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Instruction Manual

DMR-201

Dual-Channel
Microprocessor Controlled
Radio Control Interface
with Failsafe System

6th March 2003

Contents

Foreword

The DMR-201 Interface board is a general purpose Dual-Channel Radio-Control interface providing proportional motor speed control from a Radio Control Receiver.

The unit utilises microprocessor technology to implement solid features designed for use in Robotic Control Applications and general purpose High-power Radio Control projects. It exists as a stand-alone interface that connects directly to the PWM servo-outputs of a Radio-Control Receiver and is specifically designed to be used with the range of 4QD's motor speed controllers.

Features include both "Mixed" and "Tank" style steering modes, Switched or Proportional outputs, and an Advanced Failsafe system that can bring the system to a safe state. In addition, the unit implements a Dead-band areas on both centre and full stick positions and Signal Validation and Rejection routines for noise immunisation.

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

7. Trouble-Shooting

Q. A.	The output is always zero? Is there power to both the motor controller and receiver? Are the connections correct? Is the receiver supply voltage too high or too low? (This can cause invalid inputs) Is the motor controller supply voltage/current too low? (Both the interface & motor controller have under voltage protection) Is the ignition switched on? Try testing the system by connecting a servo to the output of the receiver to check the input.
Q. A.	No Reverse? Is the receiver input calibrated properly? Does the controller give zero speed on stick centre? If not adjust the offset. Does the controller operate correctly with manual reverse input? If so then the reverse driver maybe damaged.
Q. A.	The output is unstable? Are the connections correct? Is the receiver giving a bad output due to signal transmission deficiencies? Is the board damaged?
Q. A.	The unit gets hot during operation? 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. A.	The unit works but will not give maximum speed? Has the motor controller gain been adjusted to give full output with full stick displacement in BOTH forward and reverse directions? Is the supply voltage/current low?
Q. A.	The output dithers between two speeds or rises in steps? 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. "Stair-Casing" may be more noticeable on high speed motors or motors operating beyond their intended voltage rating.
Q. A.	The output is not symmetrical (forward and reverse peak) 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. Is the motor controller set to asymmetric mode? Is the motor controller operating correctly?
Q. A.	The output is either Full Speed or Zero Speed? Are the jumper settings correct? Is the Controller "Gain" set to an excessively high value? Is the Receiver giving a suitable command signal?

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

Features

- Dual Channel Radio-Controlled Electronic Speed Control utilising Micro-controller technology
- 2 256-State PWM (Pulse Width Modulated) Proportional Outputs with Reverse Drivers
- 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
- Low Power Consumption
- Compact and Lightweight Design for simple integration into existing systems

Specifications

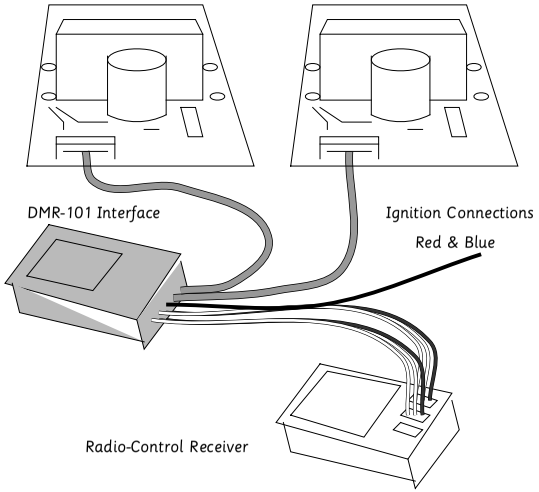
Supply Voltage	5.7-32.0V*
Supply Current	9.2mA
Power Consumption	50mW
Output Signal	
Output Method	2KHz PWM 0-100% Modulation / DC output
Output Voltage	4.3V Max
OFF->ON Switched Output Threshold	1.5mS (Centre) +- 0.17mS to Switch
Resolution	8 Bits (7 bits Control + 1 bit Reverse Signal)
Radio Control Input	
Input Method	40-70Hz PPM 1.5mS Mark Centre [RC Standard]
Input Voltage	3.2V - 5.5V Max
Input Resistance	50Kohm
Failsafe Parameters	
Valid Input	0.8-2.2mS demand and >13mS Frame Width
Fail Time-out	30mS / 490mS via Jumper setting.
Fail Output	83mV Max
Dead Time	Approx 1500mS
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:	53g

*Note: This unit is designed for direct connection to two 4QD motor speed controllers, such as the "NCC", "PRO" 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 power supply. This is because control connections made to the host controllers are connected together when the Interface board is connected.

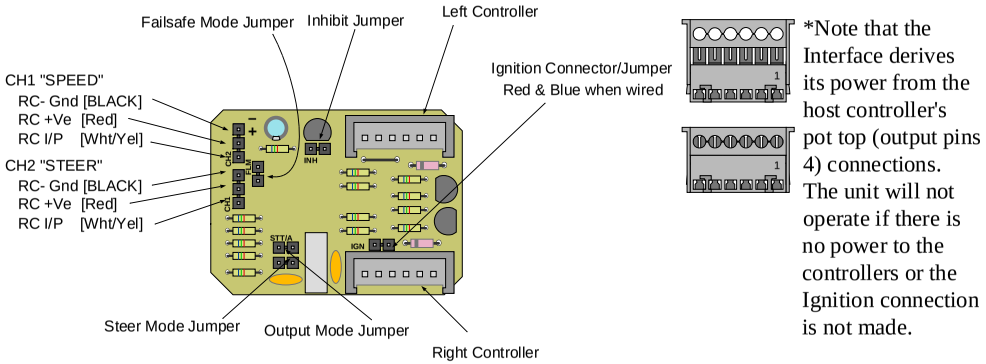
1. Installation

The DMR-201 Interface board connects directly to the outputs of a Radio-Control Receiver. The "CH1 SPEED" input should connect to the Receiver output that corresponds to forward/reverse and the "CH2 STEER" input should be connected to the steering output. Connection to the Left and Right Motor Controllers should be made using standard 6-way connectors. The Interface board is compatible with 4QD's "PRO", "NCC" and "4QD" speed controllers.

Please check your connections before powering up any devices!



DMR-201 Interface Board [viewed from above]



*Note that the Interface derives its power from the host controller's pot top (output pins 4) connections. The unit will not operate if there is no power to the controllers or the Ignition connection is not made.

2. Jumper Settings

The DMR-201 features a number of settings that can be chosen by linking or opening pins with removable jumpers on the Printed Circuit board.

When making changes to these jumpers is it 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.

The unit has been designed to operate in its safest mode without any of the jumpers linked; in case of damage or excessive vibration.

2.1 Failsafe Mode Jumper

linked	Low SENS mode FT = 490mS
removed	High SENS mode FT = 30mS

The built-in failsafe system can be set to allow either 30 Milli-seconds or 0.5 Seconds "Wait" for a valid signal to be received before activating the Failsafe mode. Under normal circumstances this jumper should be *removed* to enable the Failsafe system to react to invalid input signals due to noise, transmission loss and damage as quickly as possible. However, in particularly noisy environments, or in cases where the Failsafe may cause annoyance, its sensitivity can be reduced by setting the Fail-mode Jumper.

6. Safety Considerations

The DMR-201 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 although this is not critical.

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.

5. Failsafe Operation

The unit's failsafe system offers features usually only included in expensive dedicated units and it is directly tied in with the devices signal validation and rejection filters.

The standard servo-drive in Radio Control applications is a PWM signal with mark of 1.5mS to indicate centre position. When the stick is displaced this mark changes width from 1.0mS (full back/left) to 2.0mS (full forward/right) typically. The interface board will reject any signals that do not conform to this standard with an extra 0.2mS error bandwidth.

The unit will thus only accept and react to signals that are between 0.8 and 2.2mS input. If an input signal is invalid and gets rejected the unit will behave as a servo would by maintaining the output at the last known “good” value. This system ensures noise and other invalid inputs taken from the receiver are ignored.

The interface maintains synchronisation with the input signal. Even if the input pulse-width is valid, if the frame shape is not correct that value will be rejected. This ensures that random input signals such as those given from FM receivers are ignored. This system has priority over the activating the "Failsafe" mode.

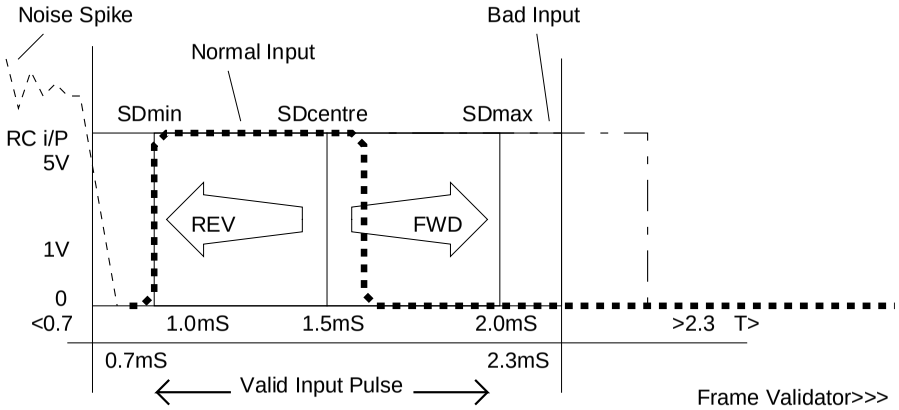
To maintain maximum safety, the "Failsafe" mode (once activated) calls a routine that will hold the output of the interface at zero for a given time. Following this, incoming valid signals will be given the opportunity to re-engage the output for a time-limit specified as the "Fail Time".

The DMR-201 facilitates "Fail Time" configuration via the "Fail mode" jumper. This determines the amount of time the unit should "Wait" for a valid signal. See the "Jumper Settings" section for details on this.

Please note that the signal validation routine requires that valid signals are received by "BOTH" channels simultaneously and for this reason the interface cannot be driven from a receiver alone unless both inputs are fed from the same connection.

Finally, it is important to remember that the controller’s reaction is entirely dependant on good signals being delivered by the receiver. Factors such as wiring, materials and aerial placement can have significant effects on the performance of an RC system and if you have these optimised then the "Failsafe" should only ever activate to hold the motor when the transmitter is switched off.

Signal Validation/Rejection & Failsafe Operation



2.2 Steer Mode Jumper

Linked MIXED mode
Removed TANK mode

The interface can operate in both "Mixed" and "Dual Independent" or "Tank" style steering mode. In "Mixed" mode the Forward/Reverse and left/Right signals are mathematically combined 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 forces 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 PWM mode

Two output modes are available. "PWM" mode gives a proportional output relative to the stick position to achieve accurate motor speed control. 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 ideal 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 Jumper

Linked IGNITION ON
Removed IGNITION OFF

The Ignition jumper is simply a direct connection the "IGNITION" connections of the "host" controllers.

Note that this does **not** apply to the 4QD series controllers where ignition should be wired normally as in the controller instruction manual.

A Header maybe used to either set the ignition to be permanently "ON", or the connections maybe brought forward to a switch, this providing a master failsafe. Note that when the "IGNITION" is "OFF", the interface board is completely powered-down due to removal of the power-supply. Also note that the "IGNITION" jumper on the interface board controls both "Left" and "Right" motor controllers.

IMPORTANT:

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.

When the unit is powered up it will load the jumper settings and then continue operation in the mode defined at start up. If the jumper settings change during normal operation (maybe due to excessive vibration causing the headers to fall out) the changes will be ignored until next time the interface is restarted.

Also note that the "Fail Safe" is able to restart the interface and the jumper settings will also be reloaded when this activates.

Although it is not recommended, you can manually change the operating mode while power is applied by setting the "INHIBIT" jumper momentarily after making changes to the jumpers. This will cause a manual "restart" of the interface to enable the changes to be reloaded.

3. Calibration

Please make sure that the unit is operating in "PWM" mode before attempting to calibrate.

3.1. Aligning Stick Centre position

The DMR-201 Interface board requires calibration before use as does any other Radio Control system. Manual calibration can be made by adjusting the joystick offset on the radio-control transmitter until the centre points align.

The transmitter stick offset should be adjusted until the interface board gives zero output and the reversing signal is off. The DMR-201 features implementation of a small Dead-Band area that will "Round-Off" input when the input signal is around the centre point. This makes finding Centre position much easier and when reached the output will appear to "Lock" to Zero. This Dead-Band area however is very subtle and has virtually no effect on control.

3.2. Scaling the Output for Maximum Resolution

To maximise the use of the available resolution given by the Interface unit the maximum and minimum stick positions should be calibrated. This can be achieved by adjusting the “Controller Gain” (See motor controller manual) to be just above full-speed when the stick position is at its maximum. Using this method forces the controller input to match exactly the interface output over the full-range. You should select Tank style steering mode to calibrate this to ensure the effects of mixing do not interfere. Full details regarding configuring the host motor controller’s “Gain Control” can be found in the relevant motor controller manual.

3.3 Mixed Steering Alignment

When the device is operating in "Mixed" steering mode, any misalignment of the transmitter stick offsets may cause the vehicle to veer off to one side when commanded to go forward only. You should adjust the offset on the "STEER" stick to ensure both motors run at the SAME speed throughout the range of the Forward/Reverse Stick.

To align, set the "STEER" stick to centre point then slightly adjust the offset on the "SPEED" stick to command both motors to run at a low fixed speed. Following this, adjust the "STEER" offset until both motors run at EXACTLY the same speed. If you are testing on a vehicle, it should go in a straight line once calibrated. Finally, reset the"SPEED" stick offset to give Zero output at centre position.

To make sure that the motor controller's "Gain" controls have no effect you should them to the maximum (See Controller Manual) value while calibrating the Steering offset. It is also wise to test the motors run at the same speeds throughout the range of the "SPEED" stick displacement.

3.4 Mixed Steering Gain Adjust

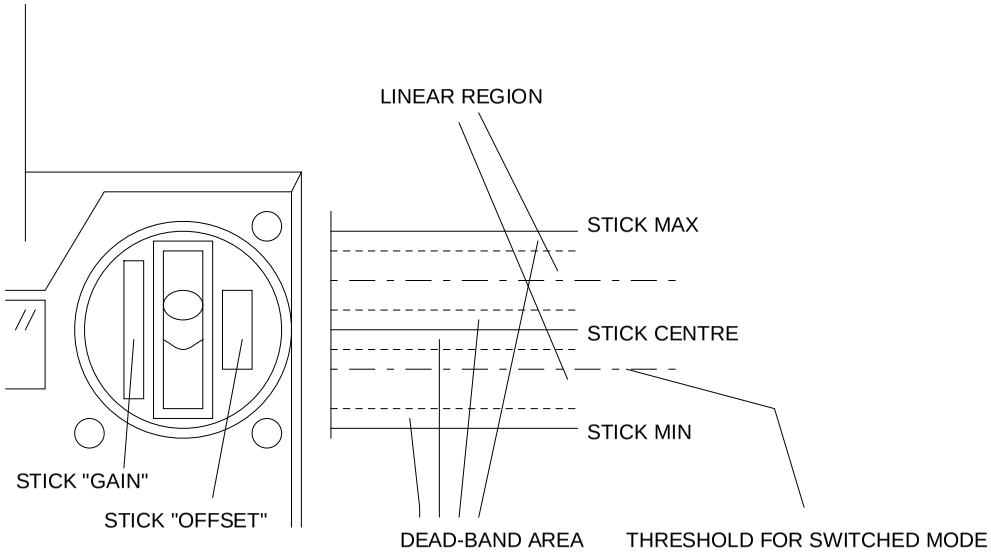
The amount of effect one channel has on the other in "Mixed" steering mode is entirely a product of the amount of stick displacement made by the "STEER" channel. To allow "Hands On" control and setup of the Steering gain its magnitude must be altered at the transmitter end of the system. Most Transmitters include a "Gain" control to allow the ratio between stick displacement and output to be adjusted. It is recommended that this be adjusted while operating the vehicle to attain a "Feel" for the control characteristic. Since the user may wish to alter this while in operation, the Interface does not allow the steering ratio to be set at a "Fixed" ratio.

4. Performance Specifications

4.1 Stick Position to Output Transfer Characteristic

The DMR-201 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. In very sensitive systems such as those employing high-speed motors this method guarantees that output will not drift around these dead-band areas provided the centre-zero calibration has been made previously.

It is common for transmitter-receiver combinations to give greatly inconsistent outputs depending on factors such as environmental noise, battery life and signal strength. Non-linear regions in the control curve have been added to prevent such factors from significantly degrading performance. Common problems that are resolved by this method include the inability to completely stop the motor or reach full speed. See the specifications for details on the actual values used.



4.2 Digital Proportional Control

The DMR-201 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.

In practise the output from the unit will "Dither". If the receiver command position is between two steps in the transfer staircase then it is normal for the unit to oscillate between steps on the output. If the command position is nearer to one step than the other the output will still oscillate between the two but the average time spent next to the closest step will be the greatest. Since the Interface responds quickly, these oscillations are fast and the "Staircase" effect is virtually "Ironed Out".