

# **.....KD Brushed Motor Controller User's Manual**

## **Devices Supported:**

<b>KD24200</b>	<b>KD48200</b>	<b>KD72200</b>
<b>KD24201</b>	<b>KD48201</b>	<b>KD72201</b>
<b>KD24202</b>	<b>KD48202</b>	<b>KD72202</b>
<b>KD24203</b>	<b>KD48203</b>	<b>KD72203</b>
<b>KD24300</b>	<b>KD48300</b>	<b>KD72300</b>
<b>KD24301</b>	<b>KD48301</b>	<b>KD72301</b>
<b>KD24302</b>	<b>KD48302</b>	<b>KD72302</b>
<b>KD24303</b>	<b>KD48303</b>	<b>KD72303</b>
<b>KD24400</b>	<b>KD48400</b>	<b>KD72400</b>
<b>KD24401</b>	<b>KD48401</b>	<b>KD72401</b>
<b>KD24402</b>	<b>KD48402</b>	<b>KD72402</b>
<b>KD24403</b>	<b>KD48403</b>	<b>KD72403</b>
<b>KD36200</b>	<b>KD48500</b>	<b>KD72500</b>
<b>KD36201</b>	<b>KD48501</b>	<b>KD72501</b>
<b>KD36202</b>	<b>KD48502</b>	<b>KD72502</b>
<b>KD36203</b>	<b>KD48503</b>	<b>KD72503</b>
<b>KD36300</b>		
<b>KD36301</b>		
<b>KD36302</b>		
<b>KD36303</b>		
<b>KD36400</b>		
<b>KD36401</b>		
<b>KD36402</b>		
<b>KD36403</b>		

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# **Chapter 1 Introduction**

## **1.1 Overview**

The manual introduces motor controllers' features, installation and maintenance. Read the manual carefully and thoroughly before using the controller. If you have any questions, please contact the support center of Controls.

Programmable motor controllers provide efficient, smooth and quite controls for electrical vehicles like golf cart, electric motorcycle, fork lift, as well as electric boat and industry motor speed control. It uses high power MOSFET, fast PWM to achieve efficiency 99% in most cases. Powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to set parameters, conduct tests, and obtain diagnostic information quickly and easily.

## Chapter 2 Main Features and Specifications

### 2.1 General functions

- (1) The controller measures battery voltage. It won't drive motor if B+ is higher than the maximum operating voltage. It also stops driving if battery voltage is too low. You can identify the error from LED codes. Under voltage threshold and over voltage threshold are configurable with PC GUI.
- (2) The controller will close the main contactor after power on self-test. Then it waits a configurable time (configurable, default to 0.5s) for contactor bumping.
- (3) Current loop and over current protection are built in for both field and armature. The field current is constant across all operation conditions except in the case of field weakening. Armature current is commanded by throttle.
- (4) The armature current is trimmed down at low temperature and high temperature to protect battery and controller. The armature current will ramp down quickly over 90°C. Both armature and field will shut down at 100°C. Low temperature current ramping down usually starts at 0°C.
- (5) Cutting back current at low battery is built in every controller to extend battery life. **Caution!** *Excessive voltage drop on wiring may cause problem! Proper gauge of wire is required.*
- (6) The max regeneration current is about half of rated current. **Caution!** *Regeneration can have braking effect, but it can't replace mechanical brake. The controller may shut down regen in some cases.*
- (7) Max reverse speed is configurable to half of max forward speed.

### 2.2 Features

- Intelligence with powerful microprocessor,
- Synchronous rectification, fast PWM, and ultra low drop to provide high efficiency.
- Rugged aluminum housing for maximum heat dissipation.
- Current loop and over current protection for both field coil and armature.
- Current multiplication. Usually the armature current is much higher than the current drawn from battery.
- LED blinking code indicates fault sources.
- Battery protection: current cutback and turnoff when battery voltage is too low.
- Thermal protection: current cuts back at high temperature and low temperature to protect battery and controller.
- Configuring current-voltage mode of field function on controller with field to achieve more reliable.
- Critical parameters can be configured with GUI to best fit your application.

### 2.3 Additional Features (Terminals available on back side)

Following features are configurable through series communication with a host PC.

- "MAIN RLY" can be configured as a Peak and Hold Main Contactor coil driver.
- "BEEP/MTR" can be configured to drive reverse alarm or current meter. Can drive Ampmeter directly.
- BRK-SW as Brake Switch is required for regeneration.

- BRK-AN as Brake analog input can be configured for continuous variable regeneration.
- TPS2-AN can be configured as alternative throttle input. 3-wire pot or 0-5V sensor can work with the input. Please configure as 0-5V throttle should the pin be used.
- Optional Waterproof.

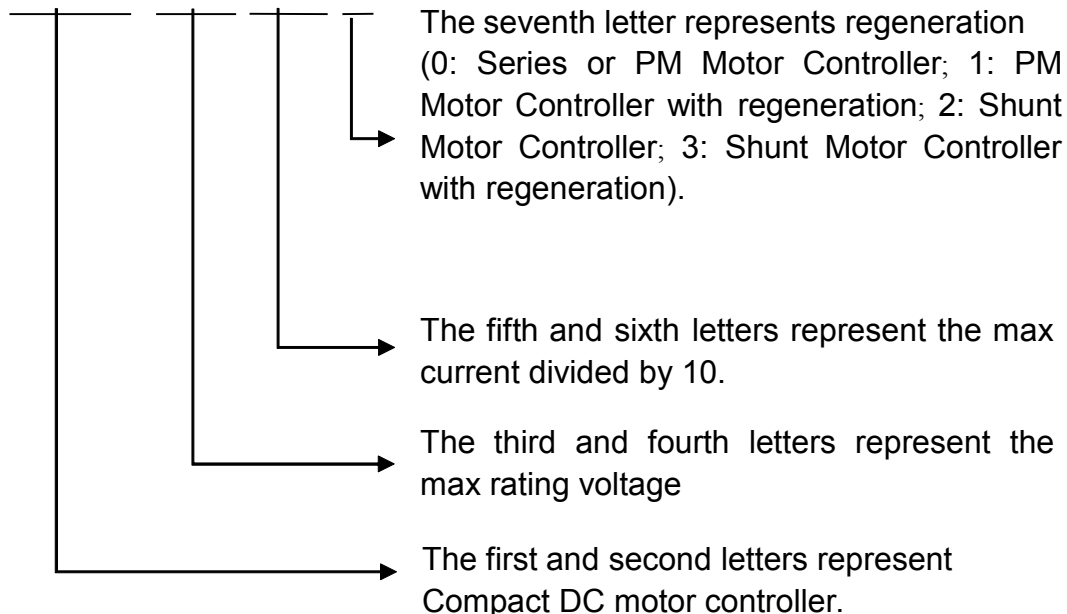
## 2.4 Specifications

- Frequency of Operation: 16.6 KHz.
- Standby Battery Current: less than 1 m A.
- Controller power supply current, PWR, <150mA.
- Controller power supply voltage, PWR, 18V to 90V (8V to 30V for 24V controller).
- Minimum operating voltage, B+, 18V (8V for 24V controller).
- Max regeneration voltage, B+, 1.25\* Nominal.
- Throttle Input: 0-5 K, 5-0 K ohms, 0-5 Volts.
- Full Power Operating Temperature Range: 0°C to 50 °C (controller case temperature).
- Operating Temperature Range: -30°C to 90 °C, 100C shutdown (controller case temperature).
- Peak and Hold Main Contactor Driver: 3A peak, 1A hold.
- Alarm Output: 200mA.
- Armature Current Limit, 1 minute: 200- 500A, depending on model.
- Armature Current Limit, continuous: 80-200A, depending on model.

## 2.5 Models

The naming regulations of the motor controller model:

### KD48301



## Chapter 3 Wiring and Installation

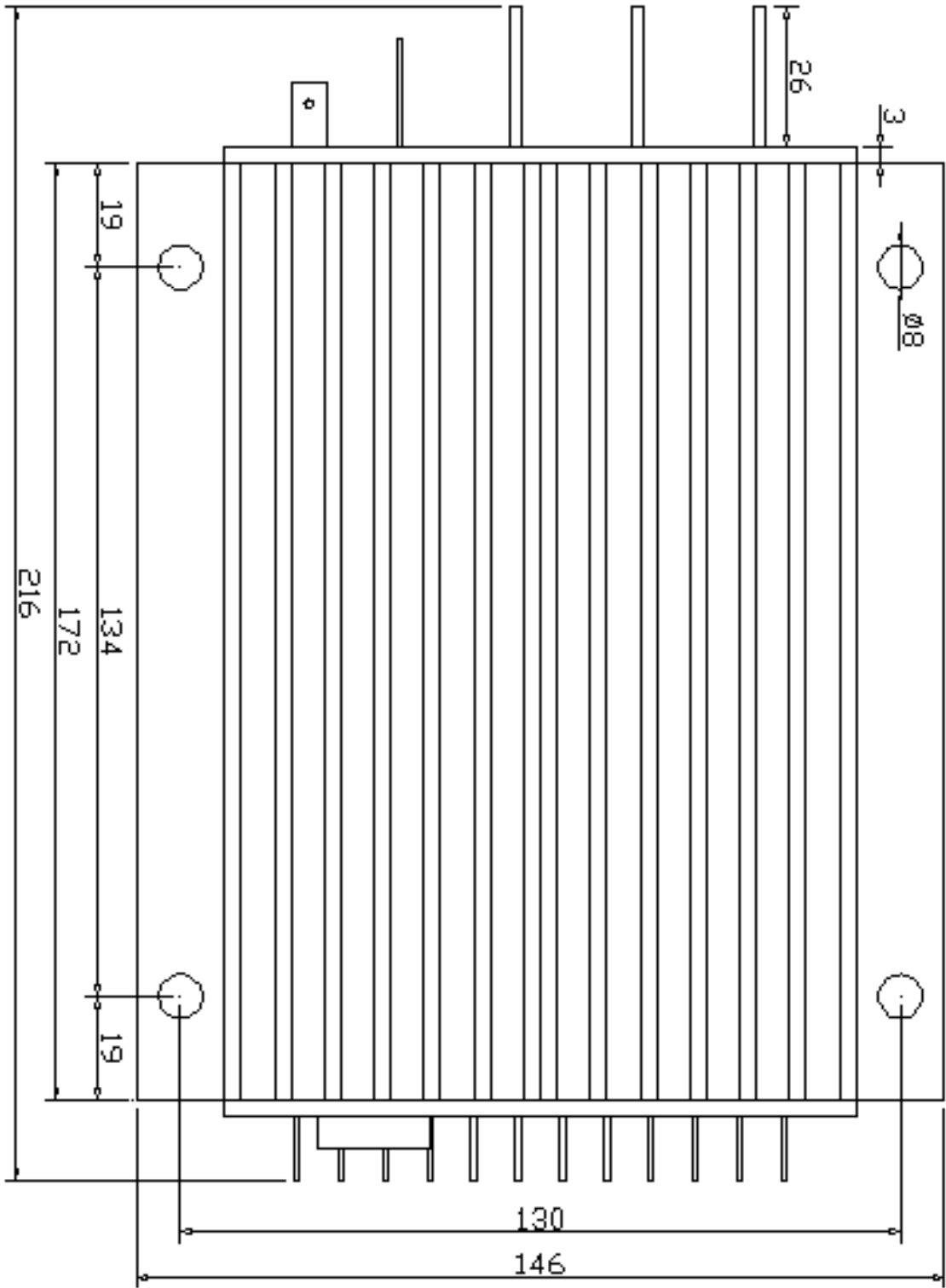
### 3.1 Mounting the Controller

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. 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.



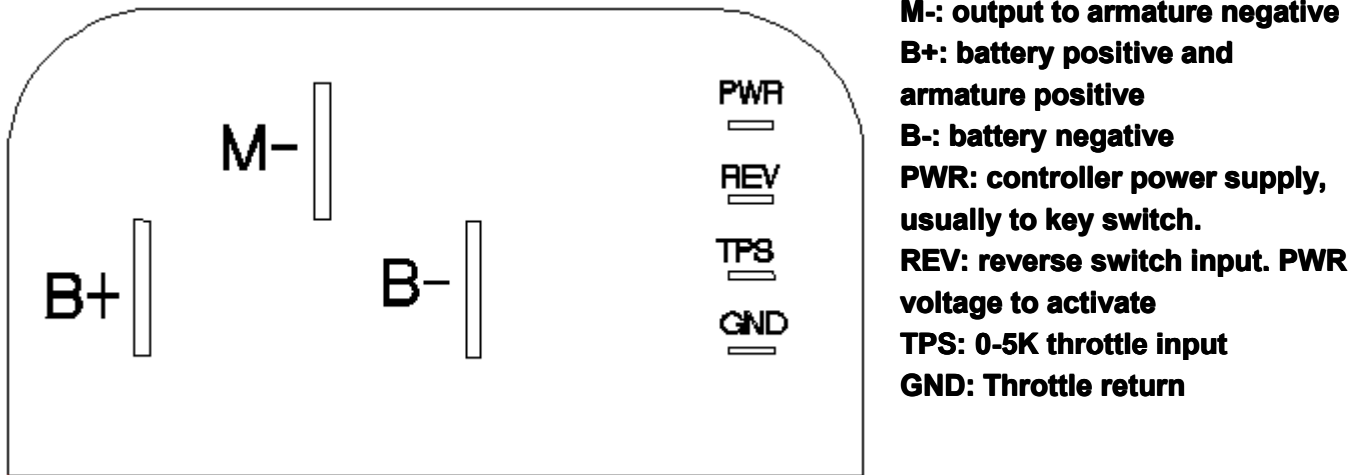
Height: 62 millimeters

**Figure 1:** Dimensions (in millimeters)

## 3.2 Connections

### 3.2.1 Front Panel of Series Wound or PM Motor Controller:

Seven metal bars are provided for connecting to the battery, motor and control signals in the front of the controller shown as Figure 2.



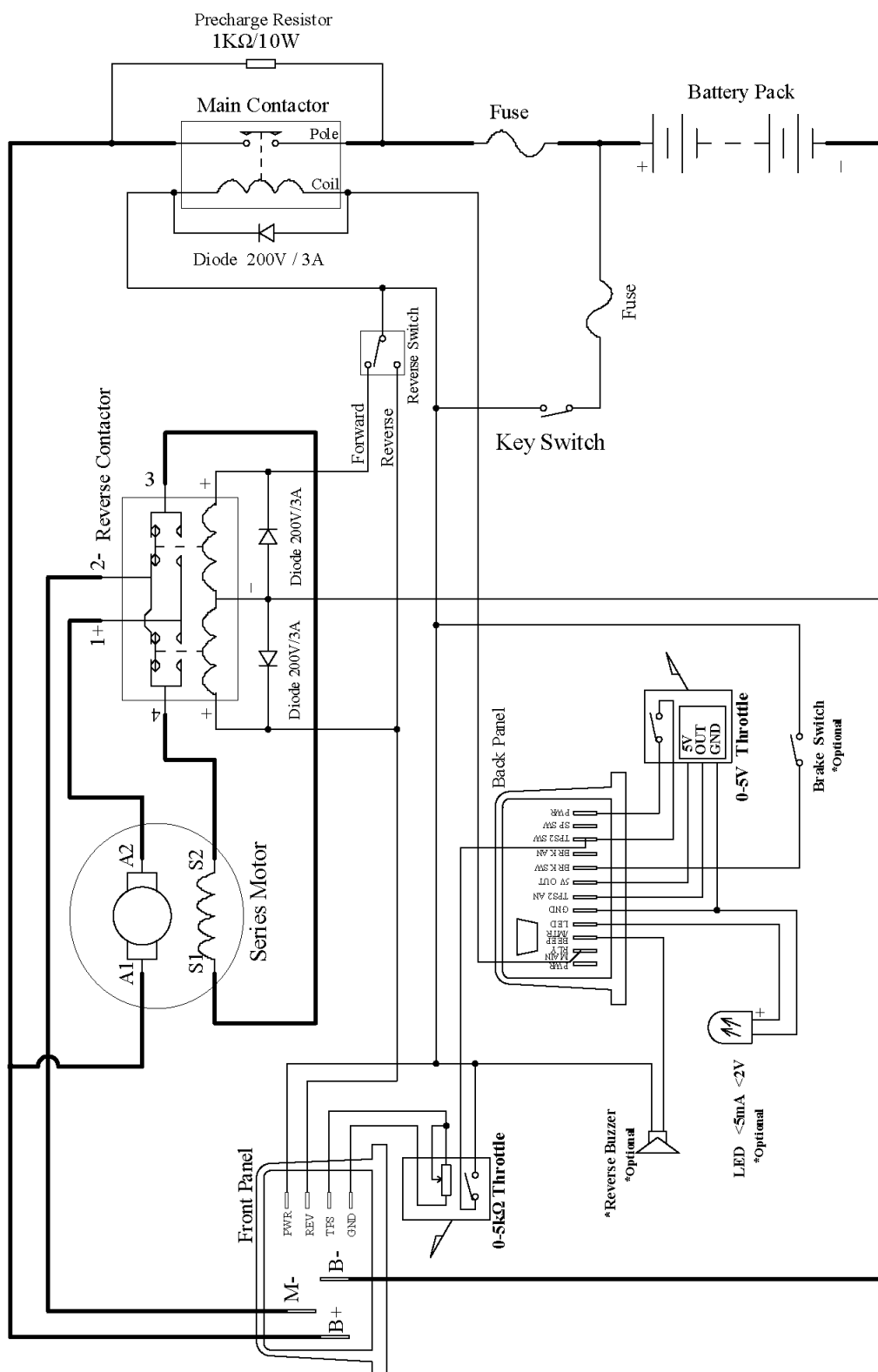
**Figure 2:** Front panel of Series Wound or PM Motor Controller

**Caution: Make sure all connections are correct before applying power. Otherwise it may damage the controller! Please securely wire B- before applying power. It's preferred to place contactor or breaker on B+. Please place precharge resistor on any breaker! It can cause damage without it!!!**

- 1. Power switch:** The vehicle should have a master switch to turn the controller on and off. PWR provides power for the controller. It is preferred that PWR provides power to switches, coils and other accessories. The wire and fuse must be capable of carrying the current.
- 2. Reverse switch input:** Make sure the throttle is released before changing direction, or controller will stop output. It is considered as reverse if the input  $> 0.7 \times \text{PWR}$ .
- 3. Resistive throttle analog input:** 0-5K or 5-0K resistive throttle input. Default to 0-5K. Default effective zone is 20%-80%. Below 1K corresponds to zero speed and above 4K corresponds to full speed. If open, controller will take TPS2-AN 0-5V input as alternative.

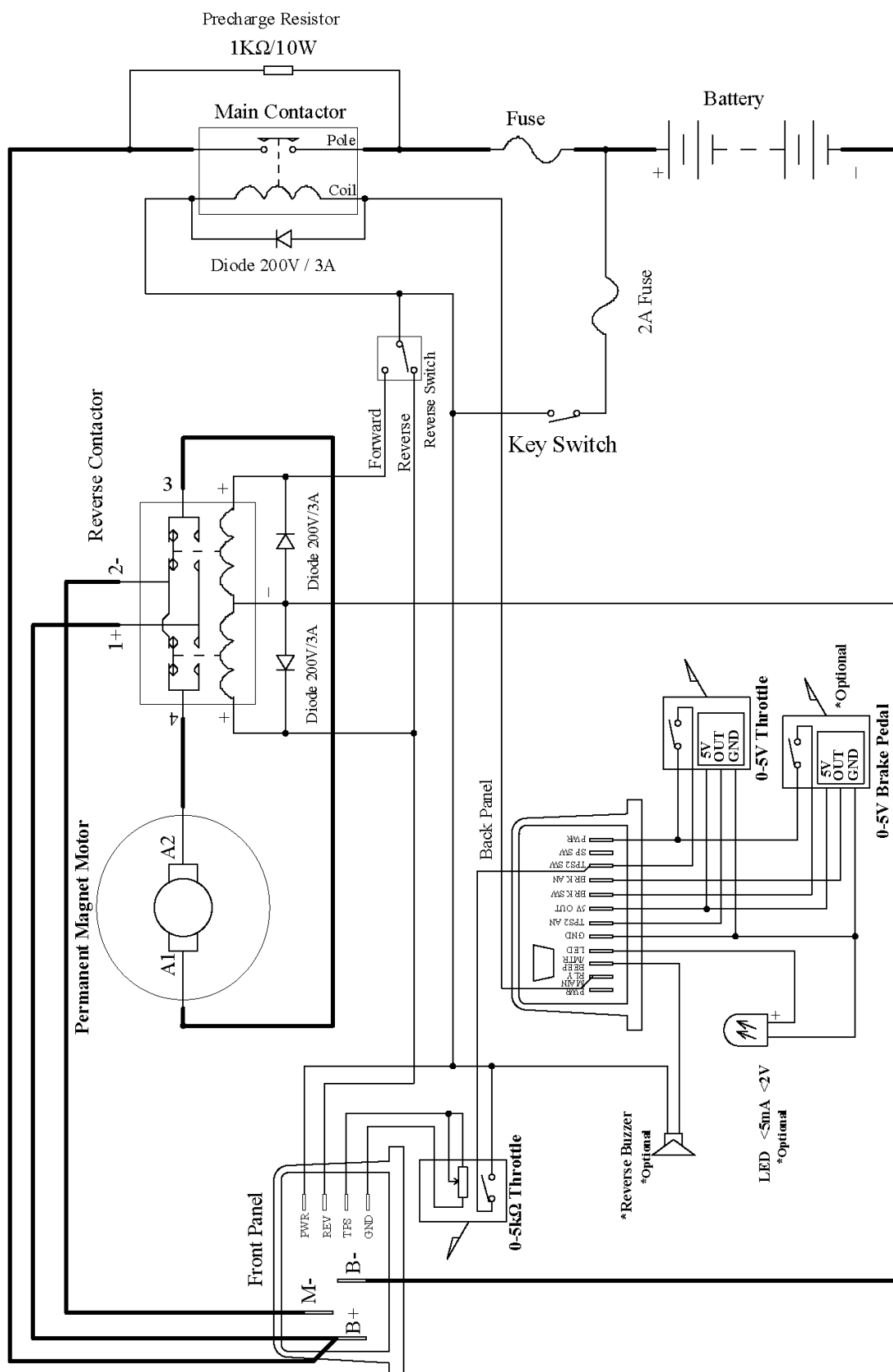


### 3.2.2 Standard Wiring of Series Wound and PM Motor Controller



NOTE: Either 0-5K Resistive Throttle to TFS Or 0-5V Throttle to TFS2\_AN.  
Please securely wire B- before any other wiring. Never put contactor or break on B-. It's preferred to wire B- to chassis.  
When you connect an external LED, the LED back panel brightness will be reduced.

**Figure 3:** Series wound motor controller standard wiring

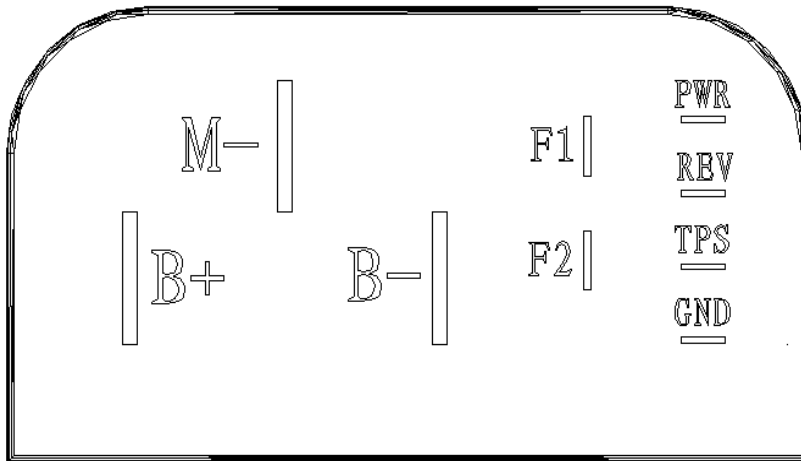


NOTE: Either 0-5K Resistive Throttle to TFS Or 0-5V Throttle to TFS2 AN.  
Please securely wire B- before any other wiring. Never put contactor or break on B-. It's preferred to wire B- to chassis.  
When you connect an external LED, the LED back panel brightness will be reduced.

**Figure 4:** PM motor controller standard wiring

### 3.2.3 Front Panel of Sep/Ex and Shunt Motor Controller:

Nine metal bars are provided for connecting to the battery, control signals, motor armature and field in the front of the controller.

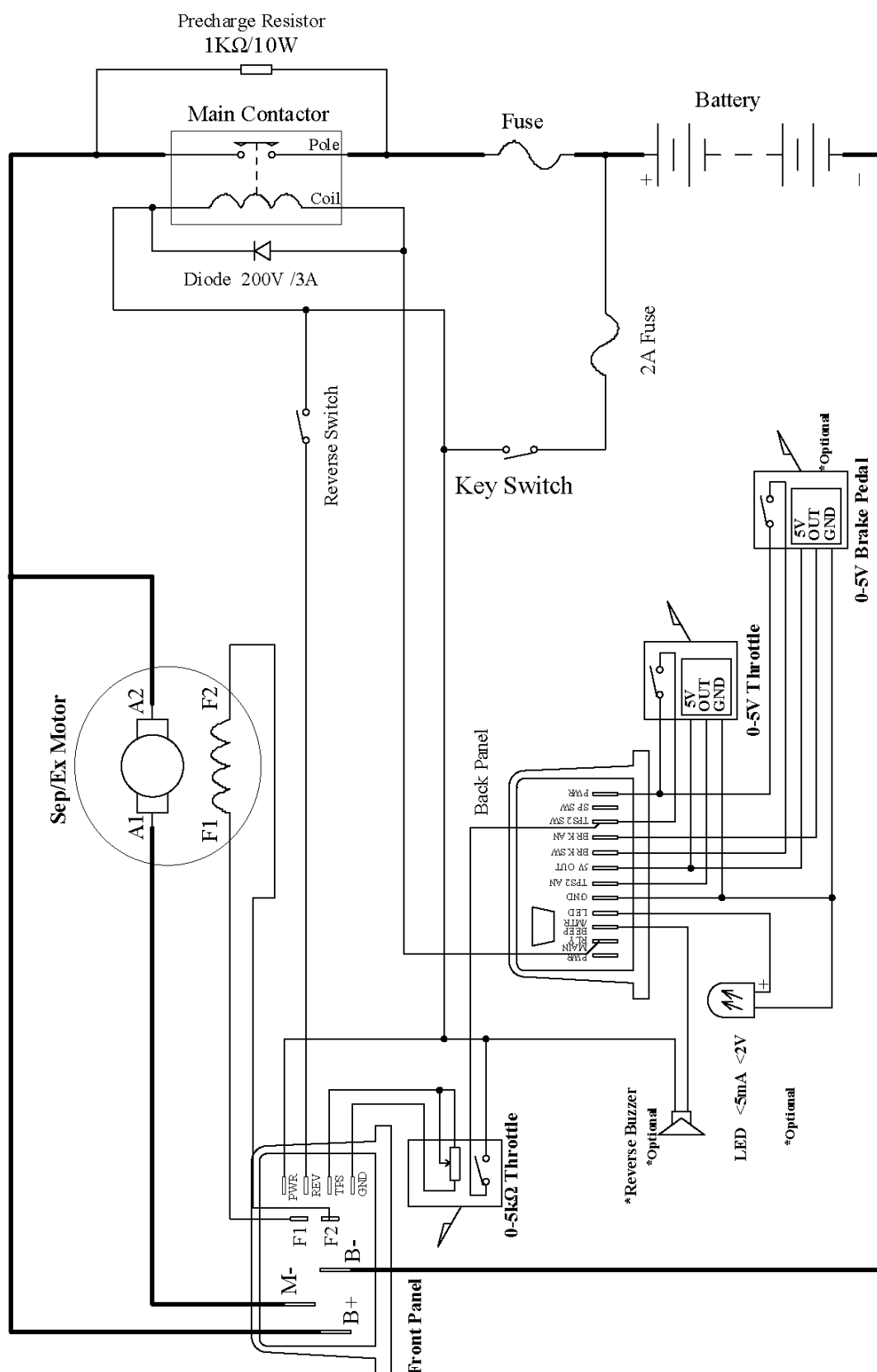


**M-:** output to armature negative  
**B+:** battery positive and armature positive  
**B-:** battery negative  
**F1:** field positive  
**F2:** field negative  
**PWR:** power switch input  
**REV:** reverse switch input  
**TPS:** resistive throttle analog input  
**GND:** sensor return

**Figure 5:** Front Panel of Shunt Motor Controller

- 1. Power switch:** The vehicle should have a master switch to turn the controller on and off. PWR provides power for the controller. It is preferred that PWR provides power to switches, coils and other accessories. It must be capable of carrying the current.
- 2. Reverse switch input:** Make sure the throttle is released before changing direction, or controller will stop output. It is considered as reverse when the input reaches  $0.7 \times \text{PWR}$  voltage
- 3. Resistive throttle analog input:** 0-5K or 5-0K resistive throttle analog input. Default to 0-5K. Default effective zone is 20%-80%. Below 1K corresponds to zero speed and above 4K corresponds to full speed. If open, controller will take AN2 0-5V input as alternative.
- 4. F1 and F2:** Connect to motor field coil. Motor moves forward when current flow from F1 to F2, in the case of REV switch open.

### 3.2.4 Standard Wiring of Sep/Ex and Shunt Motor Controller:

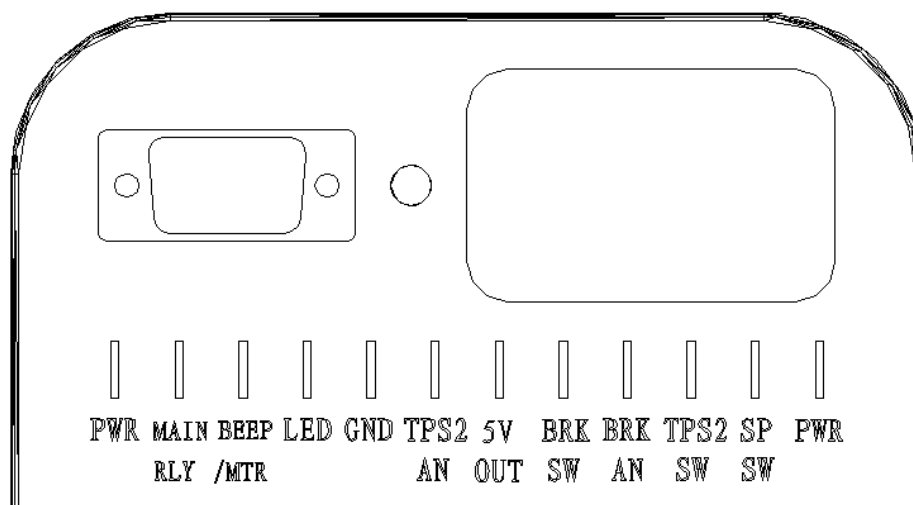


NOTE: Either 0-5K Resistive Throttle to TPS Or 0-5V Throttle to TPS2\_AN.  
Please securely wire B- before any other wiring. Never put contactor or break on B-. It's preferred to wire B- to chassis.  
When you connect an external LED, the LED back panel brightness will be reduced.

### Figure 6: Sep-Ex Motor Controller Standard Wiring

### 3.2.5 Back Panel:

Twelve metal bars and a communication port are provided on the back panel of each controller shown as Figure 7.



**Figure 7:** Back Panel of all Controllers

**PWR:** Controller power supply (output).

**MAIN RLY:** main contactor coil driver.

**BEEP/MTR:** can drive either reverse alarm or ampmeter. Default is reverse alarm. Configured as current meter. Ampmeter positive connect to 5V OUT, negative to BEEP/MTR.

**LED:** LED anode

**GND:** LED cathode and sensor return

**TPS2 AN:** 0-5V throttle analog input, as alternative of 0-5K TPS input.

**5V OUT:** +5V 30mA output as supply to throttle or brake sensors.

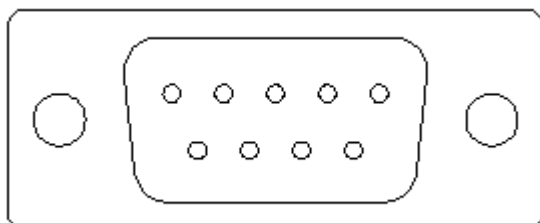
**BRK SW:** brake switch input, active when apply PWR voltage

**BRK AN:** 0-5V brake analog input.

**TPS2 SW:** throttle switch input, active when apply PWR voltage

**SP SW:** reserved switch input, active when apply PWR voltage

### 3.2.6 Communication Port



A SCI port is provided to communicate with RS232 of host computer for calibration and configuration. Please note only a special RS232 Converter provided by controls can be used. Please use straight RS232 cable to connect with PC

### **3.3 Installation Checkout**

Before operating the vehicle, complete the following checkout procedures. Use LED code as a reference. The LED codes are listed in Table 1.

**Caution:**

- Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.
- Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.
- Make sure both the PWR switch and the brake are off.
- Use well-insulated tools.

- Make sure the wire is connected correctly
- Turn the PWR switch on. The LED should blink, then keep on when the controller operates normally. If this does not happen, check PWR voltage and controller ground.
- The fault code will be detected automatically at restarting.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. If it does not, verify the wiring to the REV switches, REV contactors, Main contactor and motor. Also check fuse. The motor should run faster with increasing throttle. If not, refer to Table 1 LED code, and correct the fault according to the code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good top speed.

## **Chapter 4 Maintenance**

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller, or you will damage it. However, clearing the controller exterior periodically should be necessary.


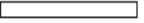
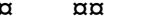
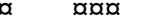
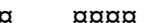
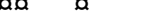
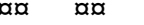
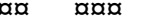
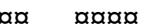
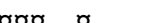
The controller is inherently a high power device. When working with any battery powered vehicle, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, avoiding loose clothing and jewelry, and using insulated wrenches.

### **4.1 Cleaning**

Although the controller requires actually no maintenance after properly installed, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped down with a moist rag. Be sure it is dry before reconnecting the battery.
- Make sure the connections to the bus bars are tight. Use two wrenches for this task in order to avoid stressing the bus bars; the wrenches should be well insulated.

**Table 1: LED CODES**

LED Code		Explanation	Solution
Off		No power or no operating	<ol style="list-style-type: none"> <li>1. Check whether the connection is correct.</li> <li>2. Check fuse and power supply switch.</li> </ol>
On		operate normally	That's great! You got solution!
1,2		Over voltage error	<ol style="list-style-type: none"> <li>1. Battery voltage is higher than max operating voltage of the controller. Please check the battery voltage.</li> <li>2. Over voltage at regeneration. Controller will cut back or stop regeneration.</li> <li>3. Please note there could be 2% error with Overvoltage setting.</li> </ol>
1,3		Low voltage error	<ol style="list-style-type: none"> <li>1. The controller will attempt to clear the fault code automatically after 5 second if battery voltage returns to normal.</li> <li>2. Check the battery voltage.</li> <li>3. Charge battery if necessary.</li> </ol>
1,4		Temperature warning	<ol style="list-style-type: none"> <li>1. The controller case temperature is over 90℃. The controller will cut back current in the case. Stop or reduce output to ensure the temperature fall.</li> </ol>
2,1		Throttle sensor fault	<ol style="list-style-type: none"> <li>1. Check whether the connecting is correct.</li> <li>2. Check whether the throttle type is correct.</li> <li>3. If configured 0-5V hall throttle, check if the voltage is over 5V.</li> <li>4. Check configured throttle type. TPS2 should be configured as voltage input if used.</li> </ol>
2,2		Internal voltage fault	<ol style="list-style-type: none"> <li>1. Check if PWR voltage is correct.</li> <li>2. Please check load on 5V supply.</li> </ol>
2,3		Over temperature error	<ol style="list-style-type: none"> <li>1. When controller case temperature is over 100℃. It will stop driving in order to protect itself.</li> <li>2. Stop driving and wait for temperature fall. The controller will resume operation once temperature falls below 80℃.</li> </ol>
2,4		Throttle error at powerup	<ol style="list-style-type: none"> <li>1. The throttle got effective signal at key-on. Cycle throttle can remove the error. You may reconfigure throttle effective range or foot switch</li> <li>2. The acceleration throttle must be turned from zero up to high when the brake is released. Otherwise the controller will report this fault.</li> </ol>
3,1		Frequent Reset	<ol style="list-style-type: none"> <li>1. It can be caused by over current, bad motor, bad ground wiring or so.</li> </ol>



3,2	□□□ □□	Internal reset	Reset caused by over current, low supply voltage, and overvoltage. It is normal if occur occasionally.
3,4	□□□ □□□□	Throttle have signal when change direction	The controller will stop output in the case. Cycle throttle can clear the error.
4,1	□□□□ □	Over voltage error at regeneration	The voltage is higher than configured overvoltage value. The controller can resume operation when voltage lowered and brake cycled.
4,2	□□□□ □□	Field error	1. Field do not reach configured current. 2. Field circuit open. Please check field wiring.
<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>			