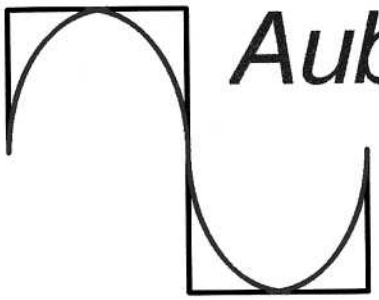

Auburn Scientific

DC Motor Controller

MPC600-144
MPWC600-144
MPWC600-192

Component and Installation Guide

Feb 1998
Revision 6

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CONTENTS

INTRODUCTION

Auburn Scientific was established to develop and produce highly reliable industrial grade products that will meet the needs of high power electric motor applications.

The Auburn Scientific Motor Controller is targeted toward DC power applications where the power source could be rectified line voltage or a significant set of large batteries. As seen in the Connection Diagram, the motor, battery pack and controller make up the major components of a typical application.

CAUTION!

The controller is intended to be used in an environment where high voltages and high currents exist. Installation of the controller, batteries, or motor should only be attempted by a skilled technician familiar with high power electrical installations.

CAUTION!

THERE IS NO MARGIN FOR ERROR IN HIGH POWER INDUSTRIAL APPLICATIONS. MISTAKES IN WIRING, FAILURE TO VERIFY THAT POWER IS DISCONNECTED BEFORE CONNECTIONS ARE MADE OR ALTERED, AS WELL AS CARELESSNESS, CAN RESULT IN DESTRUCTIVE AND DEADLY SITUATIONS!

GENERAL DESCRIPTION

Auburn Scientific DC MOTOR CONTROLLER

The Auburn Scientific is a Pulse Width Modulated DC motor controller specifically designed for high power DC Voltage applications. The Controller has been extensively tested with the Advanced DC 9 inch electric motor. This combination seems to provide a good compromise between power output and source current draw.

PRINCIPLES OF OPERATION

The Controller uses a Pulse Width Modulation at > 15,000 cycles per second to control the motor currents. This widely used principle is an excellent method of controlling intermediate power demand requirements for motor drive applications. This methodology switches battery current on and off to the motor. The "On Time" or "Pulse Width" for any given cycle can vary from 0% to 100%. The power available to the motor is equivalent to the amount of time that current is switched on. Using this method, efficiency, measured by comparing power available to the motor to total power delivered from the power source, can be maintained in the 95+ % range.

The Auburn Scientific Controller is particularly good in the area of efficiency by virtue of very low "On Resistance" through the FET transistors and the small amount of time the transistors spend in the On-Off transition.

SPECIFICATIONS

	MPC600-144	MPWC600-144	MPWC600-192
On Resistance	< .004 Ohms	< .004 Ohms	<.004 Ohms
Switch Time	< .1 micro seconds	< .1 micro seconds	< .1 micro seconds
Frequency	> 15,000 cycles/sec	> 15,000 cycles/sec	> 15,000 cycles/sec
Motor Current Limit	680 Amps	680 Amps	680 Amps
Operating Voltage	55 to 144 volts	55 to 144 volts	55 to 192 volts
Weight	22 pounds (10 KG)	22 pounds (10 KG)	22 pounds (10 KG)
Cooling System	AIR	Liquid	Liquid
No load current Draw	100 Milli-amps	100 Milli-amps	100 Milli-amps

FEATURES

The Controller provides for logarithmic power control with pre-programmed acceleration ramp. This allows the user more precise control of the motor power as well as limiting how fast the power comes on if the motor control input (5K Ohm variable resistor) is inadvertently set to full scale.

The maximum motor current is adjusted to the factory-defined maximum for a stalled motor condition (680 amps.) See Specification Table in the General Description Section for details on your controller.

High Pot Input Lockout circuitry is included to reduce the possibility of the dangerous situation in which the speed control input was set to greater than zero before the enable or contact switch is turned on. The Controller will not switch power to the motor until the speed control has been set to zero Ohms for at least 250 milli-seconds before the enable is set high.

Auburn Scientific motor controllers have an open Pot shutdown feature. This feature will shut the controller off and put it in a "sleep" state in the event that the Pot circuit is opened, or the Pot resistance exceeds about 6 K Ohms. To recover from an "open Pot" situation, all power must be shut off from the controller, and it must be allowed to completely discharge. At that time the error which caused the condition must be corrected before power is reapplied and normal operation is restored.

- Note: In our experience, we have found that a few Pot Boxes labeled 5K Ohms, actually exceed 7K Ohms full scale. Consequently, we recommend as part of the installation process, the pot values be measured at both extremes. The Pot value measurements should yield the following for a good quality Pot Box.

    1. A value of 0 (or very close to 0) exists at one extreme
    2. A value of 5Kohms (+/- 10 %) exists at the other extreme

The Controller has a low voltage shut off. This limit is set at the factory to 55 volts. In the case where the power source voltage has dropped below this value, the controller will switch off until the voltage increases above the limit. The Controller will not function if the V+ voltage is below the low voltage shut-off value.

The Controller has a temperature-controlled current reduction feature. If the controller is used in a high temperature application, the current limit value is gradually reduced as the internal controller temperature increases. This function starts current reduction at 50 degrees C (122 degrees F).

The Controller is designed specifically to "run cool". Additional heat sinks are not necessary under normal operating conditions. Under high heat conditions defined as extended periods of high current operation or ambient temperatures above 35 degrees C (95 degrees F), it is recommended that liquid cooling be used. If liquid cooling is not available, mounting the controller in a location that provides additional heat dissipation or increased airflow will help.

The Controller has a maximum temperature shutdown that disables the controller if the internal temperature exceeds 85 degrees C.

WARNINGS AND CAUTIONS

DOUBLE CHECK ALL ELECTRICAL CONNECTIONS BEFORE APPLYING POWER. INCORRECT CONNECTION OF HIGH CURRENT WIRING MAY CAUSE DAMAGE TO THE MOTOR CONTROLLER!

VERIFY FUNCTIONS OF ALL CONTROLLER INPUTS, VARIABLE RESISTORS AND SWITCHES BEFORE APPLYING POWER!

VERIFY CORRECT FUNCTION OF MOTOR, WITH MOTOR DISCONNECTED FROM LOAD BEFORE OPERATING!

NEVER ATTEMPT ANY WIRING WITH SOURCE VOLTAGE CONNECTED TO THE SYSTEM!

ALWAYS ASSEMBLE HIGH CURRENT WIRING WITH MULTIPLE DISCONNECTS IN SERIES. TYPICALLY THIS WILL INCLUDE AN ELECTRICALLY-CONTROLLED SWITCH AND A MANUALLY-CONTROLLED SWITCH, BOTH WITHIN EASY REACH OF THE USER!

ALWAYS USE AN IN-LINE FUSE FOR POWER SOURCE WIRING!

Even though the Controller is designed to survive a rugged industrial environment, the Controller can be damaged by external blows, or mechanical shock such as a fall onto a hard surface. The controller should be treated with the same care as a fine instrument or an expensive piece of stereo equipment. In the event that the Controller has been exposed to any significant shocks, or shows signs of external abuse, send the unit back to the factory for a checkup before attempting to use it in a control system. As long as there is not electrical damage, Auburn Scientific will examine the controller and make repairs at cost. This is less expensive and much safer than to risk controller failure due to mechanically damaged internal components.

CONNECTION AND OPERATION

Control of the Controller requires both an enable signal (+V) and a 5k Ohm variable resistor (Pot). The switch is used to enable the Controller. The enable voltage should be V+ volts DC with reference to the V- connection. When the voltage is applied to the enable connection (Red), the Controller is enabled.

A 5K Ohm variable resistor is used as a modulator control. The 5K Ohm resistor is connected across the variable resistor inputs. When the 5K Ohm resistor is set to 0 Ohms, the unit will not transmit any power to the motor. As the resistance is increased, the pulse width that is delivered to the motor is increased. At 5K Ohms, the Controller will reach 100% duty cycle as long as the current limit has not been exceeded.

Pulse Width Modulation is directly related to the resistor value unless the device is in current limit mode. Current limit mode means that controller has limited the current via PWM, at a value less than the Pot input would otherwise call for.

Current limit is effected by both the torque output of the motor, and motor RPM. Consequently, current limit will not stay constant as the load characteristics of the motor change.

HIGH CURRENT CONNECTIONS

Refer to the CONNECTION DIAGRAM for identification of controller connections.

There are three high current connections on Auburn Scientific Controllers.

V+ Connects to the positive side of the DC power source to the positive side of the motor (Motor +).

Note: Both the V+ battery source and the M+ motor connection should be made at the controller for optimal operation. See the Connection Diagram.

V- Connects to the negative side of the DC power source.

M- Connects to the non-positive side of the motor (Motor -).

Switching takes place between the non-positive side of the motor and the V- terminal. During a "pulse on" cycle, the non-positive side of the motor is connected directly to the V- terminal through the FET transistors in the Controller.

LOW CURRENT CONNECTIONS

With the change to Processor control, and the demand for isolation and pre-charge resistor control, Auburn Scientific has increased the functionality of the control unit. Through the use of a few external parts, features such as "low power (reverse) mode," "mid-power (economy) mode," and "pre-charge resistor bypass control" are available to the user.

The unit is still compatible with older wiring, and will still function as a single full power controller with only the Enable and the 5K ohm Pot Box connected.

Enable Input *Red Line* (#1)	This input is connected through a switch to a voltage from 12 volts to V+. When the switch is closed and the voltage is applied, the Controller becomes enabled.
Resistor Inputs *Orange Line* (#2) *Yellow Line* (#3)	These inputs are connected across a variable 5K Ohm resistor. These inputs are used to control the power output.

Enhanced Mode control

Note: The following Enhanced Mode Signals are not referenced to the battery pack voltage. Instead they float with respect to the battery voltage. In order to use these signals an external or Chassis ground needs to be established with a +12 volt source available.

Chassis GND *Green/Yellow*	This signal is connected to the Chassis GND.
Main Relay CNTL *White*	This signal is used in conjunction with the Chassis GND. It is designed to control the main relay that bypasses the Pre-Charge Resistor. It functions by monitoring the internal controller voltage and closing an internal relay to Chassis GND when the Pre-Charge cycle has completed. See wiring diagram for an example. This signal is design to be used with a 12 volt relay coil and a 12 volt power supply.

Low Power Mode
Brown

This input function limits the available power to the motor and also lowers the rate at which the power is allowed to increase. The feature is useful for much finer control of the motor at low power settings.

To invoke Low Power Mode, connect the input to Chassis +12 volts. (This is a floating input)

Medium Power Mode
Green

This function is similar to Low Power Mode, but is designed to limit the battery current. When enabled, Medium Power Mode will supply adequate power for most uses, but will limit the current drain from the power source or batteries. To enable Medium Power Mode, connect the input to Chassis +12.

PRE-CHARGE RESISTOR

Use of a Pre-Charge Resistor is a mandatory element in any motor control system that uses an Auburn Scientific Controller. A 100 Ohm 50 watt Pre-Charge Resistor is included in the controller installation kit.

Use of a Pre-Charge Resistor has three main functions.

1. To stop the massive in-rush current that occurs when the controller is switched on directly to the battery pack or source voltage. The Pre-Charge resistor will prevent possible destruction of the controller's capacitive components.
2. To bring the controller to operating voltage before the enable signal is applied.
3. To give the user an opportunity to verify that all connections are correct before full power is applied to the system.

Use of the Pre-Charge Resistor is mandatory and necessary. Failure to properly use the Pre-Charge Resistor will void all warranties on Auburn Scientific Controllers.

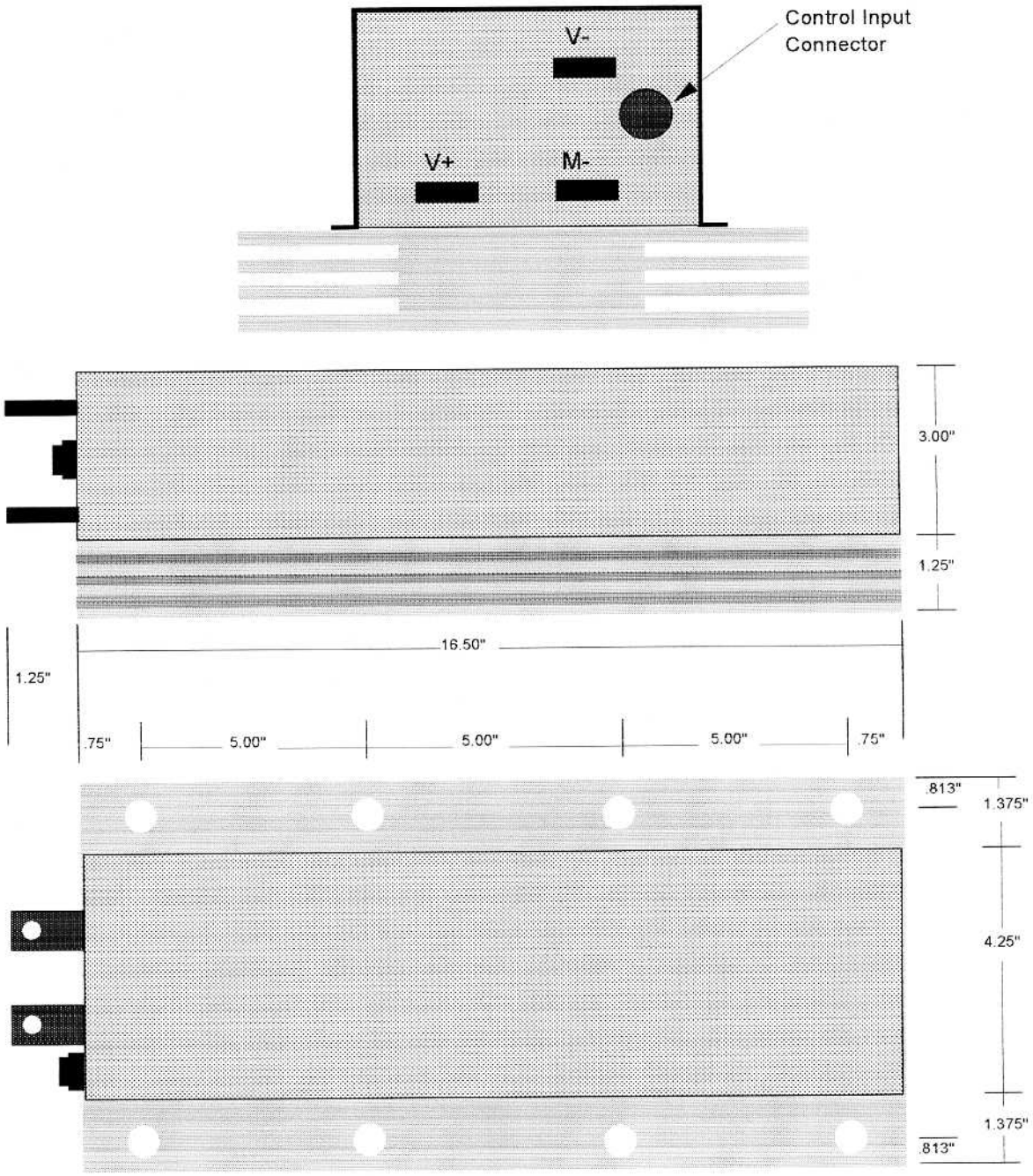
USAGE

Any high power motor control system should have at least two main switches (or contactors). Please refer to the connection diagram contained in this document. Closure (turn on) of these switches (or contactors) needs to be properly sequenced. To properly use the Pre-Charge resistor, it should be connected across the second or last switch (or contactor) to be closed. This will allow the controller to "charge up" before full system current capability is established. The pre-charge takes a few seconds to occur. Closing the last switch and supplying full system current should only occur after the pre-charge cycle. The controller ENABLE input should also only be applied after the pre-charge cycle to guarantee proper operation.

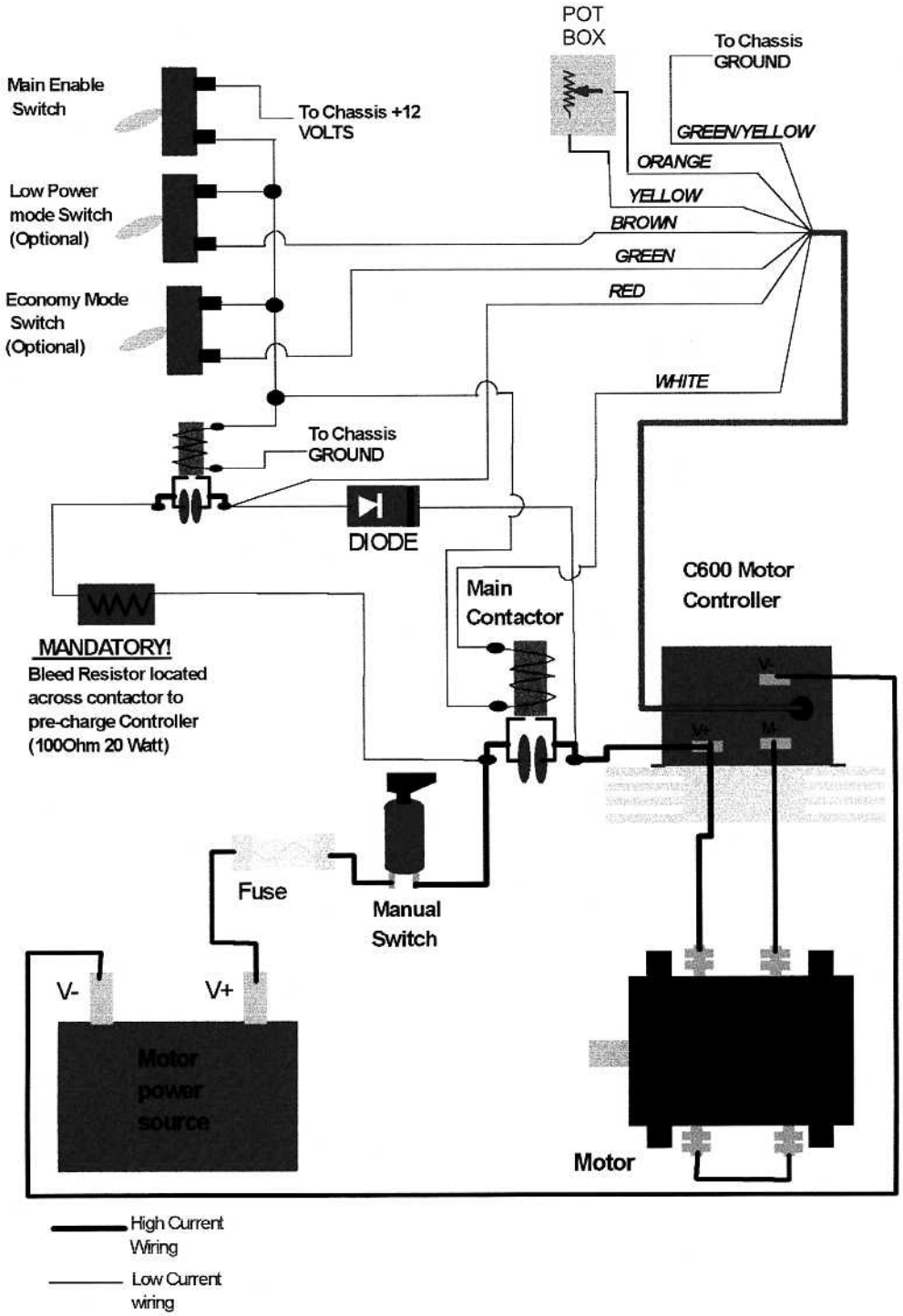
Note: To verify proper operation, voltages may be measured after pre-charge but before the final switch is closed. In this state, battery voltage across the controller will appear lower than at the system pack because of the voltage drop across the Pre-Charge Resistor. It is possible to "enable" the controller and test the motor connection in the Pre-Charge state. If all connections are made properly, the motor will turn slightly when the control pot (5k variable resistor) is actuated. The motor will appear to oscillate at a low frequency as current charges up the capacitive elements before discharge into the motor.

Warning: Even though the Pre-Charge resistor is in line between the batteries and motor, lethal voltages and currents are still possible. USE EXTREME CARE!!!

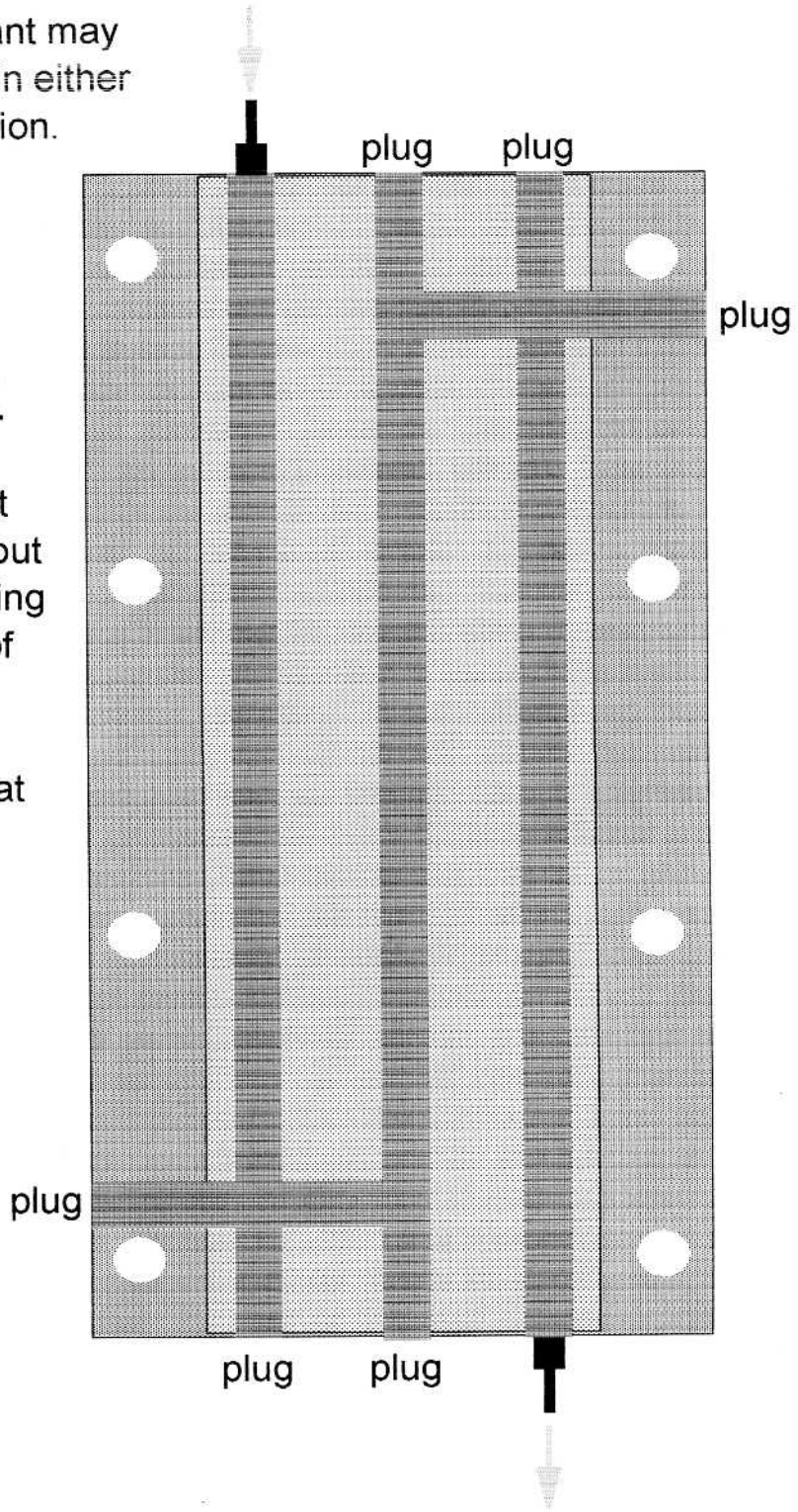
CONTROLLER DIMENSIONS



CONNECTION DIAGRAM



LIQUID COOLING SYSTEM



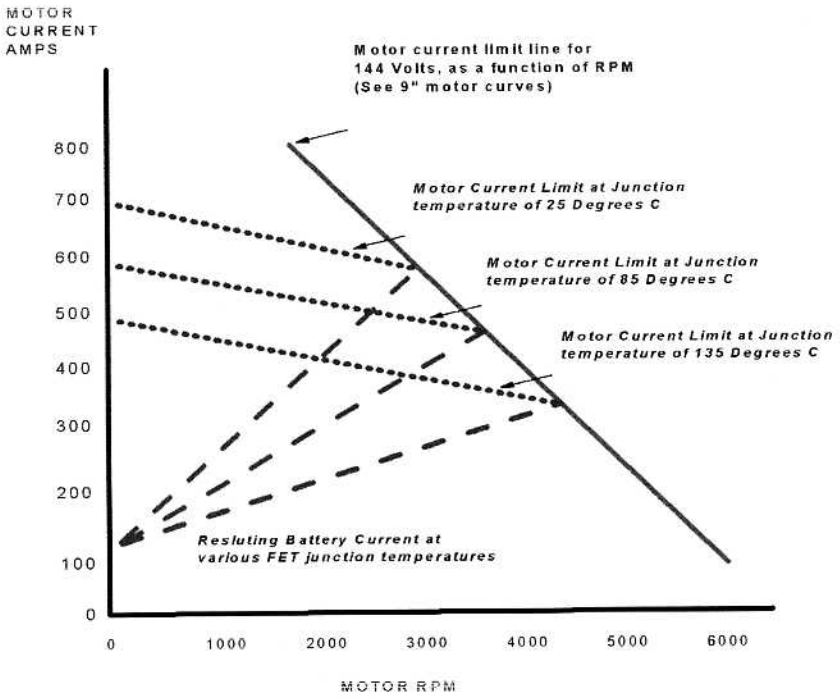
WARNING!

Liquid cooled controllers must not be run without coolant circulating for any length of time that would cause the controller to heat up.

CONTROLLER CURRENT CHARACTERISTICS

FULL POWER CONTROLLER CURRENT CHARACTERISTICS
AS A FUNCTION OF FET JUNCTION TEMPERATURE.

Derived from tests using Advanced DC 9 inch motor.
(These values can be generally applied for similar motors)



Fet junction temperature refers to the internal transistor junction. During operation, the junction temperature is always greater than the heat sink temperature. Cooling the heat sink will help reduce temperature of the junctions.

MOTOR CURRENT LIMIT is the maximum amount of current that can be pushed through a motor at a given RPM for a given supply voltage.

Maximum Motor Current has two components. The first is due to the internal limit of the controller. This value is controlled via Pulse Width Modulation. This limit is in effect until the motor current limit RPM is reached. At that point the controller is full on and current is limited by the motor. Battery current also has two limits. The first limit is made by the controller. Battery current will ramp up to the point where the controller is full on. At that point battery current is equal to motor current and is limited only by the motor.

WARRANTY

LIMITED 90 DAY WARRANTY

The Auburn Scientific Controller is warranted to the original purchaser for 90 days from date of purchase against defects in material and workmanship. During this period, Auburn Scientific shall repair or replace with like unit at Auburn Scientific's choice, defective components covered by this warranty.

This warranty does not extend to any Auburn Scientific components which have been subject to neglect, misuse, damage, incorrect wiring, improper installation, modifications, use in violation of any instructions provided with the product, alteration, unauthorized repair, or serial number modification.

No labor, removal, installation, or freight charges are included under this warranty.

This warranty is in lieu of all warranties expressed or implied and no representative or person is authorized to assume for Auburn Scientific any other liability in connection with the sale of the component. Under no circumstances shall the buyer be entitled to consequential or incidental damages. This limited warranty gives the owner specific legal rights. The owner may also have other rights which vary from state to state. Wiring harnesses and electrical connectors are not covered by this warranty.

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