Technical Manual

Stepper controller
SMCI35

Editorial

© 2010
Nanotec® Electronic GmbH & Co. KG
Gewerbestraße 11
D-85652 Landsham / Pliening, Germany

Tel.:   +49 (0)89-900 686-0
Fax: +49 (0)89-900 686-50

Internet: www.nanotec.de

MS-Windows 2000/XP/Vista are registered trademarks of Microsoft Corporation.

Version/Change overview

Version	Date	Changes
1.0	2010-01-25	New issue C+P
1.1	2010-03-05	New picture on front page
1.2	2010-03-22	Diverse changes

About this manual

Target group

This technical manual is aimed at designers and developers who need to operate a Nanotecâ stepper motor without much experience in stepper motor technology.

Important information

This technical manual must be carefully read before <u>installation and commissioning of the stepper motor control</u>.

Nanotec® reserves the right to make technical alterations and further develop hardware and software in the interests of its customers to improve the function of this product without prior notice.

This manual was created with due care. It is exclusively intended as a technical description of the product and as commissioning instructions. The warranty is exclusively for repair or replacement of defective equipment, according to our general terms and conditions, liability for subsequent damage or errors is excluded. Applicable standards and regulations must be complied with during installation of the device.

For criticisms, proposals and suggestions for improvement, please contact the above address or send an email to: info@nanotec.com

Additional manuals

Please also note the following manuals from Nanotec:

NanoPro User Manual	Configuration of controllers with the NanoPro software	
Programming manual	Controller programming • Command reference • NanoJ • COM interface	

The manuals are available for download on www.nanotec.com.

Contents

1   Overview

Introduction

The stepper motor control SMCI35 is an extremely compact and cost-effective constant current power output stage with integrated Closed-Loop current control.

Due to the great capacity and functions available, it offers designers and developers a rapid and simple method of resolving numerous drive requirements with less programming effort.

It is used for controlling standard stepper motors (including with attached encoders) or motors with integrated encoders.

SMCI35 functions

The stepper motor control SMCI35 contains the following functions:

- Microstep 1/1 – 1/64 Final output stage (0.014° step resolution)
- Closed-Loop current control (sinusoidal commutation via the encoder)
- Microstep emulation in full step operation for smoother running
- Powerful DSP microprocessor for flexible I/O
- Sequence programs with NanoJ
- Rotation monitoring for optional encoder
- Easy programming with the NanoPro Windows software

ClosedLoop

Closed-Loop current control (sinusoidal commutation via the encoder):

In contrast to conventional stepper motor controls where only the motor is actuated or the position adjusted via the encoder, sinusoidal commutation controls the stator magnetic field as in a servomotor via the rotary encoder. The stepper motor acts in this operating mode as nothing more than a high pole servomotor, i.e. the classic stepper motor noises and resonances vanish. As the current is controlled, the motor can no longer lose any steps up to its maximum torque.

If the controller recognizes that the rotor is falling behind the stator field due to overload, adjustments are made with optimal field angle and increased current. In the opposite case, i.e. if the rotor is running forward due to the torque, the current is automatically reduced so that current consumption and heat development in the motor and controller are much lower compared to normal controlled operation.

dspDrive®

With dspDrive®, the motor current is controlled directly by a digital signal processor. Unlike conventional ICs, which resolve the winding current measurement and the target current value with only 6 or 8 bit, the new dspDrive$^®$ performs the entire control with a resolution of 12 bit. The parameters of the PI current controller can be adjusted to the motor and by the user as a function of the rpm.

This has the following application advantages:

- Very smooth, low-resonance operation with a sinusoidal current in the windings.
- Very good step angle accuracy and synchronization, even in open-loop operation.
- Three-phase stepper motors and BLDC motors can be controlled as well.

Nano

With the integrated NanoJ programming language based on the Java standard, complete sequencing programs can be implemented that can be run autonomously without a superordinate controller.

The programs can be created, compiled directly and written to the controller with the free NanoJEasy editor.

More detailed information can be found in the separate programming manual.

Presettings

When the SMCI35 is delivered, it is preconfigured to clock direction mode. Connection to the PC is not necessary. The phase current can be set in 10% steps on a DIP switch (10% = 400mA, max. 150% = 6A).

The inputs for the clock, direction and enable signal are already preconfigured on the X4 connector.

The step mode can only be changed via software. Full step is preset. Sinusoidal commutation, however, means extremely smooth running and very good performance of the stepper motor is already achieved in the full step.

Further settings

The operating behavior of the motor can be set and optimized according to individual requirements by setting the motor-related parameters. The parameters can be set using the NanoPro software and significantly reduce commissioning time.

An RS232 to USB converter is required for this (Nanotec item number: ZK-RS232-USB-3.3V).

More detailed information on this can be found in the separate NanoPro user manual.

Rotation monitoring

Even if stepper motors do not lose steps during normal operation, the integrated speed control provides additional security in all operating modes, e.g. against motor stalling or other external sources of error. The monitoring function detects a stalled motor or step loss after tenth of a step at the most (for 1.8° stepper motors with 500 pulses/rotation).

Automatic error correction is possible after the drive profile is ended or during the drive.
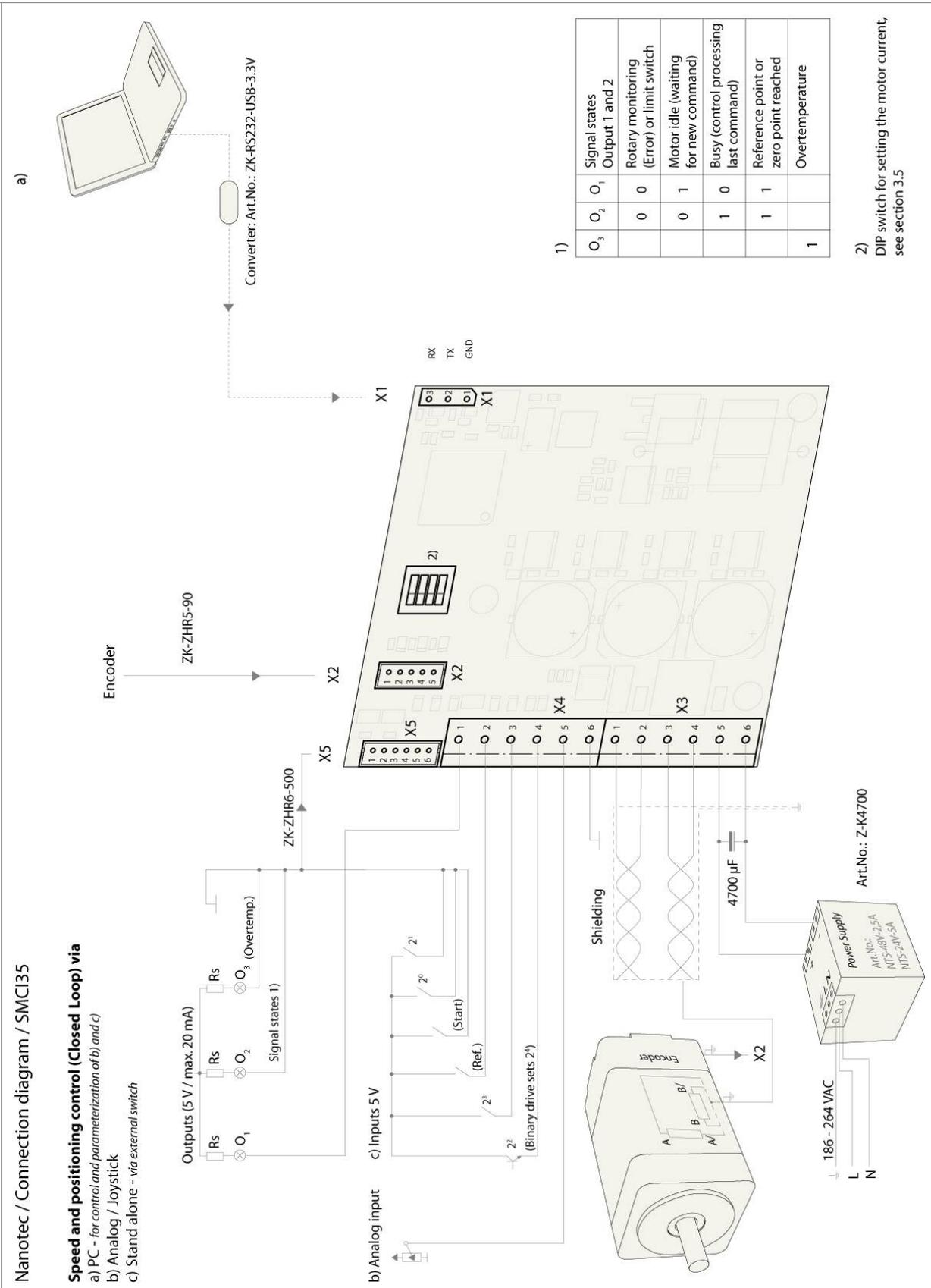
2 Connection and commissioning

2.1 Connection diagram

Introduction

To operate a stepper motor with the SMCI35 stepper motor control, the wiring must be implemented according to the following connection diagram.

Nanotec
PLUG & DRIVE

Connection diagram SMCI35

Nanotec / Connection diagram / SMCI35

Speed and positioning control (Closed Loop) via
a) PC – *for control and parameterization of b) and c)*
b) Analog / Joystick
c) Stand alone – *via external switch*

Converter: Art.No.: ZK-RS232-USB-3.3V

a)

Encoder

ZK-ZHR5-90

X1 — RX / TX / GND

X2

X5

ZK-ZHR6-500

Outputs (5 V / max. 20 mA)

Rs O₃ (Overtemp.)
Rs O₂
Rs O₁
Signal states 1)

c) Inputs 5 V

2¹
2⁰
(Start)
(Ref.)
Binary drive sets 2)
2³
2²

b) Analog input

Shielding

4700 µF

Art.No.: Z-K4700

Encoder
B/
B
A
A/
X2

power Supply
Art.No.:
NTS-48V-2.5A
NTS-24V-5A

186 - 264 VAC
L
N

1)	O₃	O₂	O₁	Signal states Output 1 and 2
	0	0	0	Rotary monitoring (Error) or limit switch
		0	1	Motor idle (waiting for new command)
		1	0	Busy (control processing last command)
		1	1	Reference point or zero point reached
	1			Overtemperature

2) DIP switch for setting the motor current, see section 3.5

2.2 Commissioning

Operation with presettings

The SMCI35 is delivered with the following presettings:

- Mode: Clock direction

- Step angle: Full step (with microstep emulation)

- Inputs on X4 connector (all 5 V):
    - Input 6 = clock signal
    - Input 5 = direction signal
    - Input 4 = enable

The phase current is set on a DIP switch, see section 3.5 „Setting the motor current".

Configuration with NanoPro

The following steps are only necessary if the positioning control is not to be operated in the preset clock direction mode.
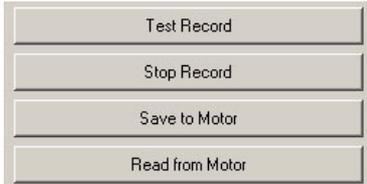
This section describes the main first steps you need to take to be able to quickly begin working with the SMCI35 if you are using the NanoPro software from a PC. You will find more detailed information in the separate NanoPro manual.

If you want to work with a PLC or your own program later, you will find the necessary information in the separate programming manual.

Familiarize yourself with the SMCI35 stepper motor control and the corresponding NanoPro control software before you configure the controller for your application.

Proceed as follows:

Step	Action	Note
1	Install the NanoPro control software on your PC. See the separate manual on NanoPro.	Download from www.nanotec.com/ downloads.
2	Connect the controller to the stepper motor according to the connection diagram.	Connection diagram, see Section 2.1. Detailed information on connections can be found in Chapter 3 „Connections and circuits".
3	Switch on the operating voltage (24 V DC ... 48 V DC).	
4	Connect the controller to the USB port of your PC. Use the converter cable ZK-RS232-USB-3.3V	Order identifier: • ZK-RS232-USB-3.3V **Note:** Download the necessary controller from **www.nanotec.com** under the Accessories/Converter menu item

Step	Action	Note
5	Start the NanoPro software.	The NanoPro main menu appears.
6	Select the "Communication" tab.	
7	In the "Port" field, select the COM port to which the SMCI35 is connected.	The number of the COM port to which the controller is connected can be found in the device manager of your Windows PC. (System control/system/hardware).
8	Select the "115200 bps" entry in the "Baudrate" selection field.	
9	Select the "Movement" tab.	
10	Click on the <Test Record> button to carry out the pre-set travel profile.	The connected motor operates with the pre-set travel profile (default travel profile after new installation).
11	You can now enter your required settings. For instance, you can enter a new travel profile.	See the separate manual on NanoPro.
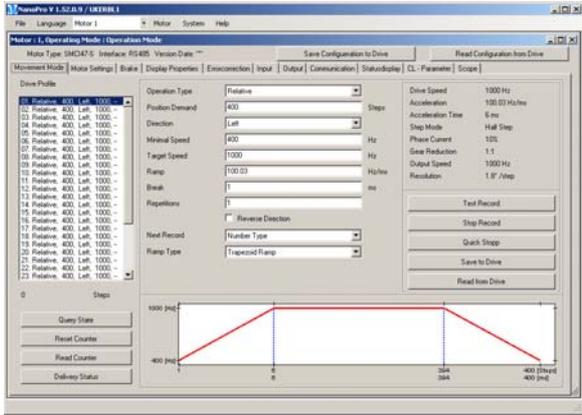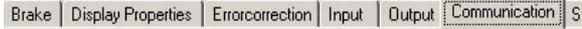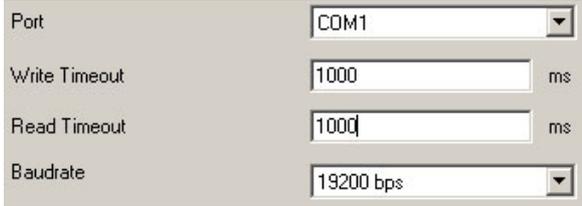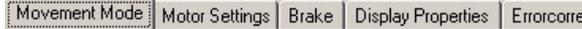
3 Connections and circuits

3.1 Overview

Plug connections

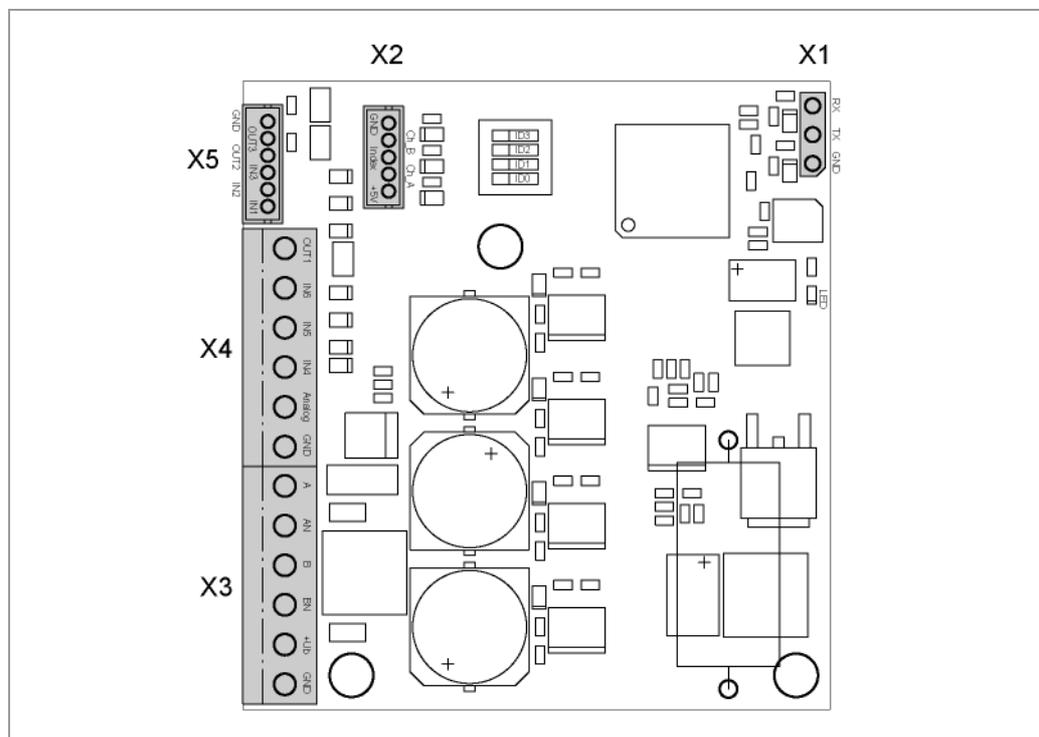The controller has the following connectors:

X1: RS232 interface

X2: Encoder interface

X3: Stepper motor and power supply connector

X4 and X5: Inputs and outputs

Configuration

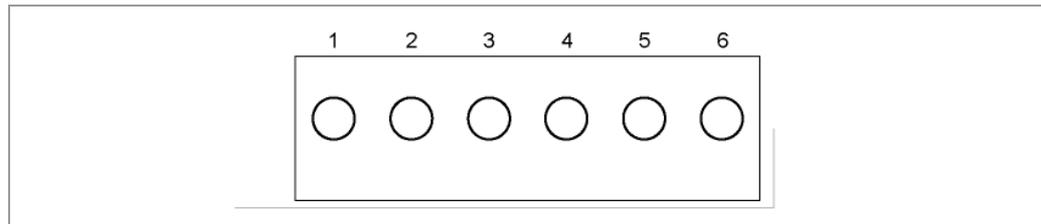The following figure shows the configuration of the connectors on the printed circuit board.

3.2 Inputs and outputs: connector X4 and X5

Introduction

An overview of the assignments can be found in the wiring diagram in Section 2.1).
This section looks in detail at the assignments, functions and circuits of connectors X4
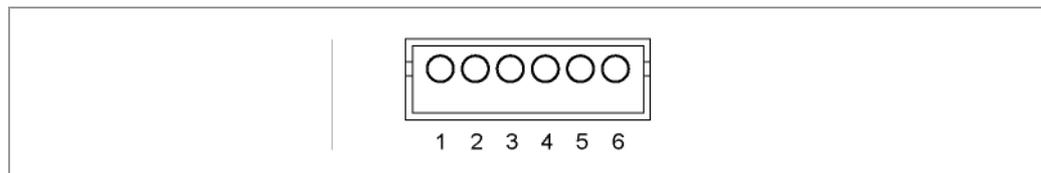and X5.

Pin assignment X4

Pin no.	Name	Observations
1	Output 1	Digital output
2	Input 6	Digital inputs
3	Input 5	
4	Input 4	
5	Analogue In 1	Analog input (–10 V ... +10 V)
6	GND	

Pin assignment X5

The X5 connector is a JST-ZHR6 connector.
Matching connection cable: ZK-ZHR6-500 (length 500 mm, single-conductor).

Pin no.	Name	Observations
1	GND	
2	Output 3	Digital outputs
3	Output 2	
4	Input 3	Digital inputs
5	Input 2	
6	Input 1	

Function of the inputs

All digital inputs – with the exception of the "Clock" input in the clock directional mode
– can be freely programmed using the NanoPro software (e.g. as a limit position
switch, enable, etc.) and can be used for sequential control with NanoJ.

All inputs can be configured for "active-high" or "active-low" with NanoPro.

Signal states at the outputs

The following table shows the possible signal states at the outputs 1 to 3:

Signal states			Meaning
Output 3	Output 2	Output 1	
	0	0	Rotation monitoring (error) or limit switch
	0	1	Motor idle (waiting for new command).
	1	0	Busy (control processing last command).
	1	1	Reference point or zero point reached
1			Overtemperature

The outputs can be freely programmed using the NanoPro software.

Input circuits

> **Note:**
> The voltage should drop below 2 V for safe switching off and be at least 4.5 V for safe switching on.
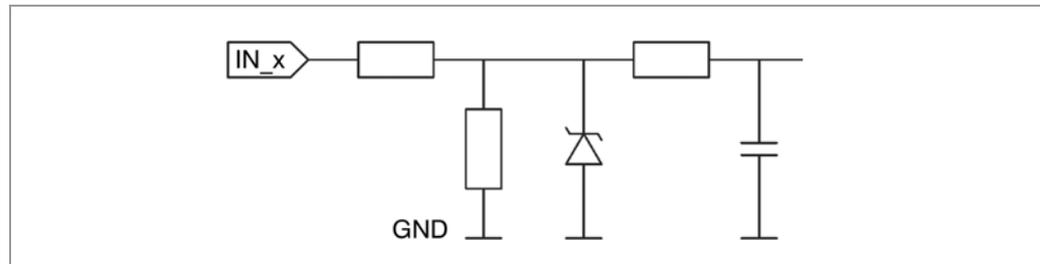
Output circuits

The outputs are a TTL output circuit (5 V / max. 20 mA). To be able to test the output, an LED with a series resistance against earth can be integrated. The LED lights up when the output is active.
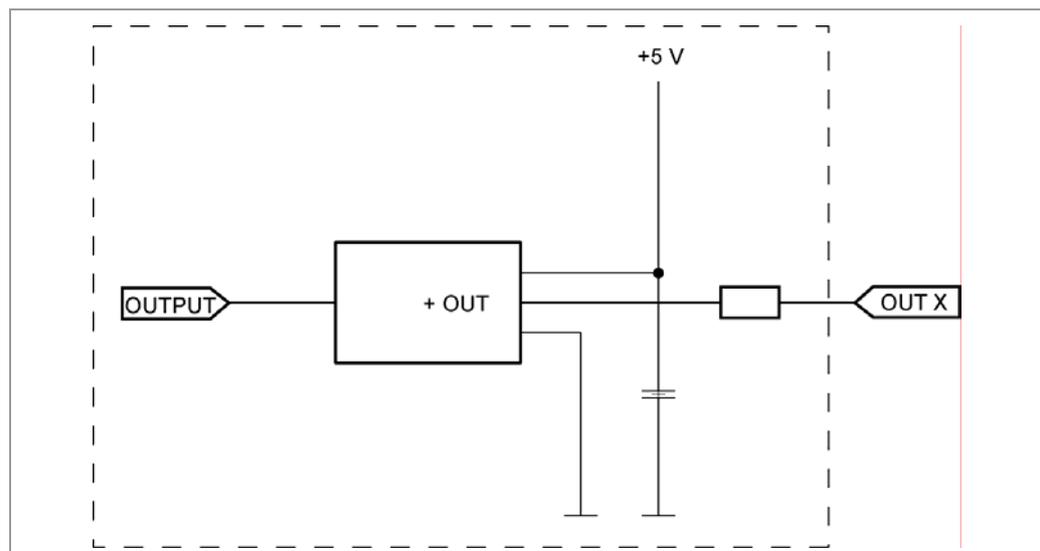
3.3 Encoder connection: Connector X2

Optional encoder

An optional encoder can be connected to the stepper motor control.

By default, the closed-loop control for a three-channel encoder is set up with 500 pulses/revolution in a 1.8° stepper motor. With an 0.9° stepper motor, you should use an encoder with 1000 pulses/revolution to achieve the same control quality. Depending on the application, it may make sense to use higher encoder resolutions (up to max. 2000 pulses/revolution) to improve control quality or to use a lower resolution (min. 200 pulses/revolution) for low-cost applications or for step monitoring alone.

The following encoder resolutions can normally be processed by the controller: 192, 200, 256, 400, 500, 512, 1000, 1024, 2000, 2048.
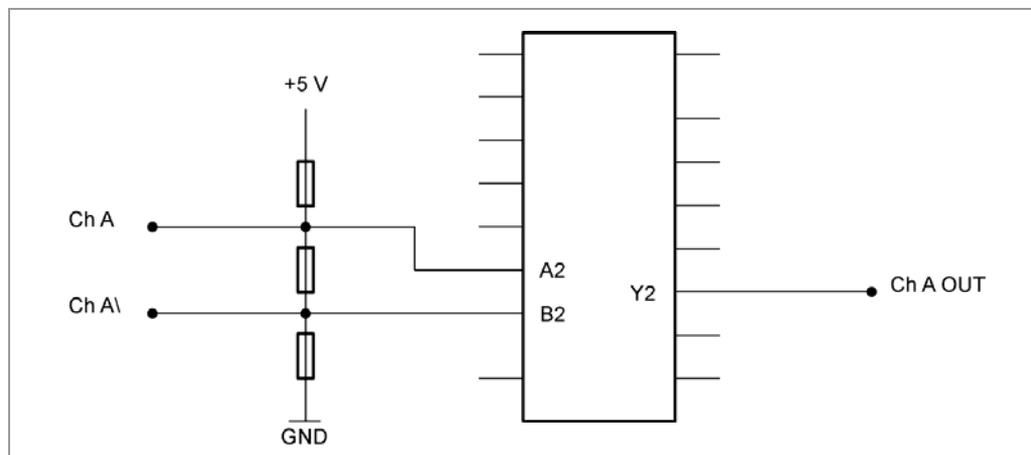
Recommended:
Where possible, use Nanotec encoders with the order number
WEDS/WEDL-5541 Xxx.

If an encoder is **not** used, the "Disable" mode must be set in the <Error correction> tab in the "Rotation Direction Mode" selection menu. See the NanoPro separate manual.

Using encoders with line drivers

The encoders of the HEDL series with a line driver output an inverted signal in addition to the encoder signal; this leads to better interference immunity and is especially recommended for long lines lengths. The differential signal can be evaluated with a line driver/encoder adapter. The following figure shows the input circuit of the encoder for channel A (Ch A) with an inverted signal (Ch A\).


The SMCP controllers themselves currently cannot evaluate the differential signal, meaning that only the channels A, B and I need to be connected to perform position monitoring. We recommend shielding and twisting the encoder line to minimize interference with the encoder signal from the outside.
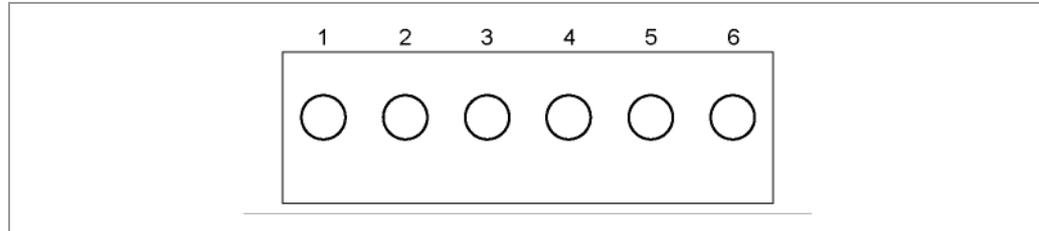
Pin assignment

Pin no.	Name
1	GND
2	Track (B)
3	Index track (I)
4	Track (A)
5	+5 V

The X2 connector is a JST-ZHR5 connector. Matching connection cable:
ZK-ZHR5-90 (length 90 mm, single-conductor).
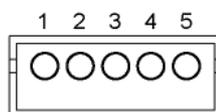
3.4   Stepping motor and power supply: connector X3

3.4.1   Pin assignment

Pin no.	Name	Observations
1	A	See also data sheet of connected stepper motor (color code of 4 wires).
2	A/	
3	B	
4	B/	
5	Vcc	Switch on the operating voltage (+24 V DC ... +48 V DC)
6	GND	Earth (0 V)

3.4.2   Stepper motor connection

General information

The motor is connected to the SMCI32 with a 4-wire cable. Twisted wire pair cables with braided shields are recommended.

	Danger of electrical surges
⚠️	Mixing up the connections can destroy the output stage! See also data sheet of connected stepper motor (color code of 4 wires). Never disconnect the link when operating voltage is applied! **Never** disconnect lines when live!

Motor with 6 or 8 connections

If you are using a motor with 6 or 8 connections, you need to connect the windings. The following figure shows four wiring diagrams for motors with 6 or 8 connections (page from the Nanotec product catalogue).
Details can be found on the Nanotec website, www.nanotec.com.

3.4.3   Power supply connection
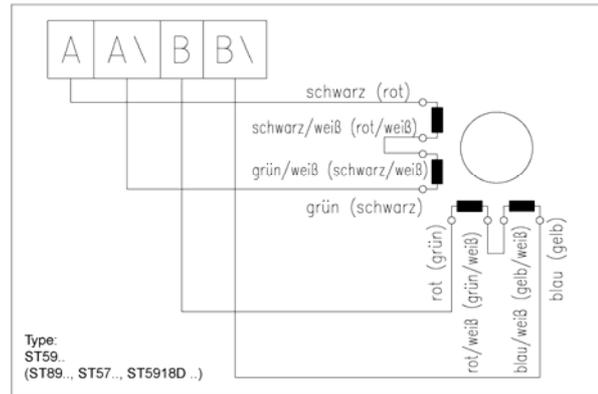
Permissible operating voltage

The permissible operating voltage for the SMCI35 stepper motor control lies between +24 and +48 V DC; it must not exceed 50 V or fall below 21 V .

A charging condenser with minimum 4700 µF (10000 µF) must be provided for the operating voltage to prevent exceeding the permissible operating voltage (e.g. during braking).
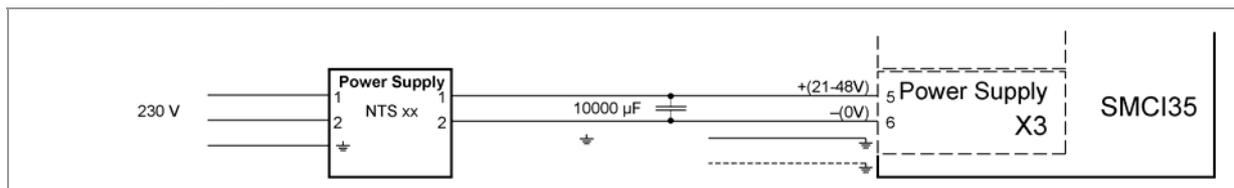
⚠️	**Danger of electrical surges** Connect charging condenser with minimum 4700 µF! Connect a condenser with 10000µF for motors with flange size 86x86 (series ST8918) or greater! An operating voltage > 50 V will destroy the output stage! Mixing up the connections can destroy the output stage! See also data sheet of connected stepper motor (color code of 4 wires). Never disconnect the link when operating voltage is applied! **Never** disconnect lines when live!

Connection diagram

Note:
Complete connection diagram - see Section 2.1.

Accessories

Appropriate power packs and charging condensers are available as accessories:

Name	Order number
Power pack	NTS-xxV-xA
Charging condenser	Z-K4700 or Z-K10000

Note:
Further information about accessories can be found on the Nanotec website: www.nanotec.com

3.5   Setting the motor current

Setting options

The motor current can be set either in the software (NanoPro) or in the hardware via the DIP switch on the board.

DIP switch

The DIP switches form the first four digits of the binary system, where the digit with the lowest value is set with switch "1" and the digit with the highest value is set with switch "4". In this way, the decimal values of 0 to 15 can be set.
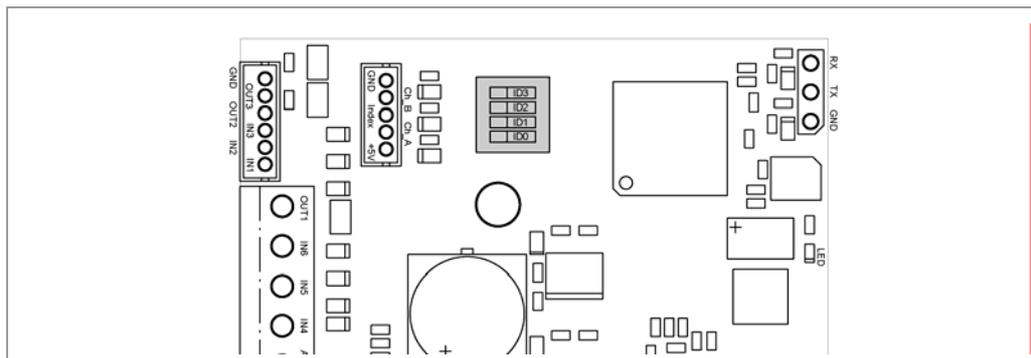
Procedure

If all DIP switches are set to OFF (decimal value 0), the motor current can be specified via NanoPro. For all other DIP switch settings, the motor current results from the following equation (in % of effective current 4 A):

Motor current = dip switch decimal value * 10%

Example: switch 4 = ON, switch 3 = OFF, switch 2 = OFF, switch 1 = ON
$\rightarrow$ Decimal value = 9
$\rightarrow$ Motor current = 90% of effective current = 3.6 A

| DIP switches				Motor current	
4	**3**	**2**	**1**	**rel.**	**abs.**
0	0	0	0	NanoPro	
0	0	0	1	10 %	0.4 A
0	0	1	0	20 %	0.8 A
0	0	1	1	30 %	1.2 A
0	1	0	0	40 %	1.6 A
0	1	0	1	50 %	2 A
0	1	1	0	60 %	2.4 A
0	1	1	1	70 %	2.8 A
1	0	0	0	80 %	3.2 A
1	0	0	1	90 %	3.6 A
1	0	1	0	100 %	4 A
1	0	1	1	110 %	4.4 A
1	1	0	0	120 %	4.6 A
1	1	0	1	130 %	4.8 A
1	1	1	0	140 %	5.2 A
1	1	1	1	150 %	6 A

3.6   RS232 interface: connector X1

Introduction

The controller has a serial TTL RS232 interface (3.3 V) for connecting to a PC.

Converter cable

Use the converter cable
ZK-RS232-USB-3.3V for connection to the USB port of the PC.

Pin assignment
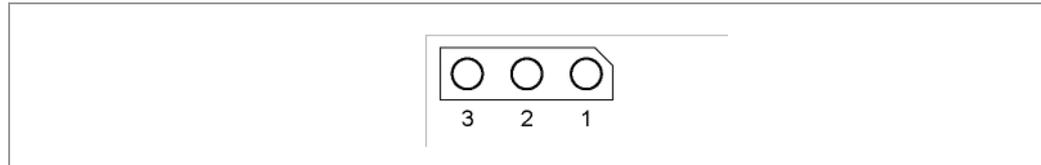
Pin no.	Name	Observations
1	GND	
2	Tx	
3	Rx	

4 Operating modes

Introduction

Depending on the drive profile, the motor can be operated using a total of 14 different operation modes. Due to the good performance and variety of functions available, they offer designers and developers a rapid and simple method of resolving numerous drive requirements with less programming effort.

Select the required operating mode for each drive profile and configure the controller according to your requirements.

More detailed information can be found in the separate NanoPro manual.

Overview of operating modes and their areas of application

Operation mode	Application
Relative Absolute	Use this mode when you wish to travel to a specific position. The motor travels according to a specified drive profile from a Position A to a Position B.
Internal reference run	During the internal reference run, the motor travels to an internal reference point at the set minimum speed.
External reference run	During an external reference run, the motor travels to a switch connected to the reference input.
Speed mode	Use this mode when you wish to travel with a specific speed (e.g. a conveyor belt or pump speed). In the speed mode, the motor accelerates with a specified ramp from the starting speed (start frequency "V Start") to the specified maximum speed (maximum frequency "V Normal"). Several inputs enable the speed to be changed on-the-fly to different speeds.
Flag positioning mode	The flag positioning mode offers a combination of the speed and positioning modes. The motor is initially operated in speed mode; when a trigger point is reached, it changes to the positioning mode and the specified setpoint position (relative to the trigger position) is approached. This operating mode is used for labeling, for example: the motor first travels with the set ramp to the synchronous speed of the conveyed goods. When the labels are detected, the preset distance (position) is traveled to apply the labels.

Operation mode	Application
Clock direction mode, left	Use this mode when you wish to operate the motor with a superordinate controller (e.g. CNC controller).
Clock direction mode, right	In the clock direction mode, the motor is operated via two inputs with a clock and a direction signal from a superordinate positioning control (indexer).
Clock direction mode, Int. Ref.	
Clock direction mode, Ext. Ref.	Depending on the mode selected (Int. Ref. / Ext. Ref.), the internal and external reference runs are supported.
Analog and Joystick mode	The motor is controlled in this operating mode simply with a potentiometer or a joystick (–10 V to +10 V). Use this mode if you want to use the motor in a simple application: • Setting a specific speed, e.g. via an external potentiometer, • Traveling synchronously with a superordinate controller with analog output (–10 V to +10 V).
Analog positioning mode	Use this mode when you wish to travel to a specific position. The voltage level on the analog input is proportional to the required position, thus enabling servo behavior.
Torque mode	Use this mode when you require a specific output torque independent of the speed as is the case in typical winding and unwinding applications. The maximum torque is specified via the analog input.

Selecting the operating mode in NanoPro
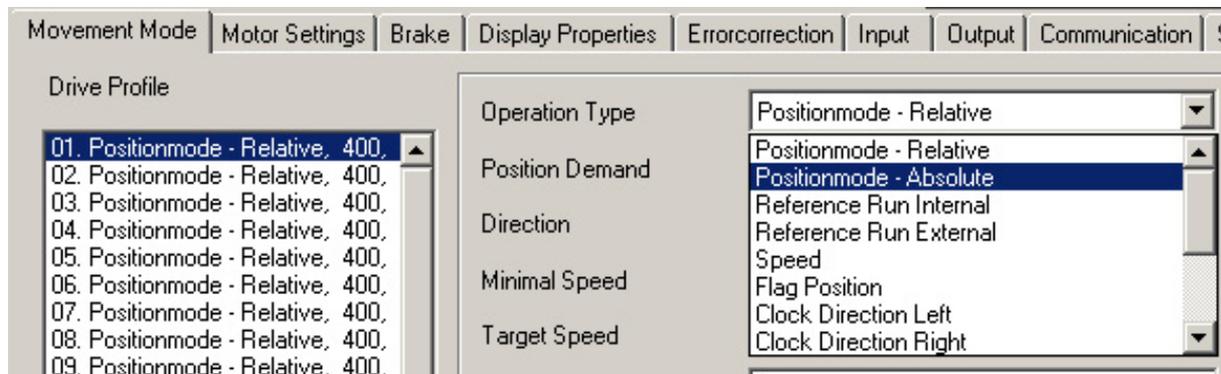
5 Troubleshooting

Troubleshooting procedure

Proceed with care during troubleshooting and error rectification to avoid damaging the controller.

⚠️	**Danger of electrical surges** An operating voltage > 50 V and incorrect connections can destroy the end stage. Never disconnect the link when operating voltage is applied! Never disconnect lines when live!

Possible error

Error	Possible cause	Rectification
Controller is not ready	Data transmission to SMCI35 not possible (communication error): Incorrect COM port selected.	In the "Communication" tab, select the PC port to which you have connected the SMCI35 (e.g." COM-1") The port used can be found in the device manager of your PC.
	Communication cable not connected or interrupted (incorrect converter used).	Function is not guaranteed with third-party 4-wire cables and 2-wire Nanotec converters do not function. Use the recommended converter from Nanotec: • Order identifier: ZK-RS232-USB-3.3V
	A non-existent motor number (module number) is set.	Set the correct module address. See the separate manual on NanoPro.
	The power supply of the SMCI35 is interrupted.	Check voltage supply, switch on if necessary.
	Another open program is blocking the COM port to which the SMCI35 is connected.	Close down other programs on your PC.
	Inadmissible data was sent to the controller during the output of a travel profile.	Click on the <Yes> button to stop the travel profile. The SMCI35 switches back to the "Ready" state. The data can then be resent to the controller.
Transmission error	Data transmission to the SMCI35 is disturbed (sender or receiver are disturbed).	Check the possible causes for the transmission error and rectify the cause of the error.
Position error	The motor cannot reach the position or the limit switch was overrun.	Click the <Yes> button in the error message; the error is reset.

6 Technical data

Electrical connections

Operating voltage V_b	DC 24 V to 48 V ±4%
Max. phase current	Adjustable up to max. 6 A/phase Continuous current 4 A/phase
Current drop	Adjustable 0 to 150% of phase current
Port	TTL-RS232 (3.3 V)

Controller parameters

|	
Step resolution	Full step Half step Quarter step Fifth step Eighth step Tenth step 16th step 32nd step Adaptive microstep (1/64)
Step angle	1.8°
Operating modes	Position Speed Flag position Clock direction Analogue Analog positioning mode Joystick Torque
Step frequency	16 kHz with a full step, corresponding multiples with a microstep (e.g. 1 MHz with 1/64)
Position monitoring	depending on encoder resolution

Protective circuits

Overvoltage and undervoltage	Protective circuit for voltages > 50 V or < 21 V
Max. heat sink temperature	Approx. 80 °C External ventilation may be required in full step operation, depending on the switch-on duration, current drop set and external cooling area.
Max. ambient temperature	0 to 40 °C

Inputs and outputs

Inputs	• 6 digital inputs (TTL) • 1 analog input (+10 V / −10 V)
Outputs	• 3 digital outputs (TTL)

SMCI35 dimensions
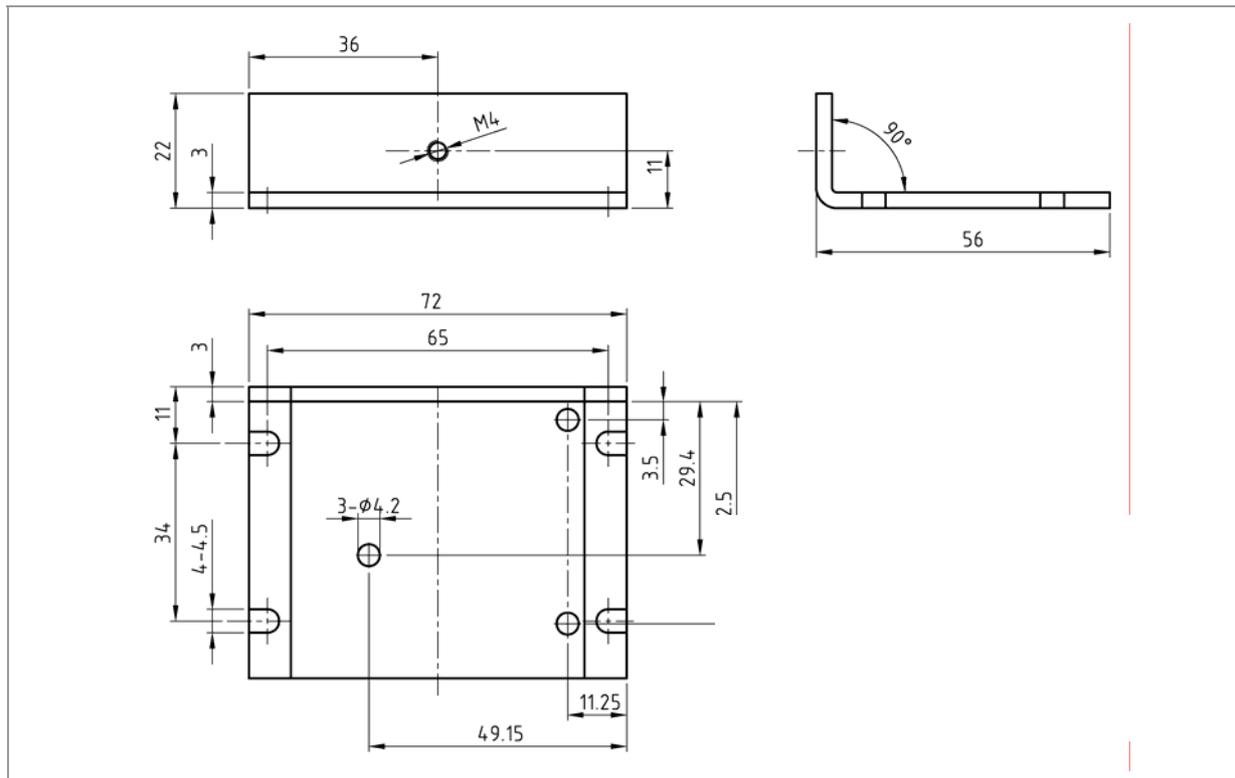
A complete set of datasheets is available for downloading at www.nanotec.de.

Connectors

The following connectors are available on the SMCI35:

- Connector X1: pin connector 2.54
- Connector X2 and X5: JST-ZH
- Connector X3 and X4: RIA 059

Index

A

C

D

E

F

I

M

N

O

P

R

V