"We're in Control"

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See us via the Internet: http://www.4QD.co.uk Email to: esupport@4QD.co.uk

Instruction Manual

Uni series controllers

Issue 07

4QD's Uni range of 1 quadrant and 2 quadrant speed controllers are well suited to general purpose speed control applications. They are used extensively by hobbyists and industry.

Amongst other applications our controllers have been successfully used in the following:
Camera dollies
Caravan shifters
Carnival floats
Conveyors
Electric boats
Electric bicycles
Electric wheelbarrows
Factory stores vehicles
Floor cleaning machines
Golf caddies
Kiddie cars
Miniature railways, 3", 5" and 7¼ gauge
Mountain rescue vehicles
Potter's wheels
Remote controlled vehicles
Ride on golf buggies
Winches
Window cleaning machines
Wherever battery motor speed control is required.

Models

2 models are available, for different current ratings. in various versions and with regenerative braking / no braking option.

12v	**24v**	**36v**	**48v**	**Current**
Uni-4-12	Uni-4-24	Uni-4-36	Uni-4-48	40 Amps
Uni-8-12	Uni-8-24	Uni-8-36	Uni-8-48	80 Amps

Introduction

4QD's Uni range are Universal, Uni-directional motor speed controllers for battery operation covering the range of currents up to 110 amps intermittent. Three voltage options are commonly available: 12v, 24v and 36v. A 48v version is also available to special order. 4QD can also supply dual voltage versions which can be changed by shorting out a resistor.

They are high frequency chopper drivers giving control of motor speed both in drive mode and braking mode. They use MOSFETs in state-of-the-art, high frequency circuitry to give best possible performance, reliability and battery economy.

Our drives are protected: provided you don't actually connect them wrongly or short them out, they will survive almost any type of motor or misuse.

The Uni case removes easily by unscrewing the two screws in the cover. You will need to take the cover off if you wish to adjust the controller's performance.

Handling

Be warned *that the main capacitors in the controller retain charge for a long time after the battery is disconnected. Do not therefore allow any metal object (screwdriver, wire etc) to contact the board when the cover is off or it may be damaged.*

Motors

The Uni is a very robust controller which will work with almost any brushed motor.

However you should always make sure the motor is in good condition: old, dirty, worn motors will not be reliable and can even cause controller failures.

We also suggest you fit a motor suppression capacitor. A 10n ceramic across the motor brushes, as close to the motor as possible, can greatly increase system reliability. Some motors are available with this capacitor fitted as a manufacturing option

Safety

It is normal practise, on passenger carrying vehicles, to include some means of disconnecting the battery or motor in an emergency. This is normally to guard against a failure in the controller or wiring which could cause the motor to run at an uncontrollable top speed. The Uni range controllers are protected so that such failure is very unlikely but the constructor should consider what might happen in the event of such a fault and should consider fitting an emergency circuit breaker, relay, or battery disconnect switch or arrange the battery so it can quickly be disconnected in the unlikely event of a controller failure. All passenger carrying vehicles should, in any case, be fitted with a mechanical braking system for emergency use.

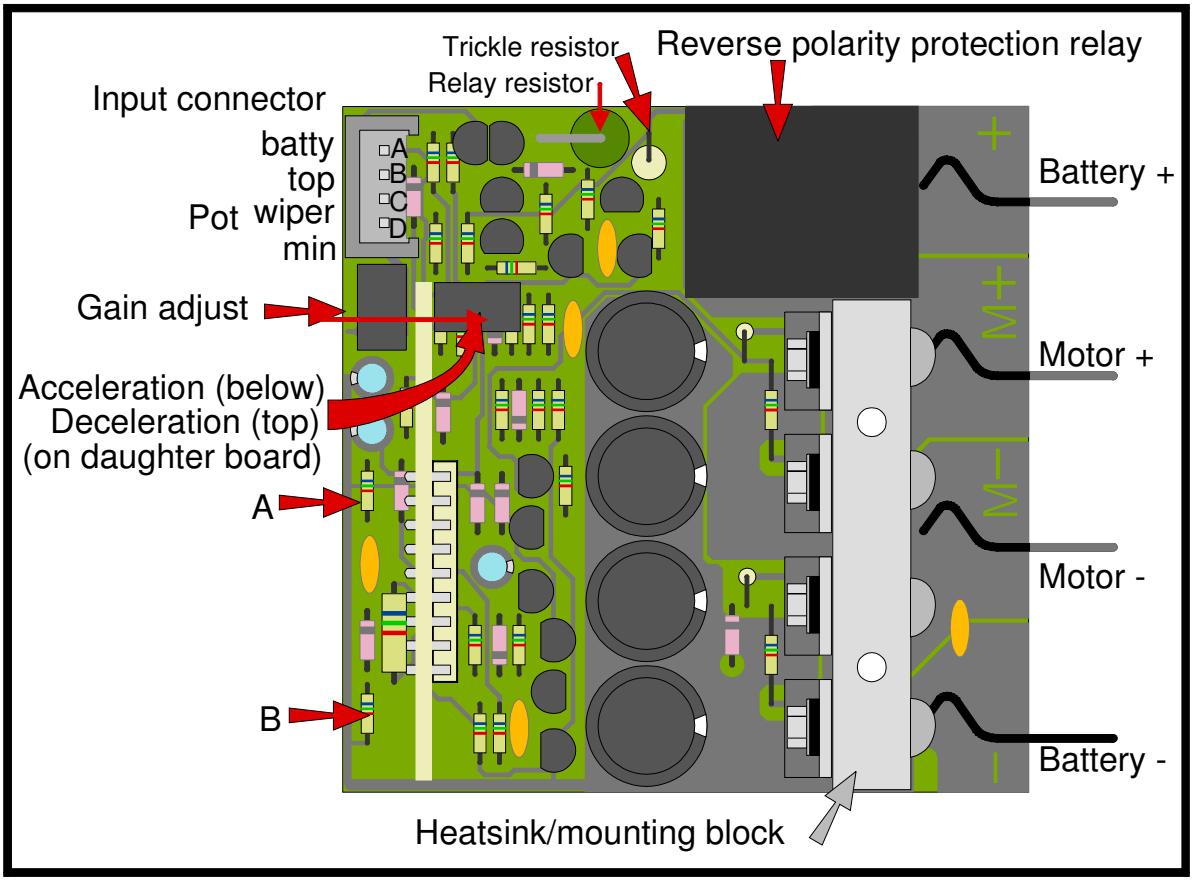
Warning: Never use a battery switch to turn the controller on with the pot not at zero. This is especially important on the 36v and 48v versions where it can cause a resistor (beside the reverse Polarity protection relay) to overheat. The controller turns itself on/off automatically as the pot is advanced/returned to zero

Battery Polarity

The Uni is polarity protected so a battery reversal will not instantly damage anything. However be warned that if the battery if left reversed for any length of time, a resistor in it can be damaged.

Be warned also that connecting any battery wire to the motor connections could destroy the controller.

Internal Features



Speed pot input is via a 4 pin connector, supplied.
Power & Motor connections are by means of 6.35 blade connectors, as shown.

Specifications - Uni-8

Supply voltage	12v or 24v or 36v or 48v	depends on model.
Supply current	30mA	at zero speed
Output voltage	0 to 100%	full speed, adjustable
Output current max (typ).	115 amps	(100 amps regen)
1 minute rating	85 amps	without additional heatsink!
2 minute rating	45 amps	without additional heatsink!
continuous	30 amps or more:	heatsink dependant
voltage drop at 20a	130mV	
Overheat current	25 amps	typical
Overheat temperature	95°C	on heatsink
Switching frequency	20kHz approximately	
Acceleration time	330mSec to 7 Sec	(adjustable)
Deceleration time	330mSec to 7 Sec	(adjustable)
Input	4k7 to 25k pot or 0-3.5v	(adjustable)
	3.5v on pot wiper (gain at max)	for full speed
Pot fault detect	greater than 130% Full Speed	approx (if activated)
Size	71mm x 71mm x 35mm	plus tags
case	75mm x 75mm x 40mm	plus tags
base	80mm x 100mm x 4mm	
Weight board version	110 gm	
enclosed version	210 gm	

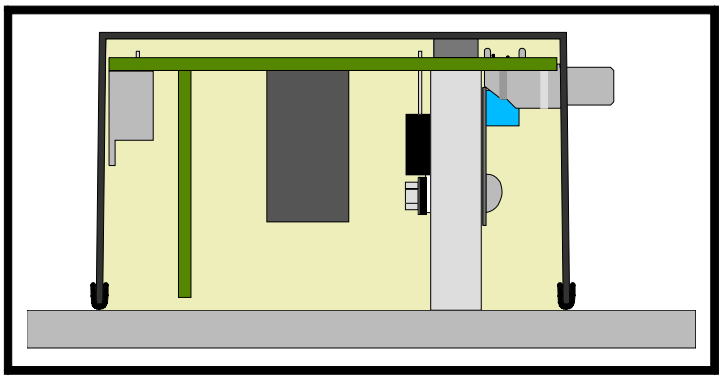
Mounting

The controller must be mounted suitable housed to protect it from the weather and from inadvertent contact with foreign bodies, so the use of the correct cover is advocated.

The controller mounts via the heatsink as shown in the diagram, right. Mounting will normally be onto a metal plate which will act as heatsinking.

Steel is not a good heat conductor -you should use aluminium or even copper.

Make sure the controller cannot get wet: normally when mounted as shown and correctly covered water cannot get onto the circuit board, and water on the base will do no harm. Make sure water cannot run down the wires into the controller.

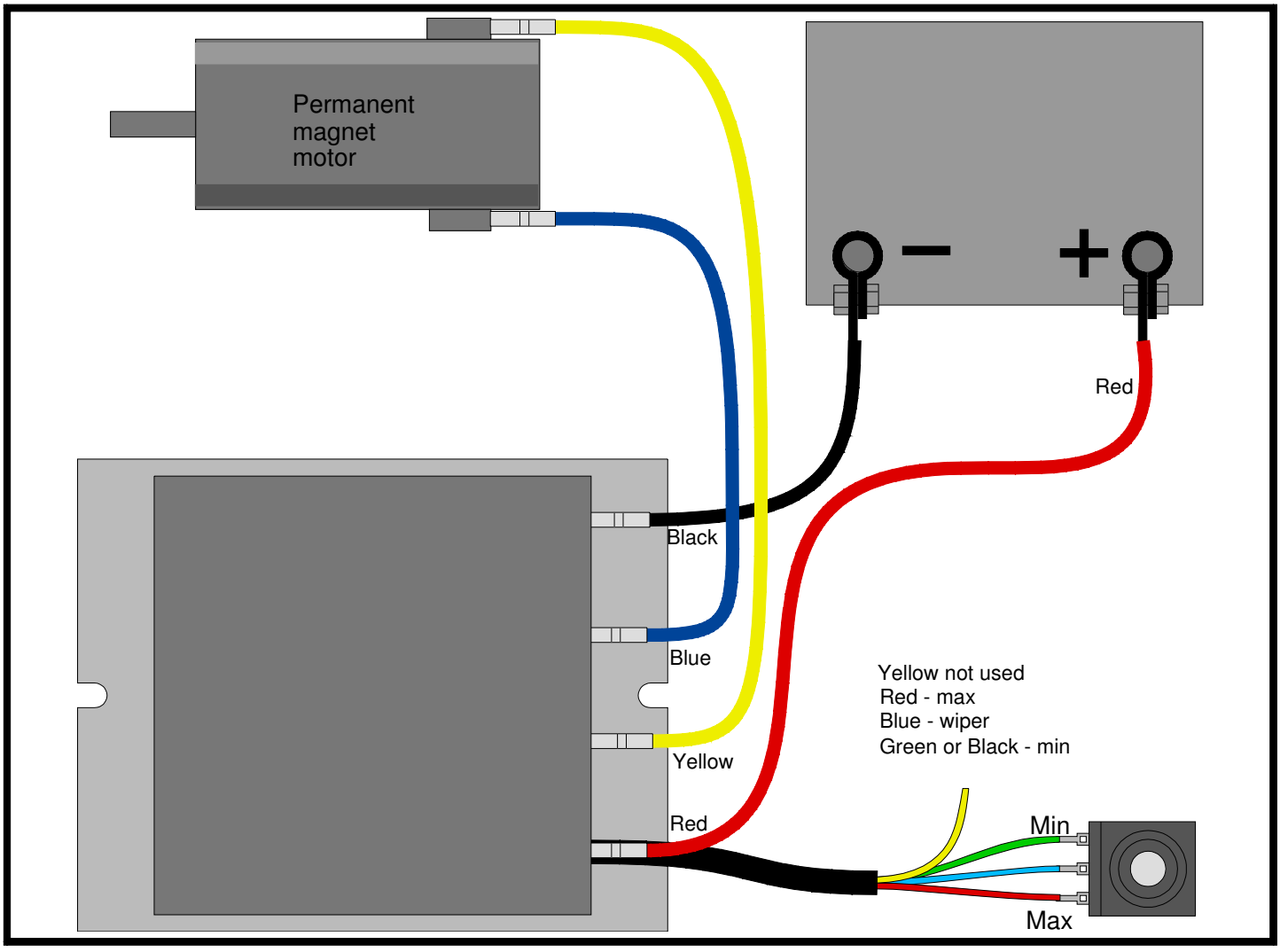


Heatsink mounting holes are tapped M3 and spaced at 25.4mm (1").

The integral heatsink is isolated.

Connections

The diagram shows the simplest connections needed to use the controller.
More detailed information on wiring follows.



Power Connections

Wire size.

Use heavy duty wire for the battery, and make them as short as possible. This also applies to the battery linking wire on 24v systems. $4mm^2_2$ wire is generally adequate.

Use of wire that is too long (and/or too thin) will cause loss of power and may also cause the decoupling capacitor (see 'features' diagram above) to heat up. Under extreme conditions the capacitor can disintegrate. Heat will also shorten the operating life of this capacitor. Once the capacitor fails the current output will fall dramatically.

Motor wiring

This is not so critical as battery wiring: too long and/or too thin wire will cause a loss of maximum current, will get hot and will waste battery power but will not damage the controller. However, wire which is too thick will do no harm either so we recommend the same wire for the motor as for the battery.

Battery wiring

Battery connections to the controller are shown in the diagram, left. Use only good quality battery connectors: a controller with regenerative braking feeds current back into the battery during braking and if a battery connector falls off when braking this regenerated current can pump up the voltage on the dud battery connection.

Controls

The only external control the UNI needs is a speed pot, shown in the diagram, below left. There are other controls that you may add if you wish.

The Uni turns itself off automatically when you turn the speed to zero, so you can fit an on/off switch in series with the red wire as shown in the diagram below, right. Opening this will remove the voltage from the pot, so the controller will run down to zero sped and switch off.

With the pot at zero, the controller draws only a very small current: (24v version, about 1.8 mA and the 12v version about 5,6mA)

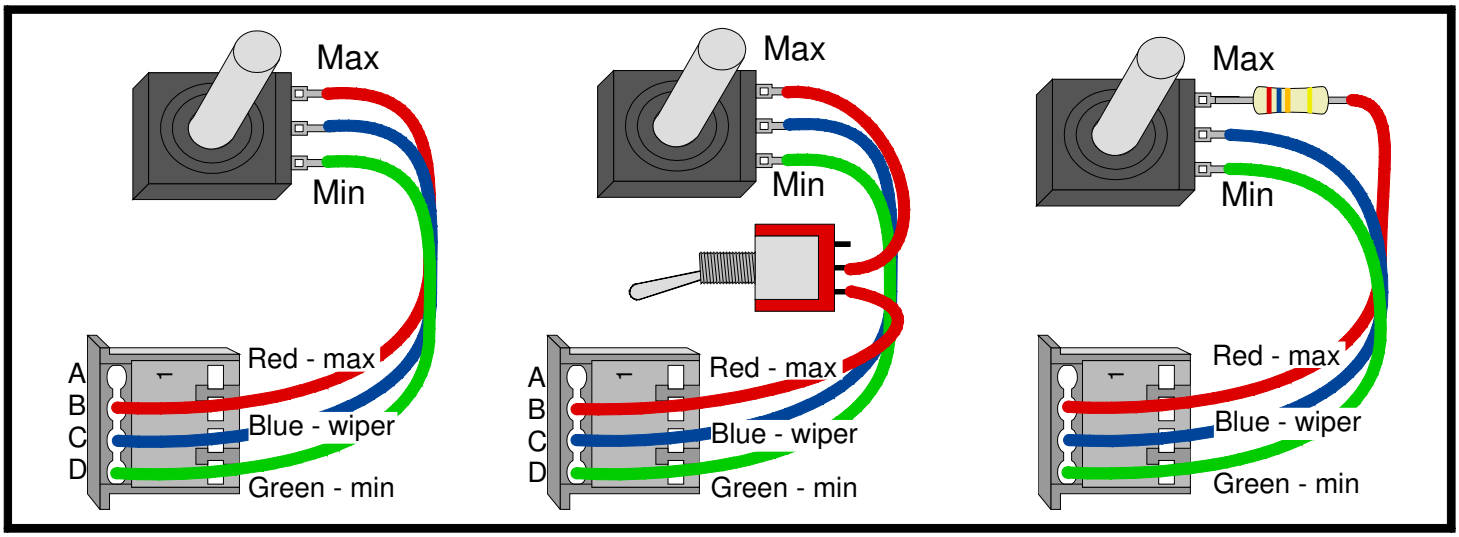
The two diagrams below also show the wiring to the connector (which is internal to the controller) so if you have the cased version - ignore the connector.

If you aren't using the yellow wire, make sure it is arranged so that it cannot touch anything: it carries the full battery voltage. It is also possible to use these four wires to connect a battery condition meter.

That's really all you need to know to get the Uni working!

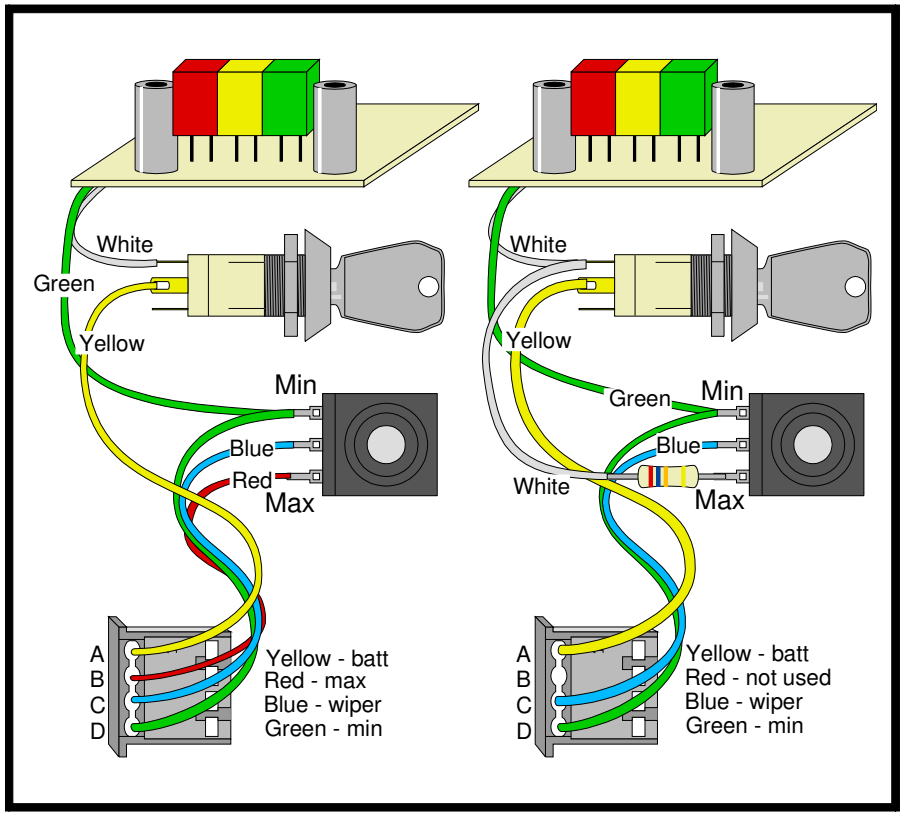
Pot fault detection

This feature is not normally engaged: for it to operate you must fit a resistor as shown in the third diagram. Use 3K3 with a 10K pot and re-adjust the gain control. Typically it is enabled to prevent the controller going to full speed in the event of a broken wire to the pot.



Battery Condition Indicator

A Battery Condition Meter can easily be fitted between pin A of the connector and pin d (green wire to pot) as shown left, below.



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 far right. In this case you will certainly need to re-adjust the gain preset.

Note that a resistor (10K with a 10K pot but not critical as you adjust the gain control) should now fitted in the white wire to the top of the pot.. If this resistor is not fitted, the pot fault detection circuit in the controller will not operate properly and the controller may go to full speed if the pot or wiring becomes faulty.

When wiring like this, you will have to adjust the Gain control so that full speed is reached at full pot rotation.

Internal connector

A 4 pin connector is supplied on the circuit board: bare board controllers are supplied with a mating connector, shown below.

This is an Insulation Displacement Connector (IDC): do not strip the insulation from the wires, simply push them into the top part of the open connector from the 'knobbly' side, and squeeze it closed in a vice or with suitable parallel action pliers.

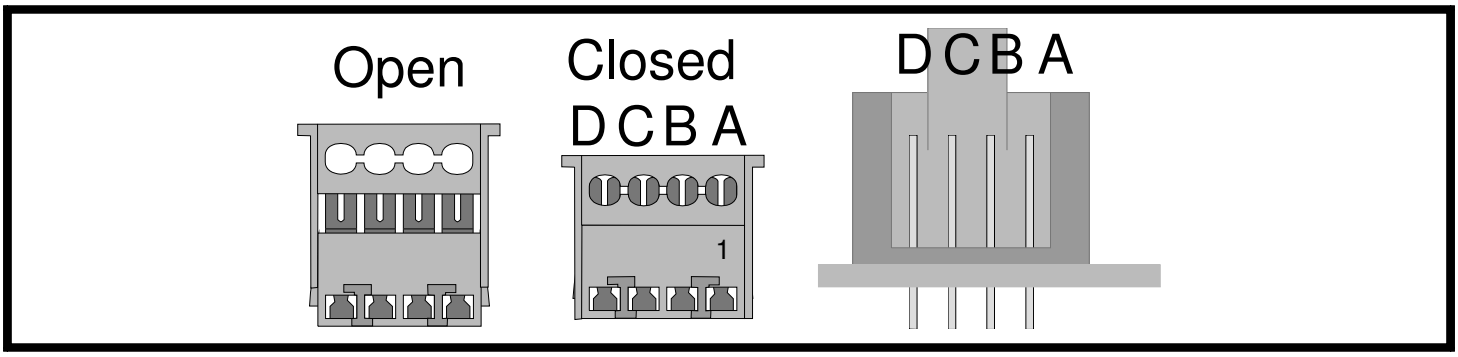
The mating connector supplied is suitable only for the correct size of wire.
Acceptable wire sizes are:

7 stranded 0.22-0.25mm²
Equivalent 24 AWG (7/32 AWG)

As you squeeze the connector closed, the tines of the contacts bite through the insulation to make contact with the conductors. Wire which is too thin will not make contact. Wire which is too thick will damage the tines.

You can re-open a closed connector by gently moving the tabs at the sides of the top cover outwards to disengage the latches while lifting the cover slightly, one side at a time.

The pin letters show how the pins mate with the 'features' diagram.



Adjustments

There are three adjustments available: Gain, Acceleration and Deceleration. These are indicated on the drawing, above.

***Important**: use an insulated screwdriver when making adjustments: the metal centres of the adjustments are 'live' to the internal circuitry. If a non-insulated screwdriver touches anything other than a preset the circuit can be damaged.*

Gain

Adjust this so that, at maximum required pot rotation, the controller just reaches full speed. This is easiest to do with the motor unloaded (i.e. with the wheels chocked up). Set the speed pot to your required maximum point then, listening to the motor, adjust the preset. It is usually quite easy to tell when the motor stops accelerating and reaches full speed.

If you set the gain control too high, the controller will probably cut out at full throttle: this is the pot fault feature which can be implemented fully. See page 5.

As supplied, the controller is set so that it works properly with a standard 10K pot. You may have to readjust with, for example, a twist-grip throttle.
For the more technical: The controller feeds approximately 5.6v to the top of the pot. With the gain at maximum, full speed is at about 3.5v on the pot wiper (pin C) and at about 4.5v, pot fault operates and the controller cuts out.

Acceleration

This adjustment controls the rate at which motor speed increases if you turn the pot sharply up. Adjust it to suit your machine.

Deceleration

This adjustment controls the rate at which motor speed decreases if you turn the pot sharply down. Adjust it to suit your machine.

If you get these adjustments wrong, little harm will be done but the machine's stopping and starting will either be very jerky because it responds too rapidly, or it will seem unresponsive as you have to wait for anything to happen!

Braking

Regenerative braking is usually a desirable feature whenever a controller is used from batteries and there are very few instances where it is disadvantageous. However for fixed use, from a mains power supply, braking may prove a problem since, during braking, energy is returned to the power supply where it can pump up the power supply to about 36v(for the 24v version), which could cause failure of some power supplies.

From Issue 7 boards, it is possible to alter the board to disable regen braking. Full details are in the service section of our www site.

http://www.4qd.co.uk/serv/

Reversing

The Uni controllers are non-reversing.

4QD also manufacture reversing controllers such as the VTX range. These are designed to decelerate and reverse the motor properly even if the reversing switch is operated at high speed.

However reversing can be done by a heavy duty switch or relay.

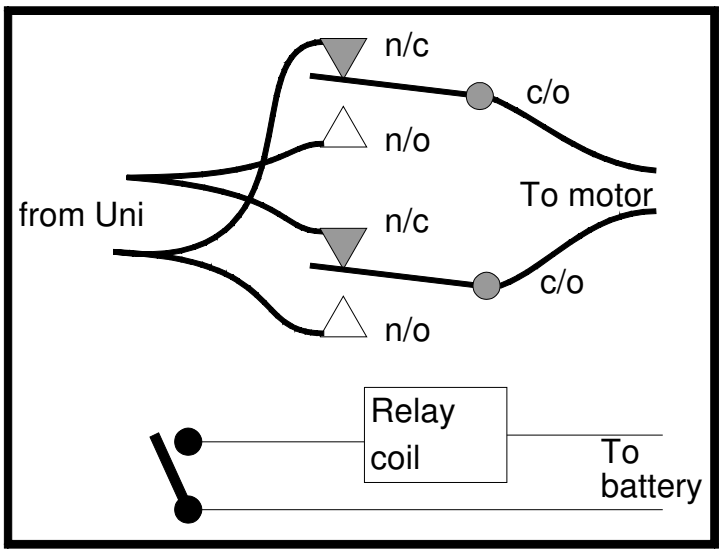
You will require a double pole changeover switch or relay to swap the armature connections. The diagram on the back page shows the wiring.

The normally open contact of one pole connects to the normally closed contact on the other pole and vice versa.

Note that motor connects to the moving contacts. If one pole of the switch jams the moving contacts can short together which might damage the controller but will not harm the motor.

IMPORTANT: the switch or relay must not be operated whilst the motor is running. To do so will place great stress on the motor and mechanics. To avoid this, put the reversing switch somewhere so that it cannot easily be operated from the normal driving position.

This is the main reason that reversing controllers are available: they are configured so that reversing is safe (to the controller) under all conditions, even when the reversing switch is operated at full speed.



Heat & Heatsinking

The rated current output of the controllers is with the heatsink hot. When cold they will give considerably more current. Thus the 35 amp version will in fact give about 50 amps when cold. This is OK because the MOSFETS used are rated at 60 amps continuous with a case temperature of 25°C. As the MOSFETs warm up their allowable current reduces so that at a case temperature of 100 they can (only!) handle 45 amps continuous. The current limiting used in 4QD's controllers senses the MOSFET temperature and automatically adjusts. However, running the controllers at full current will cause speedy heating.

However, at some temperature (well above 100°C) the MOSFETs will become unsafe, so we suggest that, during initial use, you keep a note of the heatsink temperature and, if it becomes much too hot to touch, take appropriate steps, either by mounting the Uni onto additional heatsinking or, better still, fit a higher rated drive since heat is wasted battery power and a larger drive will waste less. When using an external heatsink remember that steel does not conduct heat well: aluminium is far better.

For good heat conduction you must also use heatsink compound between the Uni's on-board heatsink and any external sink you fit.

Use as voltage follower

Instead of a pot the input may be fed from a variable voltage. 0v (common) to pin D, signal input (+ve) to pin C.

Zero speed will be for zero voltage input and full speed voltage may be adjusted (by the pre-set) to be from 3v to above 20v.

If the input is a PWM signal, e.g. from a microprocessor, and its amplitude may be above 5v, then the pot fault protection circuit needs to be deactivated. Two resistors are marked A and B on the features diagram on page 3
To disable Pot fault, either disconnect A, or link out (short circuit) resistor B.