dynamic™

RHINO2

Rhino to RHINO2

Conversion Guide

Rhino to RHINO2 Conversion Guide Issue 1, December 2011

About

This manual can help you convert an existing Rhino-based scooter system to a RHINO2 scooter system.

This manual must be read together with all other relevant scooter component manuals.

In this manual, a few symbols will help you identify the purpose of the paragraph that follows:

Notes:

Notes provide supporting information in order to install, configure, and use the product. Not following the instructions given in notes or precautions can lead to equipment failure.

Warnings:

Warnings provide important information that must be followed in order to install, configure, and use the product safely and efficiently. Not following the instructions given in a warning can potentially lead to equipment failure, damage to surrounding property, injury or death.

The term 'programming' used in this manual refers to adjusting parameters and configuring options to suit an application. 'Programming' does not change or alter any software within the controller and is performed using a controlled programming tool available only to authorised personnel.

The product is not user serviceable. Specialised tools are necessary for the repair of any component.

Do not install, maintain or operate this equipment without reading, understanding and following this manual – including the Safety and Misuse Warnings – otherwise injury or damage may result. This manual contains integration, set-up, operating environment, test and maintenance information needed in order to ensure reliable and safe use of the product.

Due to continuous product improvement, DYNAMIC CONTROLS reserves the right to update this manual.

This manual supersedes all previous issues, which must no longer be used.

DYNAMIC CONTROLS reserves the right to change the product without notification.

Any attempt to gain access to or in any way abuse the electronic components and associated assemblies that make up the scooter system renders the manufacturer's warranty void and the manufacturer free from liability.

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Contents

Introduction

This document shows you how to retrofit a *RHINO2* scooter control system. It is important that you read and follow these instructions carefully. Please adhere to all warnings and steps.

To complete the installation, you will need the following:

- A copy of the *RHINO2* Installation Manual
- A *RHINO2* controller to replace the Rhino
- Cable adaptors for battery, motor, park brake and tiller head.
- The Wizard for setting parameters and optionally, a DX-HHP (hand-held programmer) for calibrating the Throttle.
- Programmer adaptors: DWIZ-ADAPT and DR-PRGLM02 (see ***Programming*** in the ***Further information*** section at the back of this guide)

Warning:

Follow these instructions carefully. The RHINO2's current capability is higher than Rhino. Failure to follow these settings can result in damage to the scooter or serious injury to the user.

Before you start!

Make sure that you have a copy of the *RHINO2* Installation Manual at hand. This is important for details of mounting the new controller, setting the controller's profile, and detailed further information.

Warning:

This manual should be read in conjunction with the RHINO2 Installation Manual and the procedure should only be carried out by suitably trained personnel.

Note:

If you have any difficulty with the instructions in this guide, then please consult your scooter manufacturer.

Introducing the *RHINO2*

The *RHINO2* family of scooter controllers provides a reliable, refined, cost-effective control solution for most mobility scooters and includes:

DS90 - *RHINO2* 90A Controller	DS90-ACT - *RHINO2* 90A Controller with actuator
DS120 - *RHINO2* 120A Controller	DS120-ACT - *RHINO2* 120A Controller with actuator
DS160 - *RHINO2* 160A Controller	DS160-ACT - *RHINO2* 160A Controller with actuator

***RHINO2* – DS90 and DS120**

***RHINO2* – DS160**

- 90, 120 and 160A models provide the power you want when you need it
- Programmable acceleration curves, improved rollback on slopes, and improved motor matching algorithms ensuring better curb-climbing and hill-starting capabilities
- Speed reduction wiper (SRW) technology provides a seamless speed reduction in curves for extra stability
- Intelligent motor and battery management providing automatic power flow optimisation, auto battery configuration, 5V and 12V battery capacity outputs (TruCharge™) and in-depth battery logging and analysis tools
- Support for a range of battery types, multi-function pins and flexible drive inhibits
- Advanced diagnostics and servicing tools, including event and drive time logging, and programmable servicing scheduler
- 2 Drive profiles, brake and reverse lights, reversing beeper and electronic park brake release
- IP54 ingress protection
- A separately available aluminium terminal cover provides increased protection to IP55 when fitted
- Compliant with EU Directive 2002/95/EC of 27 Jan. 2003 – restrictions on use of Hazardous Substances (RoHS)
- Optional single actuator output (with Wig-wag or dedicated switch activation).

Procedure

The procedure for swapping a Rhino system to a *RHINO2* system involves both adapting the cabling, and programming some specific parameters. A summary is outlined below:

Step 1 – Capture the Rhino's existing profile
Step 2 – Replace the Rhino controller with the RHINO2 controller
Step 3 – Adapt the cables
- *Install the motor, park brake and battery cable adaptors*
- *Install the logic cable adaptor*

Step 4 – Set up the scooter profile
- *Set up throttle parameters*
- *Set up motor management parameters*
- *Set up battery management parameters*
- *Set up drive performance parameters*
- *Set up park brake management parameters*
- *Set up actuator parameters*

Step 5 – Test drive

In step 3, choose and install the correct cable adaptors for your scooter system.

For step 4, the Wizard programming tool is required to program specific parameters (see ***Programming,*** in the ***Further information*** section). For each parameter, a reference is provided next to the parameter's name (for example, **Speed Limit Pot** (**4.4.2.11**)). This refers to the section in the *RHINO2 Installation Manual* where you will be able to find out more information on that particular parameter.

Before you start!

Make sure that you have a copy of the *RHINO2* Installation Manual at hand. This is important for details of mounting the new controller, setting the controller's profile, and detailed further information.

Step 1 – Capture the existing Rhino's profile

Connect the existing Rhino system to a PC or laptop, and with the Wizard application, read the existing Rhino's configuration profile. You will use some of the existing configured parameters to set up the *RHINO2* controller in later steps. For more information on programming, see ***Programming,*** in the ***Further information*** section. Save and print out the profile for reference later on.

Step 2 – Replace the Rhino controller with the RHINO2 controller

Replace the existing Rhino controller with the new *RHINO2* controller. Note that the mounting holes of the *RHINO2* are different from the Rhino. For more information on this and the recommended mounting orientation, please see the *RHINO2* Installation Manual (section **3.1.1 & 3.1.2**).

Step 3 – Adapt the cables

Install the motor, park brake and battery cable adaptors

RHINO2 uses different cable connectors compared with the Rhino. For this reason, you will need to adapt the existing looms. Dynamic Controls have produced a number of adaptors to help you. The table below summarises the cable adaptors to use with the *RHINO2* variants.

Rhino to *RHINO2* Adaptor Loom	**Part No.**	**Use for DS52K to DS90**	**Use for DS72K to DS90**	**Use for DS72KA to DS90-ACT**	**Use for DS112K to DS120**	**Use for DS162K to DS160**	**Notes**
DS90 MTR/PB ADAPT LOOM	GLM51981	✓	✓	✓			Suitable for motor looms using Tyco 170258-2 housing.
DS120 MTR/PB ADAPT LOOM	GLM51983				✓		Suitable for motor looms using Dynamic Controls GCN51315 housing.
RHINO2 BATT/ACT ADAPT LOOM	GLM51984			✓			
RHINO2 MTR-4/RING ADAPT LOOM	GLM51985					✓	
RHINO2 BATT-6/RING ADAPT LOOM	GLM51986					✓	

Warning:

Check the motor connector on the existing motor to ensure that the receptacles are not loose or damaged. Loose or damaged receptacles can lead to over-heating, and the connector housing melting.

Warning:

The motor and battery adaptor looms are only suitable for use with scooter wiring that uses genuine AMP/Tyco housings and terminals and/or genuine Dynamic housings as specified in the Rhino installation manual.

Type	Part No.
6-way 250 series Plug Housing	*171898-1*
4-way 250 series Plug Housing	*172134-1*
250 series Receptacle w/o latch 14-12 AWG	*170258-2*
AMPINNERGY Connector Contact dual-beam 10-12 AWG	*556880-2*
Dynamic 4-way Connector Housing	*GCN51315*

Terminal kits

Alternatively, you can use the following terminal kits to re-terminate your existing looms. These kits are available from your Dynamic Controls supplier.

Terminal kit	Part No.	Details
RHINO2 - Loom Kit Logic	GSM51982	2, 4 and 14 pin connectors and terminals
RHINO2 – Loom Kit 4W MTR 6W BAT	GSM51988	4-way and 6-way housings and spade receptacles to suit DS90 and DS120
RHINO2 - Loom Kit Ring Term	GSM51989	8 ring terminals rated for 10-12 AWG wire, to suit DS160 only

Warning:

Only use genuine AMP or MOLEX crimp tools. Failure to properly crimp the terminals may result in high resistance terminations.

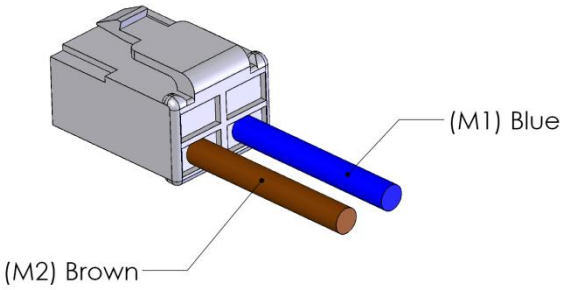
Note:
A DS90-ACT can be used to replace a DS52K or DS72K using the same looms as required by the DS90 and simply leaving the actuator pins unused. Plug the scooter's battery lead directly into the DS90-ACT. Do not use a GLM551984 "RHINO2 BATT/ACT ADAPT LOOM".

Similarly a DS120-ACT can replace a DS112K with the same looms as required by the DS120, and a DS160-ACT can replace a DS162K with the same looms as required by the DS160.

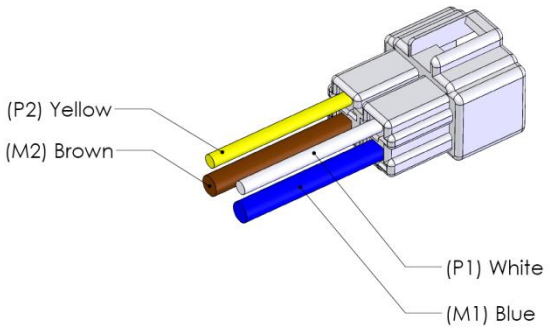
Adapting DS52K or DS72K to DS90 / 90-ACT

To adapt a DS52K loom to a DS90 / 90-ACT loom, use the **DS90 MTR/PB ADAPT LOOM** (part no., **GLM51981**) to connect the motor and park brakes. This is suitable for motor looms using Tyco 172134-1 housing.

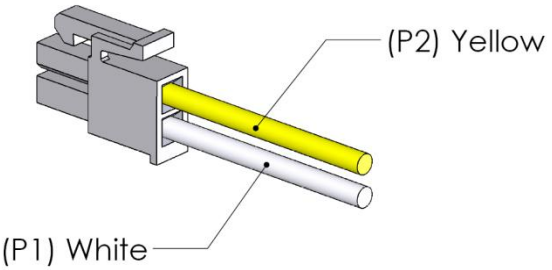
For more information, see the RHINO2 Installation Manual, section 3.5 & 3.6



GLM51981: Fit to RHINO2 motor connector socket



GLM51981: Fit to existing motor loom connector



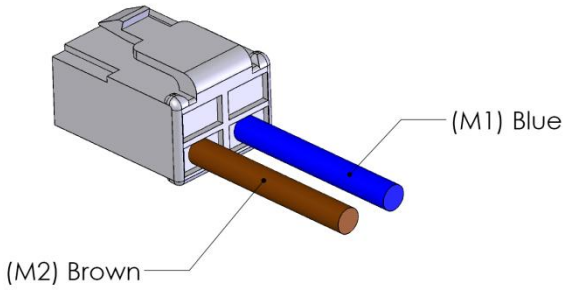
GLM51981: Fit to RHINO2 park brake connector socket

Note:
The DS52K, DS72K and DS112K do not require a battery adaptor loom. Simply connect the existing scooter battery connector directly into the *RHINO2* controller's battery connector.

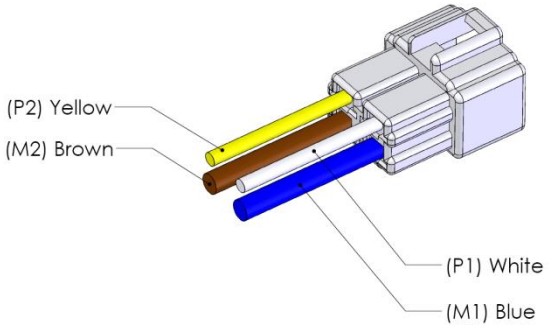
Adapting DS72KA to DS90-ACT

To adapt a DS72KA loom to a DS90-ACT loom, use the **DS90 MTR/PB ADAPT LOOM** (part no., **GLM51981**), and the ***RHINO2* BATT/ACT ADAPT LOOM** (part no., **GLM51984**).

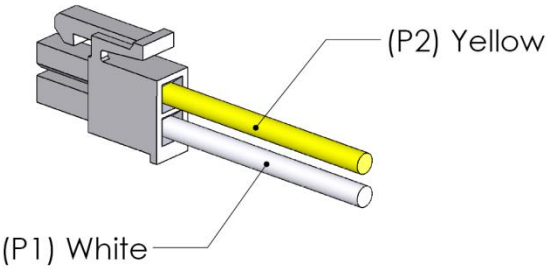
*For more information, see the **RHINO2** Installation Manual, section 3.4*



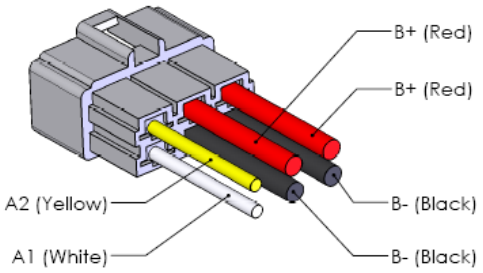
GLM51981: Fit to *RHINO2* motor connector socket



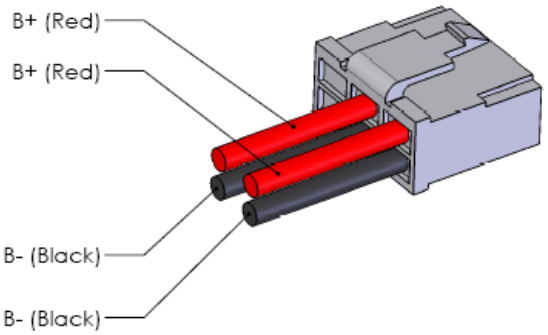
GLM51981: Fit to existing motor loom connector



GLM51981: Fit to *RHINO2* park brake connector socket



GLM51984: Fit to existing battery / actuator loom connector



GLM51984: Fit to *RHINO2* battery connector socket

GLM51984: Fit to *RHINO2* actuator connector socket

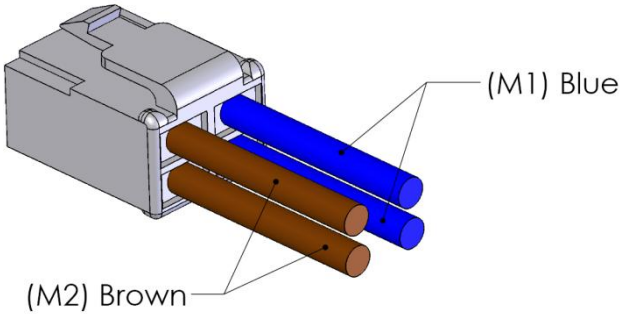
Warning:

Do not plug the scooter's battery / actuator connector directly into the DS90-ACT as this will cause the actuator to be driven.

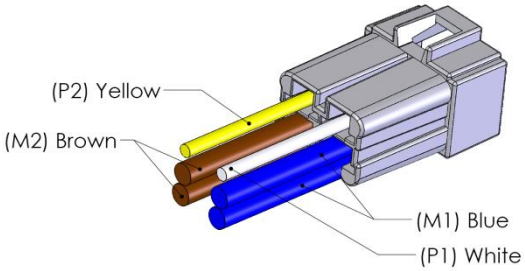
Adapting DS112K to DS120

To adapt a DS112K loom to a DS120 loom, use the **DS120 MTR/PB ADAPT LOOM** (part no., **GLM51983**). This is suitable for motor looms using Dynamic Controls GCN51315 housing.

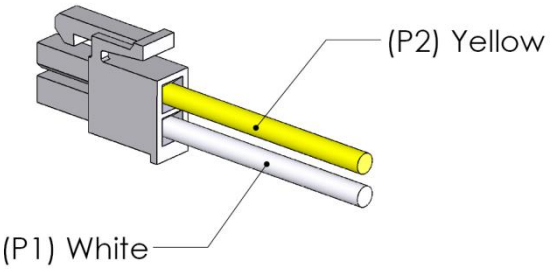
For more information, see the RHINO2 Installation Manual, section 3.5 & 3.6



GLM51983: Fit to *RHINO2* motor connector socket



GLM51983: Fit to existing motor loom connector

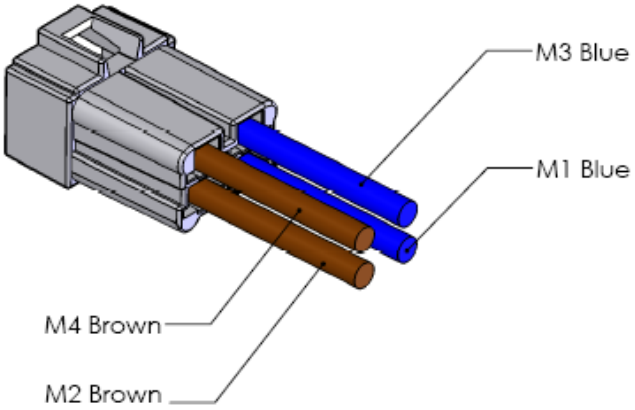


GLM51983: Fit to *RHINO2* park brake connector socket

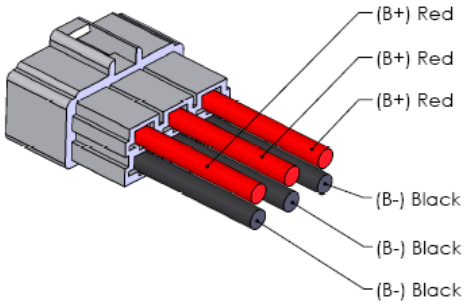
Note:
The DS52K, DS72K and DS112K do not require a battery adaptor loom. Simply connect the existing scooter battery connector directly into the *RHINO2* controller's battery connector.

Adapting DS162K to DS160

To adapt a DS162K loom to a DS160 loom, use the **RHINO2 MTR-4/RING ADAPT LOOM** (part no., **GLM51985**), and the ***RHINO2* BATT-6/RING ADAPT LOOM** (part no., **GLM51986**).



GLM51985: Fit connector to existing motor loom connector, and the ring terminals to RHINO2's motor connectors.



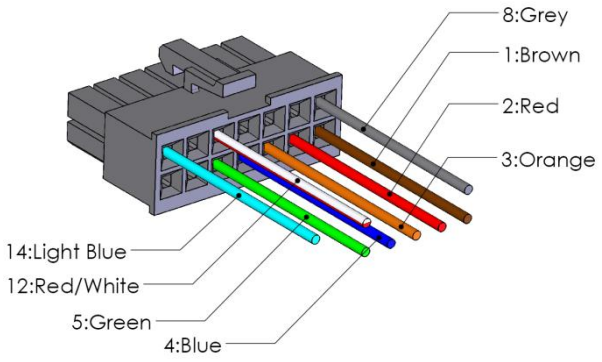
GLM51985: Fit connector to existing battery loom connector, and the ring terminals to RHINO2's battery connectors.

Note:
The torque settings for the DS160 and DS160-ACT motor and battery terminals should be between 4.5Nm and 5.5Nm

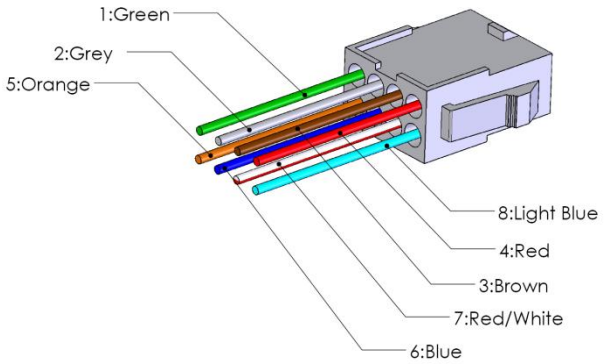
Install the logic cable adaptor

For all *RHINO2* variants, connect the **RHINO2 LOGIC ADAPT LOOM** (part no., **GLM51987**) between the *RHINO2* controller (14-way connector) and the existing tiller head connector (8-way). The table below shows the corresponding mapping between the two connectors.

*For more information, see the **RHINO2** Installation Manual, section 3.9 and the **Logic connector** section in this guide.*



GLM51987: Fit to *RHINO2* tiller connector



GLM51987: Fit to existing Rhino 8-way tiller connector

Rhino 8-way Logic Connector	*RHINO2* 14-way Logic Connector	Function	Active	Slow To	Latch	Flash
Pin 1	Pin 5	Key switch, Status LED	-	-	-	-
Pin 2	Pin 8	Throttle -	-	-	-	-
Pin 3	Pin 1	Throttle Wiper	-	-	-	-
Pin 4	Pin 2	Throttle +	-	-	-	-
Pin 5	Pin 3	Beeper	-	-	-	-
Pin 6	Pin 4	Slow/Stop, SRW	Low	50%	No	No
Pin 7	Pin 12	Reverse Drive, Actuator Select	Low	-	-	-
Pin 8	Pin 14	Charging Inhibit	Low	-	No	No

Step 4 – Set up the scooter profile

The following section involves programming various parameters to set up the scooter profile. For more information on programming, including cable requirements, see the **Programming** section on page 17.

Set up throttle parameters

- Set *RHINO2* **Swap Throttle Direction** (**4.4.1.3**) to match the Rhino's **Pot Reverse** setting.
- Set *RHINO2* **Throttle Input** (**4.4.2.2**) to "**Single**".
- Set **Throttle Neutral Offset** based on Rhino's **Speed Pot Neutral** setting. Please see **Throttle Neutral Offset** (page 20) for more information.

> **Note**:
> Use the HHP to calibrate the unit instead of setting a value manually, see 'Throttle calibration' in section 4.1.1.3 of the RHINO2 Installation Manual for details.

- Set *RHINO2* **Throttle Full Scale Deflection** (**4.4.2.4**) to ensure that the scooter's full speed can be attained with the throttle's movement. For more information, please see the *RHINO2 Installation Manual*, section **4.4.2.4**.
- Set *RHINO2* **Throttle Response** (**4.4.2.5**) to match the Rhino's **Demand Curve** setting, typically 80%.
- Set *RHINO2* **Speed Limit Pot** (**4.4.2.11**) to "**No**".

Set up drive performance parameters

- Set *RHINO2* parameters in the **Drive Performance** (**4.4.3**) section of the *RHINO2* profile, for acceleration and deceleration, to meet the scooter's requirements. See ***Acceleration and Deceleration Settings*** (page 19) in this guide for more information.
- Set *RHINO2* **Soft Start Period** (**4.4.3.9**) to a similar level of Rhino.
- Set *RHINO2* **Soft Finish** (**4.4.3.10**) between **25 to 28%** in order to match Rhino deceleration characteristics.

Set up motor management parameters

- Set *RHINO2* **Motor Reverse** (**4.4.5.4**) to match the Rhino's **Motor Reverse** setting.
- Set *RHINO2* **Load Compensation** (**4.4.5.5**) to match the Rhino's **Motor Resistance** setting; this parameter will be fine-tuned later.
- Set *RHINO2* **Load Compensation Damping**[1] (**4.4.5.7**) to, initially, 25% to give a similar behaviour to that of the Rhino.
- Set *RHINO2* **Remembered Load Compensation**[2] (**4.4.5.8**) to near zero (but not actually zero) to give a similar performance to that of Rhino.
- Set *RHINO2* **Stall Timeout** (**4.4.5.11**) to match the Rhino's **Current Limit Time (Stall Time)** setting (typically 10 – 15 seconds).
- Set *RHINO2* **Motor Testing** (**4.4.5.12**) to "**All**" (unless motor faults cause problems during testing).
- Set *RHINO2* **Current Limit** (**4.4.5.9**) as **shown in the next table (page 15)**.
- Set *RHINO2* **Boost Current** (**4.4.5.10**) as **shown in the next table (page 15)**.
- Set *RHINO2* **Boost Time** (**4.4.5.10**) as **shown in the next table (page 15)**.

[1] This parameter is new to *RHINO2*– please see *RHINO2* Installation Manual, section **4.4.5.7** for more details.
[2] This parameter is new to *RHINO2*– please see *RHINO2* Installation Manual, section **4.4.5.8** for more details.

Warning:

Follow these instructions carefully. The RHINO2's current capability is higher than Rhino. Ensure that these motor management parameters are set to that of the existing motor and no greater than that of the table below. Failure to follow these settings can result in damage to the scooter or serious injury to the user.

For example, when swapping a DS72K to a *RHINO2* DS90, set the Current Limit to 70A, Boost Current to 10A, and the Boost Time to 3 seconds.

Rhino	*RHINO2*	*RHINO2* Current Limit	*RHINO2* Boost Current	*RHINO2* Boost Time
DS72K	DS90	70A	10A	3 seconds
DS112K	DS120	110A	10A	3 seconds
DS162K	DS160	160A	20A	3 seconds

Set up park brake management parameters

- Set *RHINO2* **Park Brake Testing** (**4.4.6.1**) to "**Driving**" if the Rhino's **PB Open Circuit Drive Test** is set to "**Yes**", otherwise, set it to "**Pre-drive**". **DO NOT** set it to "**None**" as this will contravene an ISO7176 requirement.
- Set *RHINO2* **Park Brake Neutral Delay** (**4.4.6.2**) to a similar value to Rhino's **Park Brake Delay**. Note that the RHINO2's value is displayed in milliseconds, rather than seconds.
- Set *RHINO2* **Park Brake Release Delay** (**4.4.6.3**) to "**0**".

Set up battery management parameters

- Set *RHINO2* **Undervoltage Rollback Start** (**4.4.7.1**) to **19.6V**.
- Set *RHINO2* **Undervoltage Rollback End** (**4.4.7.1**) to **17.6V**.
- Set *RHINO2* **Battery Gauge Low Warning** (**4.4.7.3**) to **23.4V**.

Set up actuator parameters (where fitted)

- Set *RHINO2* **Actuator Time-Out** (**4.4.8.2**) to "**60**" to match the Rhino. This value can be decreased for greater protection if the travel of the actuator takes less than 60 seconds to complete under full load.

Fine tune Load Compensation

- Fine tune **Load Compensation** (**4.4.5.5**). Do not over compensate. For more details, see the RHINO2 Installation Manual (**4.4.5.5 Load Compensation**).

To finish

- Save a copy of the profile to your computer, and write the profile to the controller.
- Calibrate the throttle with the DX-HHP or the Wizard's HHP emulator[3]

[3] If you do not have access to the DX-HHP, then use the Wizard's HHP emulator. This can be found by selecting "Tools", "Plug-ins", "HHP Emulation" and clicking on the 4 soft keys, or pressing the "1", "2", "3" or "4" numeric keys on the keyboard.

Step 5 – Test drive

To ensure that each scooter meets a minimum level of safety, the following procedure should be undertaken. This procedure should be carried out in a spacious environment and with due regard to any possible unexpected scooter movement in the event of faulty installation.

1. Raise the wheels off the ground using blocks under the scooter frame so that the wheels can turn freely.

Warning:

Scooters can be very heavy. It is recommended that you use a jack or similar tool to help you lift the scooter.

2. Recheck all wiring, paying particular attention to polarities of batteries, motor and park brake.
3. Make the final connection to the Battery Positive (+) terminal, open the key switch and close the circuit breakers.

Note:
Wait approximately 5 seconds after closing the circuit breakers before proceeding to step 4, as the controller takes a few seconds to charge its internal circuitry after the first connection of battery power before it will be ready to drive.

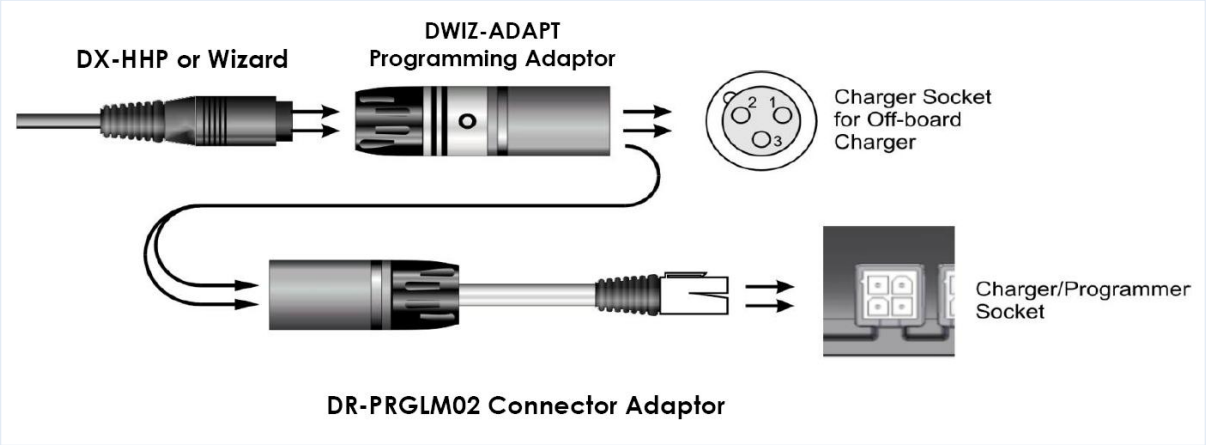
4. Turn the key-switch to turn the *RHINO2* on. Ensure it turns on correctly.
5. Turn the key-switch again to turn the *RHINO2* off. Ensure it turns off correctly. Turn the key-switch again to turn the *RHINO2* back on.
6. Ensure all installed hardware is functioning correctly by activating appropriate buttons/switches etc.
7. Move the throttle slightly out of neutral and listen for the “click” as the park brakes disengage.
8. Move the throttle backwards and forwards and ensure that the wheels respond smoothly and in the correct direction.
9. If a Speed Dial is fitted, turn it to various positions to check that it can limit the speed of the wheels correctly.
10. Release the throttle to neutral and listen for the click of the park brakes re-engaging.
11. Turn off the *RHINO2* and remove the blocks from under the scooter.
12. Turn the *RHINO2* back on and turn the Speed Dial (if installed) to the lowest speed setting.
13. Sit in the scooter and drive forward and reverse slowly, checking for precise and smooth control.
14. Repeat at higher speeds.
15. Drive the scooter on a 1:6[4] ramp and check for normal power, smoothness and parking.
16. Test all other hardware fitted.
17. Repeat testing until the scooter performs as expected.

[4] This is for guidance only. Low-current controllers may not be able to handle a 1:6 ramp at full load.

Further information

Programming

The Rhino can be programmed by simply plugging in the DS-HHP or Wizard cable directly into the round 5-pin programming connector socket on the Rhino DS52Kx, DS72K, DS72KA, DS112Kx or DS162Kx (the DS72KSPx is an exception). For programming the *RHINO2*, an adaptor, DWIZ-ADAPT, is required. A DR Programming Loom (DR-PRGLM02) may also be required unless the scooter is wired to take an external battery charger - see note below.



The DWIZ-ADAPT and DR-PRGLM02 allows the Wizard cable to be plugged into the 4-pin battery charger connector of the *RHINO2* controller. In addition, the *RHINO2* supports the DX Hand-Held Programmer (DX-HHP) using the DWIZ-ADAPT and DR-PRGLM02.

Note:
The RHINO2 **DOES NOT** support the DS Hand-Held Programmer (DS2K-PD, DS2K-PM, etc.). If you do not have access to the DX-HHP, then use the Wizard's HHP emulator. This can be found by selecting "Tools", "Plug-ins", "HHP Emulation" and clicking on the 4 soft keys, or pressing the "1", "2", "3" or "4" numeric keys on the keyboard.

External battery charger socket

The *RHINO2* can be wired to an external battery charge socket in two ways. The socket can be wired to either the 14 pin tiller head connector, or it can be wired to the 4 pin Battery Charger connector (see image above). If the battery charger socket is mounted on the tiller head of the scooter, then the wiring will be simplified if it is wired to the 14-pin tiller head connector. If the battery charger socket is mounted close to the *RHINO2* controller and no on-board charger is used, then the wiring will be simpler if it is wired to the 4-pin Battery Charger connector. If an industry-standard 3-pin XLR connector is used for the external battery charger socket then it can also be used for programming and diagnostics, providing the inhibit pin is connected to either pin 14 of the tiller head connector or pin 4 of the Battery Charger connector. The *RHINO2* should be programmed so the function of the chosen inhibit pin is set to Battery Charger Inhibit (see *RHINO2 Installation Manual* **4.4.9.1**).

Note: The *RHINO2* can be programmed to perform a battery charger inhibit function on the other 3 secondary input pins of the 14-pin tiller head connector, but we do not recommend this option as these pins do not support the programming communications.

The wiring of the industry-standard XLR battery charger connector is:

- Pin 1 = Battery Positive
- Pin 2 = Battery Negative
- Pin 3 = Inhibit

Note that pin 3 is the centre pin.

The battery charger plug should be wired so that pin 3 (Inhibit) is linked to pin 2 (Battery Negative). When properly wired and configured, plugging in the external battery charger will automatically inhibit driving, as required by ISO7176.

Logic connector

Beeper Output

Some Rhino controllers can be programmed so that the "beeper" output (pin 5 of the 8-pin Logic connector) performs a Brake Light function or a Reverse Light function. If this option is used and the Rhino needs to be replaced by a *RHINO2*, we recommend using pin 11 rather than pin 3 for this function. However if an adaptor loom is used, then pin 3 will need to be used, and programmed for the Brake or Reverse Light option. If the Rhino has been programmed so that the "beeper" output functions as both a Brake Light output and a Reverse Light output, then equivalent functionality can be achieved by using both pin 3 and pin 11 of the *RHINO2* and programming one to be a Brake Light output and the other to be a Reverse Light output. If necessary, pins 3 and 11 can be wired together so that the same lights operate as both Brake Lights and Reverse Lights.

Speed Reduction Wiper

Some Rhino controllers (DS52K, DS72KB, DS112KB, DS162K, and DS162KD) support an analogue speed-limit potentiometer wired between pin 6 of the 8-pin Logic connector and Battery Negative. For the *RHINO2*, this functionality is called **Speed Reduction Wiper** (see *RHINO2 Installation Manual* **4.4.3.15**) and is available only on pin 4 of the 14-way tiller head connector; the analogue speed-limit potentiometer should be wired between this pin and Battery Negative.

The Rhino DS72KSP supports a 100kΩ speed potentiometer wired across the main throttle (Wig-Wag) potentiometer. The *RHINO2* controllers support this as well, and if this feature is required, then the wiper of the speed potentiometer should be wired to pin 9 of the *RHINO2*'s 14-way tiller head connector. The parameter **Speed Limit Pot** (see *RHINO2 Installation Manual* **4.4.2.11**) should be set to "Yes" if this feature is required.

Forward-reverse input

Pin 7 of the Rhino's Logic connector is normally the Forward-Reverse input (except for the DS72KA where it is the Actuator Select input). We recommend using pin 12 of the *RHINO2*'s tiller head connector for the equivalent function and programming it to be either a **Reverse**

Drive input or an **Actuator Wig-Wag** input depending on the controller being replaced. Do not select "Actuator Control" as this is not the equivalent function. See *RHINO2 Installation Manual* **4.4.9**.

Status LED

If a Status LED is wired in series with the key switch, then program the *RHINO2* **Key Switch Status LED** (see *RHINO2 Installation Manual* **4.4.10.4**) parameter to "**Yes**". Note that wiring a resistor in series with the status LED on the Key Switch input can cause the *RHINO2* to switch off under low battery conditions and therefore should not be done. The *RHINO2* will limit the current through the Status LED itself making an extra resistor unnecessary.

Speed Settings

The Rhino's **Forward Speed**, **Reverse Speed** and **Reduce Speed** parameters range from 1 to 10. These translate directly into percentages from 10% to 100% used by the *RHINO2*. See next section regarding speed reduction.

The Rhino's **Maximum Motor Speed** parameter is a percentage. This should be multiplied by 24 volts to give the correct value for the *RHINO2*'s equivalent parameter **Maximum Motor Voltage** (see *RHINO2 Installation Manual* **4.4.5.13**).

Speed Reduction

The Rhino has a **Reduce Speed** input, also known as the Turn input, which is pin 6 of its Logic connector. When asserted, this causes the speed demand to be limited to the value of **Reduce Speed** unless the **Forward Speed** or **Reverse Speed** parameter (depending on the direction of travel) already has a lower value. Some Rhino variants also support an analogue speed-limit potentiometer on this pin - see above.

The *RHINO2* has several ways of achieving a similar function. One way is to program one of the multi-function inputs to be a **Slow** (see *RHINO2 Installation Manual* **4.4.9**) input, and to program the value of the corresponding "Slows to" parameter to the Rhino's Reduce Speed setting (after multiplying by 10 to convert it into a percentage). Another way is to program one of the multi-function inputs to be a "**Profile 2**" input and to program the Profile 2 Forward Speed (see *RHINO2 Installation Manual* **4.4.9**) parameter to match the Rhino's Reduce Speed setting. If this method is used, then the Profile 2 Forward Acceleration and Reverse Acceleration settings may need to be reduced to give a similar feel, but this method does give more flexibility. In either case, we recommend using pin 4 of the *RHINO2*'s tiller head connector for this function.

Acceleration and Deceleration Settings

The Rhino Acceleration and Deceleration settings range from 1 to 10, displayed as 10% to 100% on the Wizard. The *RHINO2* Acceleration and Deceleration settings (see *RHINO2* **4.4.4**), including **Slam Brake Deceleration** and **Emergency Deceleration**, have finer resolution and are displayed as 0% to 100%. However it is implemented as a non-linear (exponential) function, so 0% does not mean zero deceleration, but gives a 10 second nominal stopping time. In addition, the *RHINO2* Acceleration and Deceleration range has been widened to suit a range of applications, and so a 100% rate gives a nominal stopping time of just 0.4 seconds. For high speed scooters (14km/h or more), stopping times around 2.0 to 2.5 seconds are required, requiring deceleration rates around 50% - 45%. For low speed scooters (6km/h or less), stopping times around 1.0-1.2 seconds are required, requiring

deceleration rates of 70% - 65%. 10km/h scooters require stopping times around 1.5 seconds, requiring deceleration rates around 60%.

Acceleration rates should be programmed to be no higher than Deceleration rates for safety, and the Forward Acceleration rates may also have to be lowered below the Deceleration rates to prevent the front wheels lifting when accelerating up a slope.

The Reverse Deceleration rates should be less than the Forward Deceleration rates if the corresponding Reverse Speed is lower than the corresponding Forward Speed to reduce the risk of the front wheels lifting when decelerating while reversing down a slope. Note that in the Rhino controllers, there is only one Acceleration rate and one Deceleration rate, but these rates are affected by the maximum speed in the Forward or Reverse direction so the effective Reverse Deceleration is automatically reduced with the Reverse Speed.
High Acceleration or Deceleration rates require high motor torques, which in turn require high motor currents, particularly on slopes. The required currents are much higher for high-speed scooters as the required torque requires a proportionally higher motor current. However if the acceleration or deceleration rate is not adjusted for the speed of the scooter, the physical acceleration rate (in metres per second per second) increases proportionally with the top speed of the scooter, requiring a proportionally higher torque. These effects are multiplicative, so it is very important to reduce the programmed acceleration and deceleration rates for the higher speed vehicles.

In order to achieve the required stopping distances without requiring too high deceleration rates, the Soft Start and Soft Stop parameters should only be set as high as necessary to control the starting and stopping jerks. Setting the Soft Start Time parameter too high will delay maximum deceleration and lead to a significantly increased stopping distance. Setting the Soft Finish parameter too high will delay the final reduction to zero speed and delay the application of the park brakes, and can also increase the distance that the scooter "creeps" down a slope when stopping on a slope.

Throttle Neutral Offset

The RHINO2's **Throttle Neutral Offset** is equivalent to the Rhino's **Speed Pot Neutral** setting. This setting accounts for any mechanical offset between the throttle neutral position and the centre position of the throttle wiper. The offset is an absolute voltage above or below neutral.

> **Note**:
> Use the HHP to calibrate the unit instead of setting a value manually. See 'Throttle calibration' in section 4.1.1.3 of the RHINO2 Installation Manual for details.

The default neutral value is dependent on the value of the **Throttle Type** parameter:

- Wig-Wag and Uni-polar both have the default neutral value at 2.5 V.
- Single-ended has its default neutral value at 0 V + **Minimum Throttle Voltage**.
  In this case all negative values of **Throttle Neutral Offset** are ignored and all positive values are multiplied by 2, which means that a Wizard setting of 0.5V will produce an actual neutral offset of 1.0V.

Previous versions of Rhino used an integer range 0 – 255 to represent a voltage range 0 – 5V, where the value 128 would represent the centre position:

$$\frac{128}{255} * 5V = 2.5V$$

Values either side of 128 indicated a voltage offset of **19.6mV** per step. For example, if **Speed Pot Neutral** was set to **129**, then this represented a **+19.6mV** offset, that is:

$$2.5V + 0.0196V = 2.5196V$$

Similarly, a value of **127** would represent 2.4804V, that is:

$$2.5V - 0.0196V = 2.4804V$$

Notes

Notes

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