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Electronic

Design

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Advanced Bipolar Stepper Motor Controller

ESMC-04

Description

Easy to use 2 AMP stepper motor controller.
Bipolar output works with 4,6 and 8 lead hybrid stepper motors.
Microstep selectable by DIPswitch. Step size full, 1/2, 1/4 1/8th step.
On-board clock with adjustable frequency..
Programmable number of steps clockwise and anti-clockwise.
Simple pushbutton operation.
Direct inputs to stepper controller allows easy interface to external microcontroller.
DIP switch mode selection.
Operating voltage:7.5V to 24V DC.
Added schottky diodes for extra reliability and performance.
Ideal for robotic control and automation uses.
Thermal protection.
3.5mm mounting holes
Small size: L=78, W=46, H=15 mm

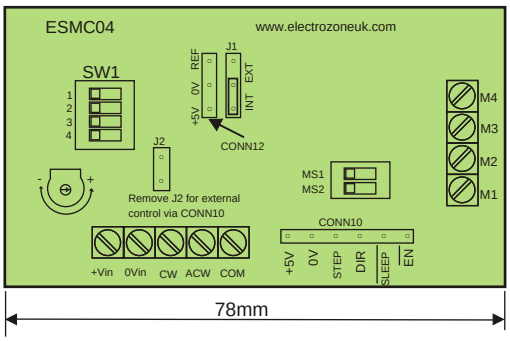
Specification

Max motor current	2 Amps
Operating voltage	7.5V to 24V DC
Max step frequency	500kHz
Min internal clock freq.	200Hz*
Max internal clock freq.	4.3kHz*
Standby current	13mA

*+-10%

Connections

Pin	Description
+V	Positive supply voltage input
0V	Supply input GND
CW	Clockwise input control
ACW	Anti-clockwise input control
COM	Switch input common. (0V)
M1	Motor coil A1
M2	Motor coil A2
M3	Motor coil B1
M4	Motor coil B2
CONN12/J1	External I trip reference
CONN10/J2	External control I/F



Height=16mm

Overview

The ESMC-04 operates in 3 main modes;

Mode1.
Simple pushbutton. In this mode, the controller turns the motor clockwise or anti-clockwise in response to the switch inputs at a step speed set by the on-board clock (VR1).
In mode 1, you can select single step or continuous operation via SW1 DIP switch 4.

Mode 2.
Programmed operation. In this mode, the controller turns the motor clockwise or anti-clockwise by a pre-programmed number of steps.

In mode 1 and 2, the step frequency has an internally adjustable clock of approximately 200Hz to 4.3kHz
A no-overshoot mode is selectable in which the motor will not step beyond the limits for programmed operation.
When setting up programmed operation, single step mode can be selected to allow programming of a precise number of steps.

DIP switch 1 settings*
switch 1 = program the number of steps (ON = setup)
switch 2 = pushbutton or programmed operation (ON = programmed OFF= pushbutton)
switch 3 = no overshoot mode (ON = no overshoot) (only applicable to mode 2)
switch 4 = single step mode (ON= single step) (applicable to mode 1 and setup for mode 2)

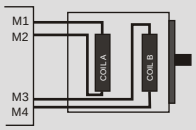
*DIP switch 1 switches must be set before powering up the PCB for the modes to operate.

DIP switch 2 settings (step size)
1=OFF 2=OFF : Full step
1=ON 2=OFF: Half step
1=OFF 2=ON : Quarter step
1=ON 2=ON :eighth step (Both switches to the right)

Mode 3.
Direct interfacing to the stepper motor controller IC.
This mode allows the user to control the stepper motor controller IC directly using +5v logic signals for STEP, DIRECTION, SLEEP and ENABLE.
To use mode 3, the link J2 must be removed before power up, this disables the on-board microcontroller.
Conn 10 has a 50mA (max) low power output to drive (for example) a microcontroller circuit.

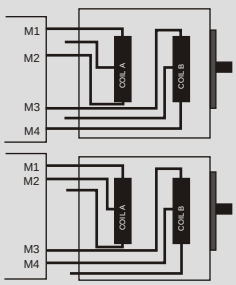
Connecting a 4 wire stepper motor

Follow the diagram on the right to see how to connect the two coils of a 4 wire stepper motor to the motor outputs of the PCB.
To find out which wires are coils A and B, simply measure the resistance between the wires. You will find that there is a low resistance between the ends of each coil.



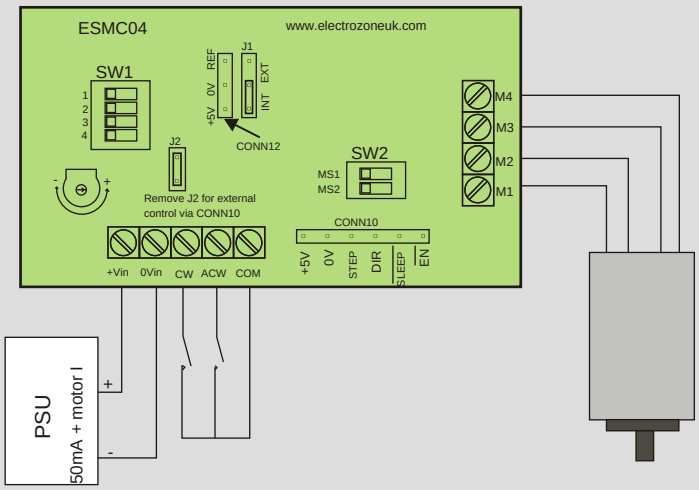
Connecting a 6 wire stepper motor

A 6 wire stepper motor can be connected using the wires from either end of the coil as shown above right, or by using the connection from the centre of the coils as shown below right.
An 8 wire motor can be connected with the coils either in series or parallel depending upon the motor coil resistance.



Pushbutton operation (mode 1)

To select pushbutton mode, place all DIP switch 1 switches into the OFF position before powering the PCB. (all switches left)
In this mode, the motor simply turns continuously clockwise or anti-clockwise while the CW or ACW switch inputs are connected to COM (internally connected to 0V). If the single step (DIP switch 4) switch is set to ON, then the motor will only move by a single step with each switch press. Single step mode should only be used with full step mode as the motor coils are switched off following each step.



The diagram on the left shows the PCB connected to a 4 wire motor with normally open switches connected for clockwise and anti-clockwise movement.

The SW1 DIP switches are all set to OFF which means that the PCB acts as a simple pushbutton motor controller.

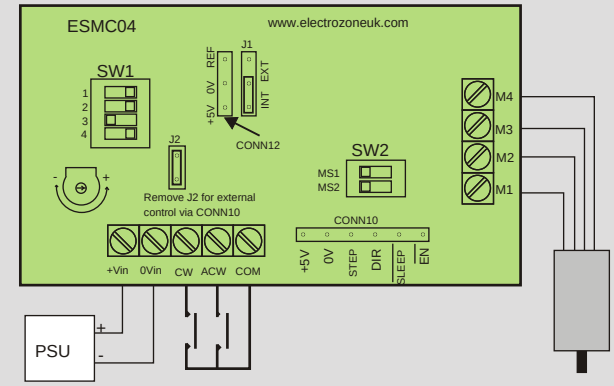
The SW2 DIP switches (micro-stepping select) are shown set to 1/8. therefore, if a motor with 200 steps per revolution (1.8 degree per step) is connected, then the motor will turn 1600 steps through a complete revolution.

DIP switch 2 can be changed while the PCB is powered. The internal clock changes the step speed, therefore the motor will change its speed according to the DIP switch 2 settings. ie the motor will turn 8 times faster in full step mode than in 1/8 step mode.

Programmed operation (mode 2)

Programming of the module allows you to set the number of steps following a trigger while in programmed operation, (mode 2).
Program the number of steps as follows;
1) Switch off power to the PCB
2) Set SW1 DIP switch 1 and 2 to ON (right)
3) Power up the PCB
4) Press the CW switch and hold down to see the motor turn clockwise, you can release the switch and re-press until the motor reaches the required position
5) When the motor has rotated the to the position needed, release the switch.
6) You can now program the number of steps anti-clockwise in the same way, or do not press the ACW switch for the PCB to automatically select the same number of steps for anti-clockwise as clockwise.
7) When you have programmed the required number of steps, switch DIP switch 1 to the OFF position (LEFT) to store the settings into memory.
They will remain in memory after removal of power but can be reprogrammed as many times as required by following the above steps.

Place DIP switch 4 into the ON position before programming to allow programming in single step mode where you have to release the switch after each step which allows precise programming of the number of steps.



Example:

The diagram on the left shows the PCB set up for programmed operation in single step mode with overrun allowed.

After applying power, press the switch connected to CW. Each press will advance the motor 1 step. When finished, press the ACW switch the required number of steps for the other direction. Or do not press the switch connected to ACW to set the same amount of steps for both directions.
When programming is complete, set SW1 DIP switch 1 into the OFF position to store the settings.
Pr ess the CW switch and the motor will step as programmed and then stop and wait for the next press of the CW or ACW switch.

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External control (Mode 3)

This mode allows the user to directly control the stepper motor driver IC through an external interface.
The control lines for STEP, DIRECTION, SLEEP and ENABLE are found on CONN10 along with +5V and 0V.
Below is a description of the control lines;

Step input (STEP)
A low to high transition advances the motor by one increment, with the size of the step depending on the state of the SW2 switches.

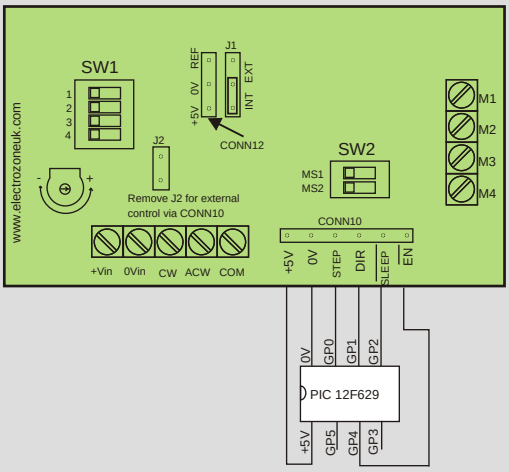
Direction input (DIR)
The state of this logic input will determine the direction of motor rotation.

Sleep input (SLEEP)
A logic LOW on this input shuts down much of the internal circuitry including the outputs to minimize the power consumption.
A logic HIGH on this input allows normal operation.

Enable input (EN)
This enable input is active LOW and enables all of the motor outputs. When this is logic HIGH, all of the motor outputs are disabled.
Inputs to the motor controller including STEP, DIR and the microstepping control SW2 are all active independent of the enable input.

J2 Jumper link for external control select
J2 must be removed before applying power if external control (mode 3) is to be used.
If mode 3 is to be used and it J2 is not removed before applying power, damage could result.

Parameter	Min	Max
Minimum STEP pulse width	1uS	
Minimum STEP low time	1uS	
Maximum STEP frequency		500Khz
Logic LOW	0V	1.5V
Logic HIGH	3.5V	5V
Wake up time after SLEEP		1mS
+5V output current		50mA

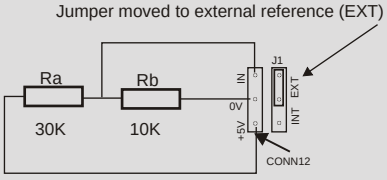


The diagram on the left shows how easily the ESMC-04 can be connected to a microcontroller.
In this case, the I/O ports of a PIC12F629 have been used to control STEP, DIR, SLEEP and ENABLE. The +5V output from CONN10 powers the microcontroller and no other circuitry is required.
Using this method, the microcontroller can be used to incorporate complex sequencing quickly and easily.
GP3 and GP5 are left unused and can be connected to trigger inputs.

*Note: The Jumper (J2) has been removed to allow external control.

External current limiting

Jumper link (J1) allows selection of internal (INT) or external (EXT) current limiting.
Connector (CONN12) allows the user to set up an external current limiting reference.
The internal current limit is set at 1152mA. The external current limit input (Vref) is connected to IN of CONN12.
The equation for external current limiting is Itrip=Vref/1.76
Reference input Impedance is approximately 160K ohms.



The diagram on the left shows an external current limit reference connected to CONN12
Observe J1 in the external position (EXT).
Vref = (Rb/(Ra+Rb)) x 5
Vref = 1.25V
Therefore: Itripmax = 1.25/1.76 = 710mA

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Additional notes

Power supply:
Always ensure the power supply is connected the correct way around before applying power.
The power supply must be capable of providing the required current for the motor and the PCB combined.
If the power supply is unstable, microstepping may not work reliably.

Microstepping:
The ESMC-04 uses the latest microstepping driver technology, but for it to work perfectly, you must ensure that the power supply is stable and preferably regulated.
While the motor is powered, you may hear a high-pitched sound coming from the motor even when it is not moving. This is perfectly normal.
For some motors, you may need to adjust the motor current control input to enable the motor to move smoothly at all speeds. If the motor appears not to move as smoothly as you would expect, check the power supply and set the current reference to external and adjust until the required result is obtained.

Pushbutton control:
Use good quality normally open switches for connection to the CW and ACW inputs.

Speed:
To obtain the required speed of rotation, you can use different microstepping resolutions to obtain further speed adjustments additional to the on-board pot speed control. Because the on-board pot adjusts the step frequency, the motor will rotate faster at full step than in microstepping modes.