

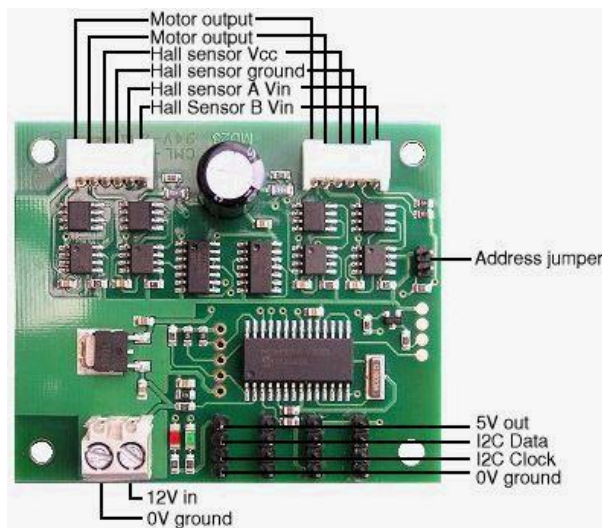
## MD23 - Dual 12Volt 3Amp H Bridge Motor Drive

### Overview

The MD23 is a robust I2C dual motor driver, designed for use with our EMG30 motors. Main features are:

1. Reads motors encoders and provides counts in registers for determining distance traveled and direction .
2. Drives two motors with independent or combined control.
3. Motor current is readable through registers.
4. Only 12v is required to power the module.
5. Onboard 5v regulator can supply up to 1A peak, 300mA continuously to external circuitry
6. Steering feature, motors can be commanded to turn by I2C register value.
7. Variable acceleration and power regulation also included

### MD23 Connections



### Motor Voltage

The MD23 is designed to work with a 12v battery. In practical terms, this means the 9v-14v swing of a flat/charging 12v battery is fine. Much below 9v and the under-voltage protection will prevent any drive to the motors. Above 14v and the driver chips may be destroyed - their absolute maximum stress voltage is 18v.

### Motor Noise Suppression

When using our EMG30 encoded motors, you will find that a 10n noise suppression capacitor has already been fitted. Other motors may require suppression. This is easily achieved by the addition of a 10n snubbing capacitor across the motors. The capacitor should also be capable of handling a voltage of twice the drive voltage to the motor.

### Leds

The Red Power Led indicates power is applied to the module.

A Green Led initially flashes the I2C address and then lights for 500mS to indicate correct I2C activity to the module. The internal 500mS timer is restarted each time there is I2C activity, so it will be on during continuous access.

### Automatic Speed regulation

By using feedback from the encoders the MD23 is able to dynamically increase power as required. If the required speed is not being achieved, the MD23 will increase power to the motors until it reaches the desired rate or the motors reach their maximum output. Speed regulation can be turned off in the [command register](#).

### Automatic Motor Timeout

The MD23 will automatically stop the motors if there is no I2C communications within 2 seconds. This is to prevent your robot running wild if the controller fails. The feature can be turned off, if not required. See the [command register](#).

### Controlling the MD23

The MD23 is designed to operate in a standard I2C bus system on addresses from 0xB0 to 0xBE (last bit of address is read/write bit, so even numbers only), with its default address being 0xB0. This is easily changed by removing the Address Jumper or in the software see [Changing the I2C Bus Address](#).

I2C mode allows the MD23 to be connected to popular controllers such as the PICAXE, OOPic and BS2p, and a wide range of micro-controllers like PIC's, AVR's, 8051's etc.

I2C communication protocol with the MD23 module is the same as popular EPROM's such as the 24C04. To read one or more of the MD23 registers, first send a start bit, the module address (0XB0 for example) with the read/write bit low, then the register number you wish to read. This is followed by a repeated start and the module address again with the read/write bit high (0XB1 in this example). You are now able to read one or more registers. The MD23 has 17 registers numbered 0 to 16 as follows;

Register	Name	Read/Write	Description
0	<a href="#">Speed1</a>	R/W	Motor1 speed (mode 0,1) or speed (mode 2,3)
1	<a href="#">Speed2/Turn</a>	R/W	Motor2 speed (mode 0,1) or turn (mode 2,3)
2	<a href="#">Enc1a</a>	Read only	Encoder 1 position, 1st byte (highest byte) and capture count when read
3	<a href="#">Enc1b</a>	Read only	Encoder 1 position, 2nd byte
4	<a href="#">Enc1c</a>	Read only	Encoder 1 position, 3rd byte
5	<a href="#">Enc1d</a>	Read only	Encoder 1 position, 4th (lowest byte)
6	<a href="#">Enc2a</a>	Read only	Encoder 2 position, 1st (highest byte) and capture count when read
7	<a href="#">Enc2b</a>	Read only	Encoder 2 position, 2nd byte
8	<a href="#">Enc2c</a>	Read only	Encoder 2 position, 3rd byte
9	<a href="#">Enc2d</a>	Read only	Encoder 2 position, 4th byte (lowest byte)
10	<a href="#">Battery volts</a>	Read only	The supply battery voltage
11	<a href="#">Motor 1 current</a>	Read only	The current through motor 1
12	<a href="#">Motor 2 current</a>	Read only	The current through motor 2
13	<a href="#">Software Revision</a>	Read only	Software Revision Number
14	<a href="#">Acceleration rate</a>	R/W	Optional Acceleration register
15	<a href="#">Mode</a>	R/W	Mode of operation (see below)
16	<a href="#">Command</a>	R/W	Used for reset of encoder counts and module address changes

### Speed1 Register

Depending on what mode you are in, this register can affect the speed of one motor or both motors. If you are in mode 0 or 1 it will set the speed and direction of motor 1. The larger the number written to this register, the more power is applied to the motor. A mode of 2 or 3 will control the speed and direction of both motors (subject to effect of turn register).

### Speed2/Turn Register

When in mode 0 or 1 this register operates the speed and direction of motor 2. When in mode 2 or 3 Speed2 becomes a Turn register, and any value in this register is combined with the contents of Speed1 to steer the device (see below).

### Turn mode

Turn mode looks at the speed register to decide if the direction is forward or reverse. Then it applies a subtraction or addition of the turn value on either motor.

so if the direction is forward  
 motor speed1 = speed - turn  
 motor speed2 = speed + turn

else the direction is reverse so  
 motor speed1 = speed + turn  
 motor speed2 = speed - turn

If the either motor is not able to achieve the required speed for the turn (beyond the maximum output), then the other motor is automatically changed by the program to meet the required difference.

### Encoder registers

Each motor has its encoder count stored in an array of four bytes, together the bytes form a signed 32 bit number, the encoder count is captured on a read of the highest byte (registers 2, 6) and the subsequent lower bytes will be held until another read of the highest byte takes place. The count is stored with the highest byte in the lowest numbered register. The registers can be zeroed at any time by writing 32 (0x20) to the [command register](#).

### Battery volts

A reading of the voltage of the connected battery is available in this register. It reads as 10 times the voltage (121 for 12.1v).

### Motor 1 and 2 current

A guide reading of the average current through the motor is available in this register. It reads approx ten times the number of Amps (25 at 2.5A).

### Software Revision number

This register contains the revision number of the software in the modules PIC16F873 controller - currently 2 at the time of writing.

### Acceleration Rate

If you require a controlled acceleration period for the attached motors to reach there ultimate speed, the MD23 has a register to provide this using a stepped change every 18ms. It works by using a value into the acceleration register and incrementing the power by that value. Changing between the current speed of the motors and the new speed (from speed 1 and 2 registers). So if the motors were traveling at full speed in the forward direction (255) and were instructed to move at full speed in reverse (0), there would be 255 steps with an acceleration register value of 1, but 128 for a value of 2. The default acceleration value is 5, meaning the speed is changed from full forward to full reverse in 0.92 seconds. The register will accept values of 1 up to 10 which equates to a period of only 0.47 seconds to travel from full speed in one direction to full speed in the opposite direction.

So to calculate the time (in seconds) for the acceleration to complete :

if new speed > current speed

steps = (new speed - current speed) / acceleration register

if new speed < current speed

steps = (current speed - new speed) / acceleration register

time = steps \* 18ms

For example :

Acceleration register	Time/step	Current speed	New speed	Steps	Acceleration time
1	18ms	0	255	255	4.59s
2	18ms	127	255	64	1.152s
3	18ms	80	0	27	0.486s
5 (default)	18ms	0	255	51	0.918s
10	18ms	255	0	26	0.468s

### Mode Register

The mode register selects which mode of operation and I2C data input type the user requires. The options being:

**0,** (Default Setting) If a value of 0 is written to the mode register then the meaning of the speed registers is literal speeds in the range of 0 (Full Reverse) 128 (Stop) 255 (Full Forward).

**1,** Mode 1 is similar to Mode 0, except that the speed registers are interpreted as signed values. The meaning of the speed registers is literal speeds in the range of -128 (Full Reverse) 0 (Stop) 127 (Full Forward).

**2,** Writing a value of 2 to the mode register will make speed1 control both motors speed, and speed2 becomes the turn value. Data is in the range of 0 (Full Reverse) 128 (Stop) 255 (Full Forward).

**3,** Mode 3 is similar to Mode 2, except that the speed registers are interpreted as signed values. Data is in the range of -128 (Full Reverse) 0 (Stop) 127 (Full Forward)

### Command register

Command		Action
Dec	Hex	
32	20	Resets the encoder registers to zero
48	30	Disables automatic speed regulation
49	31	Enables automatic speed regulation (default)
50	32	Disables 2 second timeout of motors (Version 2 onwards only)
51	33	Enables 2 second timeout of motors when no I2C comms (default) (Version 2 onwards only)
160	A0	1st in sequence to change I2C address
170	AA	2nd in sequence to change I2C address
165	A5	3rd in sequence to change I2C address

### Changing the I2C Bus Address

The I2C address can be changed by writing a new address to the MD23, or by fitting/removing the Address Jumper.

To change the I2C address of the MD23 by writing a new address you must have only one module on the bus. Write the 3 sequence commands in the correct order followed by the address. Example; to change the address of an MD23 currently at 0xB0 (the default shipped address) to 0xB4, write the following to address 0xB0; (0xA0, 0xAA, 0xA5, 0xB4 ). These commands must be sent in the correct sequence to change the I2C address, additionally, no other command may be issued in the middle of the sequence. The sequence must be sent to the command register at location 16, which means 4 separate write transactions on the I2C bus. Because of the way the MD23 works internally, there MUST be a delay of at least 5mS between the writing of each of these 4 transactions. When done, you should label the MD23 with its address, however if you do forget, just power it up without sending any commands. The MD23 will flash its address out on the green communication LED. One long flash followed by a number of shorter flashes indicating its address. Any command sent to the MD23 during this period will still be received and writing new speeds or a write to the command register will terminate the flashing.

Address		Long Flash	Short Flashes
Decimal	Hex		
176	B0	1	0
178	B2	1	1
180	B4	1	2
182	B6	1	3

184	B8	1	4
186	BA	1	5
188	BC	1	6
190	BE	1	7

Take care not to set more than one MD23 to the same address, there will be a bus collision and very unpredictable results.

**Address Jumper**

The I2C address can also be changed by fitting/removing the Address Jumper. With the jumper in place (factory default) the address is the same as programmed into the module (factory default is 0xB0). Removing the jumper will change the address to the next one up. The default address of 0xB0 will change to 0xB2 if the jumper is removed. 0xBA would change to 0xBC. The exception is 0xBE, the jumper has no effect on this address. After fitting or removing the Address Jumper, the MD23's I2C address will not change until the next time the module is powered on.

**Schematics**

The MD23 schematics: [Sheet1](#) [Sheet2](#)

**Mechanical**

