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ALLTRAX

PERFORMANCE MOTOR CONTROLLERS

Operators Manual
AC Controller
RXV

Alltrax Inc
1111 Cheney Creek Road, Grants Pass, OR 97527 Ph: 541-476-3565 Fax: 541-476-3566
Web Site: http://www.alltraxinc.com

Contact Alltrax:

Phone: 541-476-3565 EXT 3
Fax: 541-476-3566

Email:
Tech Support: helpdesk@alltraxinc.com
Orders: orders@alltraxinc.com
Shipping: shipping@alltraxinc.com
General Inquires: info@alltraxinc.com

Website:
http://www.alltraxinc.com

Facebook:
http://www.facebook.com/AlltraxInc

Twitter:
http://www.twitter.com/Alltraxinc

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WARNINGS

GENERAL WARNINGS

Safety Notes:

When working on electric vehicles, sudden unexpected events can occur, it's recommended to:

- Place the drive axle on jack stands—wheels off the floor.
- When working on wiring or batteries, always remove rings, watches and secure dangling clothing/ hair/jewelry.
- Use the proper safety equipment, eye protection, and insulated tools.
- Never connect a computer while the vehicle is being charged.
- Disconnect batteries before installing or working on the Alltrax controller.
- Wear safety glasses.
- Because hydrogen can build up due to gassing from the batteries, work in a well ventilated area.
- Make sure the battery pack is fused.
- Do not clean the controller with a high PSI pressure washer.
- When cleaning batteries, take precautions to keep the battery acid from splashing on the controller.

CAUTION:
It is the installer's responsibility to ensure the correct equipment (i.e. wire, motor, solenoid, fuse etc) is installed in the vehicle. Equipment should be sized correctly for planned usage. Failure to do so could poses a significant risk of explosion, fire, property damage and serious injury or death.

READ AND SAVE THESE INSTRUCTIONS

WARNINGS

USABILITY STATEMENT

Alltrax Inc's lines of AC Induction, IPM and SMPM Motor Controllers are intended for use with brushless motors only. Any application or usage that does not meet these criteria WILL NOT be covered by warranty. Also, any requests for design assistance or technical support outside the scope of the product intended use may be denied. Alltrax assumes no liability for any damage or injury as a result of use of the motor controllers in a non-traction or process motor application. See the warranty at the end of this manual.

WARNING: Use of this product for other than these specified uses may be highly dangerous and lead to serious injuries or death.

AC1 SPECIFICATIONS

Model	2 Min (Amps)	5 Min (Amps)	Continuous (Amps)
AC1-48650	650	500	400

Type: 3 phase AC

Operating Frequency:

Controller Voltage, KSI & Reverse: 48v controllers = 16v - 60v
72v controllers = 16v - 92v

Operating Temperature: -20c to 90c

Environmental Operating Temperature: -20c to 50c // 0F to 122F

Standby Current (Power up): 5mA

KSI & Rev Pin Input Current: 200mA max

Relay Drive Current: 4A max

Throttles Supported: 0-5k, 5k-0, E-Z-GO ITS, 5k-0 3 Wire, 0-5v, USB Throttle, Absolute Mode

Terminal Bolt Torque: 60-80 in.lb (5-7ft.lb, 6.77-9.4nm)

Mounting Bolt Torque: 15-20 in.lb (1.25-1.75 ft.lb, 1.7-2.25nm)

Terms and Definitions

IPM: *Internal Permanent Magnet*

SMPM: *Surface Mount Permanent Magnet*

KI: *Integral Gain for PI/PID controllers*

KP: *Proportional Gain for PI/PID controllers*

KD: *Derivative Gain for PI/PID controllers*

Quadrature: *Most common type of Speed Sensor Signal used in AC Induction motor applications*

Sine/Cosine: *Commonly used for speed sensors in IPM and SMPM motor applications.*

ITS: *Inductive Throttle System, used in DC EZGOs*

KSI: *Key switch input, refers to signal voltage from the KEY*

Roll Detect: *Is a feature that uses the speed sensor to determine whether or not the cart is moving with no active throttle.*

Unique Features

Low Voltage Protection -

If battery voltage falls below your set Under Voltage limit the controller will shut off the power supply completely to prevent the batteries from getting drained to the point of damaging themselves. If you plug the controller into the toolkit software you will get a large SHUTDOWN warning to notify you of what happened. You can bring power back by cycling the TOW/RUN or plugging your charger back into the cart.

Trigger Limts -

1v for one hour
5v under shutdown triggered in 5 minutes
10v under shutdown triggered in 1 minute

COMPONENTS

Heavy Duty Contactors

Main Fuse

Heavy Gauge Wires

<u>The solenoid is the primary disconnect of the battery pack in the case of the an emergency.</u> In order to be effective, the solenoid needs to be properly rated for the current that will be drawn from the batteries. It is VERY important that the solenoid be rated correctly. It is the only way to disconnect the batteries from the motor/controller loop in case of a failure. Too small of a solenoid increases the likelihood that the contacts will weld together and not be able open.

When installing a new controller, Alltrax recommends the OEM solenoids be replaced with a heavy duty version. See below for suggested sizing of solenoid replacements.

As a regular part of a preventative maintenance plan, solenoids should be replaced every 3-5 years.

Heavy Duty 400A

(800-1000A inrush)

A heavy duty solenoid is required when using any of the AC1 controllers. You need a minimum of 400A continuous and 800A inrush rating.

<u>Recommended Models</u>

MZJ400 (Shown)
SW200 (Albright)
SOL600

Fuse

Any application where there is a battery pack, a fuse must be installed. A fuse will open the battery circuit and prevent any serious damage from occurring.

The fuse should be installed on or between the battery terminals. The main battery positive OR main battery negative OR in-between 2 batteries is an acceptable location for fuse installation. The fuse must be rated for pack voltage and fault current.

Controller Amperage	Fuse Style / Rating
650A	ANN / 400A
750A	

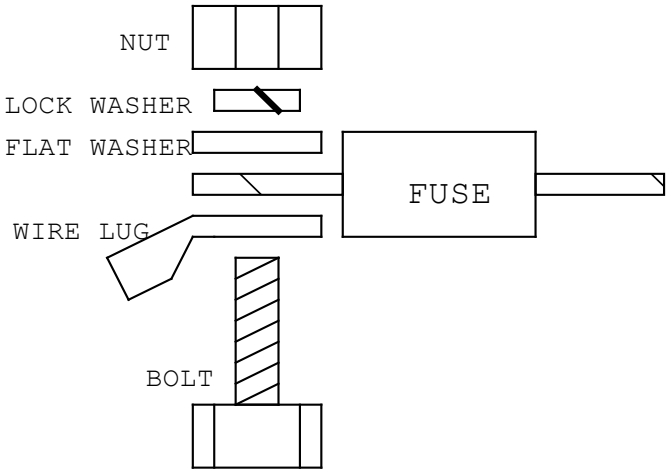


Diagram: Fuse terminal hardware

Wiring

Wiring and battery health in an electric vehicle are very important and overlooked during performance upgrades. Wiring size is important for safety and proper operation of the vehicle. Undersized wires will affect the performance of controllers and can overheat. Wires should be crimped with proper sized terminals and tools to provide a clean low resistance connection.

Controller	Min. Wire AWG Standard Duty	Min. Wire AWG Heavy Duty
650A	2 AWG	1/0 AWG

Power Wiring

When running wiring for the vehicle care must be taken for proper wire routing. Power wiring should be of proper sizing and ran as low in the framework of the vehicle as practical. Lengths of power wire runs need to be kept short and pairs of wires from common circuits should be grouped together to reduce EMC emissions. Secure all power wiring to the vehicle framework.

Motor Phase Wiring

The three phase wires should be kept close to the same length and kept together as they run from the motor to the controller. For optimum reliability don't lay wire across other connections on the controller. Low current wires should not be run alongside the motor wiring or any high current wiring.

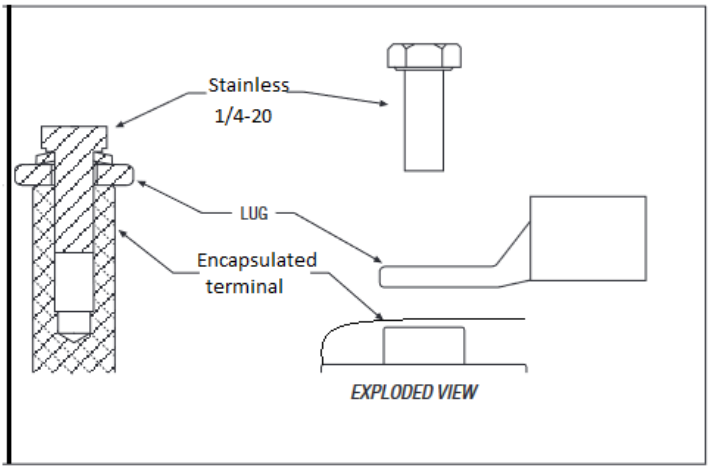
****Never swap motor phase wiring unless key is off and vehicle is not moving****

High Current Connections

TERMINAL	FUNCTION
B+	Battery positive to Controller
B-	Battery negative to Controller
R	Brake Resistor
U	Motor phase U
V	Motor phase V
W	Motor phase W

LUG ASSEMBLY

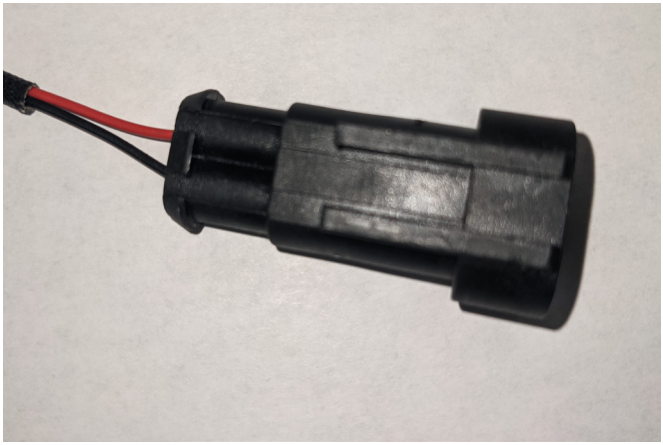
The AC controller comes with 5-6 stainless steel 1/4-20 bolts for holding the high current terminals to the controller.



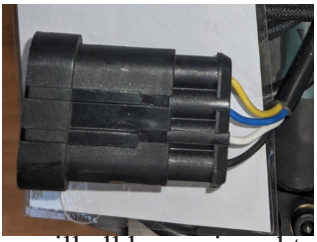
Low Power Wiring

Signal Wiring
Signal wires should be keep as short as practical. Care should be taken to protect the wires from sharp edges and rubbing. Consider the use of split loom or braided wire sheathing. Fasten bundles securely to framework. Do not route the signal wires together in the same bundle with power wires.

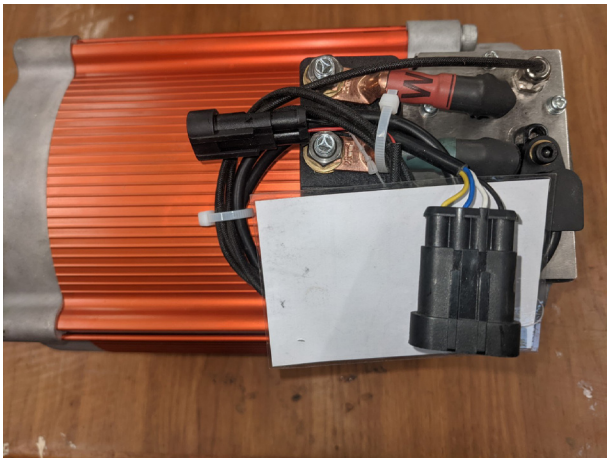
Temp Sensor
Induction motors come with a two wire temp sensor which the controller uses to monitor internal temps during operation. On DC conversions the temp sensor will run through the same harness connector as your speed sensor.



Speed Sensor Information



The speed sensor is a small group of wires attached to the side of the motor. Induction motors use a Quadrature signal that gives up to 64 readings per minute. Speed sensors are currently required. Carts that came stock with an AC motor will all be equipped to use the Quadrature sensor. For AC Conversion applications a harness adapter will be used to get the correct signal to the controller without replacing the existing harness.



In the future a sensorless option will be available but currently speed sensors are required for all ACT induction applications.

Speed and Temp sensor cable

All DC conversion systems will come with a new speed and temp sensor cable to match the new AC motor. We recommend not running this harness parallel to your high current wires. An example would be zip tying them to your large gauge motor wires. Even with shielded wires this can potentialy cause issues with the signal. Each connector can only be plugged into one location on the cart/controller but there is a full break down of each connector on the following page.

Encoder Pulses/Revolution Constraint (Quadrature Encoder)
The maximum encoder frequency the controller will accept is 10 kHz. To determine how fast this constraint will allow the motor to spin, use the equation:

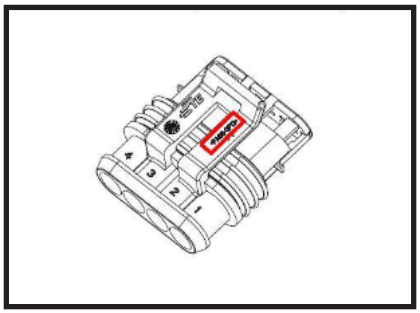
Max Speed Encoder Limit = 600000 / Encoder Size
(e.g., a motor with 128-pulse encoder can run up to 4587 rpm).

Firmware Max Speed Constraint
The maximum motor speed the controller will allow is 10,000 rpm.

Max Sped RPM Limit = 10,000

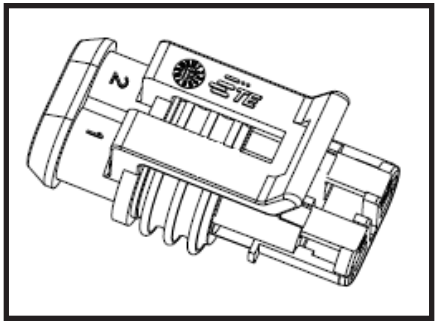
Wire Harness Pinouts

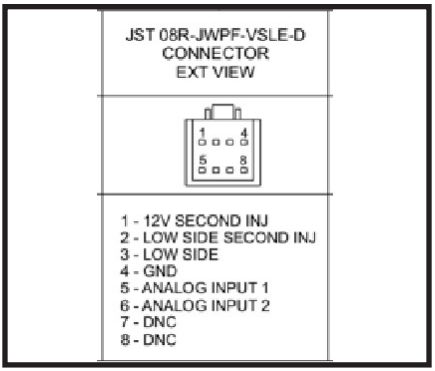
Speed and Temp sensor harness connectors
Used on all DC conversions



C3 - TE_Superseal 4P connector used for the speed sensor signal of the motor. Water resistant connector.

C2 - TE_Superseal 2P connector used for the motor temp sensor harness. Water resistant connector.





C1 - JST-JWPF O8 connector used for the controller side connection of the Speed and Temp sensor harness. Water resistant connector.

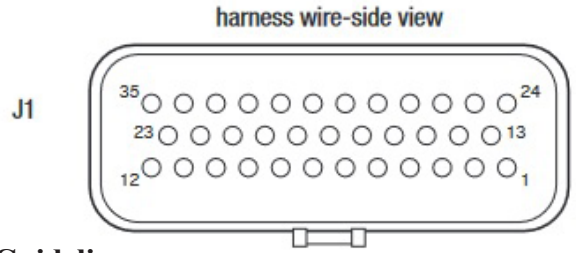
C1, C2, C3 pinouts for Alltrax harness

PIN	NAME	DESCRIPTION
**	**C1**	**CONNECTOR**
1		
2		
3		
4		
5		
6	Not Used	Not Used
7	Temp Sensor Lo	
8	Temp Sensor Hi	
**	**C2**	**CONNECTOR**
1	Temp Sensor Lo	
2	Temp Sensor Hi	
**	**C3**	**CONNECTOR**
1		
2		
3		
4		

Wire Harness Pinouts

35 PIN AMPSEAL CONNECTOR (E-Z-GO RXV/OEM)

All low power connections are made through a single 35-pin AMPSEAL connector. The mating plug housing is AMP p/n 776164-1 and the gold-plated socket terminals are AMP p/n 770520 (Strip form) and 770854-3 (loose piece). The connector will accept 0.5 – 1.25 mm (20 – 16 AWG) wire with a 1.7 – 2.7 mm diameter (thin-wall insulation). Seal any non-used connector positions that have the silo-diaphragm pierced with seal plug 770678-1.



Wiring Guidelines

Speed Sensor (Pins 7, 26, 31, 32)

All four wires (+5V, Sensor A, Sensor B, and I/O ground) should be bundled together as they run between the motor and controller connections. These can often be run with the rest of the low current wiring harness.

CANbus (Pins 28, 29)

It is recommended that the CAN wires be run as a twisted pair. The CANbus wiring should be kept away from the high current cables and cross them at right angles when necessary.

All other low power wiring

The remaining low power wires should be run according to standard practices. Be sure to keep the input lines such as throttle, brake, temperature, and the above mentioned CAN/Speed Sensor signals separate from controller's output lines such as the coil driver outputs. Avoid routing the low-power wiring parallel to the high power battery and motor cables.

35 PIN TABLE *1/2*

PIN	NAME	DESCRIPTION
1	KSI	Key Switch Input signal, provides power to the controller and drivers
2	Horn Ground	Driver pin used to pull the reverse horn LO.
3	Not Used	
4	Spare Driver -	Spare Driver “pull-down”
5	Brake Coil -	Control driver for brake coil negative
6	Relay Coil -	Used to control the ground side of the Relay Coil.
7	Power Ground	Ground Reference
8	Motor Temp	Temp Sensor input from motor to controller
9	Footswitch	Throttle Activation interlock switch
10	Tow/Run	Battery reference voltage from Tow/Run switch
11	Charger	Interlock signal from charging system.
12	Brake Switch	Engage/Disengaged microswitch on brake pedal (RXV primarily)
13	Key Switch	internally connected to pin 1
14	Not used	Not used
15	Throttle Power	5v reference for throttles
16	Throttle Wiper	Wiper connection of throttle input used for both resistive and voltage based throttles
17	Brake Wiper	Wiper connection for braking input

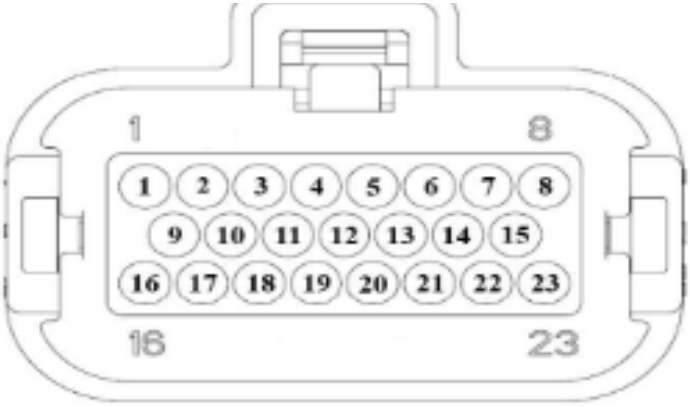
35 PIN TABLE *2/2*

PIN	NAME	DESCRIPTION
18	Reserved	Analogue Ground signal used in some throttle applications
19	Not used	Not used
20	RC Pulse In	“Positive” signal from RC device
21	RC Ground	“Negative” signal from RC device
22	Forward	Forward direction input signal
23	Not used	Not used
24	Logic Power	Pre Tow/Run power on some applications (RXV), post Tow/Run on AC Conversions. Required to operate
25	12v	12v reference, used in some throttle applications
26	5v	5v reference for speed sensor
27	ITS Throttle	12v out “High Side”
28	Can Lo	Lo-side communication for CAN
29	Can Hi	Hi-side communication for CAN
30	Reserved	
31	Tach A	Used for Quadrature and Sin/Cos speed sensors
32	Tach B	Used for Quadrature and Sin/Cos speed sensors
33	Reverse	Reverse direction input signal
34	Reserved	Ground signal
35	Tach C	Used in Absolute or BLDC Hall effect sensors

WIRE HARNESS PINOUT

23 PIN AMP SEAL connector - RXV Danaher

The majority of low power connections will be made through the 23 pin amp seal connector. The pinouts are different on the 2008-2011 carts compared to newer ones and used a 23 pin connector with a Danaher Controller.



The image shows the carts wire harness when unplugged and viewed from the rear - where the wires go into the connector itself.

23 PIN TABLE 1/2

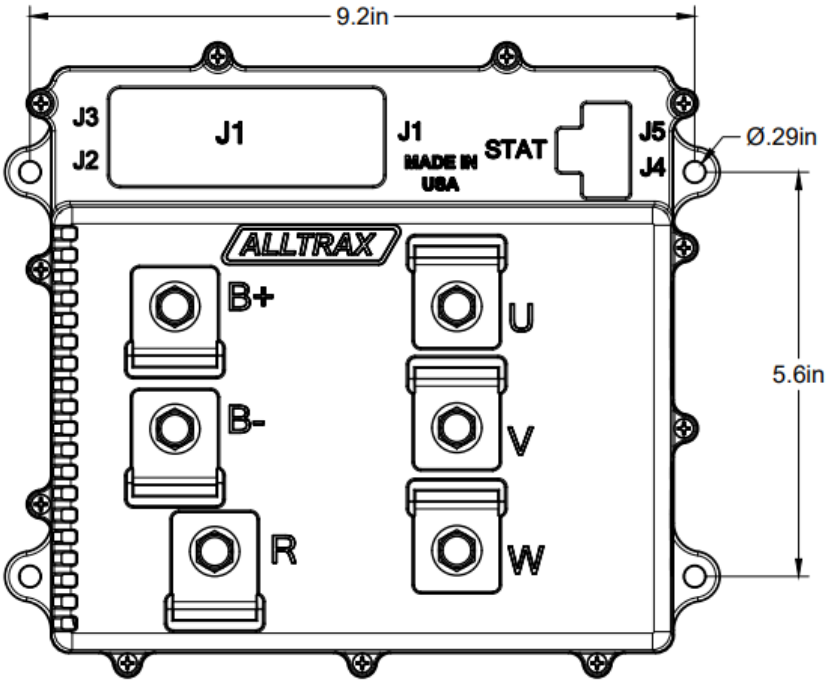
PIN	NAME	DESCRIPTION
1	Key in/Logic Power	Main battery reference for the low current system.
2	Brake Solenoid out	Output to the brake solenoid
3	5v reference	+5 volt to the speed sensor, brake sensor and throttle
4	Speed Sensor Lo	Common/Ground reference for the speed sensor
5	Speed Sensor Signal A	Speed sensor signal A
6	Speed Sensor Signal B	Speed sensor signal B
7	Brake Sensor In	Input signal from brake sensor
8	Can Ground	Ground/Common reference for CAN BUS
9	Throttle Signal	Signal output wire of the throttle
10	Horn (Reverse)	Signal control wire for activating the reverse buzzer.
11	SOC out	State of charge output

23 PIN TABLE 2/2

PIN	NAME	DESCRIPTION
12	Forward	Forward signal from direction switch
13	Tow/Run	Input voltage from the Tow/Run switch
14	Not Used	Not Used
15	Can Neg	0 to -5v signal for CAN BUS
16	Motor Temp Hi	Hi side of motor temperature signal
17	Charge Interlock	Charge interlock control signal
18	Main Contactor out	Control voltage used to activate the main contactor
19	Footswitch	Voltage out of the footswitch to signal controller
20	Reverse	Reverse signal from direction switch
21	Not Used	Not Used
22	Brake Light Relay	Control signal for brake light
23	Can Pos	0 to +5v CAN BUS signal

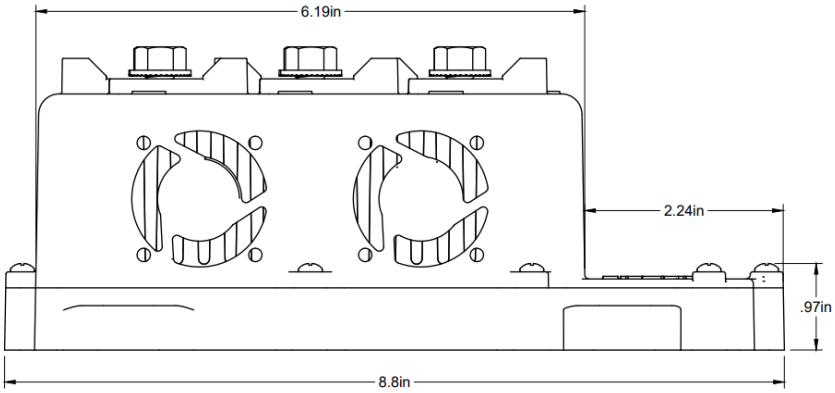
CONTROLLER DIMENSIONS

TOP DOWN VIEW

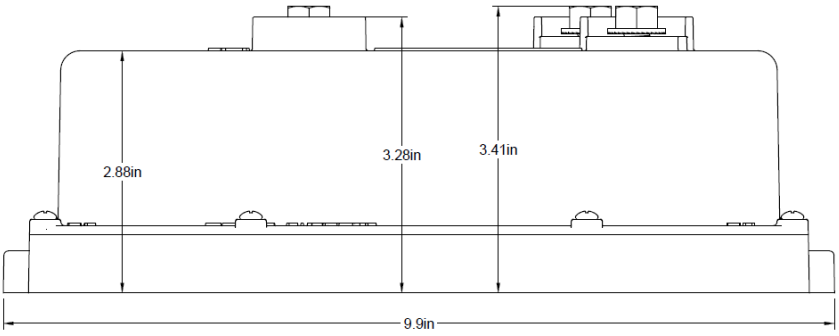


CONTROLLER DIMENSIONS

SIDE VIEW



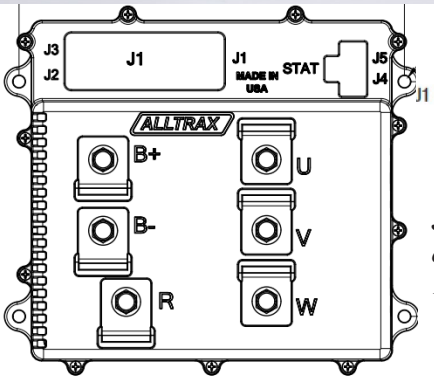
FRONT VIEW

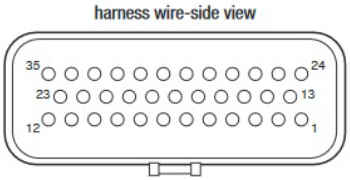


VEHICLE INSTALLATION DRAWINGS

Don’t see a drawing that suites your needs?
Visit our website for full sized, updated and more drawings.
www.alltraxinc.com

E-Z-GO RXV CURTIS



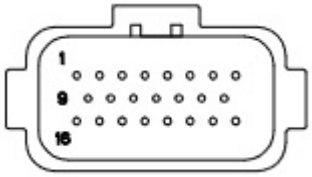


J1 - *For an indepth description of each wire on the harness see pages 18-20*

J1 - Main wire harness connector
J2 - Personality Switch
J3 - AC Motor case ground
J4 - Can Bus
J5 - Programming port (USB A)

B+ Positive from Solenoid
B- Battery Negative
R Large resistor connection
U U of the Motor
V V of the Motor
W W of the Motor

E-Z-GO RXV DANAHER



J1- *For an indepth description of the wire harness see pages 24 - 26 of this manual.*

J1 - Main wire harness connector
J2 - Personality Switch
J3 - AC Motor case ground
J4 - Can Bus
J5 - Programming port (USB A)

B+ Positive from Solenoid
B- Battery Negative
R Large resistor connection
U U of the Motor
V V of the Motor
W W of the Motor

PROGRAMMING THE CONTROLLER

Controllers ordered for stock configuration come pre-programmed and do not need to be programmed before use. If the user would like to customize their performance or has upgraded their motor and needs a matching motor map the controller can be connected to a computer with a USB A to B, commonly referred to as a “printer cable”.

The USB A to B cable is used to connect your motor controller to your personal computer. Using the free Alltrax Toolkit you can customize your performance to match your needs.

The Alltrax Toolkit software can be downloaded from:
https://alltraxinc.com/alltrax-tool-kit/
No purchase necessary

DOWNLOAD SOFTWARE

Alltrax Toolkit Software Manual

DOWNLOAD MANUAL

BLINK CODES

On power up, the controller will blink out a throttle code and then a Status or Error Code (see below)

Throttle Type Codes:

1 Green LED Flash	=	2-wire 0-5k throttle
2 Green LED Flash	=	2-wire 5K-0 throttle
3 Green LED Flash	=	0-5V throttle
4 Green LED Flash	=	EZGO ITS throttle
5 Green LED Flash	=	3-wire 0-5k
6 Green LED Flash	=	6 to 10.5 Taylor Dunn throttle
7 Green LED Flash	=	MCOR
8 Green LED Flash	=	Reserved
9 Green LED Flash	=	Pump
10 Green LED Flash	=	USB Throttle
11 Green LED Flash	=	Absolute Throttle
12 Green LED Flash	=	PWM_Throttle

Brake Type Codes:

1 Green LED Flash	=	2-wire 0-5k throttle
2 Green LED Flash	=	2-wire 5K-0 throttle
3 Green LED Flash	=	0-5V throttle
4 Green LED Flash	=	Reserved
5 Green LED Flash	=	3-wire 0-5k
6 Green LED Flash	=	6 to 10.5 Taylor Dunn throttle
7 Green LED Flash	=	MCOR
8 Green LED Flash	=	Reserved
9 Green LED Flash	=	Reserved
10 Green LED Flash	=	USB Throttle
11 Green LED Flash	=	Absolute Throttle

BLINK CODES

Normal Display Status:

Solid Green Light	=	Controller Ready to Run
Solid Red Light	=	Controller in programming mode
Solid Yellow Light	=	Throttle is wide open and the controller is NOT in Current Limit
Blinking Yellow Light	=	Throttle is wide open, but the controller is in Current Limit

Error Codes:

AC alarm codes flash a sequence of green then red. All alarms are self clearing and will repeat until the error condition has been corrected.

1 Green and 1 Red LED Flash	=	Short Circuit/Output Fault
1 Green and 2 Red LED Flash	=	Battery Under Voltage
1 Green and 3 Red LED Flash	=	Battery Over Voltage
1 Green and 4 Red LED Flash	=	Over temperature
1 Green and 5 Red LED Flash	=	Throttle Power Fault
1 Green and 6 Red LED Flash	=	Pre-Charge Failure
2 Green and 1 Red LED Flash	=	Throttle/Brake Range
2 Green and 2 Red LED Flash	=	Bad Variables
2 Green and 3 Red LED Flash	=	High Throttle Over range
2 Green and 4 Red LED Flash	=	High Throttle Under range
2 Green and 5 Red LED Flash	=	Low Throttle Over range
2 Green and 6 Red LED Flash	=	Low Throttle Under range
3 Green and 1 Red LED Flash	=	Throttle/Brake Range
3 Green and 2 Red LED Flash	=	Bad Variable Set Loaded
3 Green and 3 Red LED Flash	=	Relay Coil Overcurrent
3 Green and 4 Red LED Flash	=	Brake Coil Overcurrent
3 Green and 5 Red LED Flash	=	Reserved Overcurrent*
3 Green and 6 Red LED Flash	=	Horn Overcurrent
4 Green and 1 Red LED Flash	=	Reserved
4 Green and 2 Red LED Flash	=	Reserved
4 Green and 3 Red LED Flash	=	Hardware Failure
4 Green and 4 Red LED Flash	=	Startup Failure
4 Green and 5 Red LED Flash	=	Reserved
4 Green and 6 Red LED Flash	=	Reserved
5 Green and 1 Red LED Flash	=	General Error

CODE DEFINITIONS

Error Code Definitions:

- Short Circuit/Output Fault:
  Controller detected a short circuit or other fault on the output circuit. Check wiring.
- Battery Under Voltage:
  B+ Voltage lower than Low Voltage Battery Setting. Check pack voltage or program settings.
- Battery Over Voltage:
  B+ Voltage Higher than Over Voltage Battery Setting. Check pack voltage or program settings
- Over temperature:
  Busbar temperature exceeds 90^{o}C. Let controller cool and/or add fan.
- Throttle power Fault:
  This is a 5V fault, if the speed sensor gets damaged this alarm will be one of the alarms triggered. Can also be caused by a fault in voltage based throttles
- Pre-charge Failure:
  B+ voltage and KSI voltage differ by more than 5v. Stuck solenoid.
- Under Temp:
  Busbar Temperature reads less than -20^{o}C
- High Throttle Over range & High Throttle Under range:
  High Side of throttle signal is outside of acceptable window for that throttle type. Check and/or replace throttle. Change throttle type to correct throttle installed on car.
- Low Throttle Over range & Low Throttle Under range:
  Low Side of throttle signal is outside of acceptable window for that throttle type. Check and/or replace throttle. Change throttle type to correct throttle installed on car.
- Bad Variable Set Loaded:
  Alltrax loaded variable data is missing or corrupted. Contact Alltrax
- Throttle/Brake Range:
  The RXV has a “throttle” built into the brake pedal to communicate with the motor brake. This alarm indicates an error in that signal.

CODE DEFINITIONS

Error Code Definitions:

• Relay coil overcurrent:
Relay coil has shorted, the wires were attached incorrectly or the suppression control diode is backwards.

• Brake coil overcurrent:
Short in the brake pedals resistor coil. Presently this can only trigger on EZGO RXV applications

• Horn Overcurrent:
There is a short in the horn circuit, could be wiring or horn related

WARRANTY STATEMENT

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“Thank you Nikola Tesla, for a better motor”