Kelly KDC Series/PM Motor Controller User's Manual

KDC48600
KDC48601
KDC48602
KDC48603
KDC72600
KDC72601
KDC72602
KDC72603
KDC72800
KDC72801
KDC72802
KDC72803
KDC12602
KDC12603

Rev.3.3
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Contents

Chapter 1 Introduction

1.1 Overview

This manual introduces the Kelly KDC Series/PM 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 boat 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.
(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°C case temperature, shutting down at 100°C.
(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 KTY83-122.Optional CAN bus.
(16) 18-120V power supply for 120V controller.

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

•Intelligence with powerful microprocessor.
•Synchronous rectification, ultra low drop, and fast PWM to achieve very high efficiency.
•Voltage monitoring on voltage source 12V and 5V.
•Hardware over current protection.
•Hardware over voltage protection.
•Current limit and torque control.
•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 at high temperature.
• Configuring current-voltage mode of field function on controller with field to achieve more reliable.
•Configurable high pedal protection: Disable operation if power up with high throttle.
•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 power supply current, PWR, <150mA.
•Configurable battery voltage range, B+. Max operating range: 18V to 136V
•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, 1 minutes: 600-800A, depending on the model.
•Motor Current Limit, continuous:240-320A, depending on the model.

Kelly KDC Series/PM Motor Controller						
Model	1 minutes current	continuous current	Nominal Voltage Range	Max operating voltage	Field	Regen
KDC48600	600A	240A	24V-48V	18V-60V		
KDC48601	600A	240A	24V-48V	18V-60V		*
KDC48602	600A	240A	24V-48V	18V-60V	*	
KDC48603	600A	240A	24V-48V	18V-60V	*	*
KDC72600	600A	240A	24V-72V	18V-90V		
KDC72601	600A	240A	24V-72V	18V-90V		*
KDC72602	600A	240A	24V-72V	18V-90V	*	
KDC72603	600A	240A	24V-72V	18V-90V	*	*
KDC72800	800A	320A	24V-72V	18V-90V		
KDC72801	800A	320A	24V-72V	18V-90V		*
KDC72802	800A	320A	24V-72V	18V-90V	*	
KDC72803	800A	320A	24V-72V	18V-90V	*	*
KDC12602	600A	240A	24V-120V	18V-136V	*	
KDC12603	600A	240A	24V-120V	18V-136V	*	*

Chapter 3 Wiring and Installation

3.1 Mounting the Controller

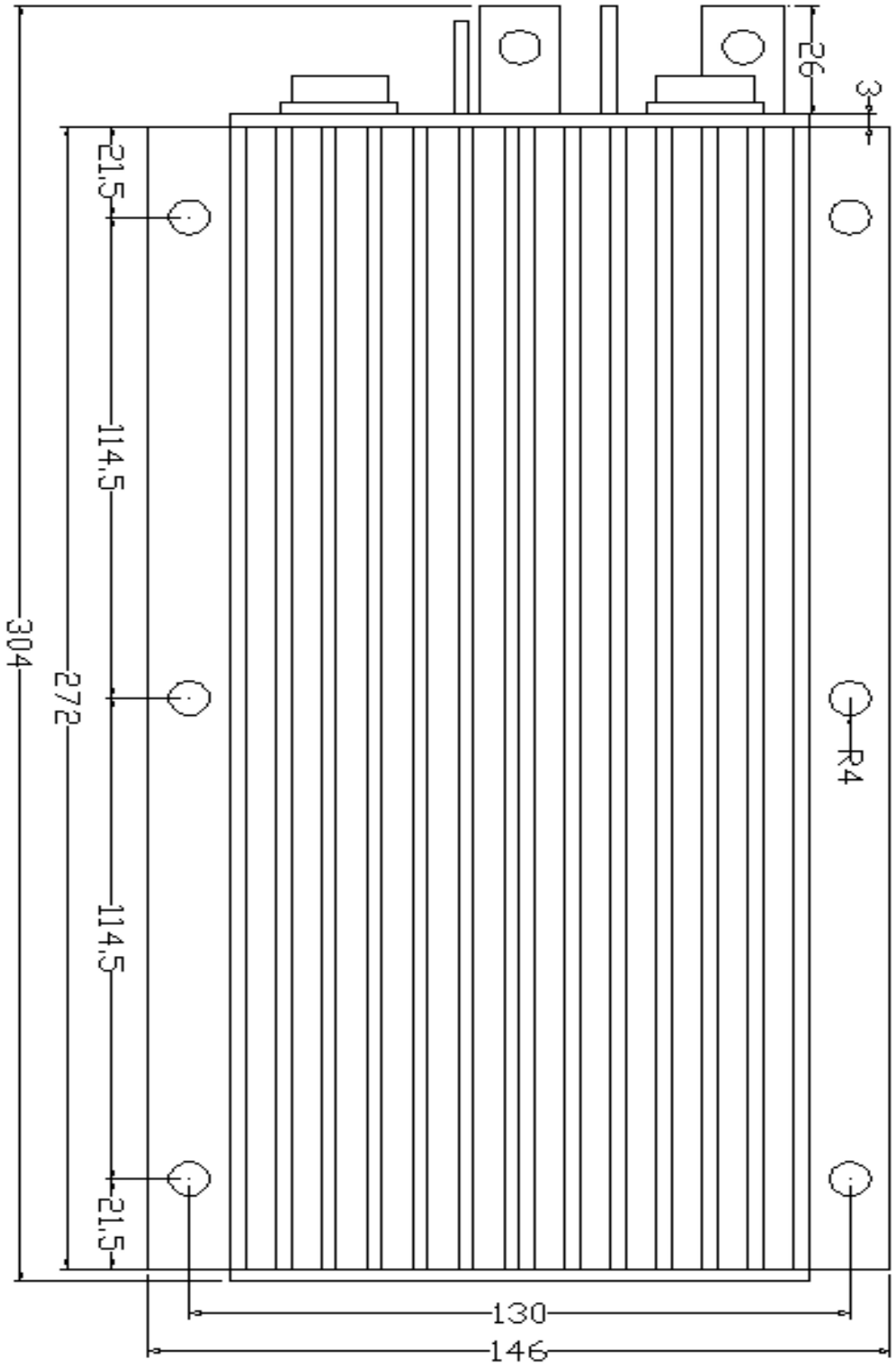
The controller can be oriented in any position which should be as clean and dry as possible, and if necessary, shielded with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with four screws. A thermal joint compound can be used to improve heat conduction from the case to the mounting surface. 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 circuit.



Height: 62 millimeters

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

3.2 Connections

3.2.1 Front Panel of KDC Series or PM 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.

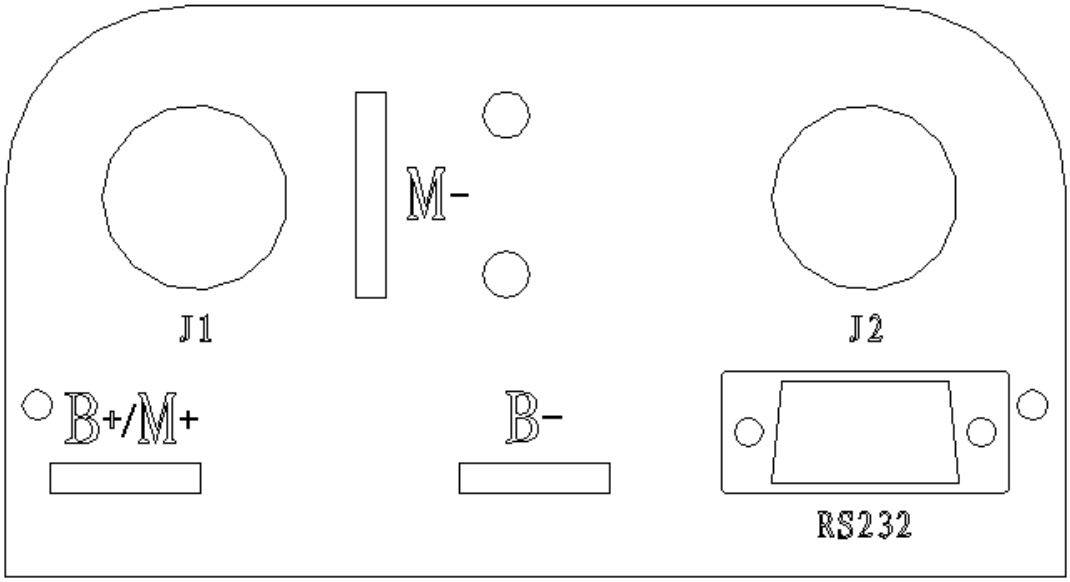


Figure 2: Front panel of KDC motor controller

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

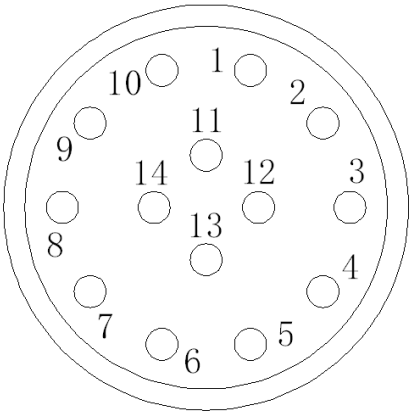


Figure 3: The connecting diagram of **J1** and **J2**

J1 Pin Definition

1- PWR: Controller power supply (output).
2- Kelly Current meter. <200mA
3- Main contactor driver. <2A
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. Optional
11- CAN bus low. Optional
12- Reserved
13- RTN: Signal return, or power supply ground

14- Red LED: Fault code.

J2 Pin Definition

1- PWR: Controller power supply (input)
2- RTN: Signal return, or power supply ground
3- RTN: Signal return
4- 12V high-level brake and motor temperature input. Demand use KTY83-122 Silicon temperature sensors.
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- RTN: 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:

- 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 KDC Series or PM Motor Controller

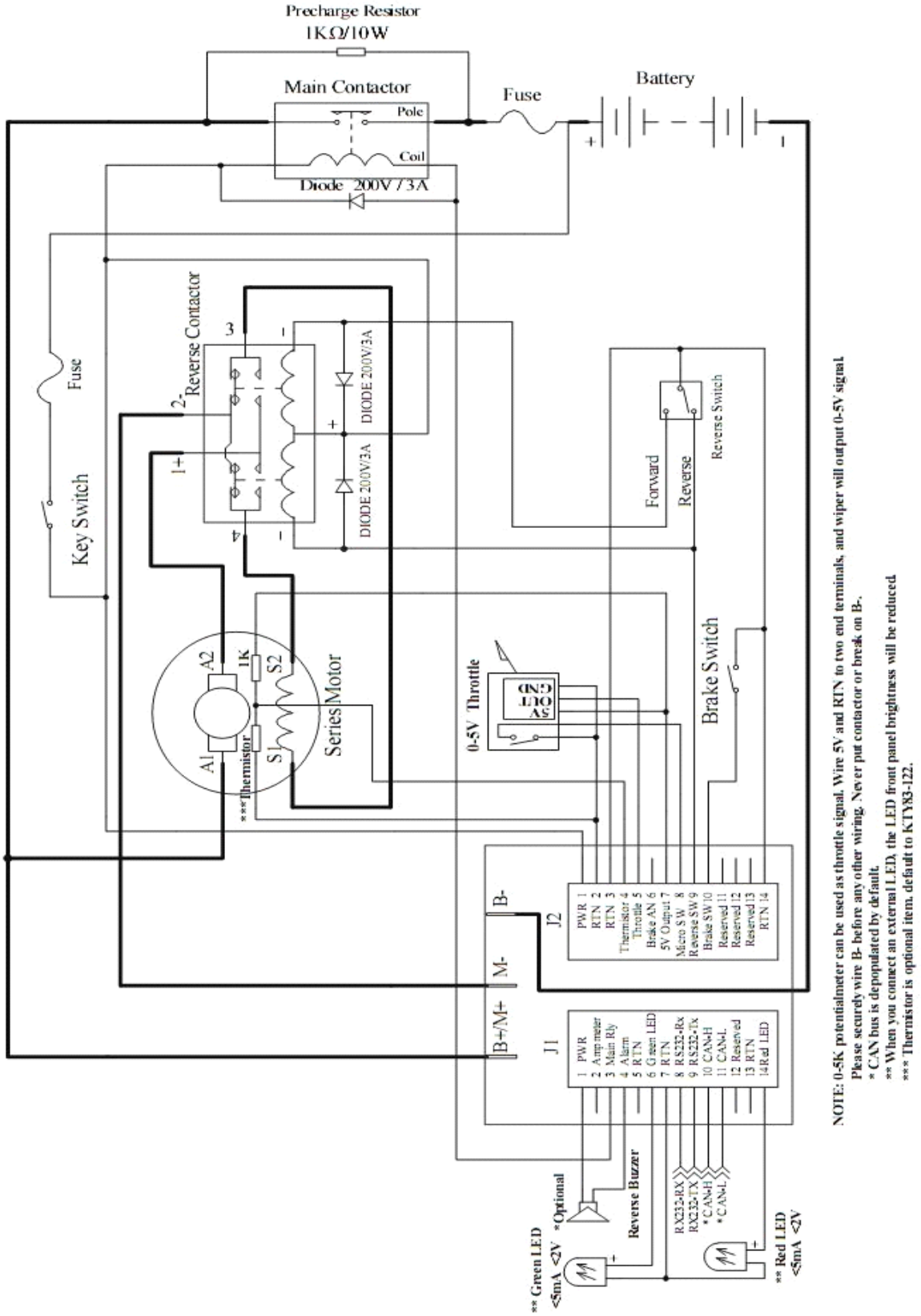


Figure 4: KDC series motor controller standard wiring

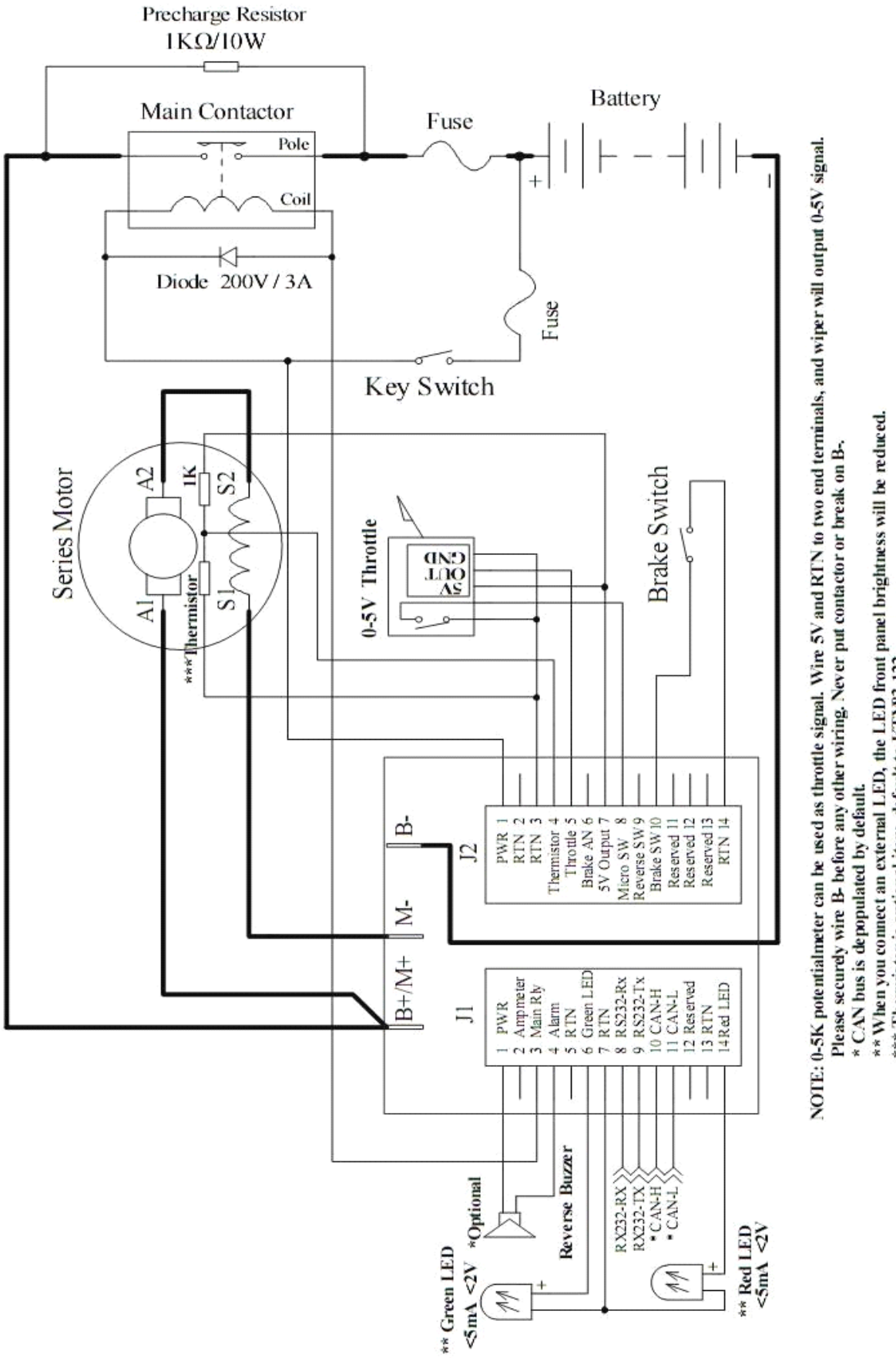


Figure 5: KDC Series motor controller standard wiring without Reversing Contactor

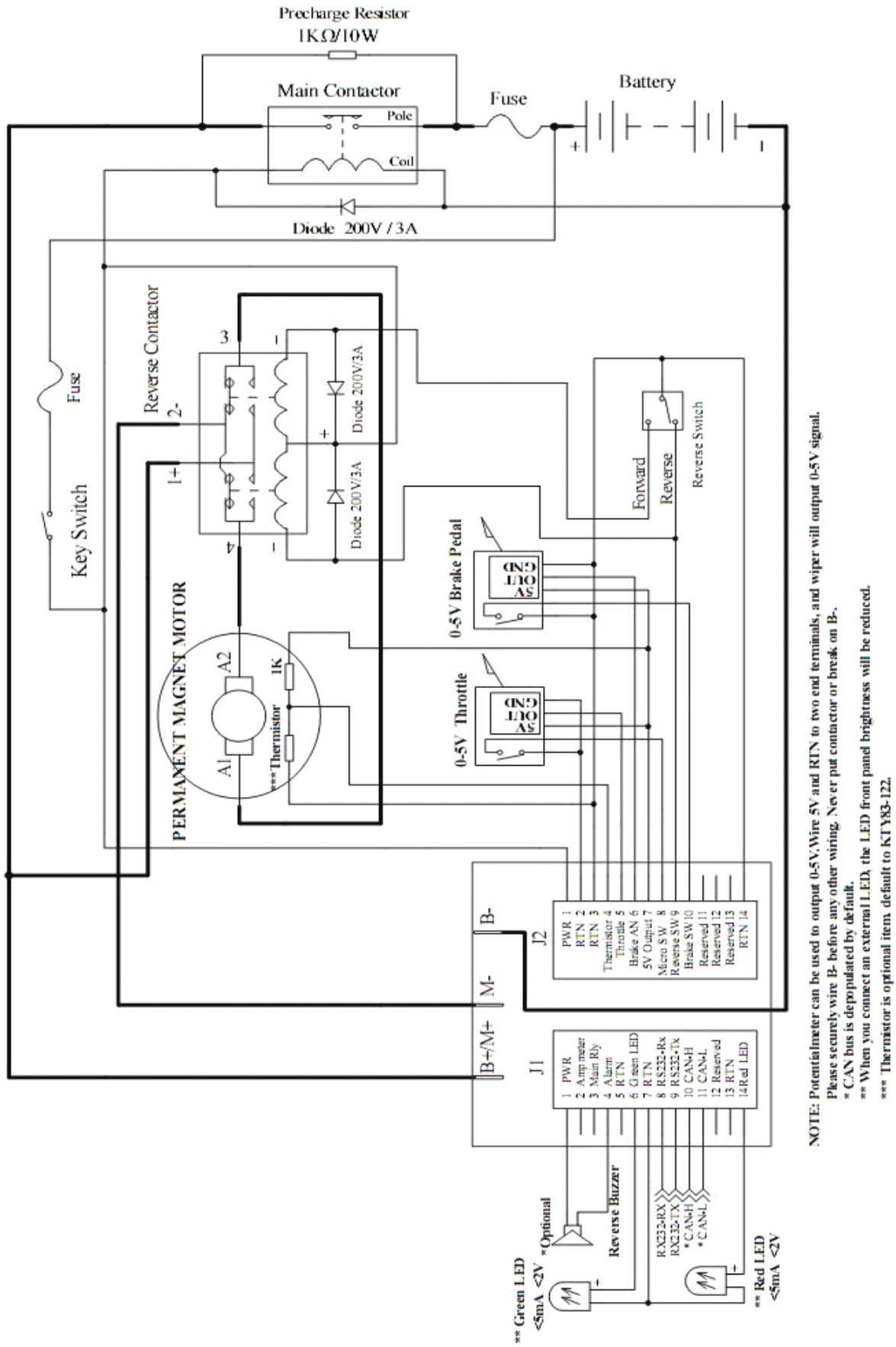


Figure 6: KDC PM motor controller standard wiring

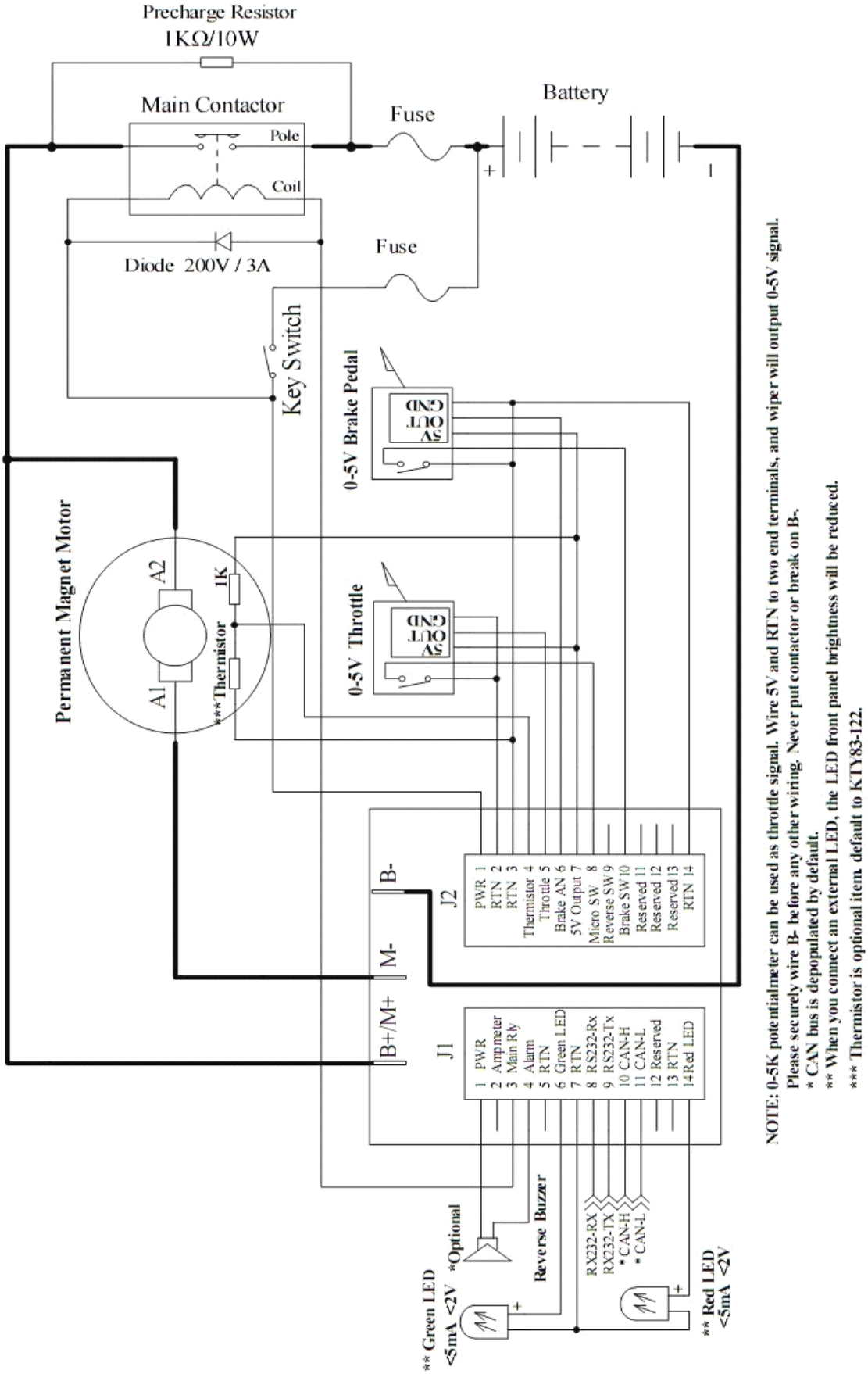


Figure 7: KDC PM motor controller standard wiring without Reversing Contactor

3.2.3 Front Panel of KDC Sep/Ex Motor Controller

Five 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 8.

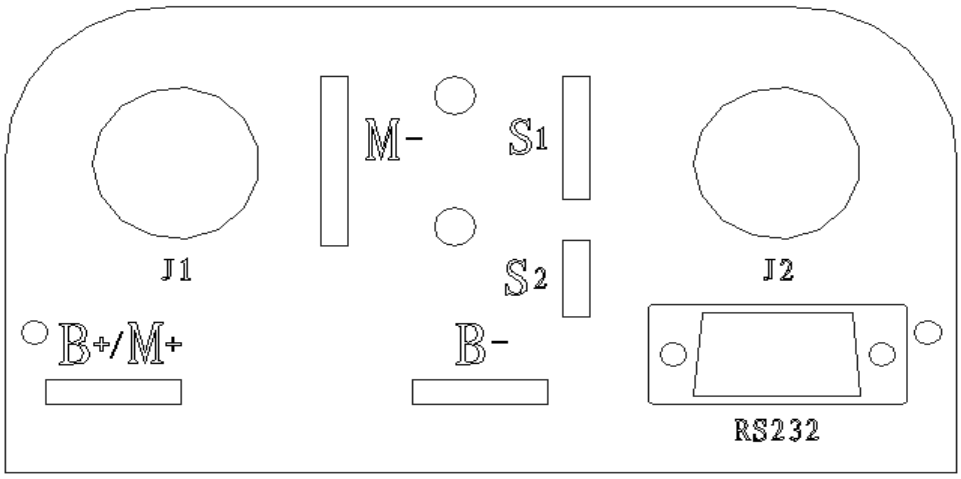


Figure 8: Front panel of KDC Sep/Ex Controller

B+/M+: battery positive and armature positive
B-: battery negative
M-: armature negative
S1: Field positive
S2: Field negative
S1 and S2: Connect to motor field coil. Motor moves forward when current flow from S1 to S2, in the case of REV switch open.

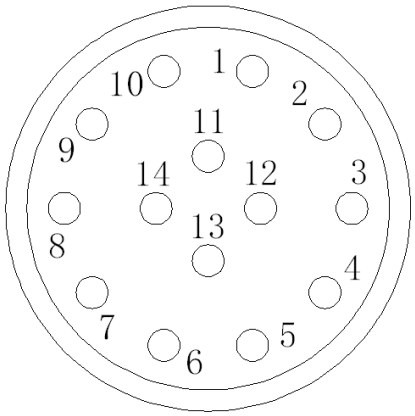


Figure9: The connecting diagram of **J1** and **J2**

J1 Pin Definition

1- PWR: Controller power supply (output).
2- Kelly Current meter. <200mA,
3- Main contactor driver. <400mA, Not be used for 120V system
4- Alarm: To drive reverse beeper. <200mA, Not be used for 120V system
5- RTN: Signal return
6- Green LED: Running indication
7- RTN: Signal return
8- RS232 receiver
9- RS232 transmitter
10- CAN bus high. Optional
11- CAN bus low. Optional
12- Reserved
13- RTN: Signal return, or power supply ground
14- Red LED: Fault code.

J2 Pin Definition

1- PWR: Controller power supply (input)
2- RTN: Signal return, or power supply ground
3- RTN: Signal return
4- Motor temperature input. Demand use KTY83-122 Silicon temperature sensors.
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- Reserved
12- Reserved
13- Reserved
14- RTN: 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:

- 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.

3.2.4 Standard Wiring of KDC Sep/Ex Motor Controller

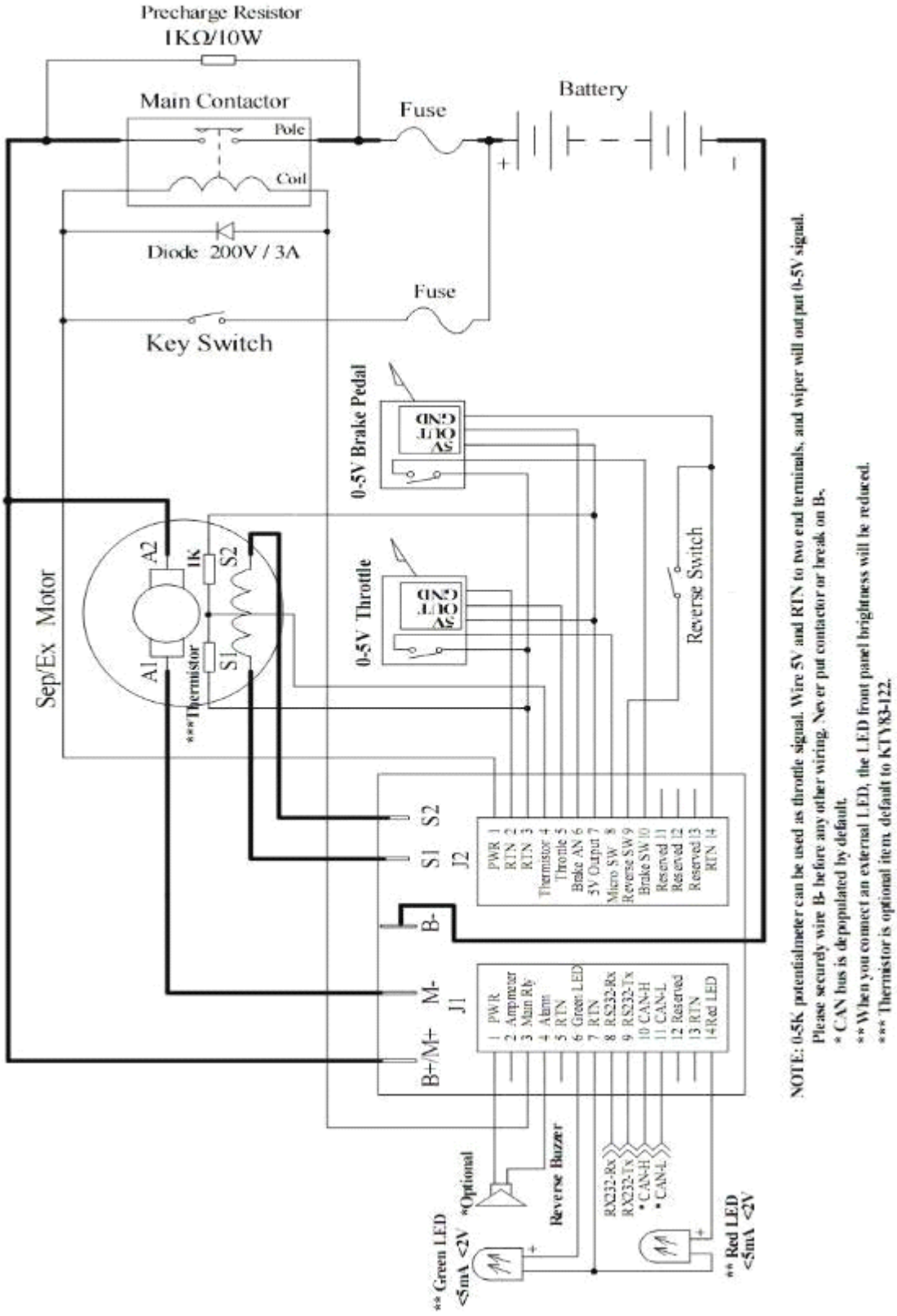


Figure 10: Sep-Ex Motor Controller Standard Wiring

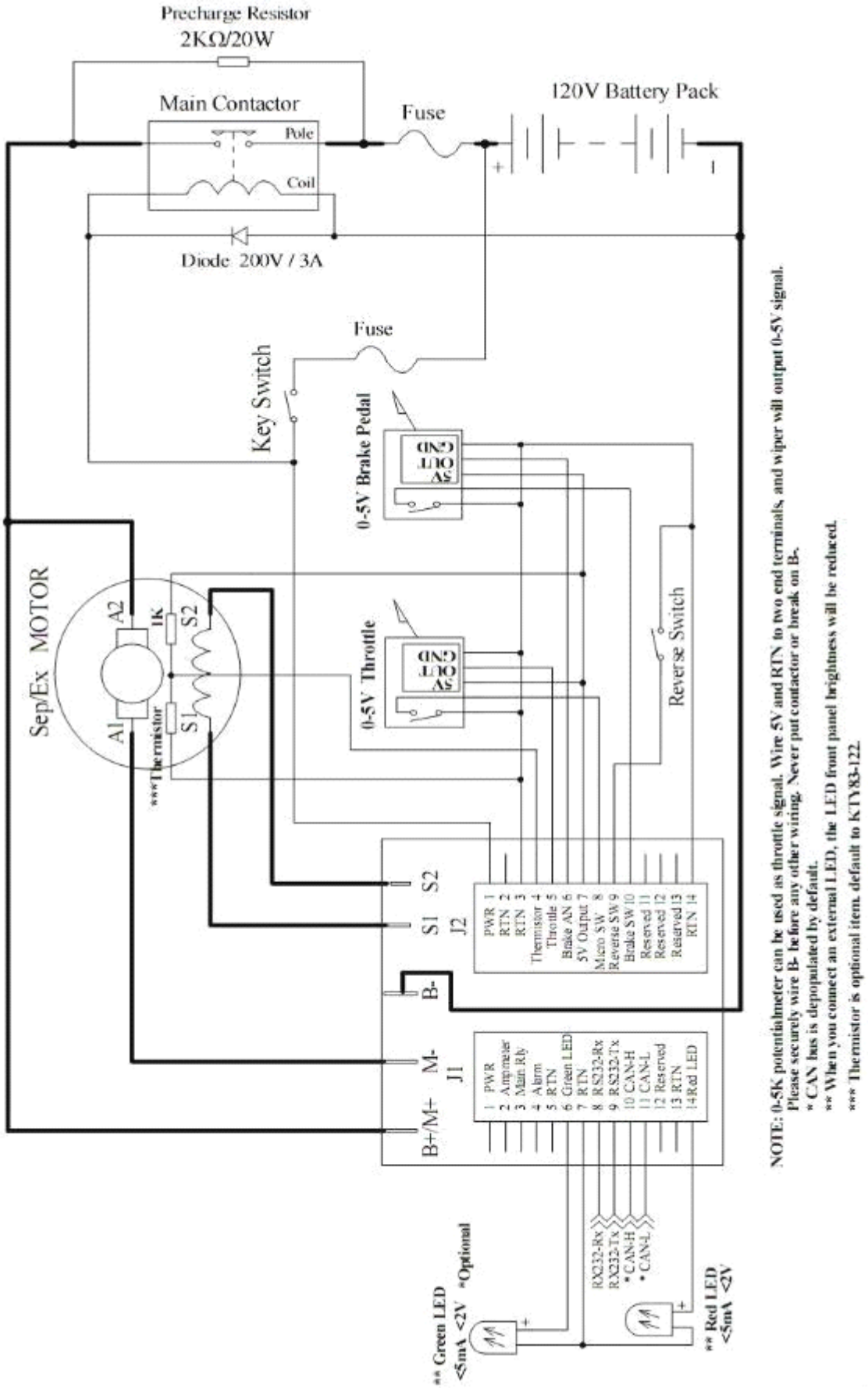


Figure 11: 120V Sep-Ex Motor Controller Standard Wiring

3.2.5 Communication Port

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

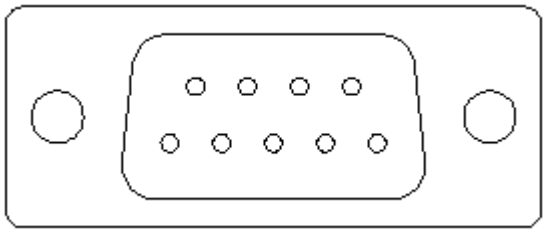


Figure 12: standard RS232 interface

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 it 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 conditotions, but it doesn't affect programming or configuration.
- Use a straight through RS232 cable or Standard USB To RS232 Converter provided by Kelly to connect to a host computer. Provide >+18V to PWR (either J2 pin1 or J1 pin1). Wire power supply return to any RTN 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.

Table 1: LED CODES

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!
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. The throttle got effective signal at key-on. Cycle throttle can remove the error. You may reconfigure throttle effective range or foot switch 2. The acceleration throttle must be turned from zero up to high when the brake is released. Otherwise the controller will report this fault.
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	¤¤¤ ¤¤¤	Wrong connection of throttle	Valid throttle signal is between 1V-4V. Fault report because signal is less than 0.5V or greater than

			4.5V.
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 over-voltage	Motor drive is disabled if an over-voltage is detected during regen. The voltage threshold detection level is set during configuration.
4,2	¤¤¤¤ ¤¤	Field error	1. Field did not reach the configured current. 2. Field circuit open. Please check field wiring.
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.			

Table 2.1: KDC 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,0x44,0x43 is 'K' , 'D', 'C', 0x30 is '0' . INFO_MODULE_NAME constant is defined as 64(0x40).

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(0x53).

Command **CCP_FLASH_READ**
Length 3
data[0] 0xF2
data[1] CAL_TPS_HIGH_DEAD_ZONE
data[2] 1
Controller response
Length 1
data[0] TPS_High_Dead_Zone

Desccription: Getting controller's Throttle high-end dead zone. CAL_TPS_HIGH_DEAD_ZONE constant is defined as 4(0x04).

Command **CCP_FLASH_READ**
Length 3
data[0] 0xF2
data[1] CAL_LOWTPS_DEAD_ZONE
data[2] 1
Controller response
Length 1
data[0] TPS_Low_Dead_Zone
Desccription: Getting controller's Throttle low-end dead zone. CAL_TPS_LOW_DEAD_ZONE constant is defined as 5(0x05).

Command **CCP_FLASH_READ**
Length 3
data[0] 0xF2
data[1] CAL_BRAKE_HIGH_DEAD_ZONE
data[2] 1
Controller response
Length 1
data[0] Brake_High_Dead_Zone
Desccription: Getting controller's Brake high-end dead zone. CAL_BRAKE_DEAD_ZONE_HIGH constant is defined as 47(0x2F).

Command **CCP_FLASH_READ**
Length 3
data[0] 0xF2
data[1] CAL_BRAKE_LOW_DEAD_ZONE
data[2] 1
Controller response
Length 1
data[0] Brake_Low_Dead_Zone

Desccription: Getting controller's Brake low-end dead zone. CAL_BRAKE_DEAD_ZONE_LOW constant is defined as 48(0x30).

Commend **CCP_FLASH_READ**
Length 3
data[0] 0xF2
data[1] CAL_F_enable
data[2] 1
Controller response
Length 1
data[0] Enable or disable Exciting Field and Field Mode

Description: Getting controller's exciting field enabled or disabled and field mode.
CAL_F_enable constant is defined as 45(0x2D).
Note: The value 0x00 indicates Exciting Field is turned off. The value 0x01 indicates Exciting Field is turned on, and selecting field mode as voltage mode (getting the value of duty cycle through next commend). The value 0x03 also indicates Exciting Field is turned on, but selecting field mode as current mode. (invalidate other values).

Commend **CCP_FLASH_READ**
Length 3

data[0] 0xF2
data[1] 0x2C
data[2] 1
Controller response
Length 1
data[0] The value of duty cycle at voltage mode when exciting field is enabled.
Description: Getting the value of duty cycle at voltage mode when exciting field is enabled.

Command **CCP_A2D_BATCH_READ 1**
Length 1
data[0] 0x1b
Controller gives one frame in response
First frame
Length 8

data[0] Brake A/D
data[1] TPS A/D
data[2] SP A/D
data[3] TEMP A/D
data[4] HS_TEMP A/D
data[5] LS_TEMP A/D
data[6] B+ A/D
data[7] BEMF A/D

Command **CCP_A2D_BATCH_READ 2**
Length 1
data[0] 0x1a
Controller gives one frame in response
Length 4

data[0] IB A/D
data[1] ICA/D
data[2] Va A/D
data[3] VcA/D

Description: Data batch reading.

1) For operation voltage, B+, Va, BEMF, Vc, A/D value and voltage mapping relation is:
   V = Vad / 4.06. (For 24V,36V,48V controller);
   V = Vad / 2.71. (For 72V controller);
   V = Vad / 1.84. (For 120V controller).
2) 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.
4) SP A/D value of motor temperature .
5) TEMP A/D value of controller temperature.
6) HS_TEMP A/D value is defined as temperature of high side FETMOS heat sink and LS_TEMP A/D value is defined as temperature of low side FETMOS heat sink.
7) B+ A/D value of battery voltage.
8) BEMF A/D is defined as Back EMF.
9) Ib A/D value of armature driving current.
   Ic A/D value of regeneration current .
10) If you are using Separately excited motor ,Va - A/D value of field voltage at reversing,Vc - A/D value of field voltage at forwarding.
    Otherwise,Va and Vc are returned 0XFF.

Command **CCP_MONITOR**
Length 1
data[0] 0x33
Controller gives one frame in response
Length 8
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
Data[6] voltage of battery
data[7] current accounts for percent of the rated current of controller
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 **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.

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:

1.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.

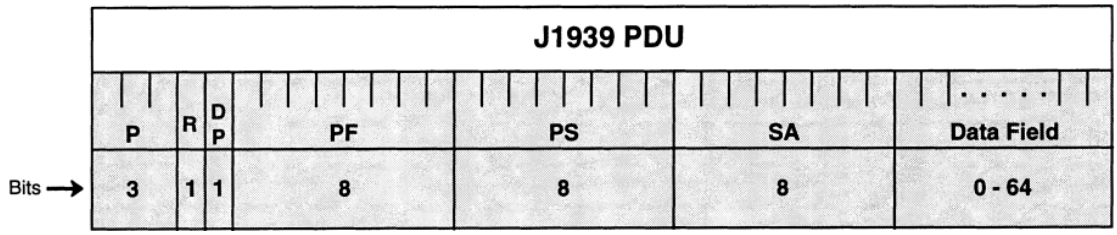


Table 2.2: KDC Controller J1939 Instructions

PDU: Protocol Data Unit, contains 29 bits extended format ID and data field. ID7-0 is SA, ID15-8 is PS, ID23-16 is PF, ID24 is DP, ID25 is R, ID28-26 is P.

Definitions: P is Priority, R is Reserved, DP is Data Page, PF is PDU Format, PS is PDU Specific, SA is Source Address.
Note: The definition of PS depends on the PF. If the value of the PF field is below 240, then the PS field is a destination address(DA). If the value of the PF field is 240 to 255, then the PS field contains a Group Extension (GE) value.

After power up, controller will send a message for address claimed to the global address. Controller will respond to the PGN requested if the message received by controller is Request PGN message which PF field is 234. If the message received by controller is a command, the controller will execute corresponding operation and then send ACK or NACK message to the global address respectively representing executing command or not. We have defined our PGNs on the DataPage1. The data fields of every response message has 8 bytes. Undefined bytes set as 0xFF.

The Message for Address Claimed: R is 0; DP is 0; PF is 238; PS is 255, the global address; Data Field is the NAME of CA(Controller Application).
E.g. P is 3, SA of this node is 0x80 and the NAME of CA is 0x80 00 00 00 00 00 00 30, the Message for Address Claimed is 0x0C 0xEE 0xFF 0x80 0x30 0x00 0x00 0x00 0x00 0x00 0x00 0x80. The first four bytes is ID and the last eight bytes is the NAME of CA(the lowest byte of NAME is sent firstly, finally the highest byte of NAME).

Preferred Address and NAME of CA(Controller Application) are programmable. It can be set by configuration program. The default value as follows:
Preferred Address: 63（configurable, limit: 0-127，248-253）

NAME (10 fields):
Arbitrary Address Capable Fields: 1 (1 bit, 0--disable, 1--enable)
Industry Group Fields: 0 (3 bits, limit: 0-7)
Vehicle System Instance Fields: 0 (4 bits, limit: 0-15)
Vehicle System Fields: 0 (7 bits, limit: 0-127)
Reserved Fields: 0 (1 bit)

Function Fields: 0 (8 bits, limit: 0-255)
Function Instance Fields: 0 (5 bits, limit: 0-31)
ECU Instance Fields: 0 (3 bits, limit: 0-7)
Manufacturer Code Fields: 0 (11 bits, limit: 0-2047)
Identity Number Fields: (21 bits, limit: 0-2097151)

The message for Request PGN: R is 0, DP is 0, PF is 234, PS is specific or global destination address, Data Field is the requested Parameter Group Number(PGN). If the node support the requested parameter group, it will send this parameter group.
E.g. A controller whose SA is 0x80 receives a message for Request PGN which is 0x18 EA 80 81 00 78 01. It means the node whose SA is 0x81 requests the Parameter Group with PGN0x017800 and P of this message is 6. If our controller supports this Parameter Group, the response to the request is 0x19 78 81 80 data[0]~data[7], whose P is 6, R is 0, DP is 1, PF is 0x78, DA is 0x81, SA is 0x80, data[0]~data[7] are the value of Parameters.

Now, the PGNs supported by our controller are as follows:

PGN：0x017800
Parameters: controller's model
Description: Controller's model in ASCII format, 8 bytes. E.g. If the model of controller is KBL72301, it would send a message with 8 bytes, which are data[0]-data[7], namely, 0x31,0x30,0x33,0x32,0x37,0x43, 0x44,,0x4B.

PGN：0x017900
Parameters: software version
Description: It is also defined as the controller's version, BCD alike format storage. data[0]-data[1], two bytes. E.g. If data[0]-data[7] are 0x02, 0x03, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, it should be parsed to ASCII characters '0' '3' '0' '2' as the software version.

PGN：0x017A00
Parameters: pedals dead zone
Description: 4 bytes, data[0]-data[3] are respectively defined as Throttle Low-end Dead Zone, Throttle High-end Dead Zone, Brake Low-end Dead Zone and Brake High-end Dead Zone of the controller. The maximum value of Throttle and Brake are 200 and 100. If the value of Throttle Low-end Dead Zone is 40, indicating 20% dead zone. (40/200 is 20%.)

PGN：0x017B00
Parameters: temperature and battery voltage
Description: 5 bytes, in Celsius temperature. data[0]-data[3] are defined as motor temperature, controller temperature, temperature of high side FETMOS heat sink and temperature of low side FETMOS heat sink. data[0] is motor temperature. The controller returns 0xFF if the temperature sensor is not connected. data[1]-data[3] are defined as controller inside temperature in Celsius temperature. The value of data[2] and data[3] are inaccurate below 30℃.data[4].is defined as battery voltage.

PGN：0x017C00
Parameters: valid value of throttle and brake
Description: 2 bytes, data[0]~data[1] are defined as TPSx and BRAKEx. TPSx -- valid throttle value, 0 -200. BRAKEx -- valid brake value, 0 -100.

PGN：0x017D00
Parameters: switch status
Description: 3 bytes, data[0]~data[2] are defined as current Throttle switch status, Brake switch status and Reverse swith status. 1 – active, 0 – inactive.

PGN：0x017E00
Parameters: A/D value of voltage and current
Description: 6 bytes, definition as following:

data[0] B+ A/D
data[1] Ib A/D
data[2] Ic A/D
data[3] BEMF/AD
data[4] Va A/D
data[5] Vc A/D

For B+, Va, BEMF/AD, Vc, A/D value and voltage mapping relation is:
V = Vad / 4.06. (For 24V,36V,48V controller);
V = Vad / 2.71. (For 72V controller);
V = Vad / 1.84. (For 120V controller).
A/D value and voltage mapping relation is:120 ~ 134 mapping to 4.75 ~ 5.25V. Ib is defined as drive current AD and Ic is defined as regeneration current AD .BEMF/AD is defined as back EMF AD.If you are using the controllers which are specially designed for Separately excited motor,so that Va is defined as reverse excited field voltage AD and Vc is defined as forward excited field voltage AD.otherwise,Va and Vc are returned 0xFF.

PGN：0x017F00
Parameters: monitor
Description: 2 bytes. data[0]--PWM is output duty cycle, from 0 to 100. data[1]--current accounts for percent of the rated current of controller.

The Message for Command: When receiving command, node will execute corresponding operation. E.g. When receiving command with PGN0x017600, controller will execute the operation of writing throttle to change the speed of motor. If P of this command is 3, R is 0, DP is 1, PF is 0x76, DA is 0x80, SA is 0x81, data[0] is 0x10, the message for this command is 0x0D 76 80 81 10. After finishing the command of writing throttle with 0x10, the controller with SA0x80 will send a ACK message to the global address, showing this command can be executed.
ACK: 0x18 E8 FF 80 00 FF FF FF FF 00 76 01
NACK: 0x18 E8 FF 80 01 FF FF FF FF 00 76 01
P is 6, R is 0, DP is 0, PF is 0xE8, DA is 0xFF, SA is 0x80. That data[0] of the last eight bytes is 0 indicates ACK. That data[0] is 1 indicates NACK. data[5]-data[7] of the last eight bytes are the PGN0-2 of requested message.

Now, the commands supported by our controller are as follows:

NOTICE: CAN bus rate should be configured to 250Kbit/s. The controller will make a response only if the message received is for address claimed, the Request PGN message, the command of writing TPSx or BRAKEx.

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