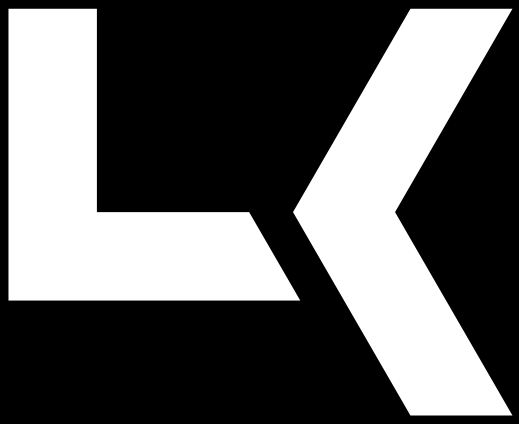

User Manual

Stepper Motor Controller SMC2242/SMC4242

Notices

Edition

January 26, 2016

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Contents

List of Figures

List of Tables

Thank you for purchasing the SMCx242 Stepper Motor Controller. This user manual will explain you how to operate the Stepper Motor Controller. Please take some time to read it carefully before operating the device. Keep the instructions in a safe place for future reference.

1 Introduction

The SMCx242 Stepper Motor Controller is a universal controller for bipolar stepper motors. It can be used to drive two (SMC2242) or four (SMC4242) stepper motors. There are three different firmware version available SMCx242-R for rotary axis, SMCx242-L for linear motion and SMCx242-U which features both options.

1.1 Package contents

Please check that the package contains all the following items:

- SMCx242 Stepper Motor Controller
- Power supply cable
- USB cable
- User Manual

1.2 Installing the device

The Stepper Motor Controller is designed for the inside use. Therefore it should not be used outside and kept away from water and moisture. Do not operate the unit near any heat sources or in direct sun light. When installing the device ensure to put it on a flat and leveled surface. Also ensure that there is adequate space around the device for ventilation.
After moving the unit to a different location, condensation inside the unit may occur. In this case please wait for some hours before you connect the Stepper Motor Controller to the power supply.
Connect the device only to power sources that meet the specifications written on its rear panel.

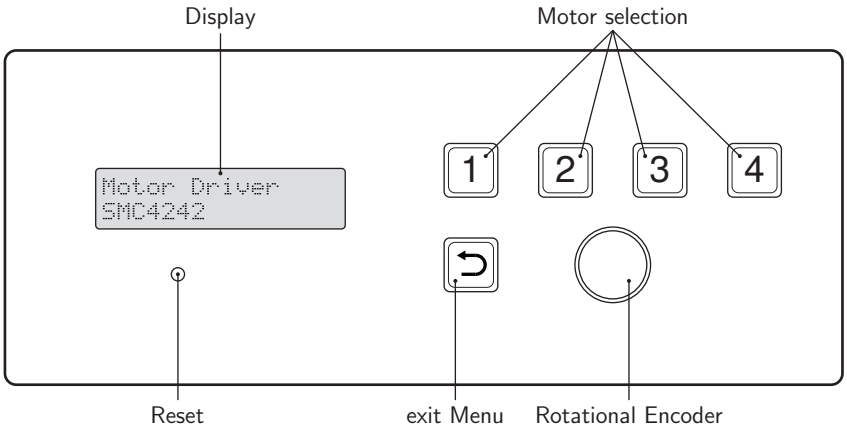


Figure 1.1: Front view of the SMCx242 Stepper Motor Controller.

2 Basic setup

3 General Operation

The SMCx242 Stepper Motor Controller features two operation modes. It can be either operated using the manual user interface or remote controlled by a computer. In this section the manual operation of the device is explained.

After turning on the Stepper Motor Controller it comes up with its start screen. Turning the rotary encoder serves to scroll through the menus (see figure 3.1). Pressing the rotary encoder enters the selected menu. Pressing the menu-escape-button leaves the menu again.

3.1 Display structure

In almost every menu four values are displayed. Depending on the previously selected menu the values correspond to different quantities. Where

- the upper left value accompanies to Motor 1
- the upper right value accompanies to Motor 2
- the lower left value accompanies to Motor 3
- the lower right value accompanies to Motor 4

3.2 Motor selection

To select a motor there are four buttons. Motor selection can solely be done in an entered menu. To select a motor, press the respective motor-selection button. A selected motor is signed with an arrow on the display. Pressing the selection-button again deselects the motor. Once a motor is selected its appropriate value can be changed by turning the rotary encoder. By leaving a menu without motor deselection the selected motor(s) stay selected in any other menu.

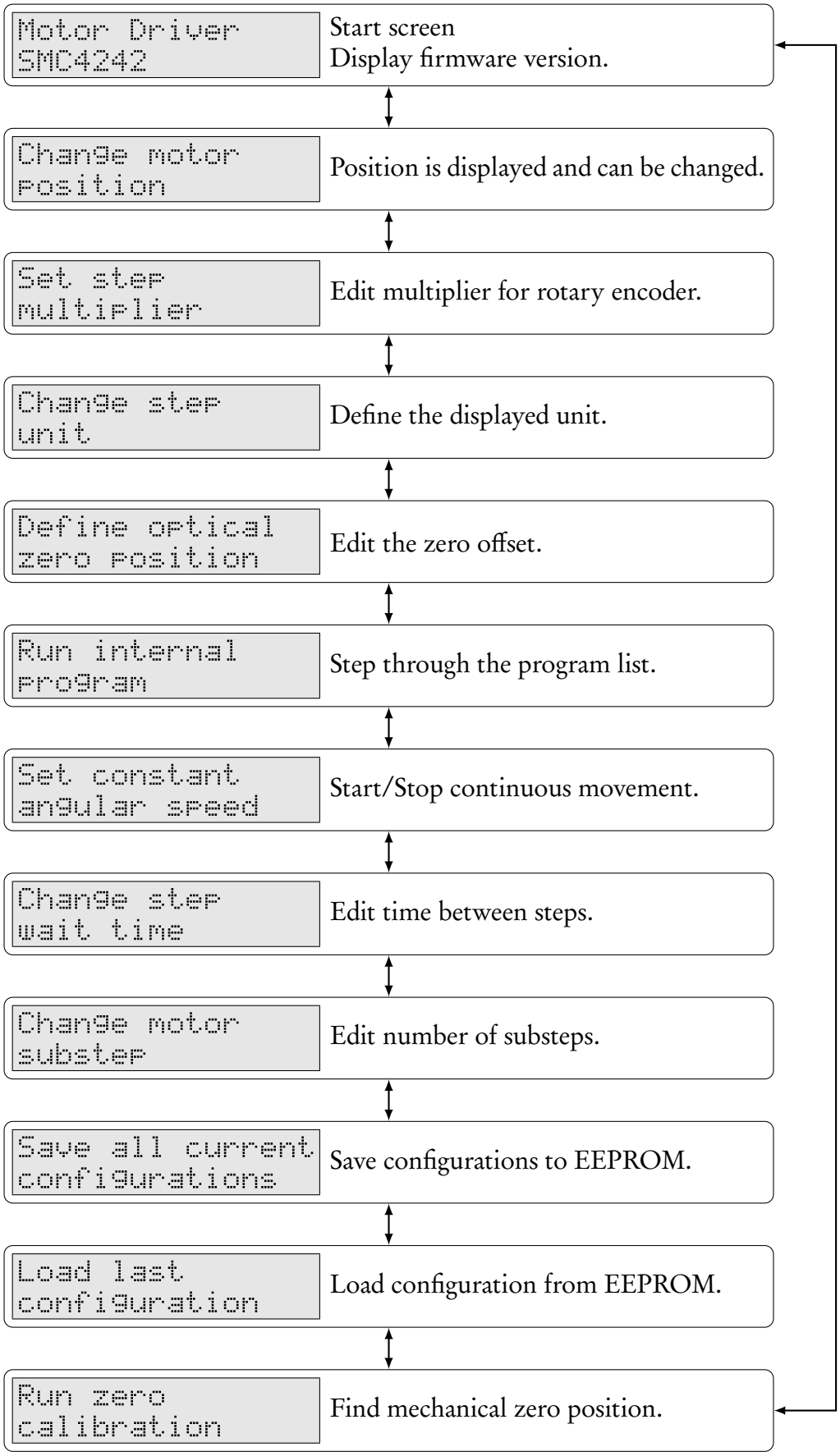


Figure 3.1: Overview of the available menus. By turning the rotary button one can navigate through the menus as indicated by the arrows.

3.3 Start screen

By pressing the rotary button while the start screen is active the firmware version will be displayed.

Firmware updates are available at `http://www.lk-instruments.com` on the corresponding product website.

3.4 Motor position

This menu displays the current motor positions. The position of any motor can be changed by the operator separately. The default display unit is degree, which can be changed to the users preferred unit, see 3.6. The position of a selected motor can be changed by turning the rotary button. Default steps for the available units are:

- 1° if unit is degree
- $\frac{\pi}{8}$ if unit is radian
- 1 step if unit is steps

Fast moving mode When pressing the rotary button inside the change-motor-position-menu one enters the fast moving mode. Pressing the rotary button again disables the fast moving mode. The fast moving mode is indicated by another marking arrow for the corresponding motor. The fast moving mode will only be enabled or disabled for selected motors. Default steps in this mode are:

- 10° if unit is degree
- $\frac{\pi}{8}$ if unit is radian
- 100 steps if unit is steps

The snapped display shows the different indicating arrows. Here, motor 1 and motor 3 are in fast moving mode, motor 2 and 4 are in normal moving mode.

3.5 Step multiplier

Step multipliers give the possibility to let the motors move in different step widths by turning the rotary button one click. It is also possible to turn the motors in different directions by applying a negative step multiplier to a motor.

A step multiplier can only be applied if the step unit is degree or radians. The factory default value for all motors is 1.0.

In this menu one can adjust a step multiplier. The step multiplier is applied if the step unit is degree or radian. The standard value is 1.0. If the step multiplier differs from 1.0 the corresponding motor will rotate more or less steps with each rotation of the rotary encoder.
For example: if the step multiplier for motor 0 is 1.0 and the step multiplier for motor 2 is 4.0, motor 2 will move four times more steps than motor 0 when changing the motors positions. Negative values are allowed as well. This will result in counter direction movements.

3.6 Step unit

In this menu one can choose the unit of the displayed position. There are three possible choices for each motor:

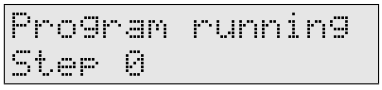
- degree
- radian
- step

3.7 Optical zero position

In this menu one can define the optical zero position. This is necessary due to a mostly unknown placement of the optical element mounted to the motor. Here one can once adjust the desired optical zero position manually. The optical zero position is always defined in steps. In this menu there is also a fast mode available (please refer to 3.4 for details about the fast mode). After adjustment it is recommended to save this configuration (see 3.12). When performing a zero calibration, as explained in 3.14, the zero position will be the defined optical zero position.

3.8 Internal programs

This menu allows the user to step through the internal program list with the rotary button. This function is only available if a program has previously been defined (see 4.2). Internal programs are also saved to the device when the current configuration is saved, see 3.12.



3.9 Constant angular movement

Here the motors can be set into an infinite moving state in clockwise (CW) or counter clockwise (CCW) direction. To get the motors moving with different velocities one needs to change the wait times between two steps (see 3.10). STOP means that the motor is not moving. Constant angular speed for a certain motor can not be activated if a forbidden zone is configured to this motor (see 3.15).

3.10 Step wait time

Here the wait time between two steps can be changed. This results in faster or slower motor movements. The default value is 3 milliseconds. We do not recommend to use shorter wait times as 3 milliseconds.

3.11 Motor substeps

In this menu one can change the motor substeps. Possible values are 1, 2, 4, 8, 16 or 32.

This adjustments result in a finer angular resolution. Values above 16 are not recommended.

Microsteps per full step	Holding torque per microstep
1	100 %
2	70.7 %
4	38.3 %
8	19.5 %
16	9.8 %
32	4.9 %

Table 3.1: Decrease of motor holding torque in dependence of the number of adjusted microsteps.

A note on microstepping. When increasing the the number of microsteps per full step the incremental torque per microstep decreases heavily. The expression for calculating the incremental tourque τ_{inc} is

$$\tau_{\text{inc}} = \tau_{\text{H}} \cdot \sin\left(\frac{90}{\mu}\right),$$

where τ_{H} is the holding torque per full step (without microstepping) and μ is the number of microsteps per full step.
The incremental torque τ_{N} for N microsteps is

$$\tau_{\text{N}} = \tau_{\text{H}} \cdot \sin\left(\frac{90 \cdot N}{\mu}\right).$$

So, the holding torque per microstep decreases as shown in table 3.1.

3.12 Save current configuration

To save the current Stepper Motor Controller configurations enter this menu and turn the rotary encoder in any direction. The menu will be automatically leaved when saving is finished.
Note, that always the configurations for all motors will be saved. It is not possible to save the configuration for a single motor.

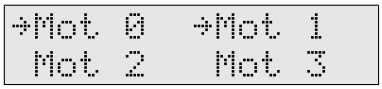
3.13 Load configuration

To load the last saved Stepper Motor Controller configurations enter this menu and turn the rotary encoder in any direction. The menu will be leaved automatically when loading has finished.

Note: The last saved configuration is loaded automatically when powering on the Stepper Motor Controller.
Note: There is just one memory space for a configuration.

3.14 Zero calibration

Here one can calibrate the motor zero position for each motor. To perform a zero calibration select the motors to be calibrated and turn the rotary encoder. Note, that during zero calibration no actions can be done on the device, even serial commands will not be accepted. The zero calibration will automatically deselect a motor when its calibration is finished. The zero calibration menu will be automatically leaved when calibration is finished.



3.15 Forbidden zones

3.16 Positioning procedures

4 Remote Programming

4.1 Communication Settings

In order to remote control the Stepper Motor Controller from a computer, it needs to be connected to the computer via the USB cable. The Stepper Motor Controller will show up as a new Virtual COM Port (VCP). In some cases it might be necessary to install some drivers, which can be found at

`http://www.lk-instruments.com/smc_software.html`

Once the Virtual COM Port has been installed successfully, the Stepper Motor Controller can be controlled by sending commands via a serial terminal. A list of all available commands can be found in section 4.2. The serial terminal needs to be configured as

- 57600 Baud
- 8 bit character size
- no parity bit
- 1 stop bit
- no flow control

4.2 Instruction set

The Stepper Motor Controller has the following commands which can be used. Note, that the command parser is case sensitive. The command parameters, denoted by `<xxx>`, must be separated by either `SPACE` or "," or ";" or `TAB`. The command is completed by sending a Carriage Return + Line Feed (`CRLF`) or Line Feed (`LF`).

Command:	`*RST`
Function:	Resets the Stepper Motor Controller to the initial state.
Example:	`*RST`

Command:	`*IDN?`
Function:	Returnes the identification name of the Stepper Motor Controller.
Example:	`*IDN?`

Command: `GETMOTSTATE <mot>`
Function: Returns whether motor `<mot>` is turned on or off.
Example: `GETMOTSTATE 3`
Returns 1 if motor 3 is turned on or 0 if motor 3 is turned off.

Command: `MOVEABS <mot> <pos> <unit>`
Function: Moves motor `<mot>` to the absolute position `<pos> <unit>`.
The units can be steps, degree or radians.
Note: The unit must be written in lower case letters.
Example:
```
MOVEABS 1 0 deg
MOVEABS 1 0 pi
MOVEABS 1 0 steps
```
The examples do the same in different units.

Command: `MOVEREL <mot> <pos> <unit>`
Function: Moves motor `<mot>`relative to the current position. The units can be steps, degree or radians.
Note: The unit must be written in lower case letters.
Example:
```
MOVEREL 2 22.5 deg
MOVEREL 2 0.125 pi
```
Both examples do the same in different units.

Command: `ZERORUN <mot>`
Function: Finds the mechanical zero position of the motor.
Note: During motor zero run no communication or usage of the Stepper Motor Controller is allowed.
Example: `ZERORUN 1`
Finds the mechanical zero position of motor 1.

Command: `ENABLE <mot> <on/off>`
Function: Turns motor `<mot>` on (1) or off (0).
Note: Both for enabeling and disabeling of a motor the same command is used.
Example: `ENABLE 2 1`
Turns motor 2 on.
`ENABLE 3 0`
Turns motor 3 off.

Command: `GETPOS <mot> <unit>`
Function: Returns the actual motor position in the given unit.
Example: `GETPOS 1 deg`
Returns the current position of motor 1 in degree.

Command: `SAVECONF`
Function: Saves all current configurations for all motors.
Note: The driver configuration is stored in an EEPROM. Maximum write cycles are 100000.
Example: `SAVECONF`

Command: `LOADCONF`
Function: Loads all saved configurations for all motors.
Example: `LOADCONF`

Command: `GETOPTZEROPOS <mot>`
Function: Returns the optical zero position of motor `<mot>`.
Note: Optical zero positions are only available in steps.
Example: `GETOPTZEROPOS 3`
Returns the optical zero position of motor 3.

Command: `SETOPTZEROPOS <mot>`
Function: Set the optical zero position for motor `<mot>`.
Note: For the optical zero position the unit is always steps.
Example: `SETOPTZEROPOS 3 574`
Sets the optical zero position of motor 3 to 574 steps.

Command: `GETWAITTIME <mot>`
Function: Returns the wait time between two steps of a motor.
Example: `GETWAITTIME 0`
Returns the wait time between two steps of motor 0.

Command: `SETWAITTIME <mot> <time>`
Function: Sets the wait time between two steps to `<time>` milliseconds for motor `<mot>`
Note: The wait time must be an integer. The unit for the wait time is always milliseconds.
Example: `SETWAITTIME 1 5`
Sets the wait time of motor 1 to 5 milliseconds.

Command: `STOPALL`
Function: Stops all motor movements immediately.
Example: `STOPALL`

Command: `FACTORYRESET`
Function: Resets the Stepper Motor Controller to factory state.
Example: `FACTORYRESET`

Command: `ISMOVING <mot>`
Function: Returns the motor moving state.
1: motor `<mot>` is moving.
0: motor `<mot>` doesn't move.
Example: `ISMOVING 0`

Command: `SETCONSTSPEED <mot> <dir> <time>`
Function: Enables motor `<mot>` to move infinite in direction `<dir>`. Possible values for `<dir>` are clock wise `CW` or counter clock wise `CCW`.
Example: `SETCONSTSPEED 1 CW 10.0`
Moves motor 1 infinite in clockwise direction. One full rotation takes 10 seconds.

Command: `SETFORBZONE <mot> <start> <stop>`
Function: Defines a forbidden zone for motor `<mot>`. The motor will not move into this zone. `<start>` must be always smaller than `<stop>`. The unit for `<start>` and `<stop>` is always steps.
Example: `SETFORBZONE 0 148 1333`
Defines a forbidden zone for motor 0 between step 148 and step 1333.

Command: `ENABFORBZONE <mot> <val>`
Function: Enables `<val=1>` or disables `<val=0>` the defined forbidden zone for motor `<mot>`.
Example: `ENABFORBZONE 0 1`
Enables the forbidden zone for motor 0.
`ENABFORBZONE 3 0`
Disables the forbidden zone for motor 3.

Command: `SETPROGSTEP <step> <M0> <M1> <M2> <M3> <mode>`

Function: Defines an internal program step for all motors. `<step>` is the program sequence number. The position for all motors `<M0...4>` must be given in steps. Mode defines if the movement to an absolute position `<mode=ABS>` or a movement relative to the current position `<mode=REL>`.

Example: `SETPROGSTEP 0 112 294 0 12 ABS`
Defines the program step `0`. Motor `0` moves to 112, motor 1 moves to 294, motor 2 to `0` and motor 3 to 12.
`SETPROGSTEP 1 10 10 -10 -10 REL`
Defines the internal program step 1 so that motor `0` and motor 1 move 10 steps forward and motor 2 and 3 move 10 steps backwards from the current position.

5 Specifications

Table 5.1: Specifications of supported motors.

	SMC2242	SMC4242
Number of Motors:	2	4
Motor Type:	Bipolar Stepper Motor	
Motor Drive Voltage:	24 V	
Motor Current:	up to 2.5 A peak or 1.75 A RMS	

Table 5.2: Features of different versions.

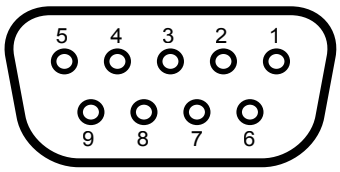
	SMCx242-R	SMCx242-L	S
Units:	°, π, steps	m, cm, mm, steps	°, π, m, cm,
Substeps:	1, 2, 4, 8, 16, 32		
Steps per Revolution:	200, 400		
Gear Ratio:	???		
Reference/Limit Switches:	1	3	

Table 5.3: Technical Specifications.

Power requirements:	?
Power consumption:	W
Dimensions:	245 mm (W) x 85 mm (H) x 260 mm (D)
Weight (without package):	kg

6 Pinout

The connectors for for the stepper motors are 9-Pin D-Type, female connectors. Please refer to figure 6.1 for their pinout.



Pin	Description
1	Bridge B output 1
2	Bridge B output 2
3	Bridge A output 2
4	Bridge A output 1
5	Ground
6	+5 V
7	Reference/Limit Switch 1
8	Reference/Limit Switch 2
9	Reference/Limit Switch 3

Figure 6.1: Pinout of the Motor Connector.