



# Operators Manual

Model: **AXE Series**

Series Wound DC Electric Motor Controller

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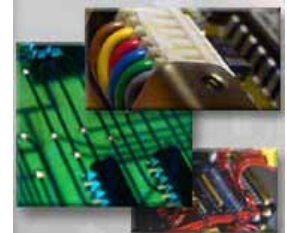
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# 1. AXE Motor Control Product Overview

Thank You for purchasing the Alltrax motor controller. We design and manufacture products for a variety of electric vehicles and markets. This motor controller employs modern power MOSFETs to provide extremely low “on” resistance, in both the main switch function and freewheel diode.

Synchronous freewheel rectification permits extended high power operation over similar sized controllers due to increased efficiency. A microprocessor based control system monitors numerous functions, and a windows interface allows the user to change numerous operating parameters and perform status monitoring.



Replaces Curtis 1204 (6.5” long)



Replaces Curtis 1205 (8.5” long)



## 2. Required Accessories

These components **are not supplied** with the controller, *except the main fuse*. For your safety and that of others, some basic precautionary measures must be employed when designing, working on, and driving electric vehicles.

- **Use a contactor in the battery circuit, rated for the amperage and voltage of the system.**
- **Use a fuse rated for the voltage and available fault current of the battery, such as the one provided.**
- **Safety interlocks must be employed to prevent enabling the controller while the vehicle is unoccupied or charging.**

Controllers have failure modes which can result in runaway (stuck throttle) conditions. This controller has been designed to prevent and preclude as many of those from ever occurring as possible. Please follow the Recommended Controller Wiring System document in this manual. Failure to do so could result in damage to the controller, and serious injury or death to vehicle occupants or bystanders

### 2.1 Battery Contactor (Solenoid or Relay)

The main battery contactor needs to be rated correctly in terms of amps and volts, in order to safely carry the intended continuous battery current, and to interrupt the pack DC voltage. It's coil voltage should also be rated for the pack voltage.



### 2.2 Main Fuse (Provided with Controller)

- The main fuse needs to be sized to protect the wiring in the drive system.
- Fuse DC voltage rating must be greater than the peak battery voltage.
- Fuse current rating equal to or less than amperage rating of controller.



Most high current fuses have very long tolerance (2 minutes or more) up to 50 - 100% overloads. Thus a 300A fuse likely won't open in a 500A vehicle application. Most Golf OEM vehicles may not have a fuse and must be added with these performance controller upgrades. When carts are equipped with large controllers, the wire gauge must be made larger. This in turn permits higher fault currents, due to the reduced wiring resistance. Under these conditions, we strongly recommend the addition of a fuse to prevent catastrophic battery failure or fire in the event of an electrical system failure.

### 2.3 Safety Disconnect

The safety disconnect provides a way to disconnect the battery pack from the controller and contactor. It may be a circuit breaker, a mechanical switch, or a large removable connector. Make sure it is rated for the current capacity and DC Voltage of your system. Some installations disconnect both the positive and negative leg of the battery pack. Most Golf type vehicles do not have a battery disconnect.

### 2.4 Drive Motors

The motor controller is designed to operate with series wound brush commutated and permanent magnet motors rated for operation from 12-72 VDC. Operation with compound motors is possible. Contact Alltrax, Inc. for information on using compound motors.

## 3. Controller Installation

Choose a location outside the driver's compartment to mount the controller. Any mounting position is acceptable. It is recommended that you protect the controller from direct contact with water, as the electrical connections can corrode. In high moisture environments, seal the electrical connections with silicone or grease.

Mount the controller as close to the motor as is reasonably possible. Ideally, your motor leads should be less than 4 feet long. Making a twisted pair out of the motor leads will reduce RF emissions.

- Most cars employ small (6AWG) battery interconnect wiring.
- For 400A controllers, a minimum of 4AWG wire should be used in light weight carts.
- 2AWG to 1/0 is appropriate for higher amperage controllers and heavier vehicles.

High current wiring to the motor controller should use 5/16" mounting hole ring terminals of tinned copper. Bolt them to the controller using 5/16" hardware.

### 3.1 Contactor Coil Diode:

**CAUTION:** A Diode (1A, 100V) MUST BE USED across the solenoid/contactor coil (and any other relays that may be installed to control lights or accessories). The Cathode or banded end faces the positive terminal. These diodes are required to prevent the speed sensor from producing erroneous signals.



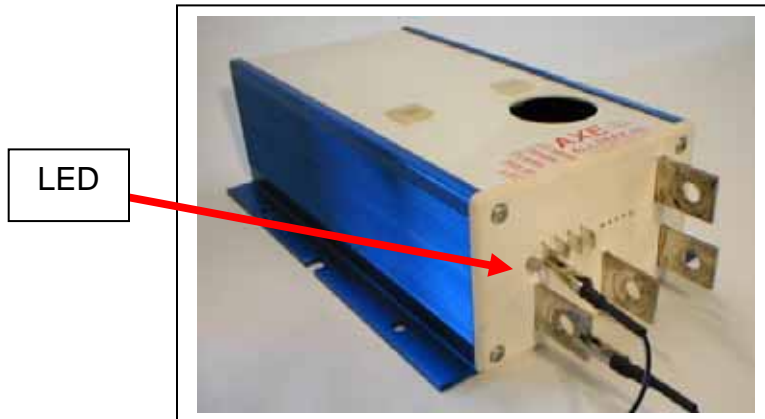
### 3.2 Pre-charge Resistor:

The controller has a fair amount of DC filter capacitance. When the contactor closes to apply power to the controller, the capacitors can arc the contactor. The pre-charge resistor will apply a low current to the capacitors to prevent any arcing and keep the capacitors at bus voltages. It also acts as a discharge snubber that helps dissipate the arc when the contactor disengages. (see schematics for proper value).



## 4. LED Status Indicator

The AXE controller has a bicolor front panel LED. This LED displays a variety of information each time the controller is powered up, by series of blinks. Count the number of green blinks to identify the type of throttle the controller is configured for. After the blink code indicating throttle type, the LED will stay green if there are no errors.



### LED Blink Codes:

At power up the number of green blinks indicates the configured throttle type:

- 1 Green = 0-5k
- 2 Green = 5k-0
- 3 Green = 0-5V
- 4 Green = EZ-GO inductive (ITS)
- 5 Green = Yamaha 0-1K
- 6 Green = Taylor-Dunn 6-10.5V
- 7 Green = CLUBCAR 5K-0, 3-wire

### Normal display status:

- Solid Green: Controller ready to run
- Solid Red: Controller in programming mode
- Solid Yellow: Controller throttle is wide open, controller is supplying max output, and is not in current limit.

### Error code display:

Number of RED blinks indicates any error conditions that might exist.

- 1 Red = Throttle Position Sensor Over Range. Check for open wires.
- 2 Red = Under Temperature. Controller below -25C.
- 3 Red = HPD. Throttle hasn't gone to zero during this power on cycle.
- 4 Red = Over Temperature. Controller over 95C.
- 5 Red = unused for series controllers.
- 6 Red = Battery Under Voltage detected. Battery V < undervoltage slider.
- 7 Red = Battery Over Voltage detected. Battery V > overvoltage slider.

Errors are self clearing when the fault is corrected.

## 5. Software Use and Calibration

The Alltrax Motor controllers utilize a computer program to provide the motor drive functions, motor field current mapping, and a myriad of other customizable features such as speed, current, throttles, etc.

A majority of the Alltrax motor controllers also have the ability to be re-programmed with upgraded software. In most cases, it is not necessary to upgrade the unit's software for stock or aftermarket replacements unless a specific revision is needed for a particular application.

**See Controller Pro Operators manual for more detailed operation.**

### Software:

- Controller Pro Software (see [www.alltraxinc.com](http://www.alltraxinc.com) and download <http://www.alltraxinc.com/old/Software/WEBControllerPRO.zip>)



Through many customer service calls we have found 90% of the problems with communicating between the computer and the motor controller was the inability of the windows software to assign communications ports. We found using a USB to Serial Adapter eliminated any communications port issues with success to connect properly the first time.

Recommended serial to USB adapter:

- Cables to Go, Port Authority™ 2 USB to Serial Adapter. [www.cablestogo.com](http://www.cablestogo.com) (shown above)
- Radio Shack, 6 Ft. (1.8m) USB-to-Serial Port Cable, Model: 26-183, Catalog #: 26-183 (Shown below)

**WARNING:** Disconnect all battery charging sources while programming your Axe Controller. The controllers RS-232 serial port is referenced to the B-battery connection.

Beware any possible ground loop faults between your computer and the controller which could damage both the Axe Controller and PC, plus the person doing the work!

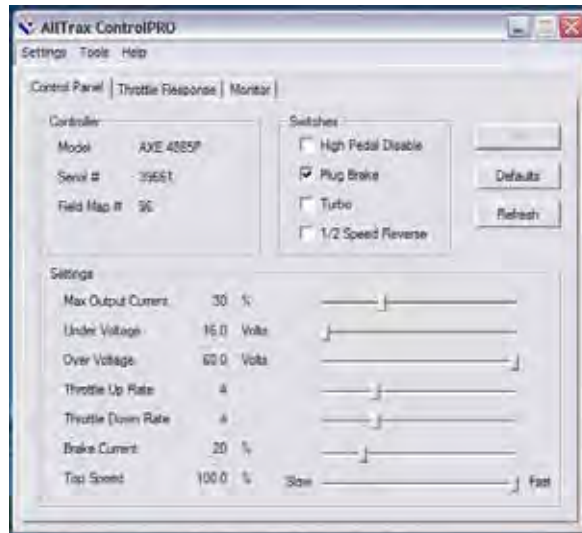


## 6. Programming the Controller:

The AXE controller must be powered up before the Controller Pro program will have any effect. Any programming changes done in the vehicle should be performed with the vehicle safely disabled. Either put the drive wheels on jack stands, or position the vehicle where it is safe to drive while altering the controller. For bench programming prior to installation, two 9V batteries in series may be used to power up the controller. Connect battery negative to the B- bus bar, battery positive to pin 1, (spade tab closest to the LED).

When the AXE is connected to the PC, and both units are energized, launch ControllerPro.EXE. If you see an error “Motor Controller Not Responding”, it means the Controller and PC are not communicating. Hit “OK”, and the Controller Pro will display a window. Recheck the cable connections then close and re-open Controller Pro. Controller Pro automatically determines which com port the controller is connected to. If, after going through this the controller will still not establish communications with the PC, try turning the AXE controller off, then back on. Observe the LED on the AXE went out, then came back on, indicating you cycled the power. Restart the Controller Pro program.

When communications is established with the controller, a Model number (like AXE4844) should be displayed in the Control Panel pane, along with the current configuration of the AXE motor controller.



The top row of functions is Settings, Tools and Help. The normal parameters of the “settings, program...” portion of this program will enable the software to work on most PCs. However, in some very electrically noisy systems, it may be necessary to increase the write delay above 20mS or increase the number of retries, such that communications errors are eliminated.

**Tools:** This function of the program allows you to modify the main executable program that operates the controller (to modify the behavior of a standard controller by adding special features like increased throttle response speeds for go-karts) or extract an error log from the controller for diagnostics.

**Upgrade:** This function loads a new executable program into the controller.

**Reset:** Restarts the controller without cycling the power.

**Write error log:** This function downloads the last 32 (if any) errors that the controller has logged into its EEPROM memory. These are things like HPD, hi/low battery voltage, and over/under temperature.

## 6.1 Control Panel Tab

This tab allows you to alter the operating characteristics of the AXE. Changes made on this pane only take effect after the “SET” button is pressed. “Refresh” will read the current settings from the controller. After any changes have been “SET”, always click “REFRESH” to confirm the changes were accepted by the controller. Note: HPD and Plug Brake switches only take effect at power up, the power to the controller will have to be cycled before these two controls have any effect on the machines operation. The “DEFAULTS” button will restore the factory default values of the sliders, note that “SET” must still be pressed for these parameters to be stored in the AXE controller.

### 6.1.1 SWITCHES:

#### *High Pedal Disable*

Checking this box enables HPD, which will prevent the controller from providing output power in the event the throttle is applied when the controller is powered on. When this box is clear, the controller will start up and provide output power, when KSI energized, regardless of initial throttle position.

#### *Plug Brake*

Checking this box enable plug braking on those controllers equipped with an A2 bus bar terminal. Plug braking on AXE controllers is proportional to throttle position, reaching full braking force at about 25% of throttle travel. Deselecting this box disable plug braking, the unit will apply normal power to motor if direction is reversed. (vehicle may jerk or spin tires if motor direction is reversed while in motion)

#### *Turbo*

A feature that allows **DCX** controllers (not AXE controllers) to go faster if under light load and 100% throttle.

#### *1/2 Speed Reverse*

Limits speed of golf car to 50% of throttle setting when pack + is applied to this pin.

## 6.1.2 SETTINGS:

### *Maximum Output Current*

This slider adjusts the maximum output current that the controller can provide to the motor. Output current is adjusted as a percent of the maximum rating of the controller. For example, an AXE4844 will provide a maximum of 400A to the motor when this slider is set to 100%. A 75% setting on Maximum Output Current will limit the controller to 300A, 50% will limit the max output current to 200A and so forth.

### *Under Voltage*

This slider sets the under voltage shutdown of the controller, in units of 1/10ths Volt. Generally speaking, it is undesirable to pull the terminal voltage of a 6V lead-acid battery below 4.0V, for example 24V on a 36V system.

### *Over Voltage*

This slider sets the maximum operating voltage of the controller. If the voltage present across the B- to B+ bus bars exceeds this setting, the controller will not produce output, given that DC voltage is below the absolute ratings of the controller.

### *Throttle Up Rate*

This slider adjusts the rate at which the controller increases its output current in response to an increase in throttle position. 1 is the slowest, 15 the fastest.

### *Throttle Down Rate*

This slider adjusts the rate at which the controller reduces its output current in response to a decrease in throttle position. 0 is the slowest, 15 the fastest. It is recommended that this parameter typically be set to twice the value of the throttle up rate, when throttle up rate is less than 7. Lower values of Throttle Down Rate can result in the vehicle feeling as if there were a large flywheel connected to the motor.

### *Brake Current*

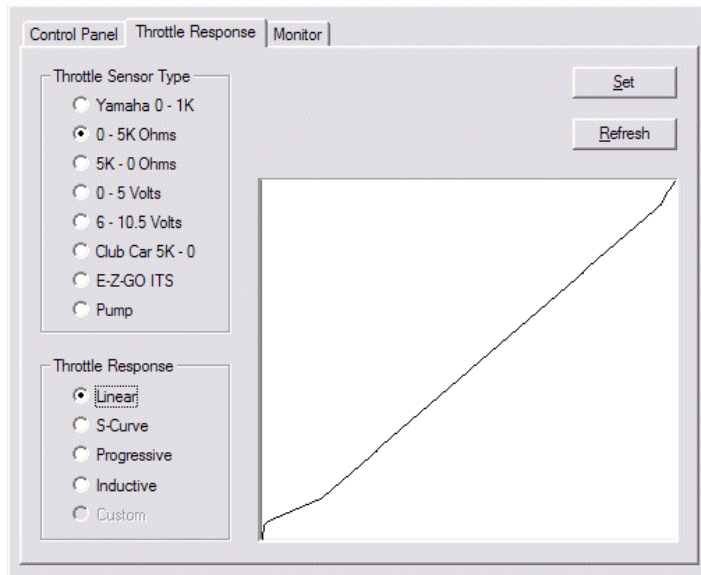
On those models equipped with a plug brake (suffix "P" in the model number), this slider adjusts the amount of brake current as a percent of maximum available brake current. Refer to AXE specifications for maximum available brake current depending on the model of controller.

### *Top Speed*

Top speed of the controller can be limited from 100% down to 50%. This is a helpful tool for elderly or handicapped drivers.

## 6.2 Throttle Response Tab

This pane allows you to select which type of throttle position sensor the controller is working with and what type of throttle response profile to use with the sensor. Changes to throttle sensor type check boxes must be SET to take effect, and then only after the power to the Axe has been cycled do they actually change the sensor type.



### 6.2.1 Throttle Sensor Type

0-1K Ohm (Yamaha type):

When selected, the controller interprets 0-80 ohms = throttle off, 1K ohms = full on.

0-5K Ohm:

When selected, the controller interprets 0 ohms = full off throttle, 5K ohms equals full on. Specifically, Zero ohms to 180 ohms = full off, 4.7K to 5K = full on.

5K-0 Ohm:

When selected, the controller interprets 5K ohms = full off throttle, 0 ohms equals full on. Specifically, Zero ohms to 250 ohms = full on, 4.3K to 5K = full off.

0-5V:

This selects a voltage controlled type of throttle input. 0V = full off output from controller, 5V = full on. Actual operating range is 0.15 – 4.90V.

6-10.5V (Taylor-Dunn type):

This throttle sensor is voltage controlled. 0-6V = throttle off, 10.5V = full on.

5K-0, 3 wire (Club Car type):

This throttle sensor employs a 3 wire potentiometer, or the V-Glide throttle position unit. 5K = throttle off, <200 ohms = full throttle.

EZ-GO ITS:

This throttle sensor type is compatible with the EZ-Go type of inductive throttle position sensor (ITS).

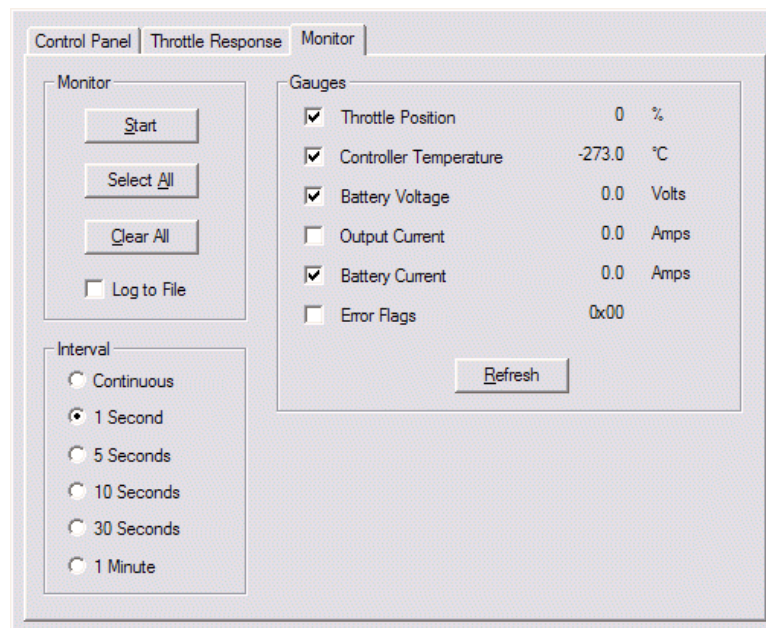
Throttle Sensor Type Continued:

Pump:

This throttle setting allows the AXE controller to power pumps used on fork lifts and other hydraulic applications where pumps are used. The controller turns on 100% output when the Pin 1 spade lug sees pack voltage. The ramp-up and ramp-down rate is still controlled by the two sliders on the Control Panel.

### 6.3 Monitor Tab

This screen is the status monitor of the Axe controller, it gives you the ability to measure and record numerous operating parameters of the Axe motor controller and the vehicle in which it is installed. When used with a Notebook computer, both real-time data display and data logging may be performed while the vehicle is in use. This gives the vehicle designer significant insight to the interaction of the motor controller with other system components. Log files may be used for problem analysis and diagnostics. You can email the log file to Alltraxinc.com for a detailed analysis by our applications engineers.



#### 6.3.1 Monitor Section:

Start/Stop: This starts and stops the data measurement process

Select All: Checks all the gauges

Clear All: Deselects all the gauges

Log to File:

This checkbox will log all of the selected gauge values to a file when selected. The file is in a comma delimited format (CSV) which can be imported into a spreadsheet program like Excel and viewed. The resulting file will be placed into a subdirectory called “Logs” in the same directory as the program Motorcontrol.exe

#### 6.3.2 Interval Section:

This checkbox selects the update rate, or frequency of data collection. For real time display, select continuous. When used in conjunction with “Log to File”, a slower update rate may be more desirable to reduce the amount of raw data being gathered.

### 6.3.3 Gauges Section:

These are the motor controller parameters which are to be monitored. Checking an adjacent box enables that measurement. Clicking “Refresh” will perform a one-time update to the gauges which are selected. It is generally recommended that you select all the gauges, as this will provide the most insight into the operation of the controller.

#### Throttle Position:

This gauge displays the % modulation of the controllers PWM output. For example 50% would be ½ throttle. The displayed parameter is the actual throttle position, limited by the fact that the controller could be in current limit. If the controllers output current reaches the maximum rating, the throttle position won’t advance any further, regardless if the throttle is full on.

#### Controller Temperature:

This is the internal temperature of the controller, in Celsius. Accuracy: +/- 5%.

#### Battery Voltage:

This is the voltage present across the B+ and B- bus bars of the controller. Exception: Club Car compatible models. This is the voltage present across the KSI input to B- bus bar of the AXE controller. Accuracy: +/- 5%

#### Output Current:

This is the measured output or motor current of the controller, accuracy +/-10%

#### Battery Current:

This is the calculated input or battery current to the controller. It is calculated as: Battery current = motor current x throttle position %. It is accurate, given that motor current is continuous (which it generally is with any series motor), not discontinuous. Accuracy: +/- 10%

#### Error Flags:

This register should display as 0x00 during normal operation. Any value greater than zero is an error, and the controller will not provide any output power.

At the moment, this data is in hexadecimal format. If the two right-most hex digits (those to the right of 0x) are converted to an 8 bit binary value, the individual bit positions (with bit 0 being the right-most digit) when set represent the following error flags:

- Bit 0 set = Throttle Position Sensor Over Range
- Bit 1 set = Under Temperature. Controller below -25C
- Bit 2 set = HPD. Throttle hasn’t gone to zero during this power on cycle.
- Bit 3 set = Over Temperature. Controller over 95C
- Bit 4 set = unused
- Bit 5 set = Battery Under Voltage detected. Battery V < under voltage slider
- Bit 6 set = Battery Over Voltage detected. Battery V > over voltage slider
- Bit 7 set = Controller in boot sequence. Occurs within 25mS of power up.

## 7. LIMITED WARRANTY

Alltrax, Inc. warrants every product it sells to be free from defects in materials or workmanship for a period of **2 years** from the date of manufacture. This warranty does not apply to defects due directly or indirectly to misuse, abuse, negligence, accidents, repairs or alterations. We shall in no event be liable for death, injuries to persons or property or for incidental, contingent or consequential damages arising through the use of our products. Alltrax, Inc. specifically disclaims the implied warranties of merchantability and fitness for a particular purpose; however some areas do not allow limitations on how long an implied warranty lasts, so the preceding exclusion may not apply to you. This is Alltrax, Inc. sole written warranty; no other warranty is expressed or implied.

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Return Procedure:

Call Alltrax, Inc. at (541) 476-3565

Fax us at (541) 476-3566

Or visit us on the Web at [www.alltraxinc.com](http://www.alltraxinc.com)

Explain the nature of the problem to our service personnel and we will provide you with return directions You pay shipping to us, we pay the return shipping. Package the device securely in original shipping box if at all possible; we are not responsible for damage in shipping.