



# MDM5253 DC Motor Driver Module with Position and Current Feedback User Manual

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### Related Document:

WiRobot PMS5005 Sensing and Motion Controller User Manual

# I. Introduction

The MDM5253 DC Motor Driver Module with Position and Current Feedback is a three-channel H-bridge switching power amplifier board. It can be directly controlled by motion controller's logic level PWM driving signals at a frequency up to 20 KHz. For each of the three independent channels, the MDM5253 also provides the current feedbacks and connectors for position sensors such as potentiometers. Each channel is able to drive inductive DC load with current up to 5.0 A and operating voltage ranging from 5.0 V to 28.0 V.

## Features

- 3 Independent channels
- Output 5.0 V to 28.0 V operations
- Up to 5.0 A inductive DC load current capability
- 5.0 V TTL/CMOS compatible Inputs
- PWM Frequencies up to 20 kHz
- Automatic PWM over-current limiting
- Output short circuit protection
- Over-temperature output current reduction and shutdown
- Under-voltage shutdown
- Analog output current feedback
- 3 Connectors for position feedbacks
- Directly plug-on to the WiRobot PMS5005 sensing and motion controller board

## Applications

- DC motor and stepper motor control
- Permanent magnet solenoid control
- Robotic systems
- General PWM power amplifier

# II. Operations

## II.1. Theory of Operation

When four switches configured as that in Figure II.1, the whole circuit is called an H-bridge. By controlling the on/off of four switches in certain patterns, the polarity of the supply power on the control output can be changed. For example, when Control Input 1 and 4 are ON while the Control Input 2 and 3 are OFF, the controlled load is supplied by power with + on the left and - on the right. When Control Input 1 and 4 are OFF while the Control Input 2 and 3 are ON, the controlled load is supplied by power with - on the left and + on the right.

When applying the H-bridge output to a DC motor or other inductive loads with PWM controlled switching command based on certain algorithms and the feedback signals, full bidirectional magnitude control, including speed, position and torque control, can be achievable.

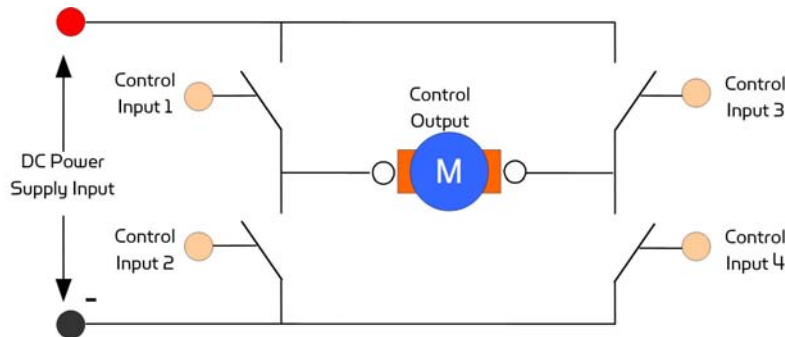


Figure II.1 H-Bridge Switching Device

In the design of the MDM5253, only one PWM control signal is required to control both the direction and the magnitude of the output for each channel. The H-bridge's diametrical opposite pairs (control input 1 and 4, control input 2 and 3) are connected and driven HIGH and LOW together, and the two pairs are controlled with strictly inverted signals.

Figure II.2 shows the relationship between the PWM duty cycle and system output. The zero average output occurs when the duty cycle is 50%. The direction of the output (in speed control, for example, the direction of rotation) depends on whether the duty cycle is larger than 50% or lower. The magnitude of the output (rotation speed in speed control) depends on the absolute difference between the duty cycle and 50%.

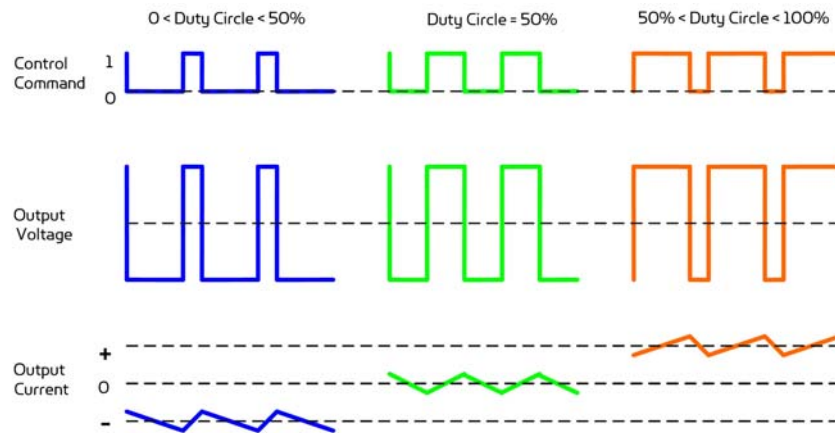


Figure II.2 Theoretic waveforms of PWM control for the MDM5253

In addition to the PWM control, the MDM5253 can connect up to 3 sensing feedback devices (e.g. MRS3302). DC motor control schemes, such as position and velocity control, can be implemented by installing feedback device on DC motor and connecting these devices to MDM5253.

## II.2. Running as Part of WiRobot System

When using the MDM5253 with the WiRobot system, users simply plug the module onto one of the DC motor drive expansion connector sets on the PMS5005 Sensing and Motion Controller board (maximum of 2 MDM5253 modules are supported) and the PMS5005 on-board firmware and device driver will take care of the motor control and sensing feedback. Since PMS5005 can support 2 MDM5253, it is able to connect and control up to 6 DC motors and have 6 position sensor channels (POT1-POT6).

Users have an option to use single rotary sensor (e.g. MRS3302 on the Position Sensor Connector), dual rotary sensor (e.g. 2 MRS3302 on 2 Position Sensor Connectors), or single encoder (Encoder port on PMS5005) as the feedback device to control each DC motor, if needed. PMS5005 already has built-in DC motor control schemes and users simply need to select the type of the feedback device for each DC motor. Note that for single

rotary sensor setting, DC motor 1 must use POT1, DC motor 2 must use POT2 and etc.; for dual rotary sensor setting, DC motor 1 must use POT1 and POT6, DC motor 2 must use POT2 and POT5 and DC motor 3 must use POT3 and POT4; for encoder setting, DC motor 1 must use ENCODER1 and DC motor 2 must use ENCODER2.

By working with the PMS5005, users can simply call a function offered by the WiRobot SDK software on PC (requires Microsoft platform) or send a data packet (platform independent) to control the DC motors or to obtain the sensor feedback. Please refer to WiRobot SDK API Reference Manual and PMS5005 User Manual for the available motor control algorithms and schemes.

### II.3. Running as a General Purpose DC Motor Driver Module

When using the MDM5253 with third party controllers, the power supply and the input/output signals should be connected properly (please refer to Section III for connection setting). The controller sends control commands to the enable pins and the PWM input pins based on your own control schemes and get current and position feedback data via an analog to digital converter.

## III. Connections

### III.1. Board Structure

Figure III.1 shows the structure, locations and functions of the connectors on the MDM5253 module board.

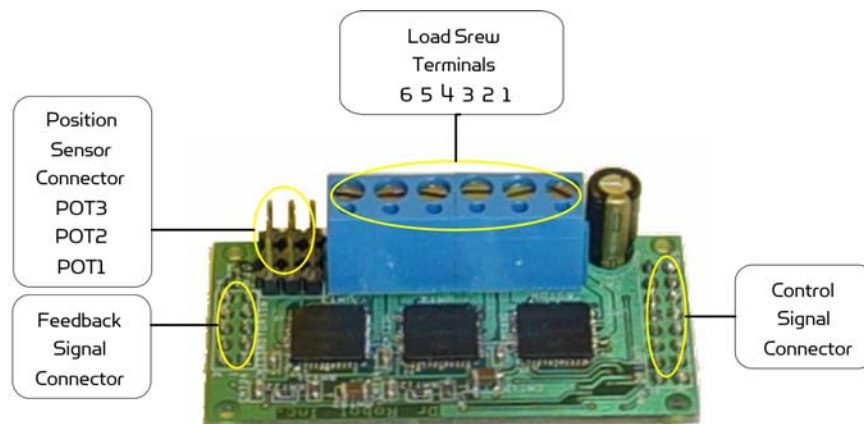


Figure III.1 MDM5253 Connector Locations

## III.2. Connector Description

The definitions of the MDM5253 connector signals are listed in the following tables.

Table III.1 Connections of the Load Screw Terminals MOTOR

Terminals	Name	Description
1	OUT1A	Channel #1 output A
2	OUT1B	Channel #1 output B
3	OUT2A	Channel #2 output A
4	OUT2B	Channel #2 output B
5	OUT3A	Channel #3 output A
6	OUT3B	Channel #3 output B

Table III.2 Position Sensor Connectors POT1 - 3

Pin	Name	Function
1	VCC3	+ 3.0 V
2	PVS	Position data, analog 0 – 3.0 V
3	GND3	Signal ground

Table III.3 Control Signal Connector MOTOROUT

Pin	Name	Function
1	CTL1	Channel #1 PWM control signal
2	CTL2	Channel #2 PWM control signal
3	CTL3	Channel #3 PWM control signal
4	ENA	Output enable for all channels: High: enable; Low: disable
5, 6	GND5	Power supply ground for VCC5
7, 8	VCC5	+ 5.0 V
9, 10, 11, 12	GNDM	Power supply ground for VCCM
13, 14, 15, 16	VCCM	Positive load power source

Table III.4 Feedback Signal Connector MOTORIN

Pin	Name	Function
1, 2	VCC3	+ 3.0 V, positive power source for position sensors
3, 4	GND3	Power supply ground for VCC3
5	CFB1	Channel #1 current feedback data, , analog 0 – 3.0 V
6	CFB2	Channel #2 current feedback data, , analog 0 – 3.0 V
7	CFB3	Channel #3 current feedback data, , analog 0 – 3.0 V
8	PFB1	Channel #1 position feedback data, , analog 0 – 3.0 V
9	PFB2	Channel #2 position feedback data, , analog 0 – 3.0 V
10	PFB3	Channel #3 position feedback data, , analog 0 – 3.0 V

## IV. Specifications

Table IV.1 MDM5253 Specification

Parameter		Conditions	MIN	TYP	MAX	Unit
Power Operating Voltage		VCCM	5.0 28.0			V
Under-Voltage Shutdown	Switch-off	VCCM	4.15	4.4	4.65	V
	Switch-on	VCCM	4.5	4.75	5.0	V
	Hysteresis		150			mV
Logic Operating Voltage		VCC5	4.5	5.0	5.5	V
Position Sensor Power Supply		VCC3		3.0	3.3	V
Standby Supply Current		VENA = 0V, IOU <sub>T</sub> = 0A			65	mA
Control Input HIGH		VENA, VCTL	3.5			V
Control Input LOW		VENA, VCTL			1.4	V
Enable Input Current		IENA		25	100	µA
PWM Input Current		ICTL		± 1		µA
Output-on Resistance		ROUT	T = 25 °C	120		mOhm
			T = 150 °C		300	
DC Load Current		T < 150 °C			5.0	A
Over-current Protection				7.0		A
Over-temperature Protection		Thermal shutdown	175			°C
		Hysteresis	10		30	
PWM Frequency					20	KHz
Output ON Delay		VCCM = 14V			18	µS
Output OFF Delay		VCCM = 14V			18	µS
Output Rise Time		VCCM = 14V, IOU <sub>T</sub> = 3A	2.0		8.0	µS
Output Fall Time		VCCM = 14V, IOU <sub>T</sub> = 3A	2.0		8.0	µS
Disable Delay Time					8.0	µS
Protection Turn-off Time				4.0		µS
Power-off Delay Time				1.0	5.0	µS
Position Sensor Input Range		With PMS5005 controller board	0.0		3.0	V
Current Feedback Sensitivity				533		mV/A
Current Feedback Accuracy		IOU <sub>T</sub> > 1.5 A		± 10		%
		IOU <sub>T</sub> < 1.5 A		± 20		
Board Size				30 x 58		mm x mm