
User guide for DC motor interface

... located at "Real-time lab"

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FACULTY OF ...

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1 Introduction

This document describes the features and limitations of the DC motor interface-box (shown in figure 1) located at "Real-time lab" at NTNU¹. The DC motor interface-box is meant to be an easy and safe way for students to control and monitor a DC motor at the laboratory.

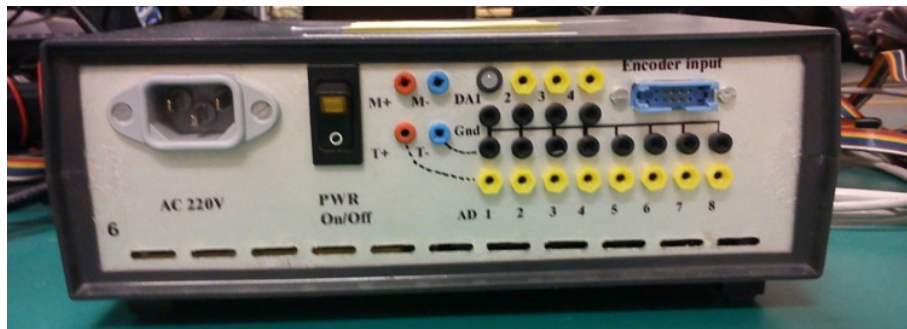


Figure 1: The DC motor interface-box described by this document.

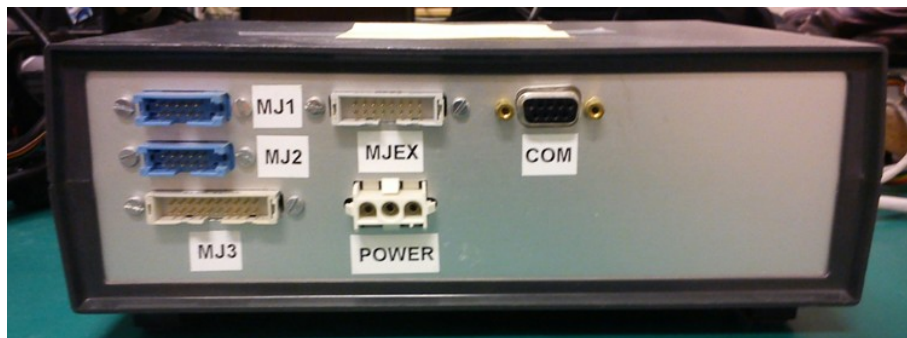


Figure 2: The backside of the DC motor interface-box described by this document.

¹Norwegian University of Science and Technology

2 General

2.1 Power

The box requires a connection for power to a $\sim 220V, 50Hz$ outlet through the connector POWER (as shown in figure 1). The power switch (SWITCH) is connected between the power connector and the power supply unit inside the box. The DC motor interface-box will start operation immediately when the power is connected. At start-up the internal speaker will beep twice. The RGB-LED² located at the front of the box, will be steady green when normal operation is achieved. If this does not occur, please see section 5 for troubleshooting.

2.2 Motor

The motor that is supposed to be controlled by the box, has to be connected to the MOTOR-pins (M+/M-) in figure 1. These pins are internally connected to a motor controller-IC³, and have protective diodes connected to shield the motor controller from transients from the motor. Inter-changing the motor cables will only serve to reverse the direction of the motor, and will not cause any hazards for the motor controller. The motor controller is internally connected to a microcontroller⁴, which transforms the user input to the necessary signals the motor controller needs for correct operation.

2.3 Encoder

The box can automatically read an encoder connected to the DC motor. The connector ENC in figure 1 shows the arrangement of signals required by the box to achieve this. These signals are interpreted by the internal microcontroller, which keeps the results in a 16-bit counter. The count will start at zero, and can hold both positive and negative numbers (positive numbers represents positive direction, negative numbers represents negative direction). Please see section 3.3 on how to use the encoder.

²Red/Green/Blue Light Emitting Diode, capable of simulating most colors

³Integrated Circuit

⁴Single-chip computer

2.4 User-interface

2.4.1 Status LED

There is an RGB-LED located at the front of the box. This LED works as a status indicator, and should be steady green during normal operation. Please see section 5 for further information.

2.4.2 Speaker

The box contains a piezo-speaker. On start-up it should beep twice to confirm operation. Please see section 5 for further information.

2.4.3 Connectors

The panels of the box is populated with various connectors to interface to the box (see appendix A). These allow setting speed, direction and braking⁵ for the connected motor. Furthermore, it is possible to control and read the output of the encoder counter. See section 3 for complete description.

2.4.4 Console terminal

The user has the option of interfacing to the box through RS-232 on the 9-pin connector marked COM. This serves a simple terminal connection to gain access to debug information from the box. The box uses a baud rate of 115200bps, 8 data bytes, no parity and 1 stop bit. See section 4 for complete description.

⁵Braking is acheived by short-circuiting the two motor-pins

3 Interfacing

All the connectors referred to in this section is located on the back of the DC motor interface-box, as shown in figure 3 in appendix A. The connector MJ1 contains only input pins (and one ground/common pin) and are all control signals. MJ2 contains only output pins (and one ground/common pin) and is the output from the encoder counter. MJEX contains an analog input pin and common/ground.

3.1 Electrical characteristics

All pins operate at a 5V level. The input pins are somewhat protected and can tolerate up to +20V and to some extent negative voltages down to -5V. An alarm will alert when the user has connected a too high voltage to a pin (above ~ 6V). The output pins are protected against short-circuits and applied voltages. An alarm will alert when one of these conditions are detected.

3.2 Controlling the motor

To be able to control a motor, it must be connected as described in section 2.2. Table 2 in appendix A shows a simple explanation of the control pins. The pinout is also shown in appendix A.

The motor is enabled by setting pin EN of MJ1, selecting direction with pin DIR of MJ1 and providing an analog value between 0V and 5V on pin DA1 of MJEX to control the output voltage to the motor. The direction the motor will rotate is depending on pin DIR of MJ1 and how the motor is connected to the motor box.

3.3 Using the encoder

If an encoder is connected to the ENCODER connector, the movement of the motor will result in an increase or decrease of an internal 16-bit counter. This 16-bit counter uses two's complement form to represent negative numbers. The counter is set to 0 when the !RST pin of MJ1 is low. To use the encoder as an indication of how much the motor has

rotated, the !RST pin must be set to high. Then the !OE pin of MJ1 should be driven low to allow the counter to appear on MJ2. The SEL pin of MJ1 selects if the high (0) or low (1) byte of the counter should be put on the pins. Notice the bit positions on the output of MJ2.

Normal procedure of reading the encoder:

- Set !OE low to enable output of encoder
- Set SEL low to get high byte
- Wait about 20 microseconds
- Read MSB
- Set SEL high to get low byte
- Wait about 20 microseconds
- Read LSB
- Toggle !RST to reset encoder
- Set !OE high to disable output of encoder
- Process received data....

4 Console terminal

The console is accessible by connecting to the COM-port. The COM-port has to be configured with baud rate 115200, 8 bits, 1 stop bit and no parity. It is best viewed using putty with the translation CP437. Table 1 shows available commands. All parameters are 8 bit values (0-255).

Command	Parameters	Usage	Comment
alarmset	3	""alarmset 1 1 0""	Set alarms on/off
alarmget	0	""alarmget""	Get alarm status
clear	0	""clear""	Clear screen
credits	0	""credits""	Show credits
diagnose	0	""diagnose""	Launch diagnose utility
down	2	""down 255 100""	Motor down, forcing (0-255),ms/2
help	0	""help""	Show list of commands
move	1	""move 255""	Move motor arrow keys, forcing (0-255)
readadc	0	""readadc""	Show current ADC value
readencoder	0	""readencoder""	Show current encoder value
regulator	0	""regulator""	Start regulator
reset	0	""reset""	Reset alarms and volume
up	2	""up 255 100""	Motor up, forcing (0-255),ms/2
volumeget	0	""volumeget""	Get volume
volumeset	1	""volumeset 255""	Set volume,volume (0-255)

Table 1: Describes commands.

The most useful command is diagnose. This command launches a utility that will show the values of the ports MJ1 and MJ2, and the encoder and input voltage (0V-5V -> 0-1023). The motor box will leave the diagnose utility by pressing CTRL+C.

5 Troubleshooting

The motor box will display its status to the user using the RGB-LED and the internal buzzer.

During boot the motor box will beep twice and a steady green light should indicate it is in normal mode. Check the power connection and on/off switch if this does not happen. Also try reconnecting the power.

The buzzer will beep constantly and the LED will be red when over-voltage has been detected on the inputs, a short-circuit of the outputs has been detected or the outputs are driven externally. Check the connections if this happens.

The LED will be blue when another mode has been entered through the console. This means that the normal control inputs on MJ1 are no longer used. This mode is entered by the commands `diagnose`, `move`, `up`, `down` and `regulator`.

Appendix

A Connectors

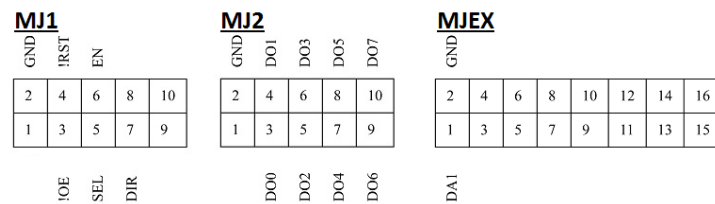


Figure 3: Connectors on the back of the motor box

Connector	Pin	Name	Comment
MJ1	2	Gnd	Common ground
MJ1	3	!OE	Active low output enable of encoder
MJ1	4	!RST	Active low reset of encoder
MJ1	5	SEL	Select Hi/Lo byte of encoder
MJ1	6	EN	Enables motor
MJ1	7	DIR	Sets the direction

Table 2: Describes motor connections.

Connector	Pin	Name	Comment
MJ2	2	Gnd	Common ground
MJ2	3 – 10	DO0-7	Output 0-7

Table 3: Describes motor connections.

Connector	Pin	Name	Comment
MJEX	1	DA1	Analog input
MJEX	2	Gnd	Common ground

Table 4: Describes motor connections.