received by our controller. However, it can be set by configuration program.
    Frame type:data frame
    Frame format:standard 11 bits ID
    Length:the number of data field bytes
    Data field:data[0] is the command which indicates the operation.

Controller response:
    ID: The controller sends data frames with ID 115, 0x73. It also can be set by configuration program.
    Frame type:data frame
    Length:the number of data field bytes
    Data field: The controller sends one or two data frames in response.

Commands definitions

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   INFO_MODULE_NAME
    data[2]   8
    Controller response
    Length   8
    data[0]~data[7]   Controller's model in ASCII format, 8 bytes.
    Description: Getting controller's model no. E.g. 0x4B,0x42,0x4C is 'K' , 'B', 'L', 0x30 is '0' . INFO_MODULE_NAME constant is defined as 64.

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   INFO_SOFTWARE_VER
    data[2]   2
    Controller response
    Length   2
    data[0]~data[1]   software version in BCD alike format, two bytes.
    Description: Getting controller's software version, it also define as the controller's version, BCD alike format storage. E.g. 0x0A,0x01 should be parsed to ASCII characters '0' 'A' '0' '1' as the software version. INFO_SOFTWARE_VER constant is defined as 83.

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   CAL_TPS_DEAD_ZONE_LOW
    data[2]   1
    Controller response
    Length   1
    data[0]   TPS_Dead_Zone_Low
    Desccription: Getting controller's Throttle low-end dead zone. CAL_TPS_DEAD_ZONE_LOW constant is defined as 4.

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   CAL_BRAKE_DEAD_ZONE_LOW
    data[2]   1
    Controller response
    Length   1
    data[0]   Brake_Dead_Zone_Low
    Desccription: Getting controller's Brake low-end dead zone. CAL_BRAKE_DEAD_ZONE_LOW
constant is defined as 5.

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   CAL_TPS_DEAD_ZONE_HIGH
    data[2]   1
    Controller response
    Length   1
    data[0]   TPS_Dead_Zone_High
    Desccription: Getting controller's Throttle high-end dead zone. CAL_TPS_DEAD_ZONE_HIGH
constant is defined as 38.

    Command   **CCP_FLASH_READ**
    Length   3
    data[0]   0xF2
    data[1]   CAL_BRAKE_DEAD_ZONE_HIGH
    data[2]   1
    Controller response
    Length   1
    data[0]   Brake_Dead_Zone_High
    Desccription: Getting controller's Brake high-end dead zone. CAL_BRAKE_DEAD_ZONE_HIGH
constant is defined as 39.

    Command   **CCP_A2D_BATCH_READ1**
    Length   1
    data[0]   0x1b
    Controller response
    Length   5
    data[0]   Brake A/D
    data[1]   TPS A/D
    data[2]   Operation voltage A/D
    data[3]   Vs A/D
    data[4]   B+ A/D
    Description: Data batch reading.
            1) For operation voltage, B+, A/D value and voltage mapping relation is:
                    V = Vad / 1.39. (For 144V controller).
            2) Vs is defined as the 5V power supply for Hall sensor, control panel,ect. A/D value
                and voltage mapping relation is:120 ~ 134 mapping to 4.75 ~ 5.25V.
            3) Brake and TPS are defined as the Brake and the Throttle analog input. A/D value
                and voltage mapping relation is: 0 ~ 255 mapping to 0 ~ 5V.

    Command   **CCP_A2D_BATCH_READ2**
    Length   1
    data[0]   0x1a
    Controller response
    Length   3

data[0]   Ia A/D
data[1]   Ib A/D
data[2]   Vb A/D

Description: Data batch reading.
    1) For Vb A/D value and voltage mapping relation is:
      V = Vad / 1.39.
    2) Ia, Ib are defined as the drive and regen current.

Command   **CCP_MONITOR1**
Length   1
data[0]   0x33
Controller response
Length   6
data[0]   PWM
data[1]   enable motor rotation
data[2]   motor temperature
data[3]   Controller's temperature
data[4]   temperature of high side FETMOS heat sink
data[5]   temperature of low side FETMOS heat sink
Description: Data batch reading.
    1) PWM is output duty cycle, from 0 to 100.
    2) data[1] indicates enabling motor rotation or disabling. 1 - enable, 0 - disable.
    3) data[2] is defined as the temperature of motor in Celsius temperature. If the temperature sensor is not connected, the controller returns 0xFF.
    4) data[3]-data[5] are defined as controller inside temperature in Celsius temperature. The value of data[4] and data[5] are inaccurate below 30℃.

Command   **CCP_MONITOR2**
Length   1
data[0]   0x37
Controller response
Length   3
data[0]   MSB of error code
data[1]   LSB of error code
data[2]   present current accounts for percent of the rated current of controller
Description: Data batch reading.
    1） Controller error status：(data[0] << 8) | data[1],

data[0]M	7	6	5	4	3	2	1	0	data[0]L
	0x44	0x43	0x42	0x41	0x34	0x33	0x32	0x31	
data[1]M	7	6	5	4	3	2	1	0	data[1]L
	0x24	0x23	0x22	0x21	0x14	0x13	0x12	0x11	

  if(dadata[0] << 8) | data[1]=0x4008,The corresponding error code is 0x43and 0x14.

Command   **COM_SW_ACC**
Length   2
data[0]   0x42
data[0]   COM_READING
Controller response
Length   1
data[0]   Current throttle switch status
 Description: Getting Throttle switch status, 1 – active, 0 – inactive. COM_READING constant is defined as 0.

21

Command   **COM_SW_BRK**
Length   2
data[0]   0x43
data[0]   COM_READING
Controller response
Length   1
data[0]   Current Brake switch status
Description: Getting Brake swith status, 1 – active, 0 – inactive. COM_READING constant is defined
as 0.

Command   **COM_SW_REV**
Length   2
data[0]   0x44
data[0]   COM_READING
Controller response
Length   1
data[0]   Current Reverse switch status
Description: Getting Reverse swith status, 1 – active, 0 – inactive. COM_READING constant is
defined as 0.

NOTICE:
- CAN bus rate should be configured to 1Mbit/s.

2.If the command is out of above commands
Controller response
Length   1
data[0]   CCP_INVALID_COMMAND
Description: CCP_INVALID_COMMAND constant is defined as 0xe3.

Contact Us:

Kelly Controls

Home Page:
http://www.kellycontroller.com

E-mail:
support@kellycontroller.com

Phone:
(01) 224 637 5092