



## **INSTALLATION GUIDE**

### **WaveSculptor Motor Controller**

TRI50.018 ver 2  
15 March 2007

# **WaveSculptor Motor Controller Installation Guide**

**15 March 2007**

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Brisbane, Australia  
<http://www.tritium.com.au>



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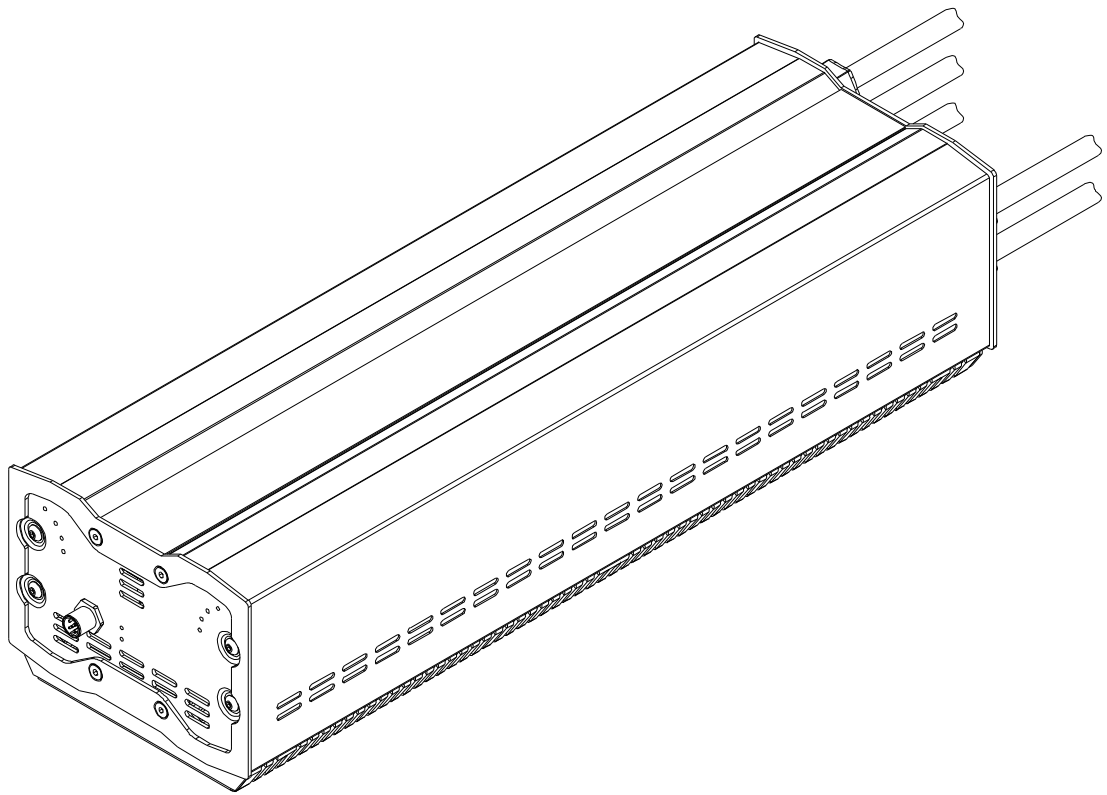
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### **1 INTRODUCTION**

This document provides an overview of the steps required to install, test, and use the Tritium WaveSculptor Motor Controller. It makes reference to several more detailed documents, which are available from the Tritium website at <http://www.tritium.com.au>

A listing of **referenced documents** are shown at the end of this guide.

Please read through this entire document, and any referenced documents, before proceeding with any testing or connections to the WaveSculptor motor controller.



### 2 SHIPMENT

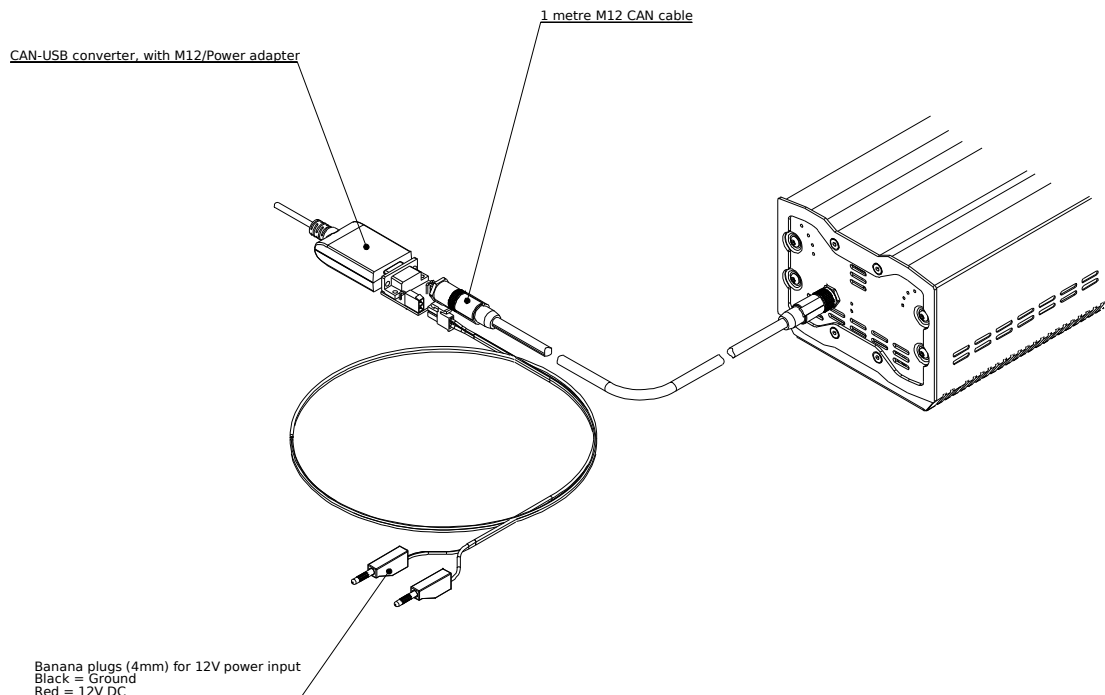
The WaveSculptor motor drive is shipped in a cardboard box with a protective internal frame. Other hardware items and documentation are packed in a separate inner box.

Please use the packing list enclosed in the inner box to ensure that all items are present and undamaged. Contact Tritium if there is a problem with your shipment – email is our preferred method. Email: [enquiries@tritium.com.au](mailto:enquiries@tritium.com.au)

### 3 CAN BUS AND LOW VOLTAGE SETUP

By default, each WaveSculptor is shipped with the cables and adapters needed for initial configuration and testing. Connect the WaveSculptor, CAN cable, and CAN – USB adapter as shown in the following diagram. This will allow you to use the Windows PC configuration program to set up the WaveSculptor to suit your motor and vehicle system.

Since this procedure uses a short cable, and the M12/Power adapter contains a CAN bus terminating resistor, you do not need to use any T-junctions or other wiring arrangements – just connect the CAN cable directly between the two devices. For some configuration items, it is a requirement that the WaveSculptor be the only device present on the CAN bus.



Provide a 12V DC power supply to the system using the banana plugs. For initial programming and testing, Tritium recommends using a good quality current-limited benchtop (laboratory) power supply, not a battery, so that you can monitor current consumption. Maximum current will depend on the voltage supplied, but will be no more than approximately 2 Amps.

You do not need to connect power to the high-current battery terminals of the WaveSculptor for this part of the procedure.



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#### 4 CAN BUS COMMUNICATIONS CHECK

Install the Tritium WaveSculptor configuration program on your Windows PC according to the **software user's manual** document. You may also need to install the CAN – USB adapter's drivers and support libraries at this point.

Run the configuration program and check that it can communicate with the WaveSculptor motor drive. You should see telemetry values being updated in the Windows program if everything is successful.

#### 5 MOTOR SETUP

Apply the connectors to your motor according to the **WaveSculptor Wiring & Connections Engineering Reference** document. Make sure to use an appropriate crimp tool for the high-current phase connections.

Use good soldering practices (correct flux, temperature regulated iron, etc) when connecting the motor position and temperature sense plug.

When you have double-checked all connectors, plug your motor into the WaveSculptor motor controller. Take note that the phase wiring (Phase A, B & C) and hall position sense (Hall #1, #2 & #3) relationship does not matter at this point, as the Tritium software will detect your configuration and adjust itself accordingly.

Make sure that your motor meets the minimum inductance requirements, as detailed in both the **Wiring Engineering Reference** and in the **WaveSculptor Datasheet**.

#### 6 HIGH POWER SETUP

This step will involve applying a high voltage operating supply to the main DC bus connection of the WaveSculptor. Please follow all appropriate safety procedures when working with the motor and controller, as lethal voltages will be present from this point onwards.

Tritium **highly recommends** the use of a current-limited laboratory benchtop power supply for this initial test, not a battery pack or other non-limited supply. In the event of a fault in the controller or motor wiring, a battery will be able to supply hundreds of amps, potentially resulting in a destructive and dangerous situation. A power supply will current-limit, allowing time to recognise that there is a fault and shut the system down.

If you are using a current-limited power supply, you do not need to use a precharge circuit, as the supply will current-limit until the DC bus capacitors in the WaveSculptor are charged. This makes the initial test setup safer and less complex as you can visually confirm correct connections.

Follow the procedure in the **software user's manual** to run the PhasorSense and Parameter Extraction algorithms. These will identify the motor hall sense positions and active states, and the motor's inductance and resistance. These values are used by the control software in the WaveSculptor, and are required for efficient and reliable operation.

Fill out the values in the configuration screen according to the software user's manual. The more accurately you enter these values, the better the performance of the controller can be.



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Once you have all values entered, save the configuration to your PC for a backup, and upload the configuration to the Wavesculptor. You're now ready to drive the motor.

## 7 **MOTOR TESTING**

Mount the motor on a test stand, or mount it in the vehicle, and lift the drive wheel off the ground. This test should also be run using a benchtop supply, not your battery pack.

Since you are running from a power supply, regenerative braking is not possible. Do not turn down the velocity slider while leaving the current slider turned up, as the motor will try to brake down to the set velocity using the set current, potentially destroying your power supply. Always leave the velocity set, and turn the current down instead. This restriction does not apply if operating from batteries.

Use the Windows driver controls software to control the motor. Set the velocity to a moderate speed (eg: 30km/h, 20mph) and gradually turn up the current slider. The motor should spin. As the motor speed builds up past approximately 3km/h (depending on pole count and motor type) you should hear the WaveSculptor switch from six-step (squarewave) to sensorless (sinewave) drive, and the motor should become much quieter.

Run this test in both the forwards and reverse direction. Allow the motor to come to a gradual stop before changing direction, to ensure that no regenerative braking occurs.

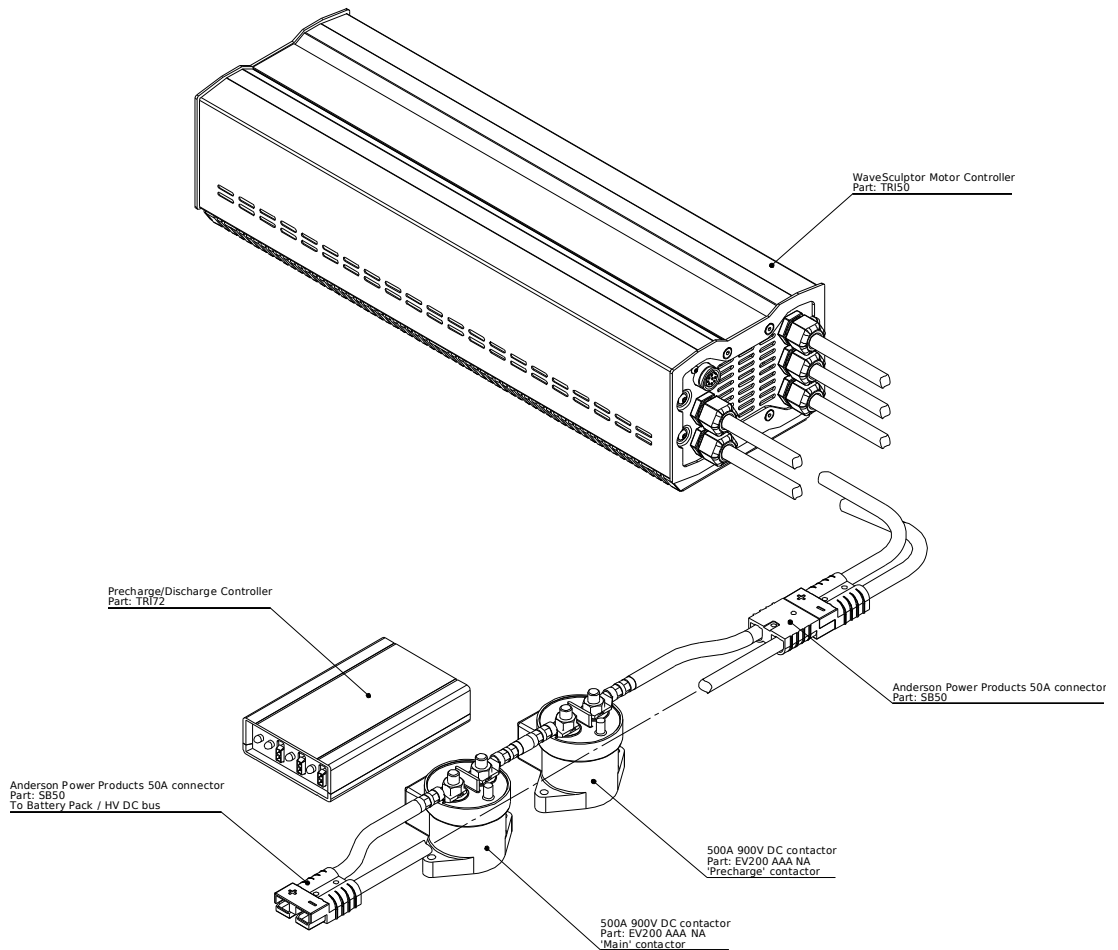
## 8 **HIGH POWER TESTING**

If all the previous tests are satisfactory, then it is time to move on to high power testing using a battery pack. Take all relevant safety precautions when working with high power systems. The battery pack, motor controller, and motor (when spinning) contain lethal amounts of energy.

Follow the recommendations in the **WaveSculptor Wiring Engineering Reference** document and the **WaveSculptor datasheet** when connecting your battery pack to the motor controller. Check that your precharge circuit is correct, your battery connectors, DC breakers and cables are correctly rated, emergency shutdown circuits are implemented, and that you have appropriate fusing in place.

Connect the high-current DC bus terminal of the WaveSculptor to the output side of your precharge circuit. Ensure that the precharge circuit is shut down, and all safety systems are in place. Connect the input side of the circuit to your battery pack. Activate the precharge controller. Use the CAN bus telemetry readings to check that the WaveSculptor is reporting the correct voltage on it's DC bus, and that temperatures and internal supply voltages are normal.

If you are performing this test with the motor mounted in the vehicle, ensure that the vehicle is secured and the drive wheel is off the ground for the full range of suspension travel. Rapid transitions from driving to regenerative braking, or from forwards to reverse, will produce large forces on the motor and mountings. If using a dedicated motor test stand, ensure it is designed and rated for this type of use.



Perform the test by sending commands from the Windows driver controls program to the WaveSculptor. Try various combinations of current and velocity control, in both forwards and reverse directions. Check that regenerative braking is operational, by reducing the velocity slider to a speed that is less than the motor is currently travelling. The motor controller will use any current up to the current slider setpoint to slow the motor down to the velocity setpoint.

Once the test is complete, bring the motor to a stop and shut down the precharge circuit. Wait for the DC bus capacitors to be discharged so that the circuit is safe. Disconnect the battery pack and motor controller.

## **9 VEHICLE INSTALLATION**

Install the WaveSculptor into your vehicle following the **Mechanical Engineering Reference** document. Pay close attention to airflow and cooling arrangements, as they are critical to the performance of your motor controller.

Connect your CAN bus driver controls, displays and other items into the WaveSculptor using the network topology outlined in the **CAN bus Engineering Reference** document.



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## **10** DRIVING

With the vehicle drive wheel still raised above the ground, check for correct operation of the motor using your driver controls interface instead of the Windows PC software.

Check operation in forwards and reverse, with regenerative braking (if implemented), and that the motor shuts down (freewheels) or actively regeneratively brakes when your vehicle mechanical brakes are applied.

Check correct operation when the vehicle ignition key is turned off, and also for correct operation of the precharge (and discharge, if implemented) circuits.

If all tests are satisfactory, then shut down the vehicle, lower the drive wheel to the ground, remove all chocks and restraints, and take your vehicle for a drive.

## **11** REFERENCED DOCUMENTS

TRI50.010	WaveSculptor Wiring Engineering Reference
TRI50.012	CAN Bus Engineering Reference
TRI50.013	WaveSculptor Mechanical Engineering Reference
TRI50.016	WaveSculptor Datasheet
TRI50.026	Software User's Manual

## **12** REVISION RECORD

<b>REV</b>	<b>DATE</b>	<b>CHANGE</b>
1	15 March 2007	Document creation (JMK)
2	15 March 2007	Minor clarifications, inserted contact details