



USER'S MANUAL

Precharge / Discharge Controller
TRI72.001 ver 1
19 January 2007

Precharge / Discharge Controller User's Manual

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Brisbane, Australia
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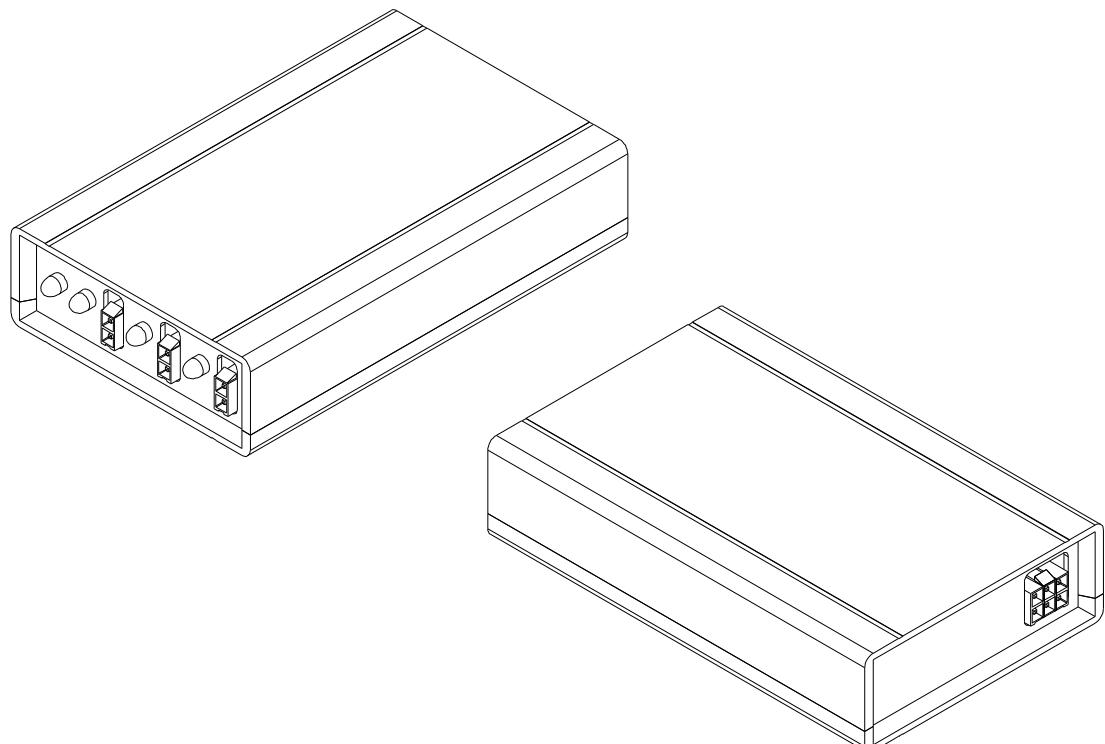
1 INTRODUCTION

This document details the interface, installation and usage requirements for the Tritium Precharge / Discharge controller.

The Precharge / Discharge controller provides a safe way to connect and disconnect a WaveSculptor motor controller (or any other capacitive load of a similar size) to a low-impedance power source such as a battery pack, without the risk of dangerous currents, contact welding, or sparks.

For operating limits and specifications, please refer to the Precharge / Discharge controller datasheet (TRI72.002), available on the Tritium website.

For further details on overall system configuration, please refer to the Wiring Engineering Reference document (TRI50.010), available on the Tritium website.





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OPERATING OVERVIEW

The precharge controller provides two basic functions:

- 1) Charges the DC bus capacitors in the motor controller in a controlled manner when power is applied to the system, to avoid high inrush currents.
- 2) Slowly discharges the DC bus capacitors when power is removed, to avoid a shock hazard when disconnecting the motor controller.

The precharge function is accomplished by first connecting the Bus+ terminal of the motor controller to the Battery+ terminal through a resistor, to limit current flow. Precharge time is determined by the RC time constant of the circuit. Once the two voltages are close then the two terminals are connected directly.

The discharge function is accomplished by disconnecting the Bus+ motor controller and Battery+ terminals, then connecting a resistor between Bus+ and Battery Ground to discharge the capacitors in the motor controller. Discharge time is determined by the RC time constant of the circuit. Note that depending on the resistances used, the discharge time may be different from the precharge time.

The precharge controller also provides protection for itself in the event of a fault in the main circuit. It operates subject to an acceptable temperature on the internal heatsinking. This heatsinking is absorbing the energy dissipated in the precharge and discharge resistors (nominally 128 Joules for a standard Wavesculptor). During normal operation, the heatsink will have only a minimal increase in temperature. However, if the output of the precharge circuit (the WaveSculptor, or other attached circuitry) has a fault, and there is a short or low-impedance connection between the output terminals, then the precharge resistor will rapidly become hot and the circuit will shut itself down.

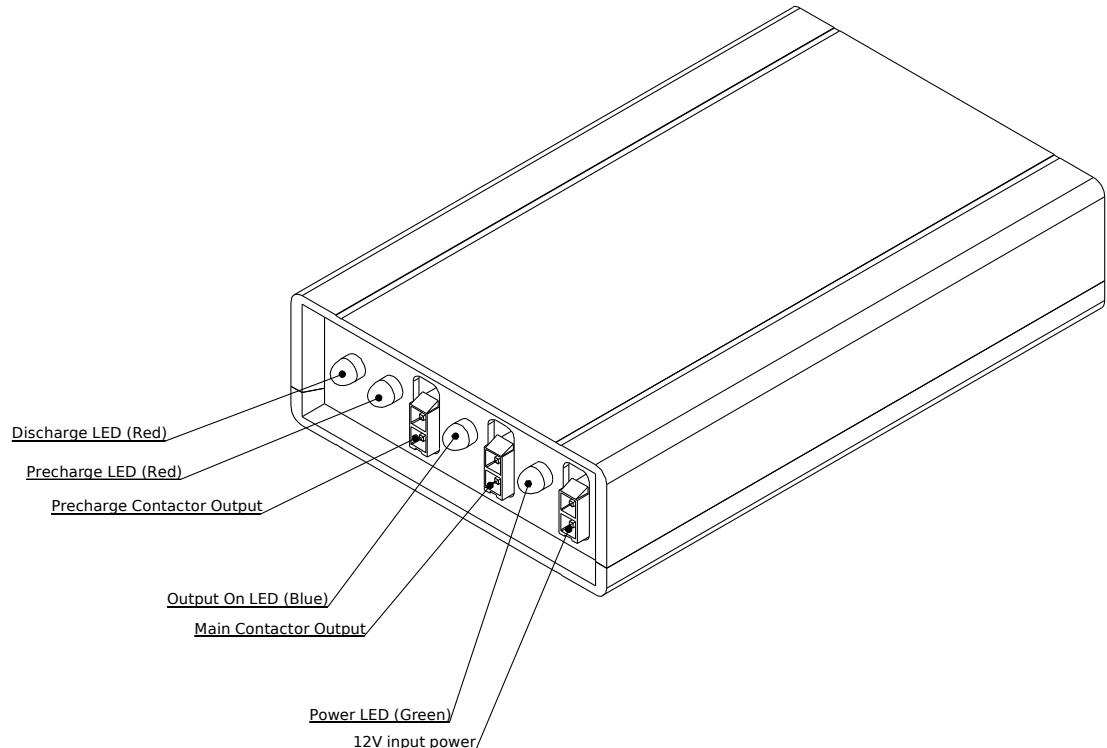


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3 FRONT PANEL

The following diagram shows the connections and status LEDs on the front panel of the precharge controller. The three connectors (power, main contactor, precharge contactor) are all 2-way Molex Mini-Fit Jr male connectors.



3.1 CONNECTIONS

Due to the possibility of the customer using various different wire sizes, Tritium does not supply mating housings or crimps for these connectors. The following part numbers (from Digikey) are suitable.

For reliable connections, please use one of the recommended crimp tools – do NOT use pliers.

Description	Order Code	Price (US\$)
18-24 AWG Mini-Fit Jr Female crimp (MOQ = 10)	WM2501-ND	\$0.10
22-28 AWG Mini-Fit Jr Female crimp (MOQ = 10)	WM2503-ND	\$0.07
2 way crimp housing	WM3700-ND	\$0.46
6 way crimp housing	WM3702-ND	\$0.61
Mini-Fit Jr dedicated prototype crimp tool	WM9996-ND	\$243.27
Generic Molex crimp tool	WM9999-ND	\$50.75



3.2 POWER INPUT

The power input provides power to operate the circuit and the external contactors, and is also the control signal for precharge / discharge operation.

When voltage is present on this input, the Green "Power" LED will be illuminated. The circuit will begin precharge operations. When power is removed from this input, the Green LED will go dark, and the circuit will begin discharge operations.

The power to this connection should be routed through a key switch near the driver (or a relay controlled via CAN bus from the driver controls) and also through an emergency shutdown switch, accessible from either (or both) the driver and outside the vehicle. Please refer to the relevant regulations for further details.

3.3 MAIN CONTACTOR OUTPUT

The Main contactor output provides a controlled on/off power supply to operate an external high voltage DC contactor in the main power path. The status of this output is indicated on the Blue "Output ON" LED.

This output will come on automatically as soon as voltage is applied to the power input connection of the precharge controller. It will turn off if the internal heatsinking rises to the temperature cut-off point, and will then turn back on when the heatsinking falls back to an acceptable level.

The voltage present on this output (when switched on) will be whatever voltage is provided to the power input connection. Please choose an external contactor that operates with a control voltage in this range.

3.4 PRECHARGE CONTACTOR OUTPUT

The Precharge contactor output provides a controlled on/off power supply to operate an external high voltage DC contactor in the main power path.

This output will come on only when the voltage on the battery (precharge input) and the voltage on the Wavesculptor (precharge output) are closely matched. It is also affected by the temperature of the internal heatsinking in the same manner as the main contactor output.

The voltage present on this output (when switched on) will be whatever voltage is provided to the power input connection. Please choose an external contactor that operates with a control voltage in this range.

3.5 PRECHARGE LED

The Red "Precharge" LED indicates that the voltage on the battery and the voltage on the Wavesculptor are not yet matched. During normal operation, it should illuminate for a limited time only, 1.5 seconds for a Type 1 circuit, and 25 seconds for a Type 2 circuit. Illumination for longer periods than this indicates that there is a short-circuit fault on the output.



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The precharge controller will shut down under these circumstances to protect both itself and the output device.

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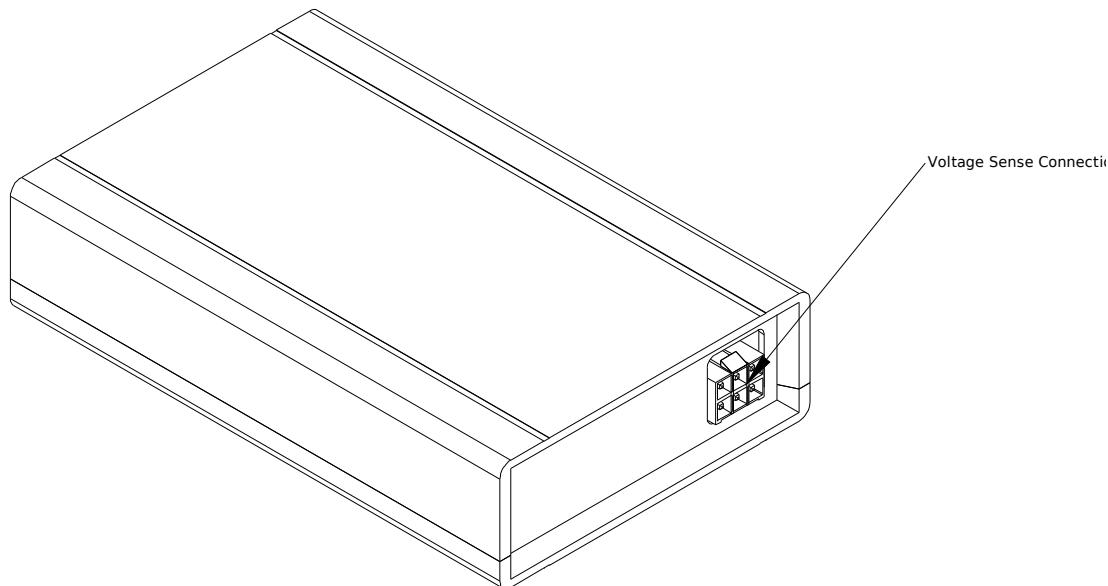
DISCHARGE LED

The Red "Discharge" LED indicates that the circuit is actively discharging the capacitors in the Wavesculptor, and that a dangerous voltage is still present on the output connections. It illuminates when there is a voltage across the 680 ohm discharge resistor.

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REAR PANEL

The following diagram shows the connections on the rear panel of the precharge controller. The single connection (voltage sense) is a 6-way Molex Mini-Fit Jr male connector.



Please refer to the following sections (Type 1 & Type 2 connections) for further information regarding this connector.

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EXTERNAL CONTACTORS

External contactors must be used in this circuit to switch the high voltage and high currents present in the Battery to WaveSculptor connection. Make sure that the contactors chosen can interrupt expected fault currents. The decision on what contactors to use should also depend on the type and rating of battery pack fusing, wiring, and internal resistances.

Tritium recommends the use of Tyco EV200 AAA NA contactors, available from Newark, order code 09J3878, rated to 500A carry current, 2000A break current, and up to 900V operating voltage.



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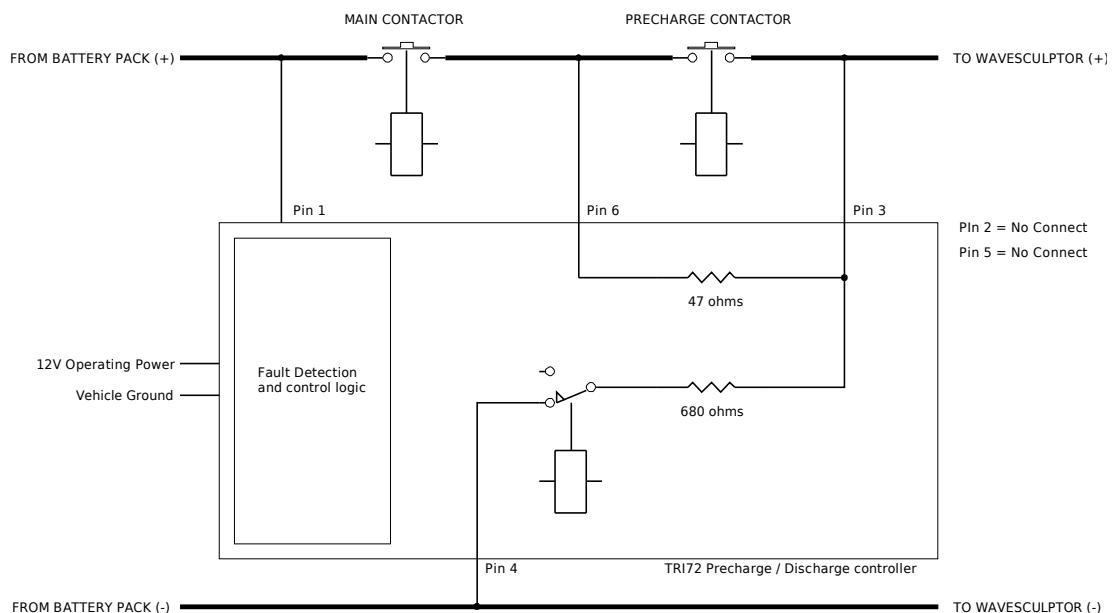
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6 CONNECTIONS – TYPE 1

The precharge controller can be used in two different configurations, depending on the cost, complexity, performance and safety tradeoffs you wish to make in your application.

This section of the document details how to configure the precharge controller for a fast precharge time of approximately 1.5 seconds, using a moderately complex system with two external DC contactors. This system will be referred to as a “Type 1” system throughout this document.

The following diagram shows an overview of the connections used in a Type 1 system. The pin numbers shown are for the 6-way voltage sense connector on the rear panel of the precharge controller.



In this circuit, the sequence of events for precharge under normal operating conditions is as follows:

- 1) 12V operating power applied, Green LED on
- 2) Internal relay disconnects 680 ohm resistor
- 3) Main contactor energises, Blue LED on
- 4) WaveSculptor charges through 47 ohm resistor, Precharge LED on
- 5) Voltages on Battery and Wavesculptor match, Precharge LED off
- 6) Precharge contactor energises
- 7) WaveSculptor is ready for operation



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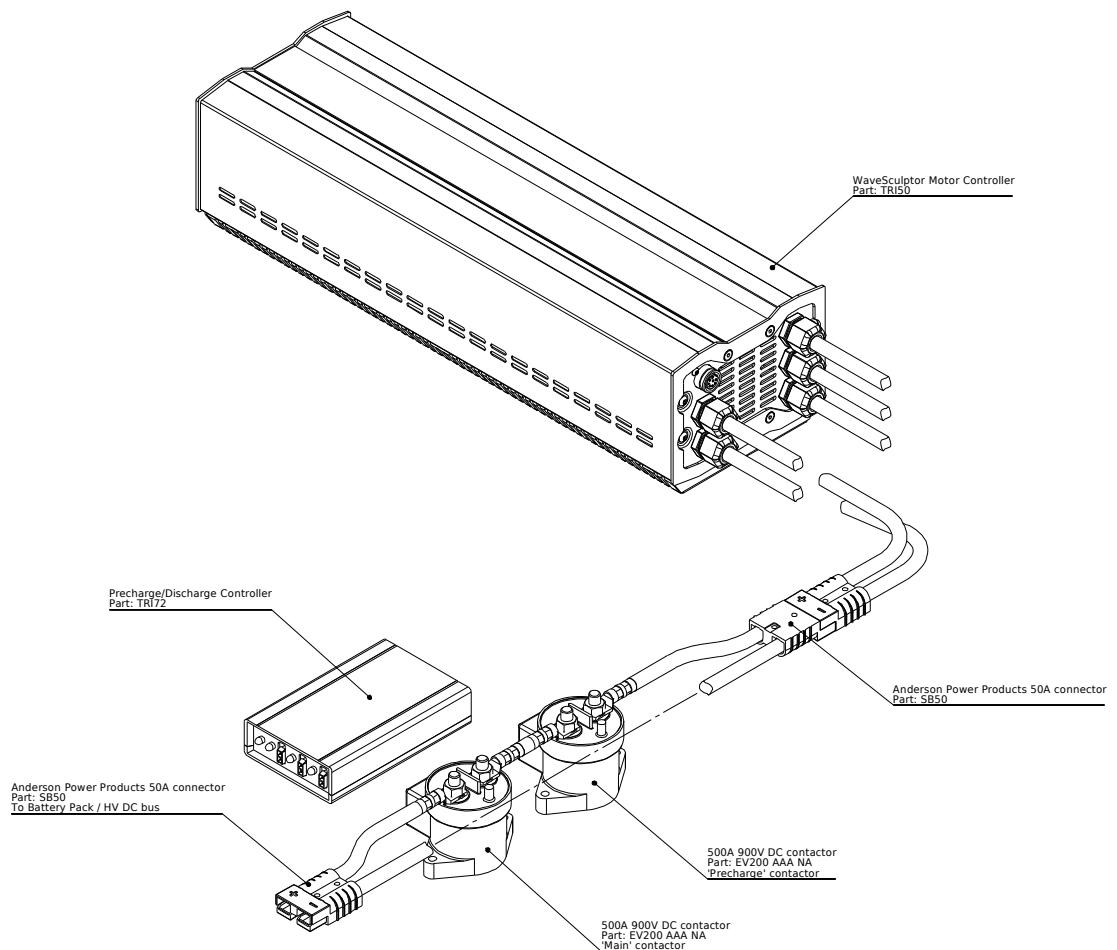
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The sequence for discharge operations is as follows:

- 1) 12V operating power removed, Green LED off
- 2) Precharge and Main contactors disengage, Blue LED off
- 3) Internal relay closes and connects 680 ohm resistor to ground
- 4) WaveSculptor discharges through 680 ohms, Discharge LED on
- 5) Low voltage reached, Discharge LED off

The following diagram illustrates a typical system using a Type 1 configuration:





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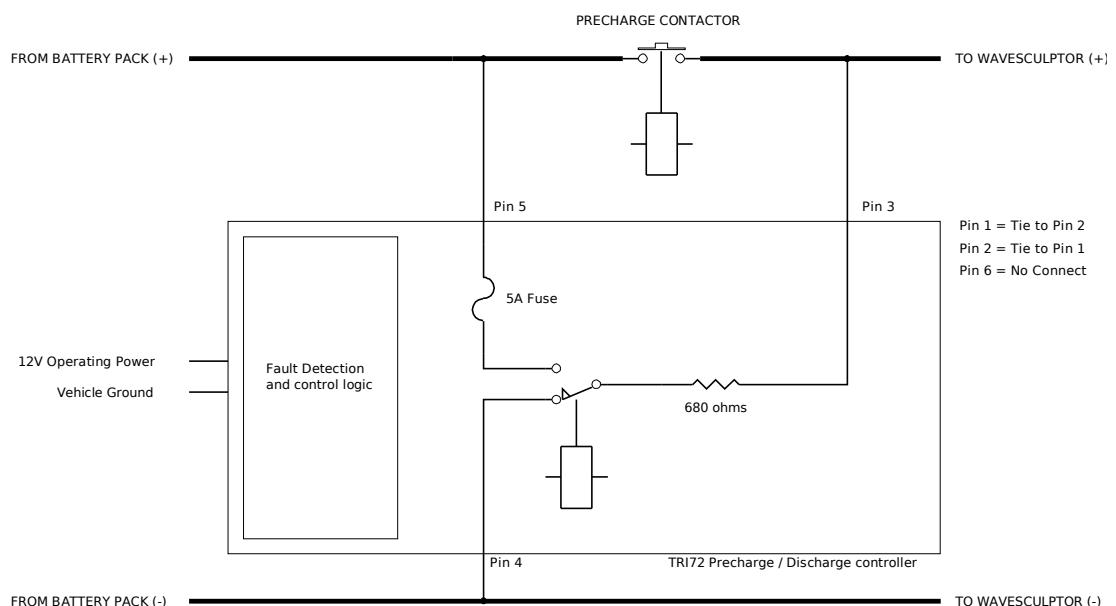
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7 CONNECTIONS – TYPE 2

The precharge controller can be used in two different configurations, depending on the cost, complexity, performance and safety tradeoffs you wish to make in your application.

This section of the document details how to configure the precharge controller for a slow precharge time of approximately 25 seconds, using a simple system with one external DC contactor. This system will be referred to as a "Type 2" system throughout this document.

The following diagram shows an overview of the connections used in a Type 2 system. The pin numbers shown are for the 6-way voltage sense connector on the rear panel of the precharge controller.



In this circuit, the sequence of events for precharge under normal operating conditions is as follows:

- 1) 12V operating power applied, Green LED on, Blue LED on
- 2) Internal relay connects 680 ohm resistor between pin 5 and pin 3
- 3) WaveSculptor charges through 680 ohm resistor, Precharge LED on
- 4) Voltages on Battery and Wavesculptor match, Precharge LED off
- 5) Precharge contactor energises
- 6) WaveSculptor is ready for operation

The sequence for discharge operations is the same as for a Type 1 circuit.



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SAFETY

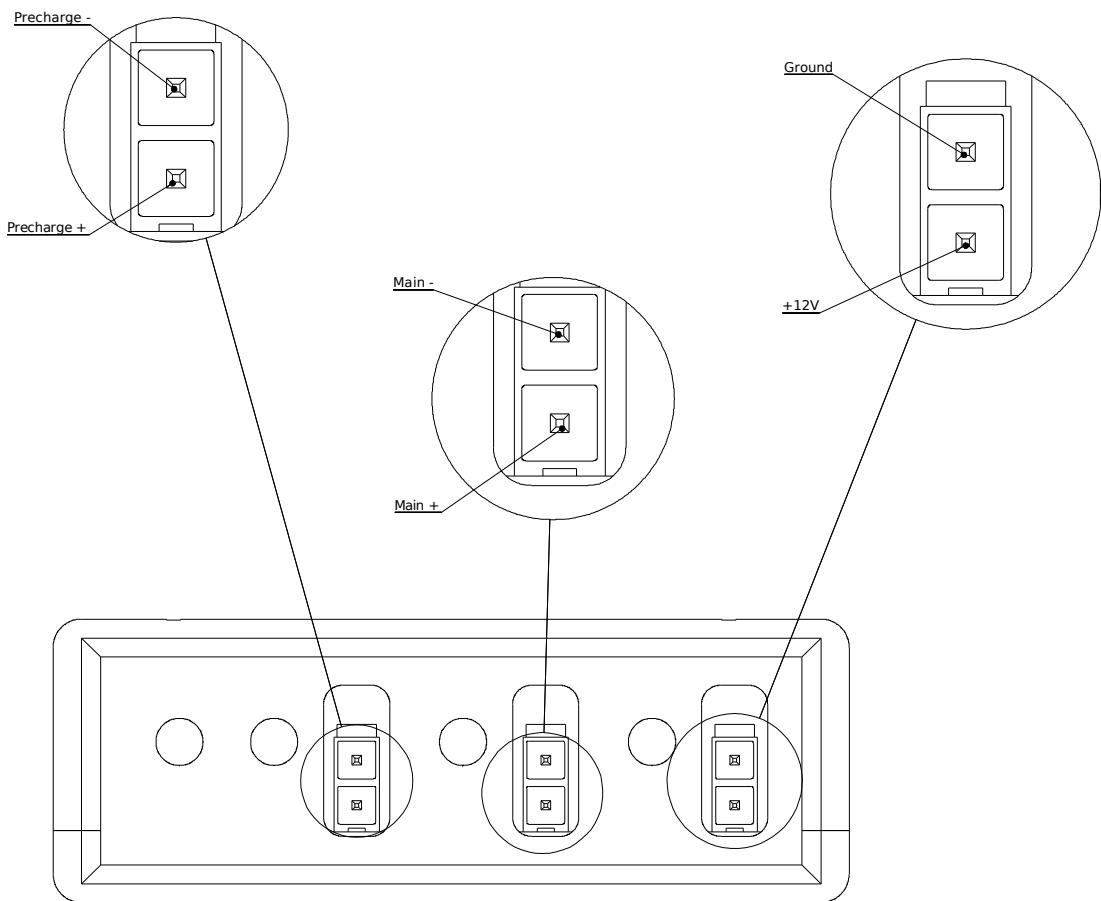
If **any** LEDs on the front of the precharge controller are illuminated, then the output is potentially at a high voltage and in an unsafe state.

Always treat any high voltage connection as potentially live. Do not rely on the LED indicators of the precharge controller for notification of a live connector, as a LED or part of the circuit responsible for driving it may have failed.

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FRONT PANEL CONNECTOR PINOUTS

The following diagram shows the connector pinouts as viewed when looking at the precharge controller, ie the view you have when inserting crimps into the rear of the connector housing.





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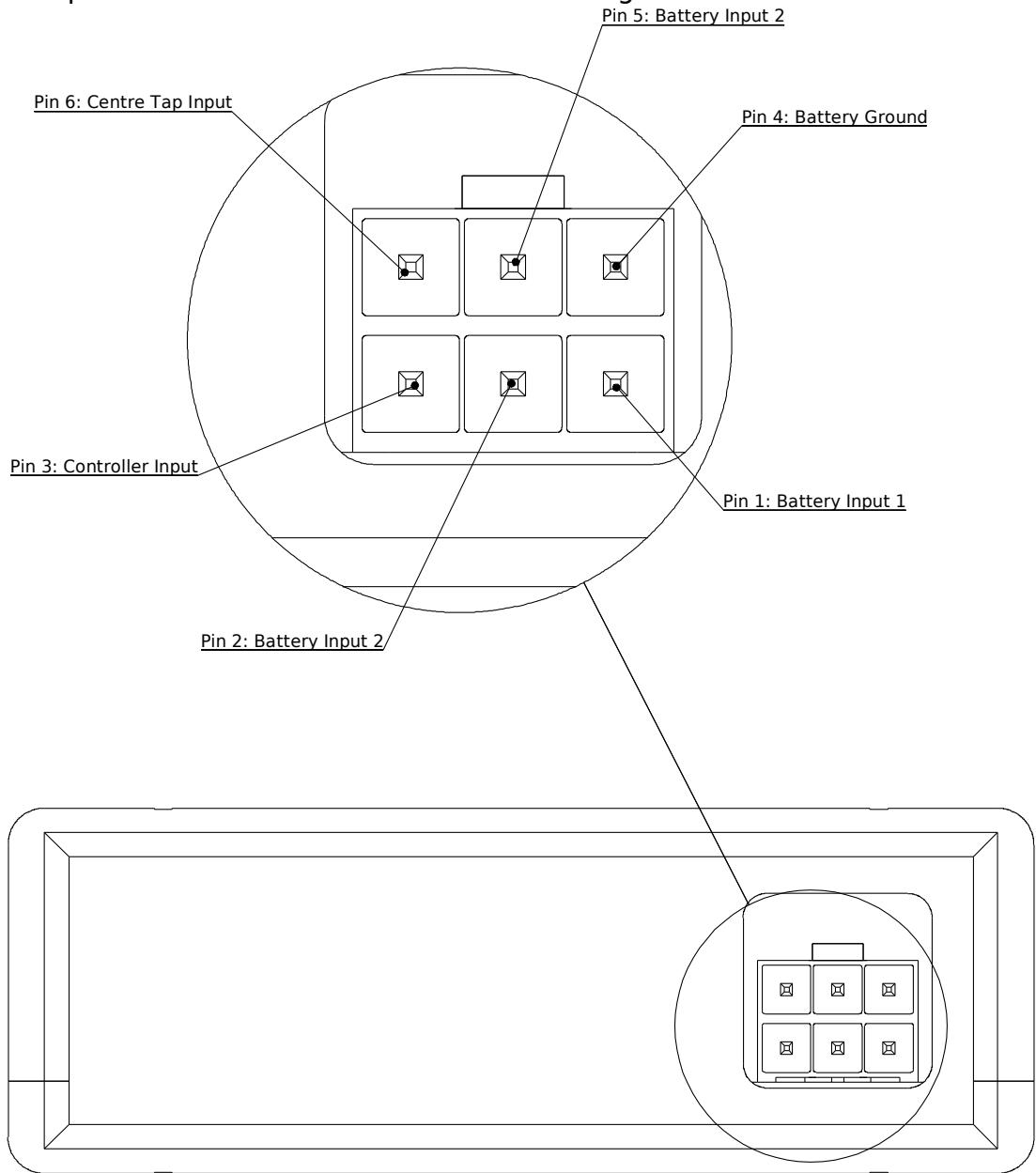
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REAR PANEL CONNECTOR PINOUT

The following diagram shows the connector pinout as viewed when looking at the precharge controller, ie the view you have when inserting crimps into the rear of the connector housing.



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REVISION RECORD

WHO	DATE	CHANGE
JMK	19 January 2007	Version 1 - Initial Document