ALLTRAX

INCORPORATED

AXE SERIES

ELECTRIC VEHICLE MOTOR DRIVES

SERIES DC MOTOR CONTROLLER

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1.   AXE Motor Control Product Overview

Thank You for purchasing this Alltrax motor controller. We design and manufacture products for a variety of electric vehicles. 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.

2. Required Accessories

These components **are not supplied** with the controller. 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.__*
- *__Safety interlocks must be employed to prevent energization of 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

- 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 (2 minutes or more) tolerance to 50 - 100% overloads. Thus a 300A fuse likely won't fail in a 500A vehicle application.   We understand most Golf type vehicles do not have a fuse, with little or no problem. However, 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 DC motors rated for operation from 12—72 VDC. Operation with compound and permanent magnet motors is possible.

3. Controller Installation

Choose a location outside the drivers 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 carts 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.

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 blinking some number of times. Count the number of green blinks to identify the type of throttle the controller is configured for, any red blinks indicate an error. Errors are self clearing when the fault is corrected.

LED Blink Codes:
> At power up, # of green blinks indicates 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:

>**#** 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
>>6 Red = Battery Under Voltage detected. Battery V < undervoltage slider
>>7 Red = Battery Over Voltage detected. Battery V > overvoltage slider

5. Software Use and Calibration

The interface, "MotorControl.exe",is a utility program which operates on Windows NT/XP machines and is available online at **www.alltraxinc.com**. The program provides a fairly intuitive way to change motor controller parameters, and monitor various operating data.

Use a standard STRAIGHT-THROUGH DB-9 pin / RS-232 serial interface cable to connect the controller to the PC. If your computer is not provided with a DB-9 pin serial port a USB to RS-232 Serial adapter / converter is available through **www.StarTech.com** and other sources.

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!

Hardware : A 9 pin standard serial cable (DB-9 connector, male on one end, female on the other) up to 50 feet in length may be used to link the computer to the controller.

The AXE controller must be powered before the MOTORCONTROL 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 jackstands, or position the vehicle where it is safe to drive while altering the controller. For bench programming prior to installation, a single 9V battery may used to power the controller. Connect battery negative to the B- bus bar, battery positive to pin 1.

When the AXE is connected to the PC, and both units are energized, launch MOTORCONTROL.EXE.

If you see an error "Motor Controller Not Responding", the serial port properties will need to be changed. Hit "OK", and the Alltrax Motor Control Monitor ("Monitor" hereafter) should be displayed.

Click Settings, Port…
This allows you to tell your computer which of several available serial ports it should use to communicate with the AXE controller. Trial and error selection will work if you don't know your computers port assignment. Select COM1, then OK. Select the "Control Panel" pane, and click "Refresh". If the program pauses, then displays the error "Motor Controller Not Responding", Repeat this step, selecting the next higher COM port number.

If, after going through this the controller will still not establish communications with the PC, try changing the port COM address, then close the MotorControl program. Turn the AXE controller off, then back on. Observe LED on AXE went out, then came back on, indicating you cycled the power. Restart the Motorcontrol program. Repeat this sequence of events, changing the COM port address each time, until the AXE establishes communications.

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. Once communications has been established, the program will subsequently recall the correct COM port on your computer.

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 reprogram 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 it's EEPROM memory. These are things like HPD, hi/low battery voltage, and over/under temperature.

Main Function Panes of the MotorControl.exe Program

Control Panel

This pane 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 ay changes have been "SET", always click "REFRESH" to confirm the changes. 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.

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).

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 undervoltage 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 it's 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 it's 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 their 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.

Throttle Response Pane:

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.

Throttle Sensor Type:

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.

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

0-1K Ohm (Yamaha type)
When selected, the controller interprets 0-80 ohms = throttle off, 1K ohms = full on.

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.

MONITOR Pane:

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.

Interval:
This checkbox selects the udate 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.

Monitor:
      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.

Gauges:
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 < undervoltage slider
Bit 6 set =   Battery Over Voltage detected. Battery V > overvoltage slider
Bit 7 set =   Controller in boot sequence. Occurs within 25mS of power up.

6. 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.

In the event you should need warranty repair, Please see the Return Procedure below. Alltrax reserves the right to repair or replace merchandise at its option. Alltrax reserves the right to make changes to any of its products or specifications without notice.

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**

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.