

## # Water & waterproofing

All electronic and electrical items object to water but most controllers which have water problems have either been hosed down or they have been for a swim in a pond! Neither will cause an immediate problem since the damage is done not by the water itself but by corrosion caused when the water conducts electricity. If ever you suspect water has got into the electronics (either the controller or the hand control box), disconnect the battery immediately and do not reconnect it until the insides have been thoroughly drained and dried. The circuit boards themselves are varnished and this gives adequate protection against normal humidity and condensation.

You should consider water when mounting the units: although they are not sealed (they need to breathe) they are unlikely to get water into them if you mount them sensibly. However water can be drawn into the joints between lid and base. It can also get in via mounting and other holes. Generally, once water is inside a box, gravity will cause it to run to the lowest point: perhaps you should put a drain hole here to avoid water collecting? Whilst running, what will the water touch? If it drips onto the circuit boards you will have a problem.

## Service & Guarantee

All 4QD's products carry the normal 12 month guarantee. Outside the guarantee period, or when the fault is caused by misuse, we will repair the controller at a fixed price:

This price includes VAT & return carriage (UK only) only when the relevant payment is included with the controller and it is returned to the factory for service.

Eagle 40 £15.00  
Eagle 80 £18.00  
Hand Control box £9.00

## Hand Control Box

Water is unlikely to get inside via the pot or the switch. However if it gets into the switch it could sit inside the switch which will not do any immediate damage - unless you switch the controller off without removing the battery! It could get in past the LEDs - but this is quite unlikely. The most likely entrance will be the extra holes you add for mounting and leads.

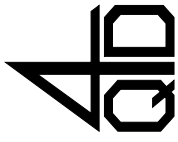
## Controller

Water has a nasty habit of running along motor, battery & jack leads so make a kink near the controller so that any water drips off the lead before it can reach the controller. The controller may get warm and breathe so if it sits in water it could suck this in. If you mount the controller with the lid at the bottom water could not build up inside the controller and would be expelled by any breathing action. Water could get into the controller via Jack connector, battery connection or motor leads as well as by any mounting holes you make but the jack connector is the most likely entrance. With the lid at the bottom any water that gets in here is unlikely to get onto the circuit board.

## Other products

4QD manufacture a wide range of controllers for battery vehicles - a range covering golf caddies to small electric cars, and including such things as golf buggies, kiddie cars, wheelbarrows, conveyors etc.. The controllers range from 12v to 48v and currents up to 300 amps.

We also supply have a range of accessories such as switches, wires, connectors, LED voltmeters for 12v and 24v.



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See us via the Internet:

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## Instruction Manual

## Eagle series controllers

## Introduction

4QD's Eagle series are cased, economy motor speed controllers for battery operation covering the range of currents up to 40 amps intermittent.

They are intended for small, slow machines such as golf caddies. They are **not** intended for passenger carrying machines.

The controller is a high frequency chopper driver giving full motor control from zero to full speed. It uses MOSFETs in state-of-the-art high frequency circuitry to give best possible performance and battery economy. A special feature is the ultra low dissipation circuitry, unique to 4QD, and the smooth, linear acceleration ramp for smooth power take-up.

The usual version of the controller is supplied boxed with a battery connector and with tails coming from the box for the motor.

The circuitry is wide voltage range so the 12v, 24v and 36v versions are all very similar, with only a slight internal change. However because there is a slight internal change they must be used on the correct voltage.

A 48v versions is also possible - contact the factory.

Speed pot input is via 3 cores of a 4 core wire. The 4th core is supplied to operate a battery condition meter, if required.

Optionally, the 12v version only can be supplied matched to our own Eagle Hand Control Box. (-HCB option) instead of the standard 10K pot (-10K option).

The Hand control box (which is covered in this manual) includes a speed control pot, a 3 LED battery voltmeter and an on-off switch. It is suitable, as supplied, only for 12v operation - contact the factory for other voltages.

For board-only applications a version of the Eagle is available. This is called the Egret and is not covered by this manual.

Because this manual covers the leaded and the jack versions as well as the hand control box, we have marked the numbered paragraphs:

# These paragraphs apply only when using the Hand Control box **EHC-123**.

§ These paragraphs apply only to the leaded option,, EAL-40 only.

¶ These paragraphs are more technical and may be ignored.

Unmarked paragraphs are of general interest.



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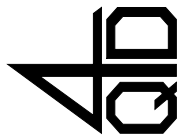
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5th February 2003

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## Models

2 basic models are available.

One (EAL-40) is as shown below.

The second (EAJ-40), shown at foot of facing page, has a flying Jack socket and lead.

Both can be used from 12v, 24v or 36v but one preset must be adjusted inside the controller.

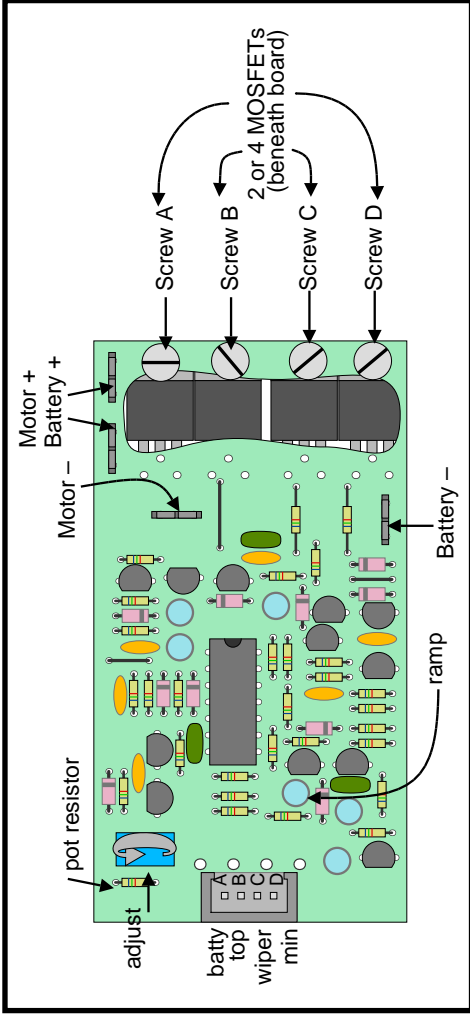
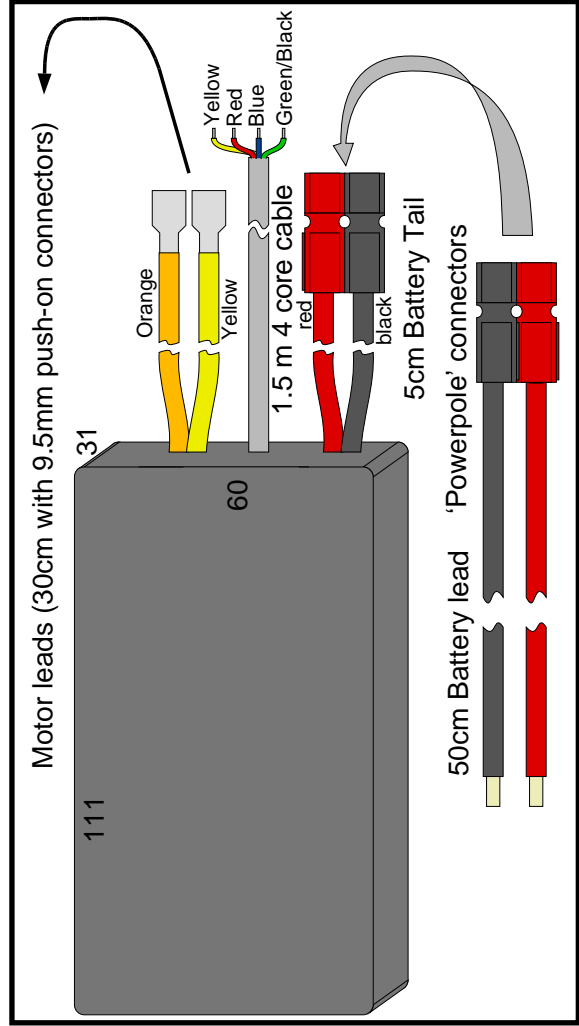
Also available (and covered in this manual) is a hand control box: this is for 12v only operation.

## Features

The controller consists of a diecast aluminium box housing the circuitry. Battery connection is by means of 30 amp 'Powerpole' connectors, located in the box.

Motor connectors are 9.5mm push-on receptacles to suit EMC motors but may be changed as required.

Hand Control Box (optional) or speed pot connects to the controller via a 4 core lead.



## Adjustments

¶ There is only one adjustment on board but several performance parameters can be altered by value changes. Contact the factory for details.

### Sensitivity and Voltage

There is a small preset adjustment, shown above. It will need adjusting to match the controller to your battery voltage and potentiometer.

You can adjust it from the left or the right in the diagram, using a small screwdriver. Rotate as shown by the arrow to increase speed.

The adjustment should be made with the batteries fully charged. It should be set so that your motor just reaches full speed slightly before the speed control pot reaches maximum setting.

Jack the machine up so the wheels are free to rotate and turn the speed pot to maximum. Now adjust the preset in the direction of the arrow and see if the speed increases. If it does, turn the preset until the motor stops increasing speed. Back the preset off slightly if necessary to the motor is only just at full speed.

If you get no increase in speed, then back the preset off until the motors start to slow.

The correct setting is just above the point where the motor is at full speed. If you adjust the preset too far

above this point, the motor will slow and stop quite suddenly as the fault detection (pot fault) operates.

### ¶ Current limit

This is pre-set but it can be altered by a component value change. The controller is quite safe at the value chosen but since it is more powerful than most golf caddy controllers there may be a tendency for the golfer to use the extra power to help him up hills - this will increase battery drain and may not be desirable.

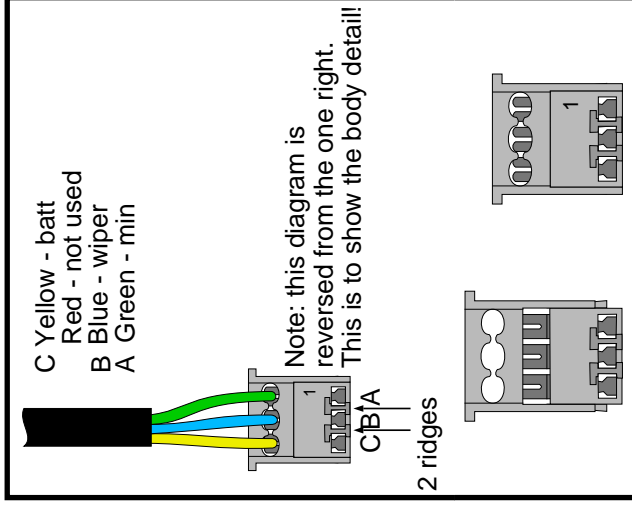
### ¶ Acceleration ramp

The Eagle has a sophisticated, linear, acceleration ramp to ensure smooth power take up. This ramp is also preset (standard value about 2.3 seconds) but it can be altered by a value change.

### Heat & Heatsinking

The Eagle 40's rated current output is about 40 amps: when delivering this it will get quite hot. The internal temperature gets to 100°C after about one minute when delivering full current (e.g. into a stalled motor) which will normally be more than adequate. If the case is mounted in thermal contact with additional metalwork then the controller will be able to give full current for longer.

## # Hand Control box.



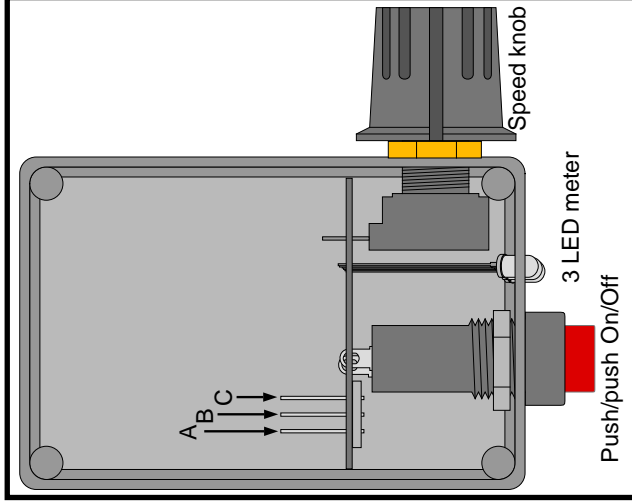
The top left diagram shows how to fit the IDC (Insulation Displacement Connector) to the lead.

Yellow must connect to pin C, blue to pin B and green to pin A.

The IDC is supplied open as shown left. Don't strip the coloured insulation from the wires, just push them into the slot at the top of the connector (so the ends of the wires are flush with the flat back of the connector) as shown top above, then squeeze the connector closed (as shown right) using a vice, parallel jawed pliers or even with your fingers.

Connections in the HCB are to 3 pins as shown in the right diagram, which is numbered as the pins mate with the crimps. The pins are at .1" spacing and will mate with many standard connectors.

- ¶ **Pin A** is battery negative and should connect to the green.
- ¶ **Pin 2** is the pot wiper, to the blue wire.
- ¶ **Pin 3** is battery +, to the yellow wire.



### Operation

With a full battery, all 3 LEDs are on. As the battery discharges the green LED flickers and dims, then the yellow LED starts to go off.

The LEDs will go off more on steep hills which is useful as, if the orange LED used stay on on this hill but now grows dim, it shows your battery is ageing.

Over discharge can damage a battery and although there is no fixed threshold, it is generally said that you should not discharge your battery below about 10v. So, if the yellow LED starts to go out, be careful. If it is out when your machine is at rest, you should not use the battery until it is recharged.

LED 1	Green	12.3 - 11.8
LED 2	Yellow	10.3 - 9.8
LED 3	Red	9.0 - 8.5

### Hand control box with EAJ-40

These can be supplied for use with each other and will be pre-wired at the factory.

## Specifications

Supply voltage	12v to 36v	see section 8.01.
Supply current	20mA	at zero speed
	1mA	standby, pot at zero
Output voltage	0 to 100%	of full speed
Output current	40 amps peak	nominal
Switching frequency	Eagle 40	1 minute rating
	Eagle 40	approximately
Size:	111mm x 60mm x 31mm	box
hand control box:	71mm x 50mm x 27mm	without knobs.
Weight	93mm x 52mm	board only
	225g	Controller
Input	12.5g	Hand control box with jack lead.
Input volts for full speed	10k pot	or hand control box
Overvoltage (pot fault detect)	3.5v	approx
Accelerate ramp time	6v	approx, at pot slider
	2.3	Seconds to full speed

## Mounting

### Controller

Fixing holes are not provided in the boxed controller for the very simple reason that we do not know how you will wish to mount it. On quantity orders we can of course supply the box with suitable holes.

If you wish to drill mounting holes on the box, do so with care: remove the lid of the box so you can see what clearance is available inside.

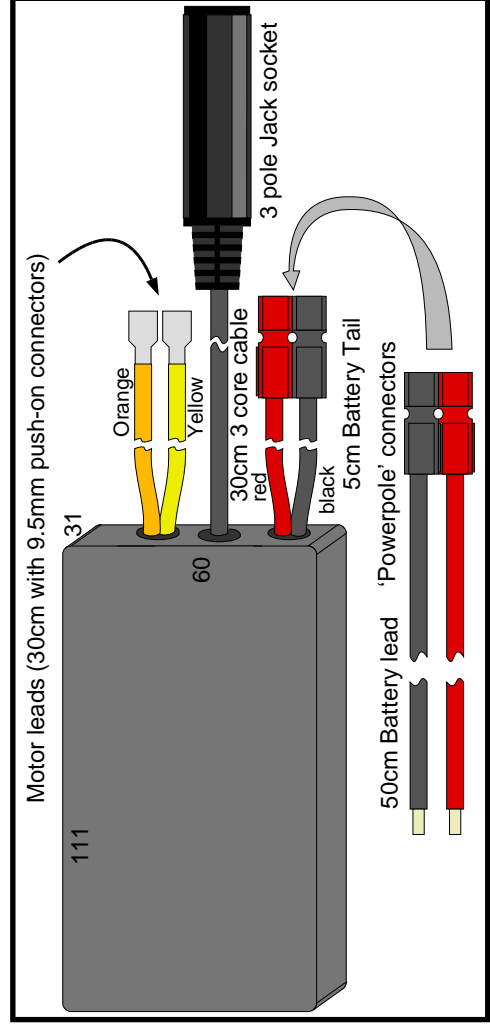
When drilling the box be very careful not to damage the board and be careful to remove all drill swarf: if

this remains behind it could get onto the board causing a short circuit and possible destruction.

Mounting by the lid may be safest as there is less danger of introducing drill swarf into the works.

### Hand control box

For the same reason this has no mounting holes. As well as mounting holes you will need to drill a hole for the jack lead which you may wish to thread through existing metalwork first.



## Safety

The Eagle is very reliable. However no electronic equipment is ever 100% reliable and if a failure does occur, it is theoretically possible for the controller to fail to full speed. The Eagle does not contain any internal emergency battery disconnect device. It is therefore up to the user to determine what will happen in the event of such a failure and to take appropriate action.

This is the reason why the Eagle is not suitable for passenger carrying machines.

The Eagle also has no main capacitor in it, relying on the battery as a large capacitor. The leads between battery and controller must therefore be as short as possible or performance and reliability may degrade.

## Connections

### Battery wiring

Battery connections to the controller are via a 30 amp Powerpole® connector, shown in the 'Features' diagram (page 2).

**Beware!** the controller is **not** protected against reversed battery - which will *instantly* destroy the controller.

The 'Powerpole' connector is colour coded and is polarised so you should not be able to reverse polarity at this point but this does not apply to the battery connections themselves - which are outside our control.

You should, therefore, always disconnect the battery at the Powerpole connectors and not at the battery terminals

**Do not** use crocodile clips for battery

connection - they are not good and are too easy to connect wrongly. You do not need quick release battery terminals as you will unplug the Powerpole to disconnect controller from battery so permanent battery connections are fine.

Standard lead length supplied is 50cm. If you can shorten this, do so but we suggest you do not lengthen it: in common with all similar controllers the work the controller has to do depends strongly on the battery lead length. Leads which are too long can reduce the available power and can cause the

This is supplied attached to the controller and total lead length is 35cm (some of which is inside the box). Other lead lengths are available to special order.

Standard motor connections supplied are 9.5mm push-on blade connectors to suit EMD motors which are the commonest. Other connectors can be supplied by negotiation.

We suggest you fit a motor suppression

capacitor across the motor brushes. This should be a ceramic capacitor, value around 10nF and should ideally be fitted inside the motor at time of manufacture. However, if one is not present fit it between the brushes, as close as possible to the motor body.

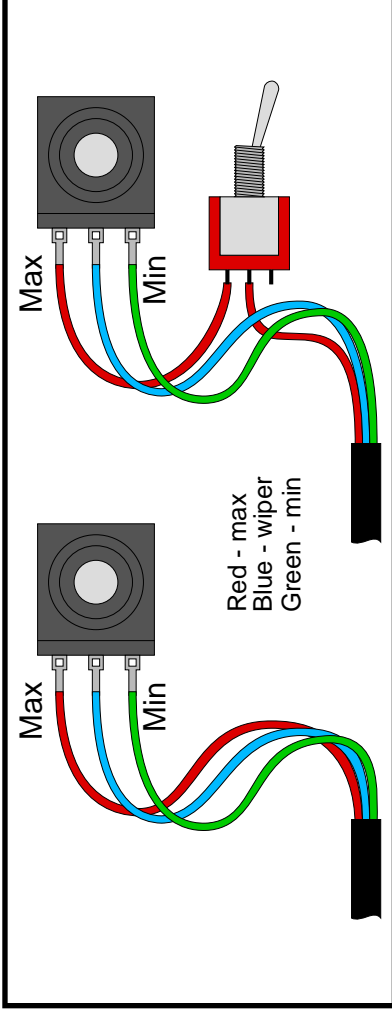
This will help suppress motor noise, which is necessary to pass E.E.C. legislation and which may on rare occasion actually cause controller failure.

## Controls

### Speed pot

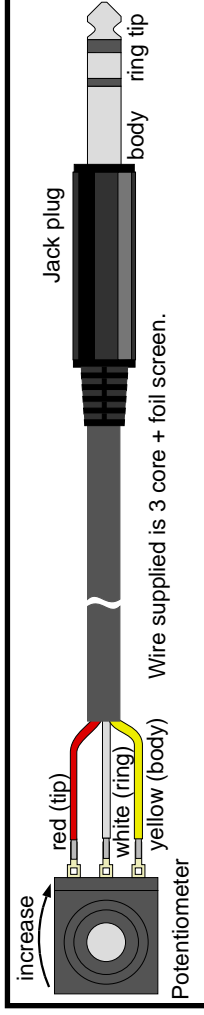
You should use a 10K linear pot. Other values from 1K to 100K, linear or log, can also be used, but may require re-adjustment inside the controller.

The diagram (right, top) shows the wiring for a standard 10K pot. The controller switches itself off automatically when the pot is turned to zero speed.



The corresponding connections for the Jack version are shown below. **Note** that it uses a different colour code to the leaded version! Differences are as shown to the right.

EAL-40	EAJ-40
Pot top	Red
Pot centre	Blue
Pot bottom	Green
+battery	Yellow
	Not fitted



### \$ On/Off switch

You can also fit an on/off switch as the diagram right, above. This allows you to leave the speed knob at your preferred setting and use the switch to stop and start your machine.

### \$ Battery Condition Meter

A Battery Condition Meter can easily be fitted between yellow wire and green wire. However you will probably want to fit an ignition switch to turn this off.

If you want the ignition switch also to disconnect the pot, then the pot's max connection can be connected from the battery positive, via the ignition switch as shown right.

Note that a resistor (10K) is now fitted in the top end of the pot. If this resistor is not fitted, the pot fault detection circuit in the controller will be disabled and the controller could go to full speed if the pot or wiring becomes faulty.

