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Instruction Manual

DMR-203

Dual-Channel Microprocessor Controlled Radio Control Interface with Failsafe System and Opto-isolation.

Features

- Dual Channel Radio-Controlled Electronic Speed Control utilising Micro-controller technology.
- 2 256-State PWM (Pulse Width Modulated) Proportional Outputs with Reverse signal.
- 2 Steering Modes (Dual Independent / Mixed)
- Advanced Failsafe System
- Configurable Output Modes (Switched / Proportional)
- Signal Processing, Validation and Rejection for Noise Immunisation and Improved Control
- Opto-Isolated Input Connections (Constant current over wide voltage range)
- Low Power Consumption
- Compact and Lightweight Design for simple integration into existing systems

Foreword

The DMR-203 Interface board is a general purpose Dual-Channel Radio-Control interface for use with 4QD motor speed controllers to give proportional motor speed control from a standard Radio Control system.

The interface uses microprocessor technology and is aimed principally at Robotic Control Applications. However it is also useful for other Radio Control projects.

It is a boxed unit which connects directly to the PWM servo outputs of a standard Radio-Control Receiver and to the inputs of two speed controllers.

It may be used with 4QD speed controllers such as

VTX, Pro-120, Pro-150, 4QD series and probably with other controllers as well.

Features include both *channel mixing* and *dual independent channel* ("Tank" style steering) modes, Switched or Proportional outputs, and an advanced failsafe system that can bring the system to a safe state in the event of a poor signal.

Single channel use

The failsafe has been designed so that, by connecting just Channel 1, the unit can be also used as a single channel interface.

Please read this instruction manual carefully before operation and retain this document for further use.

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Specifications

Supply Voltage	5.7-32.0V*
Supply Current	9.2mA*
Power Consumption	50mW*
Output Signal	
Output Method	2KHz PWM 0-100% Modulation / DC output
Output Voltage	4.3V Max
OFF->ON Switched Output Threshold	1.5mS (Centre) +- 0.17mS to Switch
Resolution	8 Bits (7 bits Control + 1 bit Reverse Signal)
Radio Control Input	
Input Method	40-70Hz PPM 1.5mS Mark Centre [RC Standard]
Input Voltage	2.2V - 18V Max
Input Resistance	50Kohm
Receiver Current Required	Fixed at 5mA/Channel
Failsafe Parameters	
Valid Input	0.8-2.2mS demand and >13mS Space Width
Fail Time-out	120mS / 490mS via Jumper setting.
Fail Output	83mV Max
Consecutive Valid Pulse Requirement	4 within any 120ms/490ms window.
Operating Temperature.	-30 - +60°C
Dimensions mm(")(max):	H 25.0(0.98) x W 64.0(2.52) x D 43.0(1.69)
Weight:	62g

*Note: This unit is designed for direct connection to two 4QD motor speed controllers, such as the VTX, PRO-120 or 4QD models. The unit is powered directly from the connections made to these so no external power supply is required. Be aware that it is not recommended to use unmatched controllers for each channel and both controllers MUST operate from the same set of batteries.

1. Installation

VTX

Wiring of the interface to two VTX (or earlier NCC) controllers is shown in the diagram.

Pro-150

Wiring is as below, but the DMR must be modified: see the www site for details:

<http://www.4qd.co.uk/serv/appnotes/DMR+Prog.html>

There is also an alternative wiring scheme linked from the above page.

Pro-120

Pro-120s can be used instead of VTXs with no alterations. HPLO must be disengaged on the Pro-120s.

4QD series

4QD series controllers may also be used but the *ignition connection to the DMR is not used*. The 4QD ignition connectors must be wired as in their instruction manual.

The link J2 on the 4QD control board should be changed from its default condition or removed. In the default condition reverse will not operate.

You will also need to disable HPLO (High Pot Lock-Out" as in the) 4QD controller instructions.

All controllers

The "CH1 SPEED" input should be connected to the forward/reverse receiver output and the "CH2 STEER" input should be connected to the steering output. Make sure that the blue wire goes to the notched end of the socket, i.e. the end that a servo's white wire goes to.

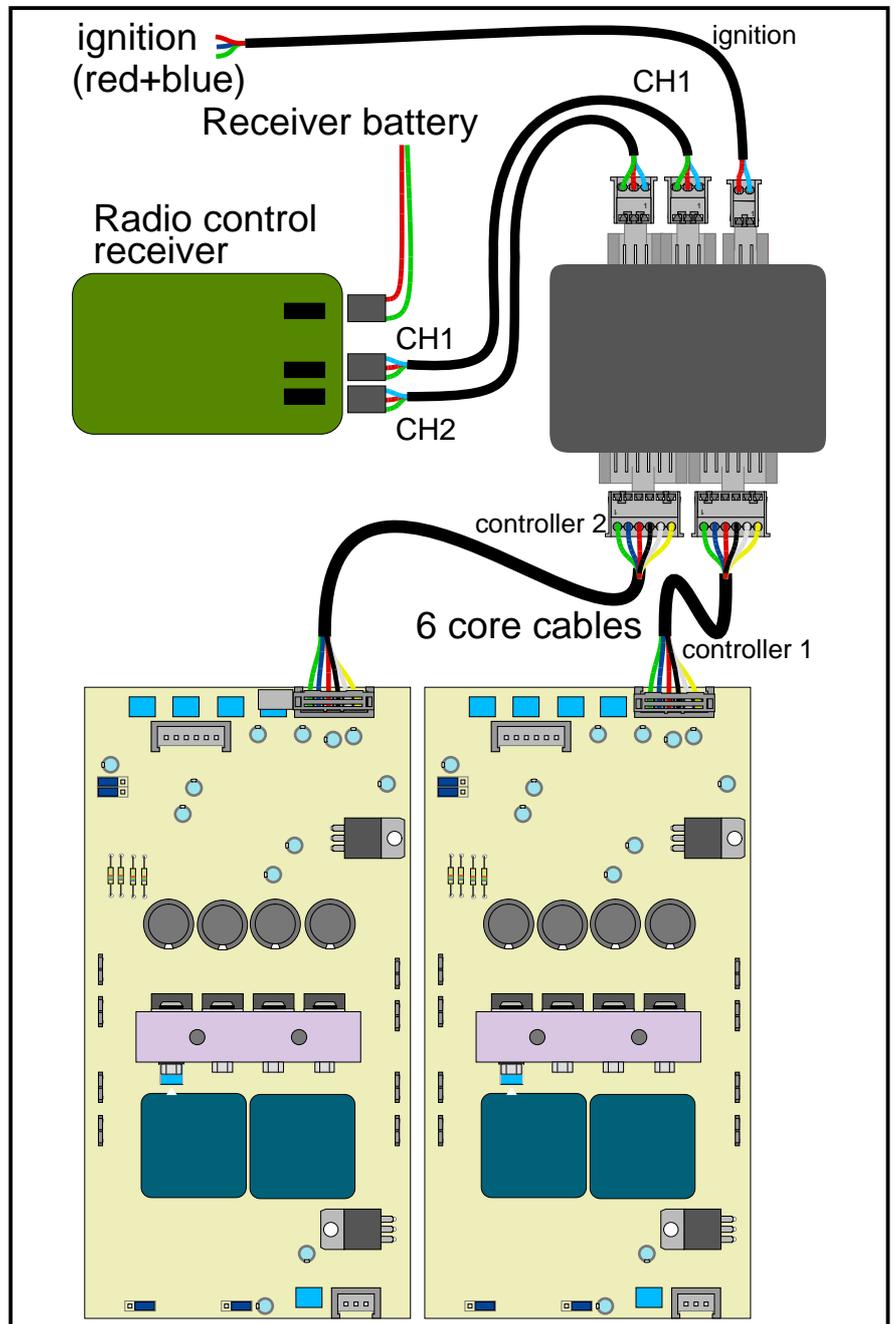
Connection to the left and right motor controllers should be made using standard 6-way connectors.

Please check your connections before powering up any devices!

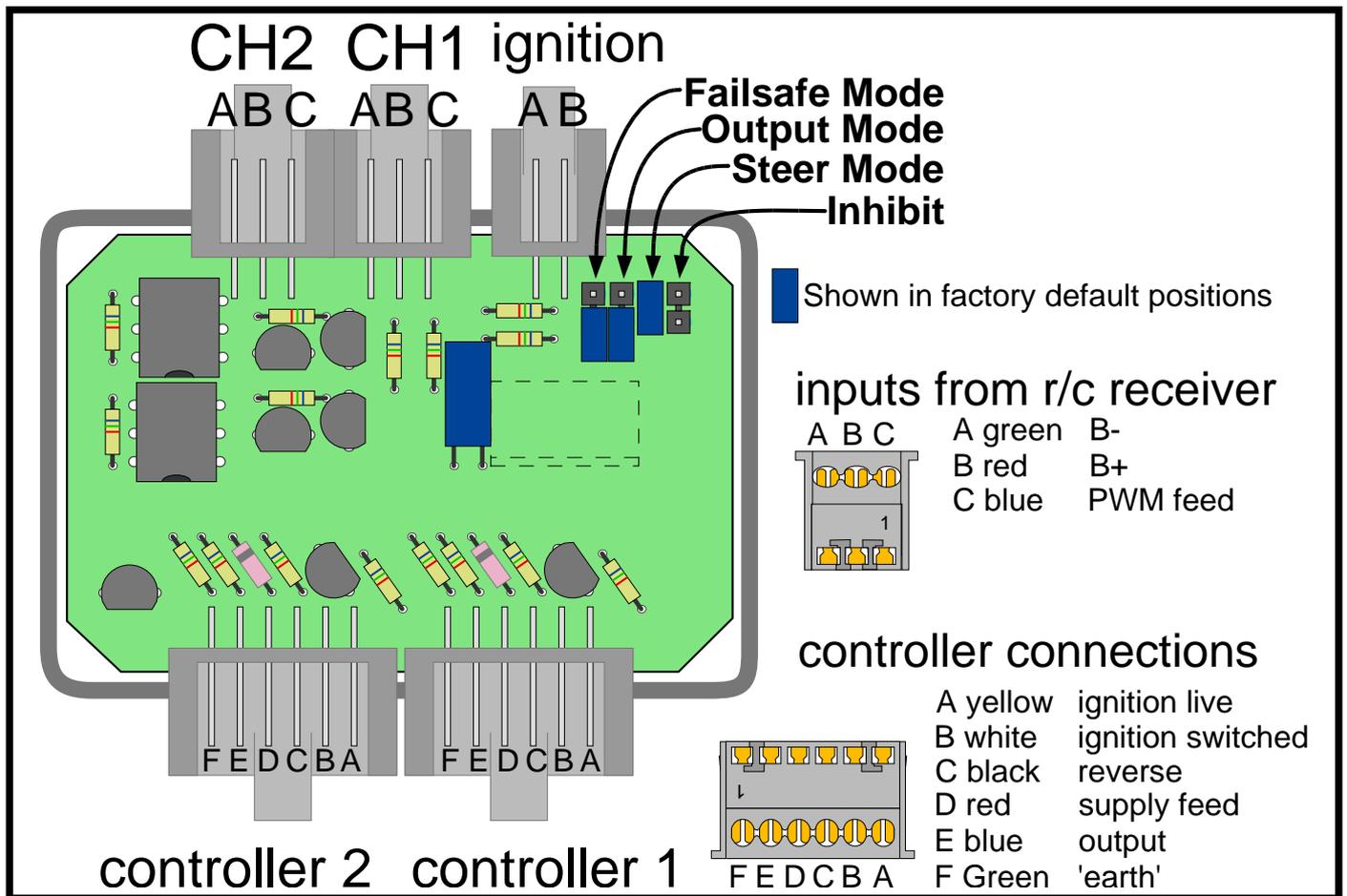
Single channel use

The DMR-203 derives its power from either of the host controller's pot top (output pins D) connections.

However ignition is via controller 1 only. The unit will then not operate if there is no power to controller 1 or it is absent.



2. Jumper Settings



The diagram above shows the DMR-203 with the cover removed (held on by 4 corner screws).

Warning.

When modifying jumper settings you should always power-down the Interface to avoid damaging it. This can be done in system by turning the controller "IGNITION" off or by disconnecting Controller 1 and Controller 2 connectors.

Disconnecting the batteries does not necessarily work as the main capacitors in the controllers can take a long time to discharge!

The jumper settings are read when the unit is powered up and when the unit reactivates following operation of the failsafe.

The DMR-203 features a number of settings that can be chosen by setting or removing jumpers on the Printed Circuit board.

When making changes to these jumpers it is wise to take great care so not to damage the board. It is also recommend that you ground yourself by touching an exposed area on an earthed appliance before

handling. Please ensure that jumpers are firmly in place before powering up.

Factory defaults

Failsafe	Open	High sensitivity
Output Mode	Open	Linear mode
Steer Mode	Linked	(tank mode)
Inhibit	Open	Normal

Two spare header are parked on Failsafe and Output Mode pins: these are parked on a single pin so the option is not engaged.

2.1 Failsafe Mode Jumper

Linked	Low SENS mode FT = 490mS
Removed	High SENS mode FT = 120mS

The failsafe sets the outputs to safe values in the event of a poor signal

The failsafe mode jumper configures the sensitivity of the failsafe. With the jumper removed, the failsafe applies stricter threshold of signal quality, and will activate more easily than with the jumper mounted. However, decreasing the sensitivity of the failsafe increases the likelihood of the motors responding erratically to a poor signal.

4QD strongly recommend that, if there is any risk of injury posed by the application in which the DMR is used, the failsafe mode jumper should be removed.

2.2 Steer Mode Jumper

Linked	TANK mode
Removed	MIXED mode

The interface can operate in both "Mixed" and "Dual Independent" or "Tank" style steering mode.

In "Mixed" mode, a sum and difference calculation is performed on Forward/Reverse and left/Right signals to produce the desired steering behaviour commonly used in Robotics applications. When the Left/Right stick is fully displaced but the Forward/Reverse stick is at centre, the output will cause the vehicle to spin on the spot. At full Forward/Reverse one of the motor speeds is slightly reduced on steering to steer the vehicle.

"Tank" style steering mode configures the unit to behave like two single channel interfaces. This not only facilitates the "tank" style steering configuration but also allows the unit to be used in other applications such as a 2-channel 3-State radio controlled switch, or for auxiliary motors.

2.3 Output Mode Jumper

Linked	SKIP mode
Removed	LIN mode

Two output modes are available. "LIN" mode gives an output proportional to the stick positions. Alternatively, "SKIP" mode causes the outputs to be either High or Low. The transition between these is determined by a threshold documented in the "Specifications". This mode is useful for controlling switched outputs, or low-speed motor control where the output is required to either be ON or OFF without the requirement of proportional control.

2.4 Inhibit Jumper

Linked	INHIBIT
Removed	NORMAL Operation

This jumper simply acts as an enable control for the unit. If the jumper is set the unit will be in power-down mode and will not operate. This can be useful if you wish to interface the board with external Control circuitry such as a Microprocessor system. The Interface is disabled by driving the "Normally High" jumper connection low. The switching mechanism should be able to handle a current of 50uA when "Inhibiting" the Interface board.

2.5 Ignition

This is brought out to the ignition connector. Connecting the two pins (via an ignition switch) will power-up the whole system. The ignition power is supplied via pin A of controller 1. If this pin is not connected the system will not power up.

Internally, this Ignition is simply a direct connection via the interface to the same pins on the host controller.

- pin A connects through to Controller 1 pin A.
- pin B connects to both pins B

Be careful: Pin A of the ignition is connected through to Battery +ve: if it touches anything other than the blue wire you could blow tracks in the interface or in a controller.

Note that, when the ignition is off, the interface board is completely powered-down as it is powered from the host controller's 9V line.

3. Calibration

Calibration is easiest when the unit is operating in "PWM" and "TANK" mode (see 2.2 & 2.3).

3.1 Stick Centre position

Stick centring must be done using the trimmers on the transmitter.

The trimmers should be adjusted so that, for each channel, the DMR-203 gives zero output and the reversing signal is just off. If the centring is incorrect, the direction relays in the VTX or Pro-120 will jitter and can be heard doing so: adjusting to remove this jitter is possibly the easiest way of finding the centre.

The DMR-203 implements a small Dead-Band and thus will treat as zero any input signal is around the centre point. This means that the output is reliably zero when both sticks are centred, but has virtually no effect on control.

If you can't be bothered to change the Steer Mode Jumper to TANK mode (since this involves taking the lid off!) you can set the trimmers as follows:

- 1) Set the steering trimmer so that you can make both motors stop using only throttle stick- keep the steering stick centred.
- 2) Set the throttle trimmer so that both motors stop

with both sticks centred.

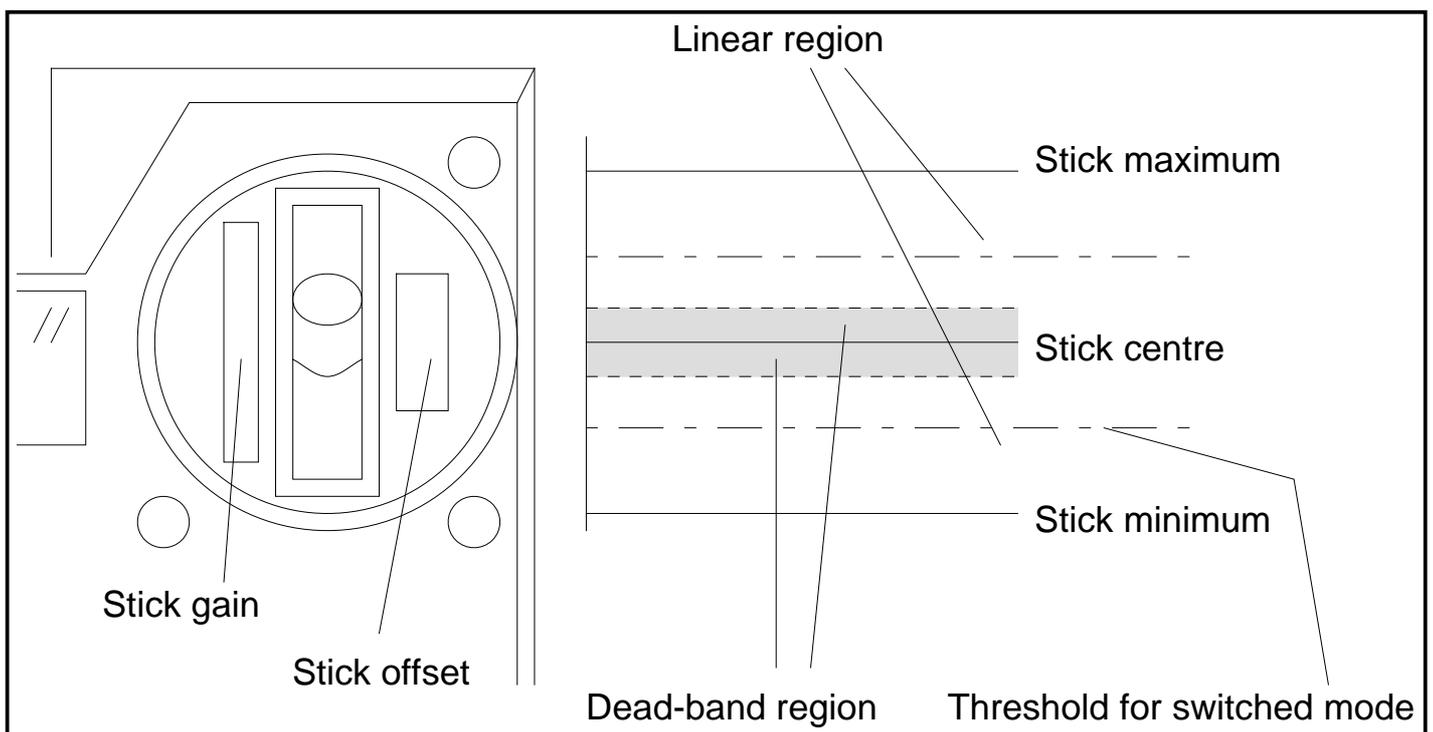
3.2 Controller Gain Adjustment

See motor controller manual for this adjustment.

The maximum and minimum stick positions should be calibrated to maximise the use of the available resolution, so the controller is just at full speed when the stick is at maximum - on most sticks maximum output is in a fully diagonal position.

With the VTX and Pro-120, the gain controls should be set to maximum.

Acceleration and deceleration ramps are best set to near maximum.



4. Performance Specifications

4.1 Output Transfer Characteristic

The DMR-203 Interface board implements Dead-band areas both at the centre and peak of the control range. This is to ensure that when the unit is commanded to either "Stop" or go at "Full Speed", the output will follow regardless of inconsistencies in the control signal.

4.2 Digital Proportional Control

The DMR-203 utilises Digital Sampling to monitor the inputs from the receiver in Real-time. The PWM output is also digitally derived and is therefore limited to a finite number of steps known as the "Resolution". Under most circumstances the effects of a "Staircase" between minimum and maximum stick positions can be ignored. This may however be noticeable in very high-speed applications.

5. Failsafe

The DMR-203 uses a failsafe system that offers features usually only found in expensive dedicated units.

5.1 Standard Receiver Output

The standard servo-drive in Radio Control applications is a 20 Hz PWM signal with a mark of 1.5mS at centre (zero position). When the stick is displaced from one extreme to the other, this mark changes from about 1.0mS to about 2.0mS.

The DMR-203 will reject signals that differ sufficiently from this standard.

When the signal quality is below an acceptable standard, DMR-203 enters failsafe mode, and all outputs are set to safe values.

5.2 Failsafe Algorithm

The failsafe algorithm used by the DMR-203 is simple and yet effective.

Each pulse is tested to determine whether it is likely to be a valid pulse, or just a section of random receiver output.

The results of this test are used to define whether the input signals can be trusted. If not, the DMR-203 goes into failsafe mode, and the outputs are set to zero.

A valid pulse must have a mark of between 0.8 and 1.2 ms, and must be followed by a space of at least 13 ms. All pulses that do not conform to this standard are treated as invalid.

The unit will enter failsafe mode if, over any period defined by FT (see 2.1), no sequence of 4 *consecutive* valid pulses occurs. This works well because it is very unlikely that a random signal will contain a section that looks like 4 consecutive valid pulses.

The system looks at both channels at the same time, so a set of 4 consecutive pulses could consist of 2 pulses from each channel received alternately (if pulses arrive simultaneously on both channels, channel one is treated as if it arrived first), or if only one input is connected, 4 pulses from that input.

When an invalid pulse is received, the output will correspond to the last valid input, unless, or until, the failsafe has activated.

6. Safety Considerations

The DMR-203 Interface board implements low-voltage microprocessor technology to control unlimited user-defined loads. The potential for the development of hazardous conditions is therefore great and the following safety recommendations should be adhered to fully.

Safe Operating Procedure

1. BEFORE powering up check the correct order of input connections fully.
2. BEFORE use check the unit for damage. DO NOT use the device if any connections are open-circuit or damaged.
3. ALWAYS use the same power supply for BOTH motor controllers and if possible use identical controllers for both channels.
4. Minimise noise and the possibility of connection failure by using short and properly terminated connection cables. Do not twist wires together.
5. DO NOT make connections while the system is powered up. RC control requires signals to be synchronised and the input signal may be misinterpreted.
6. DO NOT connect LED's or other I/O devices to the interface board. The unit is designed for use under minimal power supply power arrangements and any user modifications may cause the device to either stop functioning, or even worse, produce an unstable output that may oscillate out of control.
7. DO NOT touch the circuit while in operation. This may have adverse effects on performance.
8. DO NOT allow the unit to get wet and observe the operating temperature specifications.

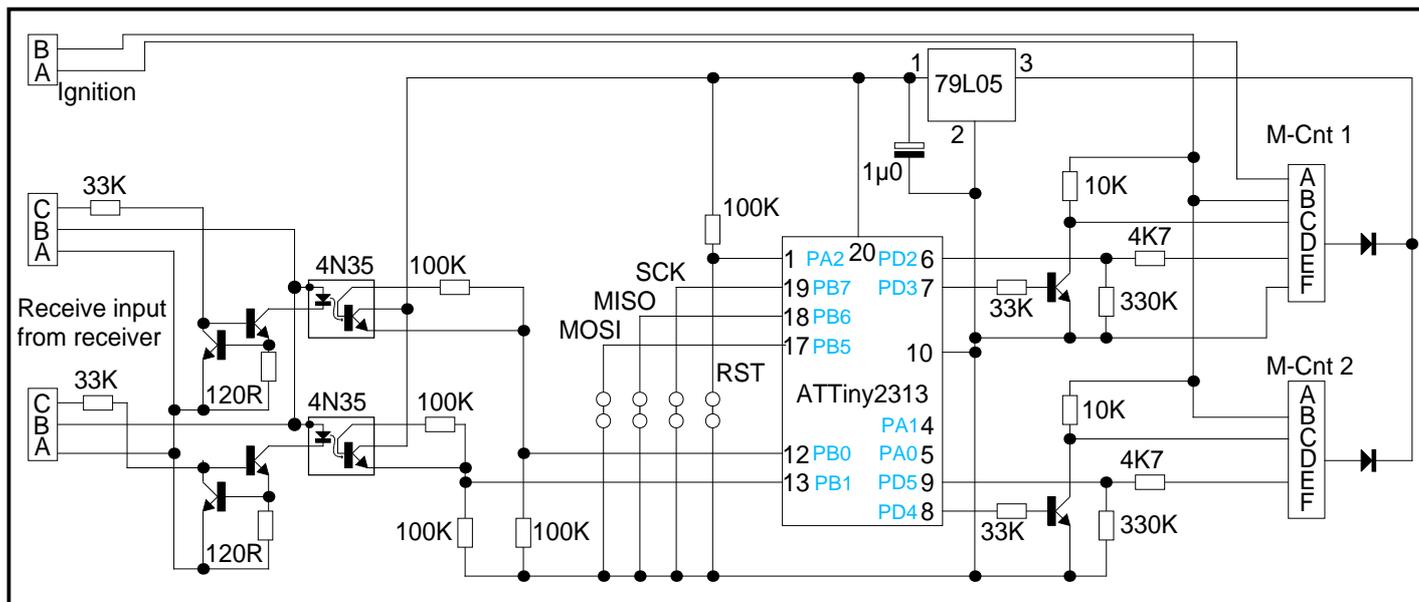
Note:

Any experienced Radio Control user will know it is good practise NOT to switch off the transmitter during operation as this commonly produces an undefined output which will be reacted too until the failsafe activates. We also recommend that the Receiver is powered up and signals checked before applying power to the motor controller.

Moreover, it is always best to operate potentially dangerous machinery with great care. Minimise risk by removing the possibility of danger until confidence is achieved. As an example, if using this unit with a vehicle make sure the wheels are off the ground until the interface has been setup correctly.

As a final recommendation, it is always best to use a master Failsafe system such as a battery isolator or other mechanical switch to ensure ultimate safety.

7 Circuit diagram



The two radio control inputs are shown on the left. Each has a pair of transistors associated with it to drive the opto-coupler at constant current, so the input will work over a wide voltage range.

All of the clever bits are done in software in the AT90 microcontroller. This delivers two pwm outputs (pins 6 and 9) whose levels are averaged in the VTX controllers.

Pins 7 and 8 are the direction outputs driving two transistors to interface to the (higher voltage) input of the controllers. The collectors of these transistors are pulled up via 10K resistors fed from the ignition line.

Ignition is fed from controller 1 only so if this controller is not present, controller 2 will not work!

8. Radio control connections

Most radio control receivers (e.g. Futaba, Hitec, JR) have the positive connection in the centre and the supplied lead will fit these. However some makes (e.g. Airtronics) have the negative lead in the centre and the supplied leads will need to be altered to suit - swap over the red and green wires.

Our supplied leads are colour coded:

Blue	Pin C	Signal
Red	Pin B	+ (Positive)
Green	Pin A	- (Negative)

The individual contacts are held into the shell by a tongue on the shell latching with the contact. This can be seen in the 'window' in the shell. Gently lift the tongue upwards with a pin and the contact is released and can be pulled out.

The DMR input circuitry is very forgiving and is unlikely to be damaged by and wrongly-wired connection.

9. Trouble-Shooting

Q.	The output is always zero?
A.	<p>Is there power to both the motor controller and receiver?</p> <p>Are the connections correct?</p> <p>Is the receiver supply voltage too high or too low? (This can cause invalid inputs)</p> <p>Is the motor controller supply voltage/current too low? (Both the interface & motor controller have under voltage protection)</p> <p>Is the ignition switched on?</p> <p>Try testing the system by connecting a servo to the output of the receiver to check the input.</p>
Q.	No Reverse?
A.	<p>Is the receiver input calibrated properly? Does the controller give zero speed on stick centre? If not adjust the offset.</p> <p>Does the controller operate correctly with manual reverse input? If so then the reverse driver maybe damaged.</p>
Q.	The output is unstable?
A.	<p>Are the connections correct?</p> <p>Is the receiver giving a bad output due to signal transmission deficiencies?</p> <p>Is the board damaged?</p>
Q.	The unit gets hot during operation?
A.	If this occurs you should discontinue use immediately. Under normal use the unit uses such little power that its temperature will not change at all. Check the board for short circuits.
Q.	The unit works but will not give maximum speed?
A.	<p>Has the motor controller gain been adjusted to give full output with full stick displacement in BOTH forward and reverse directions?</p> <p>Is the supply voltage/current low?</p>
Q.	The output dithers between two speeds or rises in steps?
A.	<p>This is normal and a product of using a microprocessor to sample the RC input signal. You can minimise this by ensuring the gain is adjusted to give full output at full stick displacement.</p> <p>"Stair-Casing" may be more noticeable on high speed motors or motors operating beyond their intended voltage rating.</p>
Q.	The output is not symmetrical (forward and reverse peak)
A.	<p>Is the transmitter signal symmetrical? Adjust the controller gain to give maximum output when the transmitter gives its lowest output for the full stick displacement.</p> <p>Is the motor controller set to asymmetric mode?</p> <p>Is the motor controller operating correctly?</p>
Q.	The output is either Full Speed or Zero Speed?
A.	<p>Are the jumper settings correct?</p> <p>Is the Controller "Gain" set to an excessively high value?</p> <p>Is the Receiver giving a suitable command signal?</p>

Please visit the 4QD web-site for further support, feedback and technical information.