Technical Manual

Stepper driver
SMCI33

Editorial

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Version/Change overview

Version	Date	Changes
1.0	2009-02-20	New issue C+P
2.0	2009-07-01	Revision C+P
2.1	2010-04-08	Revision C+P

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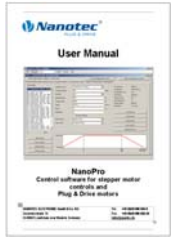
Nanotec® reserves the right to make technical alterations and further develop hardware and software in the interests of its customers to improve the function of this product without prior notice.

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 driver SMCI33 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 or brakes.

The SMCI33

Variants

The SMCI33 is available in the following variants:

- SMCI33-1: with USB interface (drivers neccessary)
- SMCI33-2: with RS-485 interface

SMCI33 functions

The stepper driver SMCI33 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)
- Powerful DSP microprocessor for flexible I/O
- Rotation monitoring for optional encoder
- RS485 or USB interface for parameterisation and control
- Network capability of up to 32 motors
- Easy programming with the Windows software NANOPRO

Operating modes

The following operating modes can be selected:

- Positioning
- Speed
- Flag positioning
- Clock direction
- Analogue or joystick operation (±10 V)
- Analogue positioning mode
- Torque mode

Function overview

The operating behaviour of the motor can be set and optimised according to individual requirements by setting the motor-related parameters such as phase current (selectable in 1% increments), step resolution (from 1.8° - 0.014°), as well as the adaptive microstep (automatic adaption of step width). Machine-related parameters can be set using the NANOPRO software and significantly reduce commissioning time:

- Distance in steps, degrees or mm
- Speed in Hertz, rpm or mm/s
- Feed constant in mm/revolution
- Gear reduction with reverse clearance

Three adjustable reference modes (external and internal) enable automatic machine settings, whereby external reference switches may be inapplicable if there is a shift < 360° possibly due to the index signal of the internal encoder.

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 half a step at the most (for 1.8° stepper motors).

Automatic error correction is possible after the drive profile is ended or during the drive.

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 driver recognises 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 driver are much lower compared to normal controlled operation.

2 Connection and commissioning

2.1 Connection diagram

Introduction

To operate a stepper motor with the SMCI33 stepper driver, the wiring must be implemented according to the following connection diagram.
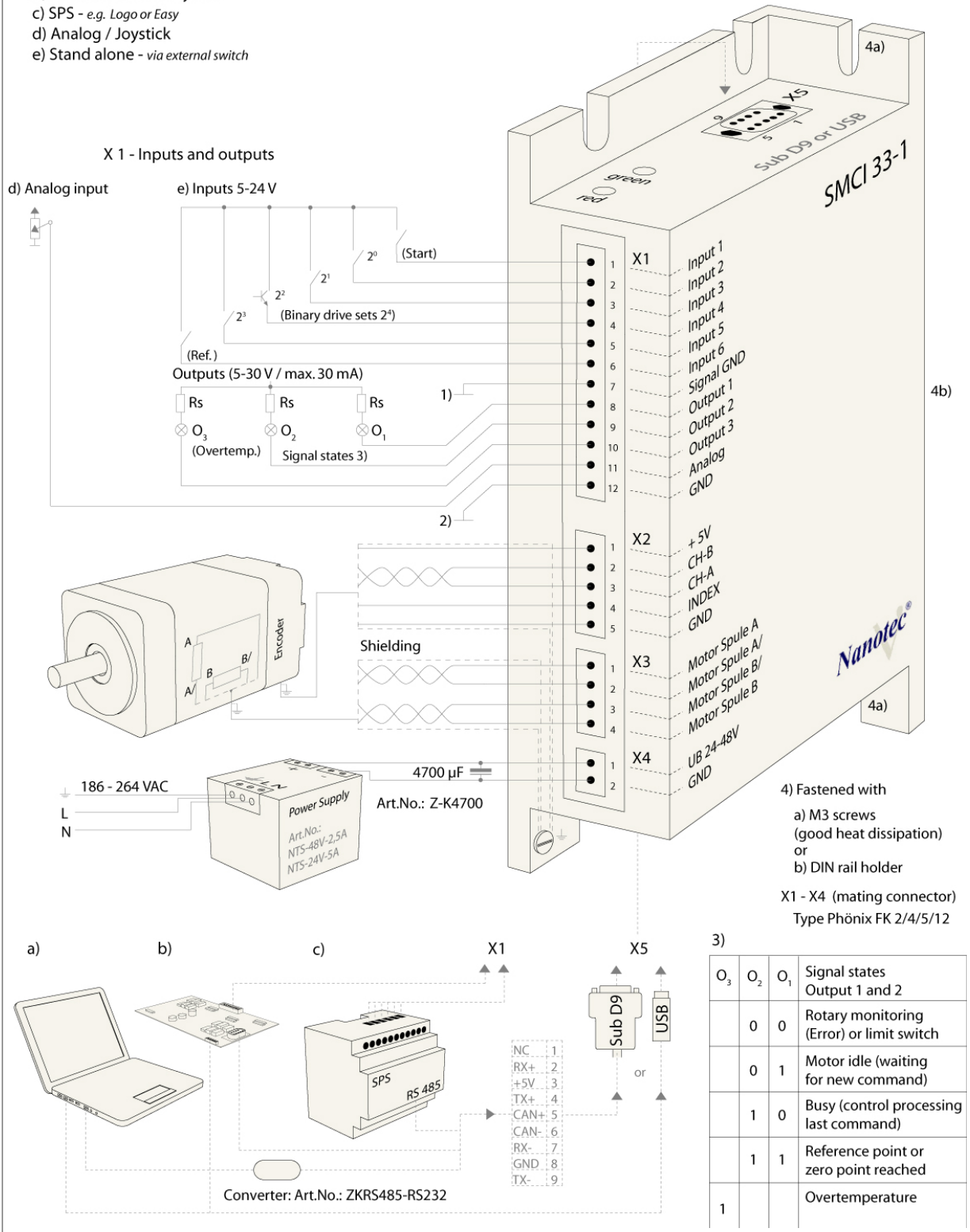
Inputs (Pin 1 to 6) on the connector X1 and the encoder input (connector X2) can be used optionally.

Connection diagram SMCI33

Nanotec / Connection diagram / SMCI 33-1 (USB) / SMCI 33-2 (RS 485)

Speed and positioning control (Closed Loop) via
a) PC - *for control and parameterization of c), d) and e)*
b) Industrial control system
c) SPS - *e.g. Logo or Easy*
d) Analog / Joystick
e) Stand alone - *via external switch*

X 1 - Inputs and outputs

d) Analog input   e) Inputs 5-24 V

X1		
1	Input 1	
2	Input 2	
3	Input 3	
4	Input 4	
5	Input 5	
6	Input 6	
7	Signal GND	
8	Output 1	
9	Output 2	
10	Output 3	
11	Analog	
12	GND	

X2	
1	+ 5V
2	CH-B
3	CH-A
4	INDEX
5	GND

X3	
1	Motor Spule A
2	Motor Spule A/
3	Motor Spule B/
4	Motor Spule B

X4	
1	UB 24-48V
2	GND

Outputs (5-30 V / max. 30 mA)

186 - 264 VAC
L
N

Power Supply
Art.No.:
NT5-48V-2,5A
NT5-24V-5A

4700 µF
Art.No.: Z-K4700

4) Fastened with

a) M3 screws
(good heat dissipation)
or
b) DIN rail holder

X1 - X4 (mating connector)
Type Phönix FK 2/4/5/12

Converter: Art.No.: ZKRS485-RS232

NC	1
RX+	2
+5V	3
TX+	4
CAN+	5
CAN-	6
RX-	7
GND	8
TX-	9

3)

O$_3$	O$_2$	O$_1$	Signal states Output 1 and 2
	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

2.2   Commissioning

Provisions

The connection and commissioning of the SMCI33 stepper motor are described below.
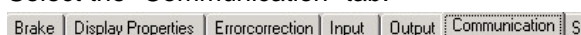
The main "First steps" are described here to work as fast as possible with the SMCI33 if you want to work with the NANOPRO software from a PC. You will find more detailed information in the separate NANOPRO manual.
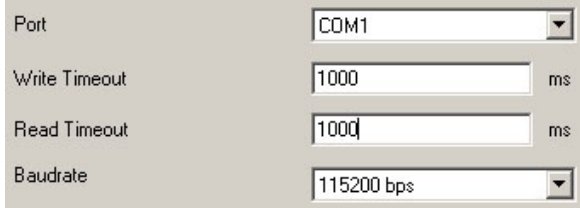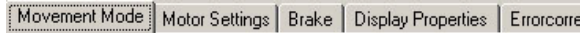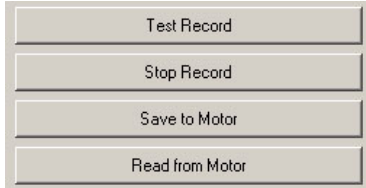
If you want to work at a later time with a PLC or your own program, you will find the necessary information in the separate "Command Reference".

Familiarise yourself with the SMCI33 stepper driver and the corresponding control software NANOPRO before you configure the driver for your application.

Procedure

Proceed as follows to commission the driver:

Step	Action	Note
1	Install the driver software NANOPRO on your PC. See the separate manual on NANOPRO as well.	Download from www.nanotec.com/downloads.
2	Connect the driver to the stepper motor according to the connection diagram.	Connection diagram, see Section 2.1. Detailled information on connections can be found in Chapter 3 „Connections and circuits".
3	Switch on the operating voltage (24 V DC ... 48 V DC).	The green LED lights up.
4	Connect the driver with your PC. Use one of the following converter cables for this purpose: • ZK-RS485-RS232 for connection to the serial interface • ZK-RS485-USB or standard USB cable type MINI-B for connection to the USB interface (for SMCI33-1)	Order number: • ZK-RS485-RS232 • ZK-RS485-USB **Note:** Download the necessary driver from **www.nanotec.com** under the menu item Accessories/Converter
5	Start the NANOPRO software. 	The NANOPRO main menu appears.
6	Select the "Communication" tab. 	

| Step	Action	Note
7	In the field "Port", select the COM port to which the SMCI33 is connected. Port COM1 Write Timeout 1000 ms Read Timeout 1000 ms Baudrate 115200 bps	The number of the COM port to which the driver is connected can be found in the device manager of your Windows' PC (System Supervision/ System/ Hardware).
8	Select the entry "115200 bps" in the selection field "Baudrate".	
9	Select the "Movement Mode" tab. Movement Mode | Motor Settings | Brake | Display Properties | Errorcorrec	
10	Click on the button <Test Record> to carry out the pre-set travel profile. Test Record Stop Record Save to Motor Read from Motor	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 as well.

3   Connections and circuits

3.1   Inputs and outputs (I/O): Connector X1

Introduction

An overview of the assignments can be found in the connection diagram in Section 2.1.. This section looks in detail at the assignment, functions and circuits of the connector X1..

The connectors and sockets used are from Phönix, Order number: FK-MC 2/4/5/12.

Connection diagram inputs and outputs (I/O) (X1)
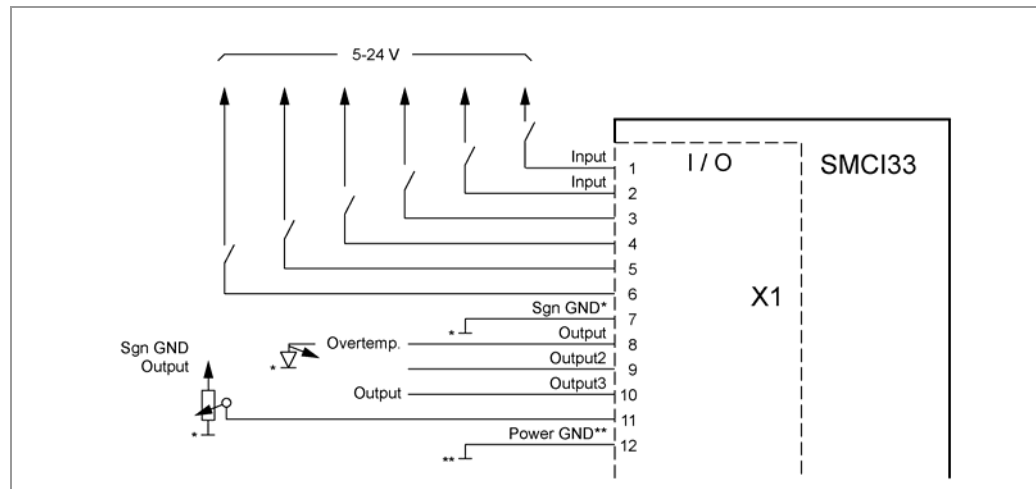
Pin assignment connector X1: Inputs and outputs (I/O)

| Pin-No.	Name	Observations	Operating mode					
			Position	**Speed**	**Flag position**	**Clock direction**	**Analogue**	**Joystick**
1	Input1	5-24 V Optocoupler	Start Reset	Enable	Start	Enable	Enable	Enable
2	Input2	5-24 V Optocoupler	Travel profile	Speed	Travel profile	Manual mode	Speed	Speed
3	Input3	5-24 V Optocoupler	Travel profile	Speed	Travel profile	Manual mode	Speed	Speed
4	Input4	5-24 V Optocoupler	Travel profile	Speed	Travel profile	Ext. limit switch	Speed	Speed
5	Input5	5-24 V Optocoupler	Travel profile	Speed	Trigger	Direction	Speed	Speed
6	Input6	5-24 V Optocoupler	Ext. limit switch	Direction	Ext. limit switch	Clock	Direction	
7	Com	Signal GND						
8	Output1	Open-Collector						
9	Output2	Open-Collector						
10	Output3	Open-Collector						
11	Analogue In	–10 V ... +10 V					Analogue In	Analogue In
12	GND	Power & Analogue GND						

Note:
The Com and GND connections are not joined. Com provides the mass for the inputs and GND provides the mass for the outputs and the internal circuits.

Input circuits

All inputs (apart from the "Analogue In" input) are electrically isolated by optocouplers from the voltage supply of the SMCI33 and designed for 5 - 24 V input signals at an input current of 10 mA.

The digital inputs 1 to 6 can be configured with the aid of the software NANOPRO for "active-high" or "active-low". In addition, these can be freely programmed there, e.g. as limit switch, enable, etc.

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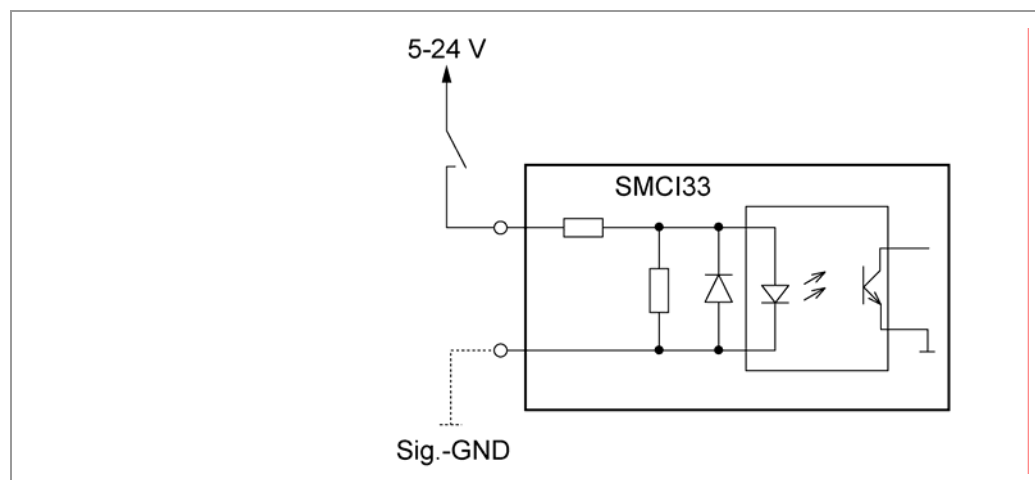
Output circuits

The outputs are transistor outputs in Open-Collector circuits (0 switching, max. 30 V / 30 mA). An LED can be integrated to test the output. The LED lights up when the output is active.
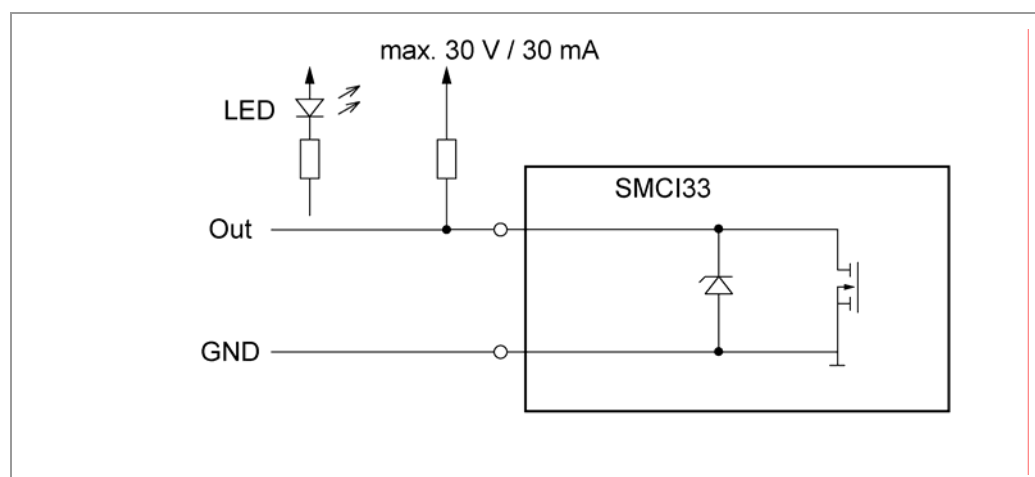
3.2 Encoder connection: Connector X2

Optional encoder

An optional encoder can be connected to the stepper driver.

By default, the closed-loop control for a three-channel encoder is set up with 500 pulses/revolution in an 1.8° stepping motor. With an 0.9° stepping 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 driver: 192, 200, 256, 400, 500, 512, 1000, 1024, 2000, 2048.

Recommended:
Where possible, use Nanotec encoders with the order number WEDS/WEDL-5540 Xxx.

If an encoder is **not** used, the mode "Disable" must be set in the tab "Errorcorrection" in the selection menu "Rotation Direction Mode". See the separate manual on NANOPRO as well.

Using encoders with line driver

As well as the encoder signal, the encoders of the HEDL series with line driver also output an inverted signal that contributes to better interference immunity and is especially recommended for long cable lengths.

SMCI drivers in order to monitor positioning. We recommend shielding and twisting the encoder line to minimise external interference influences on the encoder signal.

In the third quarter of 2009 Nanotec is bringing an adapter onto the market which can also evaluate the differential signal.

Encoder connection diagram (X2)
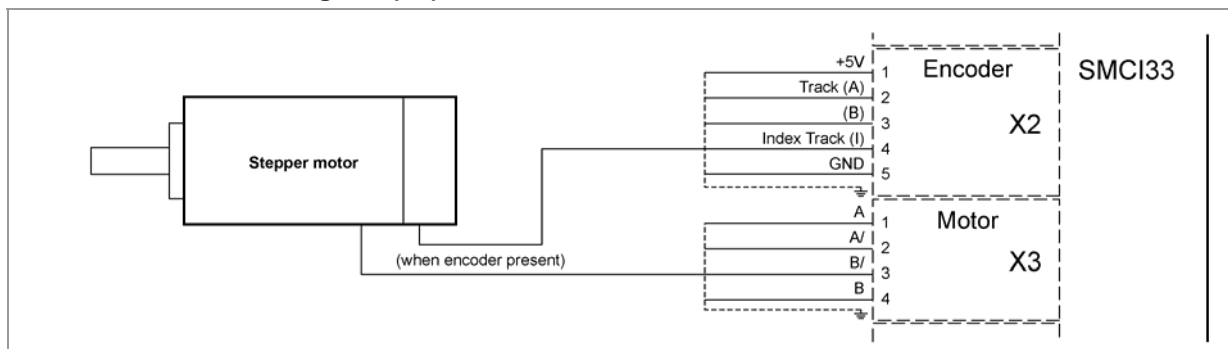
Note:
Complete connection diagram - see Section 2.1.

Pin assignment connector X2: Encoder

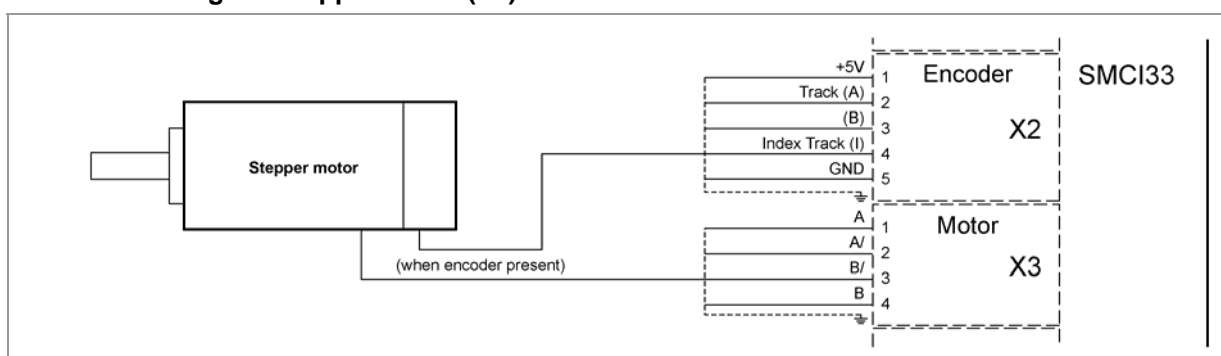| Pin-No.	Name	Observations
1	+5 V	
2	Track (A)	
3	Track (B)	
4	Index track (I)	
5	GND	

3.3 Stepper motor connection: Connector X3

General information

The motor is connected to the SMCI33 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! Never disconnect the link when operating voltage is applied! **Never** disconnect lines when live!

Connection diagram stepper motor (X3)

	Note: Complete connection diagram - see Section 2.1.

Pin assignment connector X3: Stepper motor

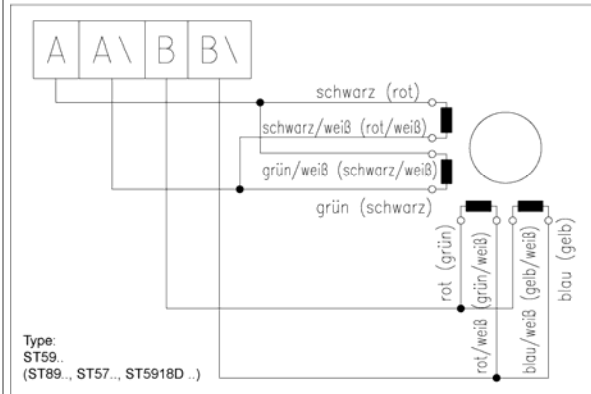| Pin-No.	Name	Observations
1	A	See also data sheet of connected stepper motor (colour code of 4 wires).
2	A/	
3	B/	
4	B	

If you are using a motor with 6 or 8 connections, you need to connect the windings.

The diagram on the next page shows four wiring plans for motors with 6 or 8 connections (page from the Nanotec product catalogue).

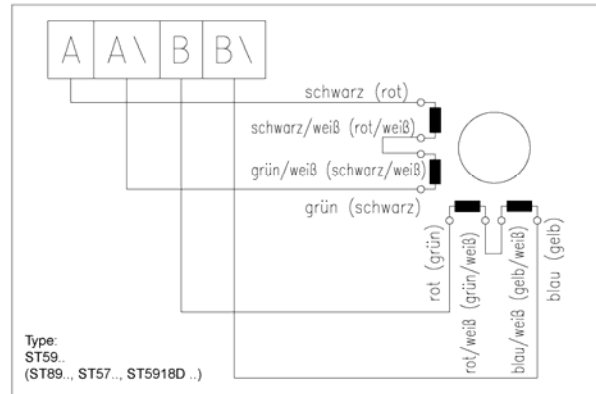Details can be found on the Nanotec website www.nanotec.com.

8 lead wire - parallel   for high frequency > 1 kHz

current per winding x 1,4   = current per Phase
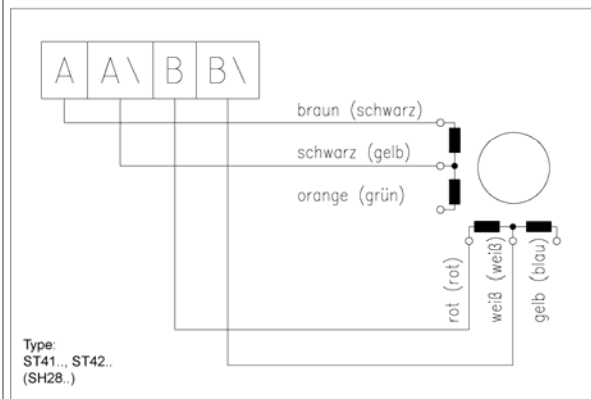example: current / winding 1A = 1,4A / Phase

A A\ B B\

schwarz (rot)
schwarz/weiß (rot/weiß)
grün/weiß (schwarz/weiß)
grün (schwarz)

rot (grün)
rot/weiß (grün/weiß)
blau/weiß (gelb/weiß)
blau (gelb)

Type:
ST59..
(ST89.., ST57.., ST5918D ..)

8 lead wire - serial   for low frequency < 1 kHz

current per winding x 0,7   = current per Phase
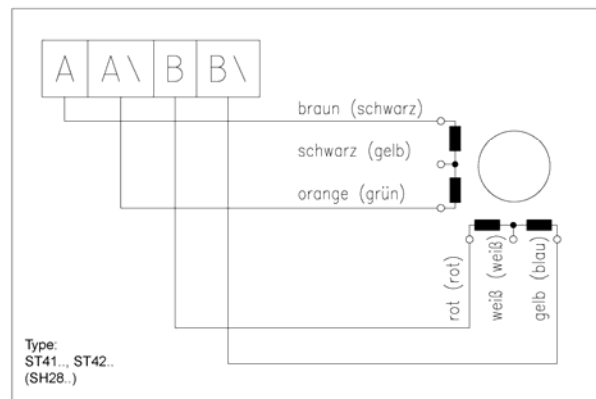example: current / winding 1A = 0,7A / Phase

A A\ B B\

schwarz (rot)
schwarz/weiß (rot/weiß)
grün/weiß (schwarz/weiß)
grün (schwarz)

rot (grün)
rot/weiß (grün/weiß)
blau/weiß (gelb/weiß)
blau (gelb)

Type:
ST59..
(ST89.., ST57.., ST5918D ..)

6 lead wire

current per winding   = current per Phase
example: current / winding 1A = 1A / Phase

A A\ B B\

braun (schwarz)
schwarz (gelb)
orange (grün)

rot (rot)
weiß (weiß)
gelb (blau)

Type:
ST41.., ST42..
(SH28..)

current per winding x 0,7   = current per Phase
example: current / winding 1A = 0,7A / Phase

A A\ B B\

braun (schwarz)
schwarz (gelb)
orange (grün)

rot (rot)
weiß (weiß)
gelb (blau)

Type:
ST41.., ST42..
(SH28..)

4 lead wire

current per winding   = current per Phase
example: current / winding 1A = 1A / Phase

A A\ B B\

braun (schwarz)
orange (grün)

rot (rot)
gelb (blau)

Type:
ST41.., ST42..
(SH20..)

current per winding   = current per Phase
example: current / winding 1A = 1A / Phase

A A\ B B\

rot
weiß

gelb
grün

Type:
ST110..
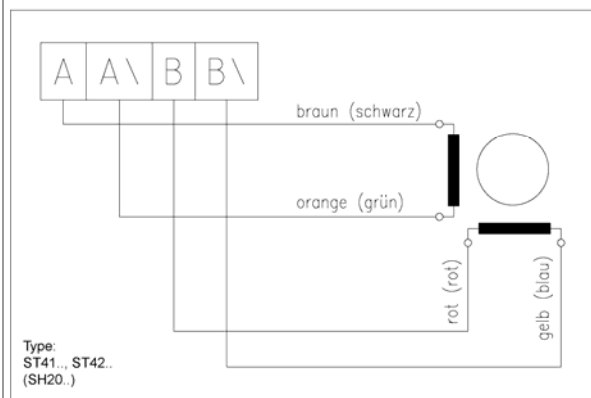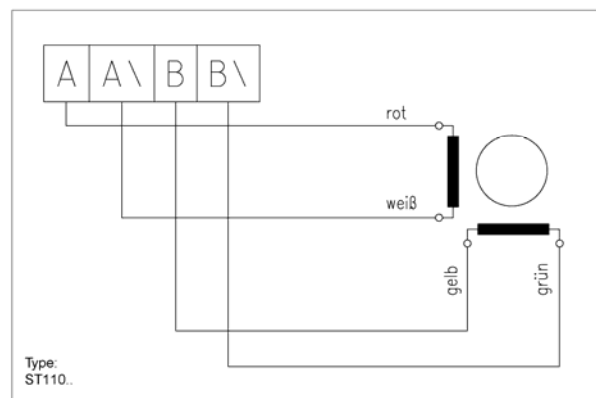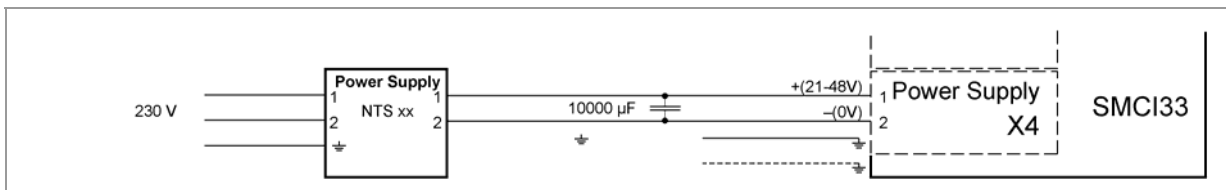
3.4 Voltage supply connection: Connector X4

Permissible operating voltage

The permissible operating voltage for the SMCI33 stepper driver 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! Never disconnect the link when operating voltage is applied! **Never** disconnect lines when live!

Connection diagram voltage supply (X4)

Note:
Complete connection diagram - see Section 2.1.

Voltage supply connections: Connector X4

Pin-No.	Name	Observations
1	Vcc	Switch on the operating voltage (+24 V DC ... +48 V DC)
2	GND	Earth (0 V)

Accessories for voltage supply

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   Interface RS485 network: Connector X5

SMCI33 in a network

Up to 254 stepper drivers can be controlled in a network from a PC or PLC.

These network connections are set up via the RS485 interface.

RS485 interface (D-Sub socket connector): Connector X5

A 9 pin D-Sub socket connector is located on the top of the SMCI33 (connector X5). The connector X5 provides the optional connection to the RS485 network.

RS485 socket connector
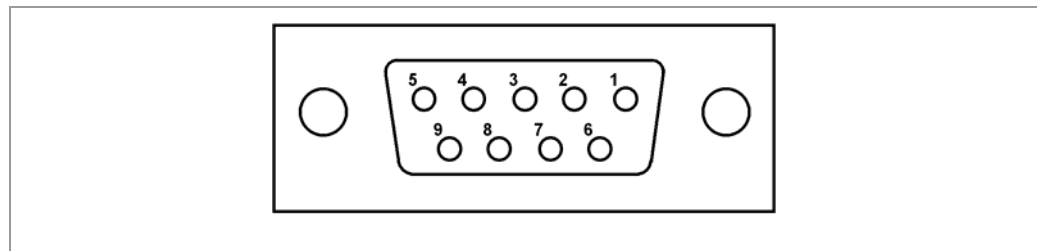
Pin assignment connector X5: RS485 interface

Pin-No.	Name	Observations
1	NC	not assigned
2	A	RS-485 Rx+
3	+5 V	Output +5 V
4	Y	RS-485 Tx+
5	NC	
6	NC	
7	B	RS-485 Rx–
8	GND	Output GND (0 V)
9	Z	RS-485 Tx–

Two-wire operation

To enable RS-485 two-wire transmission capability, all bus stations must have a direction control.

An intelligent converter, which automatically switches to transmission mode when a start bit is received at the RS-232 interface and returns to reception mode at the end of the stop bit, enables two-wire operation of the SMCI33. This solution does not require software support.

We can recommend the ICP-7520 converter, for example, that is available from Schuricht.

Talk to our Technical Hotline if you require support for this.

Circuit diagram RS485 network

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). 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). Depending on the mode selected (Int. Ref. / Ext. Ref.), the internal and external reference runs are supported.
Clock direction mode, right	
Clock direction mode, Int. Ref.	
Clock direction mode, Ext. Ref.	
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
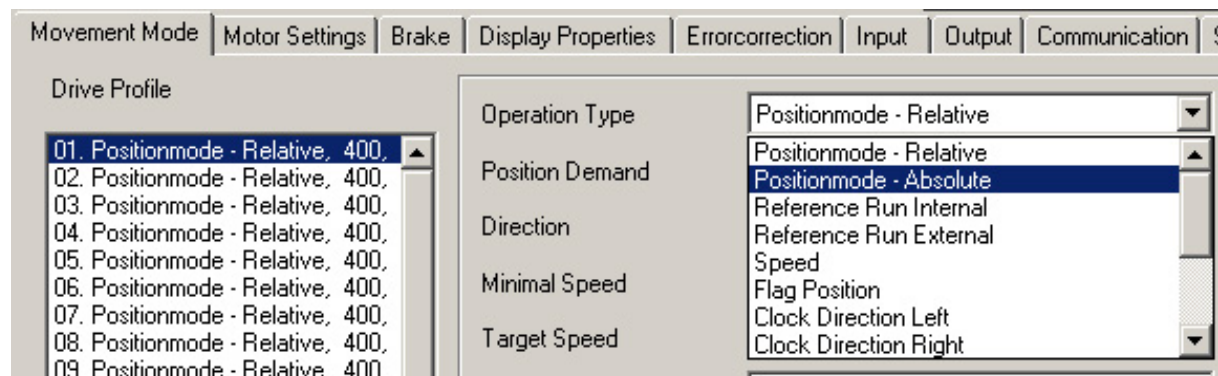
5 Troubleshooting

Troubleshooting procedure

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

⚠️	**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
Driver is not ready	Data transmission to SMCI33 not possible (communication error): Incorrect COM port selected.	In the "Communication" tab, select the PC port to which you have connected the SMCI33 (e.g." COM-1") The port used can be found in the device manager of your PC.
	Communication cable not connected or interrupted (incorrect RS232-RS485 converter used).	Function is not guaranteed with third-party 4-wire cables and 2-wire Nanotec converters do not function. Use the recommended RS232-RS485 converter from Nanotec: • Order number: ZK-RS485-RS232
	A non-existent motor number (module number) is set.	Set the correct module address. See separate manual on NANOPRO.
	The power supply of the SMCI33 is interrupted.	Check voltage supply, switch on if necessary.
	Another open program is blocking the COM port to which the SMCI33 is connected.	Close down other programs on your PC.
	Inadmissible data was sent to the driver during the output of a travel profile.	Click on the <Yes> button to stop the travel profile. The SMCI33 switches back to the "Ready" state. The data can then be resent to the driver.
Transmission error	Data transmission to the SMCI33 is disturbed (sender or receiver are disturbed).	Check the possible causes for the transmission error and rectify the cause of the error.
Position error	A button was clicked while the driver was in error mode (position error or limit switch in normal operation).	Click the button <Yes> in the error message: the error is reset.

Error	Possible cause	Rectification
Red LED on the SMCI33 lit up.	Overtemperature of power electronics > 75 °C	Switch off driver and allow to cool. The error is reset when the SMCI33 is disconnected from the power supply unit.
	Undervoltage	Check voltage supply.

6 Technical data

Electrical connections

Operating voltage U_b	DC 24 V to 48 V ±4%
Max. phase current	Adjustable up to max. 3 A/Phase Continuous current 2 A/Phase
Current drop	Adjustable 0 to 80% of phase current

Interfaces	• **SMCI33-1:**
	  USB standard
	
	• **SMCI33-2**
	  RS-485 (4-wire)
	  19200 Baud (adjustable)
	  1 start bit, 8 data bits, 1 stop bit
	  no parity

Driver parameters

|	
Step resolution	Full step Half step Quarter step Fifth step Eighth step Tenth step 16th step 32th step 64th step Adaptive microstep (1/128)
Step angle	1.8°
Operating modes	Position Speed Flag position Clock direction Analogue Joystick
Step frequency	0 to 50 kHz in clock direction mode 0 to 25 kHz in all other modes
Position monitoring	Automatic error correction up to 0.9°

Protective circuits

Overvoltage and undervoltage	Protective circuit for voltages > 50 V or < 21 V
Max. heat sink temperature	Approx. 67 °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 optocouplers
	5 – 24 V ±10%
	• Safe switch off: max. 2 V
	• Safe switch on: min. 4.5 V
	Signal delay time:
	• Inputs 1 to 5: 120 μs
	• Input 6: 10 μs
Outputs	3 transistor outputs in Open-Collector circuits (0 switching, max. 30 V / 30 mA)

SMCI33 dimensions
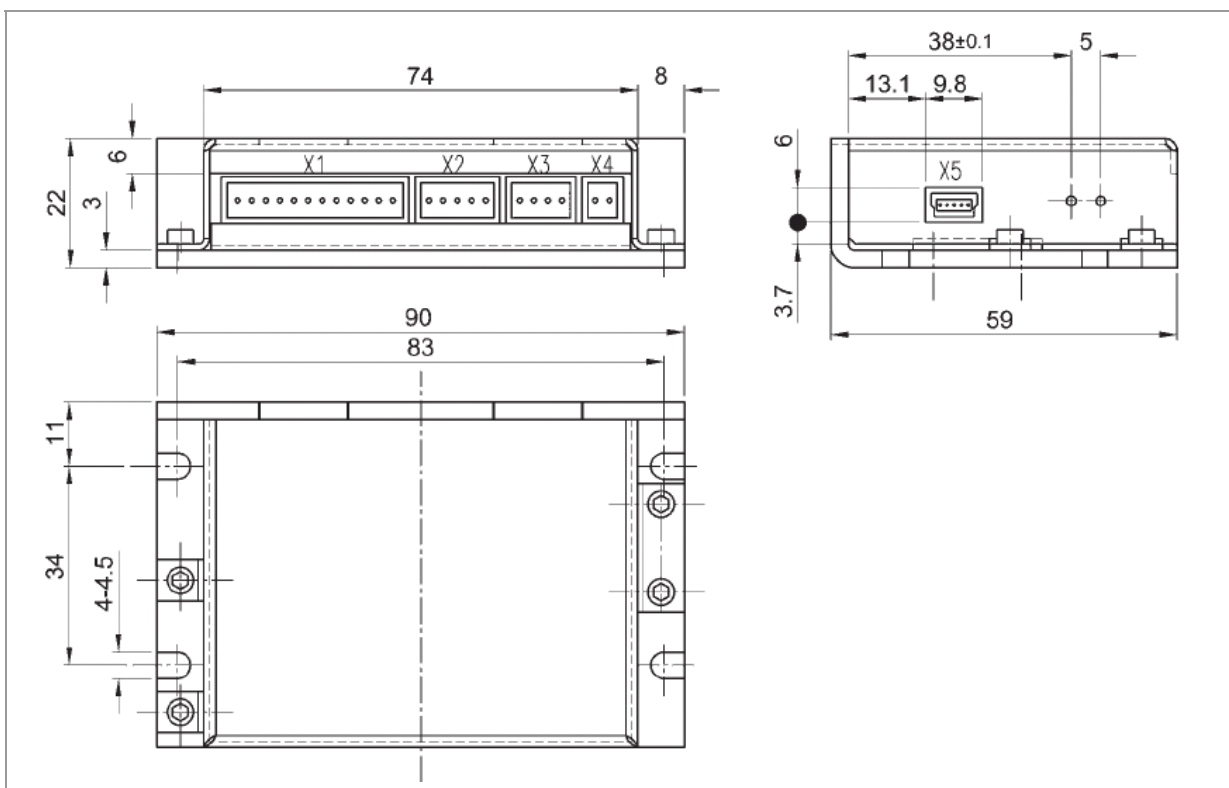
A complete set of datasheets is available for downloading at www.nanotec.com.

Connectors

The following connectors are available on the SMCI33:

- Connectors X1, X2, X3 und X4:
  Phönix connector, Type MICRO COMBICON

- Connector X5
  - SMCI33-1: Mini-USB Type B
  - SMCI33-2: Sub-D 9-pin (RS485)

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