



**SMART MOTOR
DEVICES**

<http://smd.ee>

**PROGRAMMABLE STEP MOTOR
CONTROLLER SMSD-4.2RS-232/RS-485**

Manual
2018

1. Product designation

Programmable step motor controller SMSD-4.2 (the unit) is designed to operate with stepper motor with maximum current per phase up to 4.2 Amp. There are three control modes provided: programmable, manual or simple driver.

2. Functions and possibilities

- Recording the operation algorithm from a computer to EEPROM of the unit as a sequence of ASCII commands.
- Reading the saved algorithm from the EEPROM to a computer;
- In the programmable mode: control the stepper motor as per the program, saved in the unit's memory. Speed, acceleration/deceleration, displacement, direction of the stepper motor are set as a sequence of execution commands and is storage in the non-volatile memory of the unit.
- In the simple driver mode: the unit receives logic signals "PULS" and "DIR" – 0VDC low level and 5-24VDC high level. · In the manual mode: the unit receives analog signal "Speed" (voltage signal 0-5VDC, internal or external potentiometer) and digital signals "Reverse" and "Enable".
- For synchronized operation of several SMSD-4.2 units and other devices there are 3 digital inputs and one output relay are provided. These inputs and output relay are used in the programmable mode.
- Programmable control of the built-in relay.
- The unit can operate and be controlled by a computer or in a standalone mode.
- There is zero positioning function provided: start zero search by a command or by a signal on the digital input. Stop zero searching movement as input signal is received. The function provides homing by an individual input.
- The unit stops motor motion as receives a signal on an "Enable" input.
- The unit changes rotation direction as receives a signal on a "Reverse" input (in the manual and programmable modes).
- The microstepping can be changed on-fly in the manual and programmable modes.

3. Technical Data

Table 1.

Common characteristic:	
Number of controlled stepper motors	1
Maximum output current per phase, Amp	4.2
Minimum output current per phase, Amp	0.2
Microstepping modes	1/1, 1/2, 1/4, 1/16
Pulses frequency in programmable and manual modes, Hz	1 - 10000
Voltage input, VDC	12 – 48
Dimensions, mm no more 120x116x26	120x110x24
Inputs DIR, STEP (simple driver mode):	
High voltage level, VDC	4
(Please, connect current-limiting resistance when use high level voltage, more than 5VDC: 1 KOhm for 12VDC, 2 KOhm for 24VDC)	
Low voltage level, VDC	0-1
Input resistance, KOhm no less	3

Digital inputs EN, Reverse, IN1, IN2:	
Contact to GND	
Communication interface - RS232/485:	
Baud	9600
Bits	8
Parity	even
Stop bit	1
RELAY Output:	
Type of relay - solid state semiconductor	
Maximum voltage at open contacts, V	350
Maximum load current, mA	120
Resistance of closed contacts, Ohm	<30
Additional output «5VDC»:	
Voltage, VDC	5
Maximum load current, mAmp	20
Resistance, Ohm	27

Environmental Conditions:

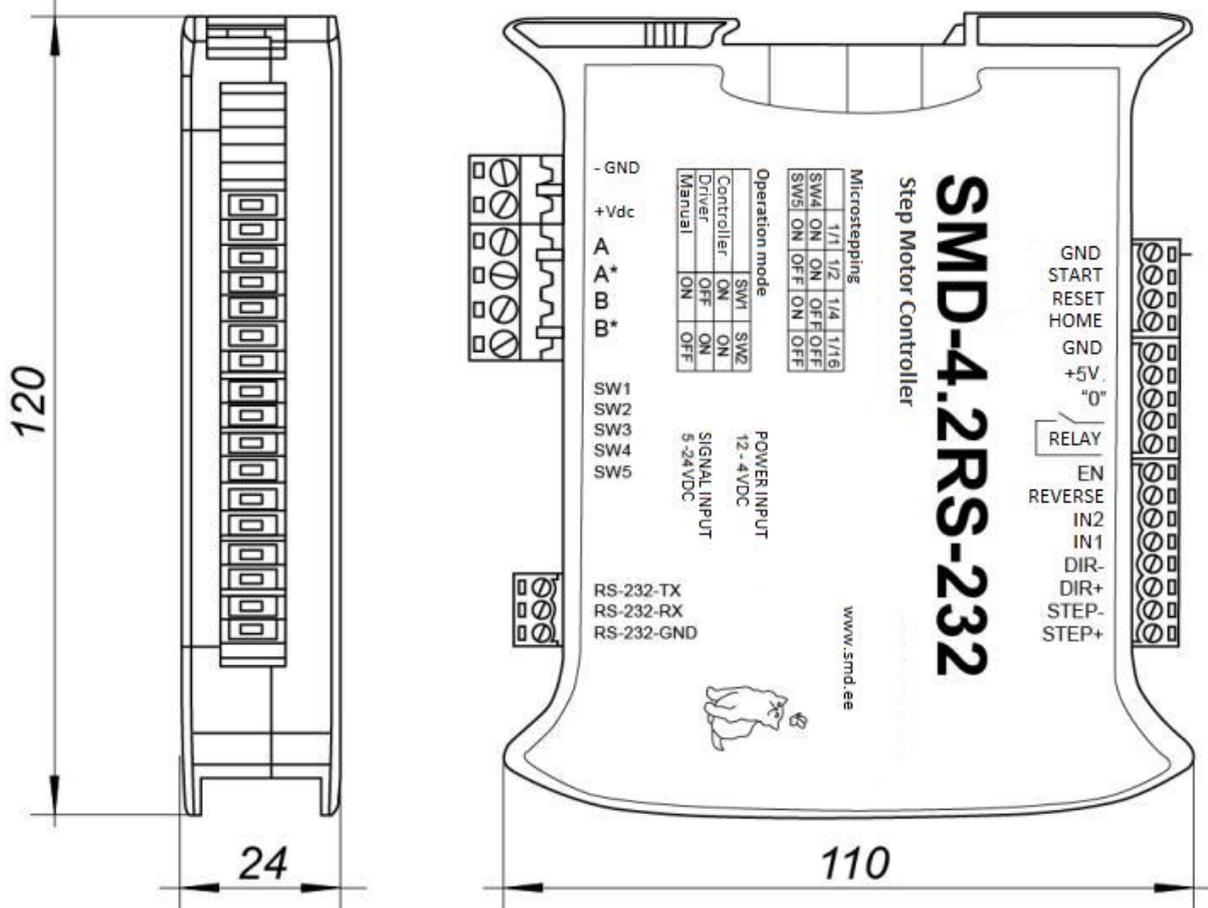
Ambient Temperature: -25...+50°C

Humidity: 90% RH or less upon condition +25°C

Condensation and freezing: none

Pressure: 650...800 mm of mercury

Dimensions:



The SMSD-4.2RS-232 was designed as a circuit board with electronic components, display elements, controls, terminals and connectors located on it. The circuit board is installed in a plastic housing, which is used for mounting on a DIN rail. Graphic images of controls and explanatory inscriptions are printed on the housing surface. Besides electronic components, there are indicating and control elements, connection terminals and connectors on the board:

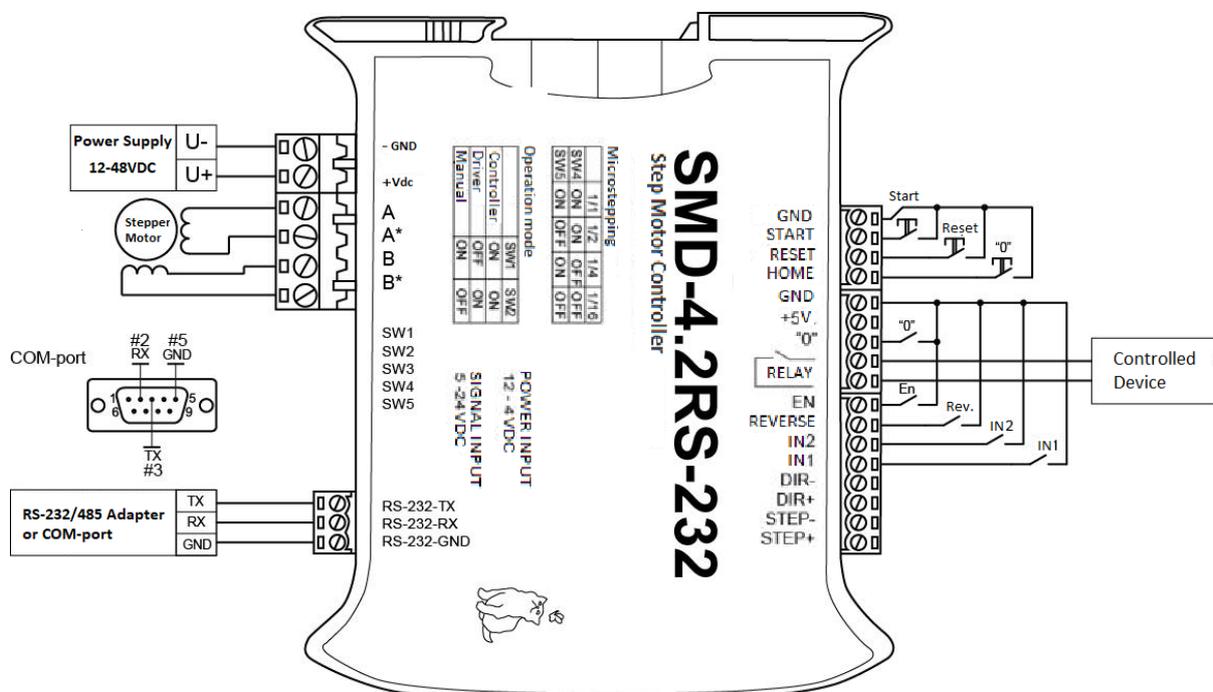
- Terminal screws for power supply, stepper motor windings and control circuit connection;
- USB plug for a computer connection;
- Control buttons “Reset”, “Homing”, “Start”;
- Internal preset potentiometer «V» to adjust speed in the manual mode.;
- LED for indication of the controller status;
- Switches SW1 – SW2 to set the operation mode;
- Switches SW3 – SW5 to set the microstepping mode;
- Internal potentiometer to adjust output current.

5. Assembly and connection

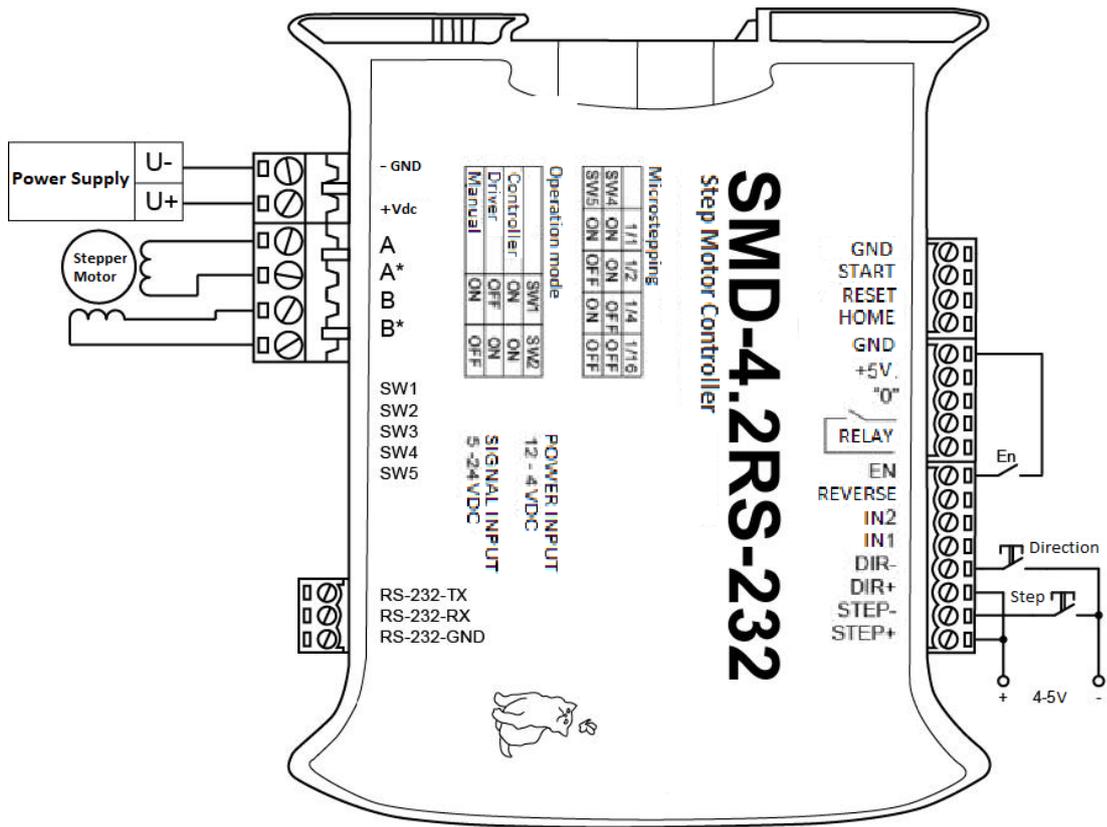
Please, read this manual carefully before connection and assembly.

Please, wire only when power is off. Do not attempt to change wiring while the power is ON. Please, provide a reliable contact in connection terminals. During wiring, please check the polarity and wire management.

Connect the SMSD-4.2 controller with stepper motor, switches and electric DC power supplier according to one of schemes shown on images 2-4.

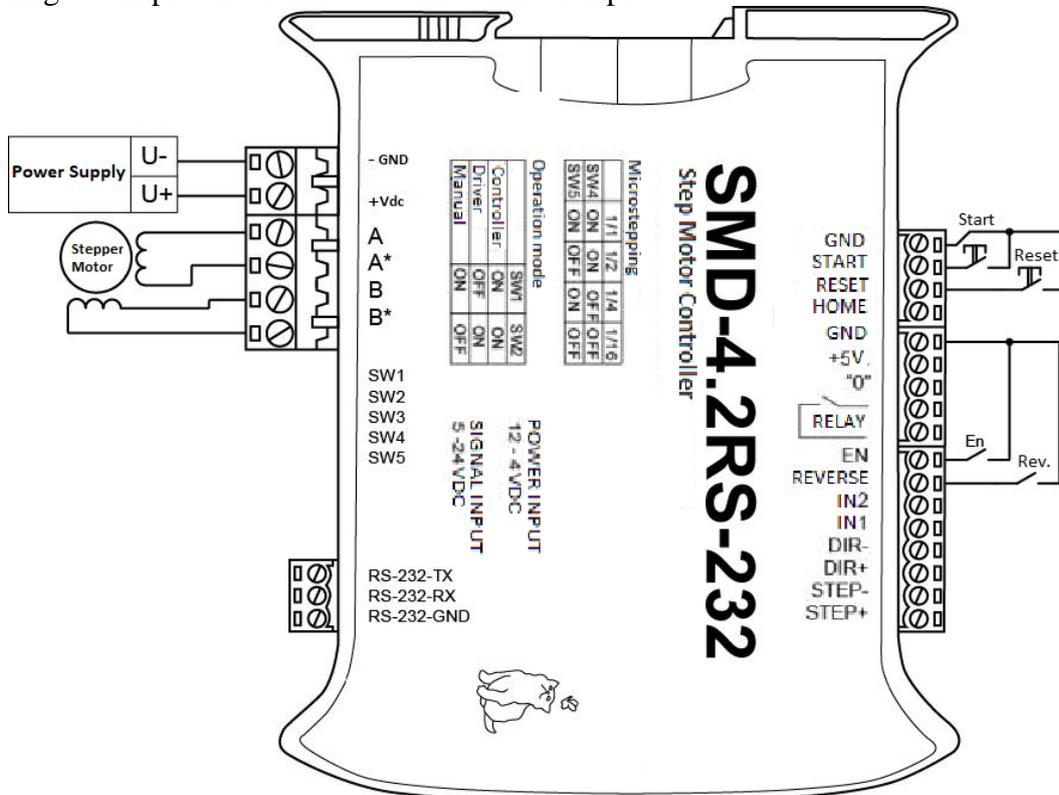


Img.2 Controller mode – connection example

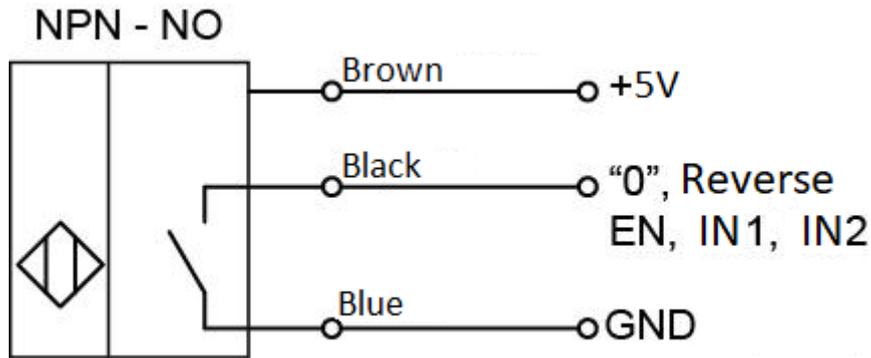


Please connect current-limiting resistance when using high level voltage more than 5VDC. (1 KOhm for 12VDC, 2 KOhm for 24VDC)

Img 3. Simple driver mode – connection example



Img 4. Manual mode – connection example



Img.5 NPN switch connection example

Motor connection

The SMSD-4.2 controller provides operation with 2 or 4-phase stepper motors, 4, 6 or 8 wires. Winding connection examples are in the table 2. Connect step motor wires to A, A*, B and B* terminals of SMSD-4.2.

Table. 2

Scheme 1	Scheme 2	Scheme 3	Scheme 4
<p>8 wires steppmotor connection (4 phases): Scheme 1 – serial connection; Scheme 2 – parallel connection. 6 wires steppmotor connection (2 phases with midpoint taps):Scheme 3; 4 wires steppmotor connection (2 phases without midpoint taps):Scheme 4 .</p>			

6. Before starting

Caution: When handling a load having a large inertia moment, there is a possibility of the motor shaft rotation when braking. In this case, as well as with forced rotation of the shaft, the motor will induce an EMF, which can damage the output unit of the driver. To avoid such situations, you should avoid sudden braking of the motor, its forced rotation, as well as disconnecting the phases of the motor or turning off the power of the drive during operation.

1. Make sure the power supply is turned off..
2. Connect the motor according to paragraph 5.
3. Choose the suitable operation mode and set microswitches SW1 and SW2 according to the table 3.

Table 3.

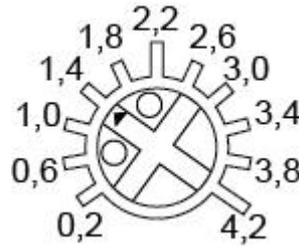
Operation mode	Microswitch		Control
	SW1	SW2	
Programmable	ON	ON	As per the preset motion algorithm, saved in the controller's memory. Algorithm consists of a sequence of commands – simple instructions.
Simple driver	OFF	ON	Pulse and Dir logic signals – low and high level voltage.
Manual	ON	OFF	Speed is adjusted by a potentiometer or analog signal 0-5VDC, direction is changed by a logic signal (pulse).

- Choose suitable microstepping mode and set microswitches SW4 and SW5 according to the table 4.

Table 4.

	1	1/2	1/4	1/16
SW4	ON	ON	OFF	OFF
SW5	ON	OFF	ON	OFF

- Set suitable for the stepper motor current per phase. Please, use the potentiometer “Current” on the board of the controller. Adjust current according image 7. The output current, set by the potentiometer, should be set according to the motor's description. Low current leads to a weak torque of the motor, high current leads to the motor heating and can damage the motor.



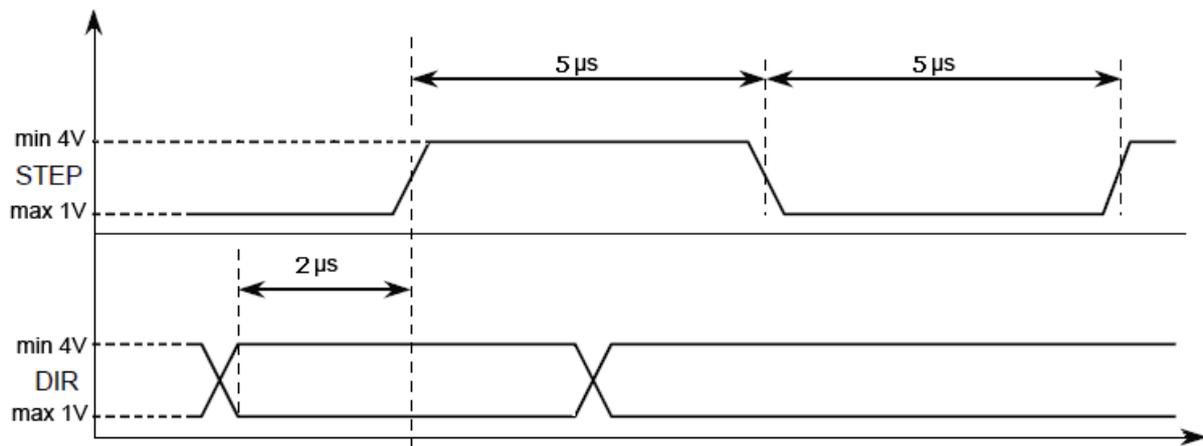
- If needed, connect the SMSD-4.2 controller to a computer.
- Check wiring once again and turn on the power supply.
- To change the operation mode set SW1 and SW2 according to the table 3 and RESET the controller (by button or input signal).
- To change the the microstepping mode set SW3 and SW4 according to the table 4.
- To control the stepper motor:

In the simple driver mode (connection example on the image 3) set the required sequence of logic signals “STEP” and “DIR” according to the scheme below (image 7).

One step (or microstep) executes as the front edge of the voltage pulse on the “STEP” input.

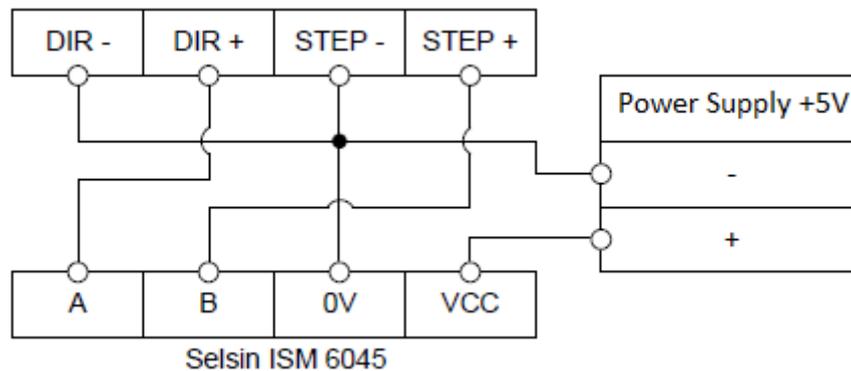
Direction switches by changing voltage level on the “DIR” input.

The motor can be stopped by the active signal on the “EN” input (clean contact of EN and GND).



Img. 8. STEP and DIR input signals.

The motor can also be controlled by a two-phase quadrature signal with a phase shift of 90°. Such a signal can be obtained, for example, at the output of optical selsyn. The connection scheme for optical selsyn is shown in Img. 8.



Img. 8

When powering on the unit automatically provides power to the motor. In this mode the indicator illuminates solid green.

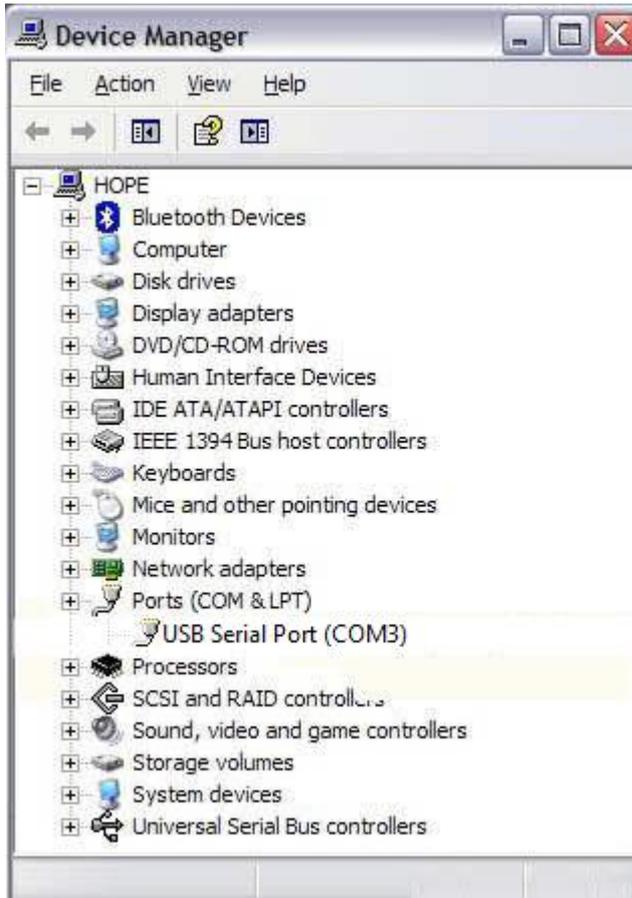
- **In manual control mode** (connection according to Img. 4) Adjust the speed of rotation with the potentiometer on the front panel of the unit. When exiting the manual control mode, the speed value is stored. When you re-enter the mode, the set speed is restored (it is important to note that the set speed may be too small for the motor to start).

In the manual mode information of current speed of the motor is available via communication interface as the ASCII string. To change direction set signal to the "REVERSE" input – contact "REVERSE" and logic "GND". Direction changes as the front edge of the signal. To start the motor rotation press the „Start“ button on the front panel or shorten the „Start“ input. By pressing the „Reset“ button or shortening the same input, motor stops and the power is removed from the motor phases. When the power is applied to the unit and the engine is stopped, the green LED is on, while the motor is rotating, the green LED flashes at a frequency of 1 time per second. If the contacts "EN" and "GND" are closed - emergency mode - the motor automatically stops - orange blinking color of the indicator.

- In Controller mode

to operate in real time mode via a computer a stable cable connection should be provided. For a standalone operation the executing program should be saved via RS-232 to the controller, after that the controller will be able to operate on its own. For virtual RS-232 communication with the computer the special driver USB-RS-232 should be installed.

When the controller is connected to the PC, the additional program COM-port appears (USB Serial Port (COM3)). The presence and port number can be viewed through the Windows Device Manager. The USB port that appears must be configured in accordance with the Table. 1



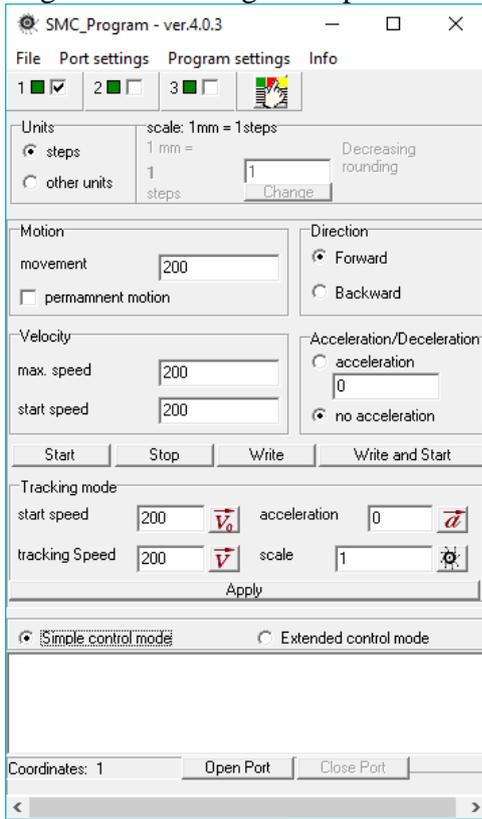
Img. 9

You can use the program SMC-Program (available for free download) or any other program that provides an interface for data transfer via the COM port to store the executable program in the controller memory.

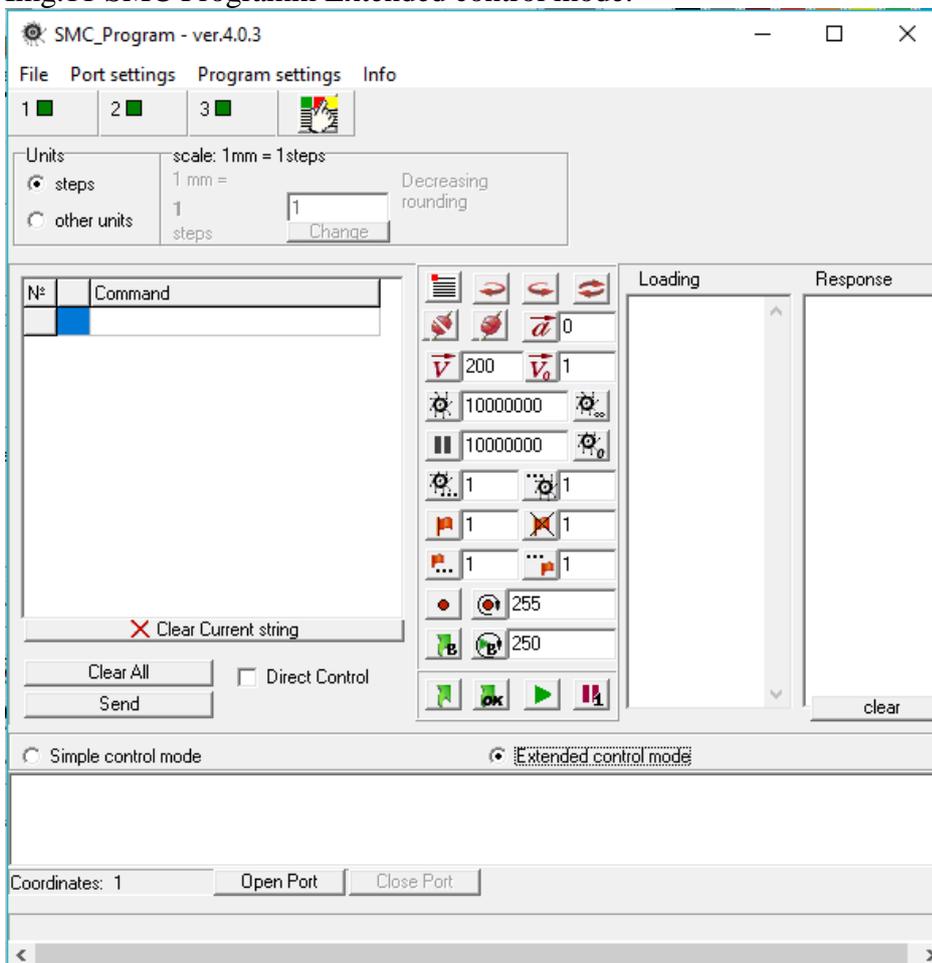
Saving the control program to the controller memory using SMC-Program 4.0.3 and higher.

SMC-Program needs to be saved to any folder of the computer, this program does not need no installation and can be started at once. SMC program windows are shown on Img.10 and Img.11.

Img. 10 SMC Program Siple control mode

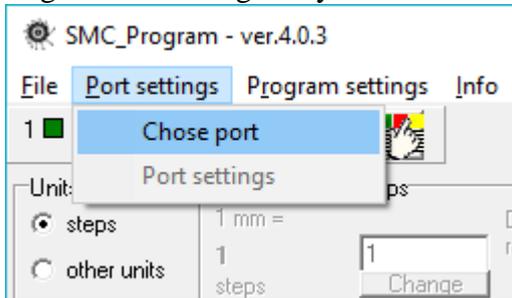


Img.11 SMC Programm Extended control mode.

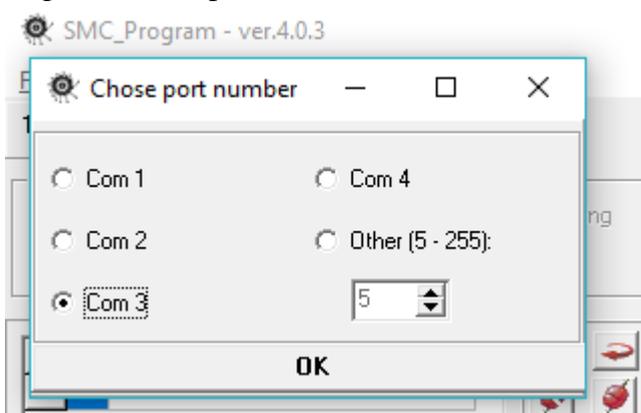


In the menu of the program "Port settings" >>> "Chose port" (Img. 12) select the port number to which the block and standard of data transmission (RS-232) is connected, then click "OK" (Img. 13). Make sure that the unit is in standby mode (see paragraph 8).

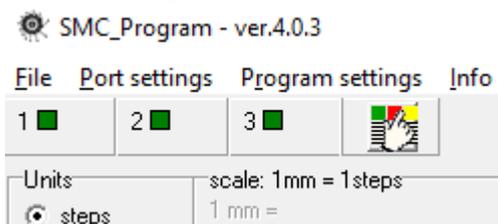
Img.12 Port setting meny



Img.13 Choose port menu



In the program window (Img. 10/ Img. 11), check the box with the number 1 (the first channel - Img. 14).



Img. 14. Chosing the channel

If the program is in the simple control mode (image 10) - input motor operation parameters (steps number, speed, acceleration, direction) and press the button "write" to record parameters to the controller and press the button "start" to start motion according to the recorded command sequence. Or press the button "Write and start" to record new parameters and start motion at the moment.

If the program is in the programming control mode (image 11) add to the command list:

- 1) «Start loading to the coordinate 1» ; 
- 2) Add commands to assemble the operation algorithm.
- 3) «End loading» .
- 4) Press the button «send» under the command list. 

Commands list and description can be found in paragraph 7 "Commands", and in the SMC_Program manual.

After the command sequence (operation algorithm) is saved to the controller there are two possibilities: to continue control via the SMC_Program or to use the controller in standalone mode. To start program executing in the standalone mode press the “Start” button or contact “Start” and “GND” at the controller frame.

Saving execute program with other terminal program with RS-232 communication function.

Set the port number (check in the windows device manager, image 9), set port parameters according to the table 1. Input required commands sequence using the ASCII codes (table 5, 6; paragraph 7).

7. Commands

Commands in the programmable mode should be byte-serial (character-serial) transferred. Every command should be completed with the ending character “*”. The ending character “\” instead of “*” cancels previous bytes transfer (whole string). There is the commands list in the table 5 and 6. The SMSD-4.2 controller receives and checks every command after receiving the ending character “*”. Controller sends to the communication port a reply after receiving every command (successful or error command). All possible controller replies are presented in the table 7. Commands in the table are presented for autonomous operation mode - the program is written into the block memory and it is disconnected from the PC; and for the mode "Directcontrol" - control from the PC is carried out in the "real time" mode.

Table 5. List of control commands

№	Command	Autonomous Operation Mode	Directcontrol
1	LD (LD1)	Entering the program loading mode, the execution of the current program is stopped, power is removed from the phases of the motor.	-
2	RD	Read the command sequence from the controller memory.	-
3	ST (ST1)	Start the program from the controller's standby mode, stop - if the program is running.	
4	LB		Entering the program load to the buffer mode, execution of the current command is terminated, the power from the phases of the motor is removed.(the program in the buffer is not saved if the power is turned off).
5	RB		Reading the buffer, execution of the current command is terminated.
6	SBddd		Run the operational buffer ddd (1 ... 250) times. In the absence of a value, the start occurs 1 time.
7	ED	Exit the programming mode to standby mode, write commands to the unit memory.	Save commands to buffer, enter standby mode.

Table 6. List of Executing commands

№	Command	Autonomous Operation Mode	Directcontrol
8	BG	Sets the address to 0 (beginning of the program)	
		When writing a new program into the controller memory, after the LD command.	When writing a new program to the buffer, after the command LB
9	EN	Enable power supply to the motor windings	
10	DS	Removing the power from the motor windings (power from the motor windings is removed by default)	
11	DL	Set rotation to the left	If the motor does not rotate: it will start rotating to the left; If the motor rotates: the remaining steps are made to the left (command is set by default).
12	DR	Set rotation to the right	If the motor does not rotate: it will start rotating to the right; If the motor rotates: the remaining steps are made to the right
13	RS	Reverse	If the motor does not rotate: it will start rotating in reverse direction; If the motor rotates: the remaining steps are reversed
14	AL(-)ddd (-1000 to +1000)	Set acceleration (deceleration)	If the motor does not rotate: the beginning of the motion with a given acceleration (deceleration) from the initial speed SS to the final speed SD; If the motor rotates: the next time the SD speed changes, the remaining steps are processed with the specified acceleration (deceleration) from the current speed to the new value (AL = 0 by default)
15	SDddd (from 1 to 10000)	Set the ddd speed. If SS start speed is not set, then it is used as starting and working speed	If the motor does not rotate: it is used as the starting and operating speed. If the motor rotates: the remaining steps are processed at the preset speed ddd (SD = 200 by default)
16	SSddd (from 1 to 2000)	Starting speed. When accelerating AL ≠ 0, acceleration (deceleration) to SD speed is performed. The SS command is taken into account only at the beginning of the motion (the motor is stopped) (by default SS = 1)	
17	SF	Turn on relay.	
18	CF	Switch off the relay (the relay is off by default).	
19	MV	Turn on the motor-continuous motion	If the motor does not rotate: start motion indefinitely; If the motor rotates: continue the rotation indefinitely.

20	MVddd (from 1 to 10000000)	Perform ddd Steps	If the engine does not rotate: run ddd steps and stop. If the motor rotates: from now on, execute ddd steps and stop
21	MH	Continuous motion before the signal to the input IN2	If the motor does not rotate: Continuous movement before the signal reaches the input IN2; If the motor rotates: from this moment start continuous movement before the signal to the input IN2.
22	ML	Continuous motion before the signal to the input IN1	If the motor does not rotate: Continuous movement before the signal reaches the input IN2; If the motor rotates: from this moment start continuous movement before the signal to the input IN2.
23	HM	Continuous motion before the signal to the input "0"	If the motor does not rotate: Continuous movement before the signal arrives at input "0"; If the motor rotates: from now on, start continuous movement until the signal arrives at input "0" (the SD command allows you to adjust the speed).
24	SPddd	Stop (pause) on dddms, the maximum is 10,000,000	Stop (pause) on dddms, maximum 10,000,000. After pause continue to execute the current command. If commands MV, MVddd, MH, ML, HM are received during a pause, they are immediately executed, and the pause and the previous command are considered complete.
25	LL	Set cycle start mark	Set the start mark of the cycle - the command is available when writing the program to the buffer
26	JPddd (from 1 to 255)	Run the commands after the LL label to JP ddd times.	Command is available when writing the program to the buffer
27	WL	Wait for the signal at the input IN1	If the engine does not rotate: wait for the signal at input IN1 and start the next incoming command; If the motor rotates: the current command continues. Only after receipt of a signal at the IN1 unit accepts the next command.
28	WH	Wait for the signal at the input IN2	If the engine does not rotate: wait for the signal at input IN2 and start the next incoming command; If the motor rotates: the current command continues. Only after receipt of a signal at the IN2 unit accepts the next command.

In the "Directcontrol" mode, the acceleration value is checked:

1. With $AL = 0$, a step change in speed, immediately to the SD value, the initial speed value is ignored.
2. The motor does not rotate: if at the moment of the beginning of the movement, $(SD - SS) \cdot AL < 0$ the acceleration and initial speed are ignored, the engine immediately starts at the speed of SD.

3. The motor rotates: if the command SD: $(SD - S_{max}) \cdot AL < 0$ where S_{max} is the current speed, the acceleration is ignored, the motor changes speed in SD, and the remaining steps are processed at this speed.

The execution of the execution program by the controller consists of reading the next command from the non-volatile memory and in issuing the corresponding commands of the control signals to the Stepper Motor. At the same time, the signals from the inputs "IN1", "IN2", "REVERSE" and "EN" are analyzed. The direction of rotation can be changed by shortening the inputs "GND" and "REVERSE".

Table 7. Controller responses.

Responses	Meaning
E10*	Succesful execution of the command
E13*	Error in the code of the executive program
E14*	Completion of the executive program
E15*	Error receiving RS-232
E16*	Command error
E19 *	Command data error

8. Controller mode – submodes

The smsd-4.2 controller goes in one of the submodes:

Standby mode – red color LED indicator.

The SMSD-4.2 controller goes to the standby mode in one of the next cases:

- After program executing completed;
- After program executing was stopped by command «ST1» from a PC (table 5).
- After power on (if switches SW1=On and SW2=On);
- After “Reset” button or input activated (if switches SW1=On and SW2=On).

In the standby mode the SMSD-4.2 controller waits for one of the next event:

- Arrival one of the control commands from a computer (table 5, accepted commands are «LD1», «RD1», «ST1»);
- Start executing program by pressing the button “Start” or input signal “Start” (connect “Start” and “GND”);
- Turn to the other operation mode: manual or simple driver mode (see paragraph 6, table 3).

Program executing mode – blink red color LED indicator.

The SMSD-4.2 controller turns to the program executing mode and start motion algorithm from the standby mode in case of:

- “Start” button pressed or input activated (connect “Start” and “GND”);
- Recieving the control command «ST1» from a PC;

The SMSD-4.2 controller turns back from program executing to the standby mode in case of:

- Executing program completed;
- Recieving the control command «ST1» from a PC;
- “Reset” button pressed or input activated (connect “Reset” and “GND”).

The commands of the sequence (operation algorithm) are executed one by one, as they were recorder to the controller. The controller commutates motor windings according to the executing commands. At the same time SMSD-4.2 controls the inputs state for “IN1”, “IN2”, “EN”, “Reverse”, “0”. Active “EN” signal suspends and inactive signal resumes the program executing. Active “Reverse” signal changes motion direction.

Waiting for an external signal submode – red colour LED indicator.

The SMSD-4.2 controller turns to this sub mode during program executing, as per the command “WH” or “WL” – waiting for an external signal. The controller suspends program executing till receiving active signal to input IN1 or IN2. As the signal arrives to IN1 or IN2 (as per the command) the controller resumes program executing.

Commands loading to the controller memory – orange color LED indicator.

The SMSD-4.2 controller turns to this mode from the standby mode as receives the command “LD1”. In the commands loading mode the controller accepts the executing commands only (table 6). After arriving the command “ED” the controller record all received executing commands to the memory and turns to the standby mode.

Reading commands from the controller – orange colour LED indicator.

The SMSD-4.2 controller turns to this mode from the standby mode. The sequence of executing commands from the controller memory transfers to the computer as the controller receives the command “RD1”. After the commands transferred the controller turns back to the standby mode.

Temporary stop mode – orange blink colour LED indicator.

The SMSD-4.2 controller turns to this submode during program executing as receives the signal «EN» (contact «EN» and «GND»). The controller suspends program executing while the signal is active. As the signal turns to inactive the controller resumes the program executing.

Executing program error –orange colour LED indicator.

The SMSD-4.2 controller turns to this submode during program executing in case of wrong command in the sequence. The exit of this mode as “Reset” button pressed or input activated (connect “Reset” and “GND”). The executing program should be recorded again to the controller memory.