Manual

Stepper motor drive

TSP10

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1 General

1.1 About this manual

This manual contains information on the installation and use of the stepper motor control TSP10. It addresses specialist staff which has the following knowledge or training:

Transport:	knowledge of how to handle construction elements susceptible to electrical discharge
Mounting:	electro-technical training, knowledge of the safety directives
Commissioning:	good knowledge in the areas of electrical engineering and propulsion technology

Observe the national accident prevention instructions.

1.2 Characteristics and modes of operation

The stepper motor controls of the TSP10 are compact microstepping subassemblies to control 2-phase stepper motors.

Operating voltage:	24... 74 V DC
Motor current:	0.2... 7 A_{rms}

Modes of operation of the basic device TSP10-BA:

- control with step and direction signal
- start of programmed motion tasks by digital inputs (indexing function)

Set the device parameters either by two rotary switches at the top side of the device or use the ***TopSuite*** set-up program.
The contact jack for the serial RS232 interface is located in the face of the device. A computer and a Windows® operating system are necessary to use the ***TopSuite*** set-up program.

All digital inputs and outputs are opto-isolated.

A two-colour LED indicates the device status by colours and flashing signals.

The devices of the TSP10 are intended for switchboard mounting.

Heat is removed by the back or lateral supporting surface of the case.

If the back surface is used for mounting, you may fasten a heat sink at the lateral supporting surface. This improves the dissipation of heat.

1.3 Warning and note icons

The following warning and note icons are used in this manual:

Icon	Meaning
⚠ WARNING	Warning against a hazard which may cause heavy injury or death. Observe instructions to avoid hazards!
⚠ CAUTION	Warning against a hazard which may cause slight injury. Observe instructions to avoid hazards!
NOTICE	Note on a situation or unsafe procedure which may damage the product or objects nearby. Observe instructions on safe operation of the product!
INFO	This is no warning icon against a dangerous or injurious situation. This icon indicates notes on use and other very useful information.

2 Safety

This chapter provides important instructions on the safe and intended use of the stepper motor control TSP10.

In your function as a machine manufacturer you are responsible for integrating the stepper motor control TSP10 in your machine. AHS Antriebstechnik GmbH is not liable for any damage which may originate from wrong or unintended use of the stepper motor control TSP10.
Hence, follow strictly the instructions given in this manual to avoid damage to body or property and to apply the stepper motor control TSP10 correctly and efficiently.

2.1 Important safety notes

⚠ WARNING High electric voltage may cause hazardous electric shock to people.

- Never use the stepper motor control unless the case and all cable shields are grounded.
- Never use the stepper motor control while the case is opened. Construction elements and wires in the device are live.
- Do not touch the connections of the supply voltage connector if power is on.
- Do not touch the connections of the motor connector if power is on.
  These contacts are live even if there is no motor connected.

⚠ WARNING Unintentional movements of the driving mechanism may damage people or objects.

- Assess the risk of your machine and take suitable measures to make sure that unintentional movements will not cause damage to persons or objects.
- To safely shutdown the driving mechanism, always interrupt or switch off the supply voltage. Switching the stepper motor control off by the ***enable*** input is not a safe method of interrupting during emergency failures.

⚠ CAUTION Connecting or separating live wires and connections may lead to arcing. This damages wires and contacts and may injure people.

- Connect or disconnect electric contacts only when the supply voltage is switched off.

NOTICE The stepper motor control contains construction elements which are susceptible to electrical discharge and may be damaged by improper use.

- Observe ESD preventive measures according to DIN EN 61340-5.

2.2 Intended use

The stepper motor controls TSP10 may be used only according to points (1) to (7) below.

(1) The stepper motor controls of the TSP10 are intended for installation in electrical plants or machines and may be commissioned only as integrated components of plants or machines.

(2) The stepper motor controls of the TSP10 may be used only in plants or machines that comply with applying national directives or standards.

(3) The manufacturer of these plants or machines have to assess the risk and make sure that unintentional movements of the driving mechanism do not damage people or objects.

(4) To safely shutdown the driving mechanism, always interrupt or switch off the supply voltage of the stepper motor control. Switching the stepper motor control TSP10 off by the ***enable*** input is not a safe method of interrupting during emergency failures.

(5) Use the stepper motor controls TSP10 only to drive suitable stepper motors. The output current of the stepper motor control may not be higher than the rated motor current.

(6) Use only copper wire to establish electric connections of the stepper motor controls TSP10. The cross sections of the conductors are defined in the EN 60204 standard or in table 310-16 of the NEC (columns 60 °C or 75 °C for AWG cross sections).

(7) Observing these operating instructions is a part of the intended use. Observe esp. data on supply voltage, ambient conditions and safe operation.

No other use of the stepper motor controls of the TSP10 is considered compliant with the requirements given in points (1) to (7).

AHS Antriebstechnik GmbH assumes no liability for damages which may result from use which is not compliant with the requirements.

2.3 Standards and directives

TSP10 Step motor drives are components intended to be built into machines or plants for industrial purpose.
The units meet the following standard:

EN 61800-3	Adjustable speed electrical power drive systems Part 3: EMC requirements and special test methods

2.4 CE conformity

TSP10 Step motor drives are components that are intended to be built into electrical plant and machines for industrial use. The manufacturer of the machine is responsible that the machine or plant fulfills the requirements of the EMC directive.

EC-DECLARATION OF CONFORMITY

The following company hereby declares

AHS Antriebstechnik GmbH
Fichtenweg 17
64319 Pfungstadt

The Conformity of the following Product Series	
Description:	**Step Motor Drive**
Series	**TSP10**

With the following standards:

EC-Directive 2014/30/EG	Electromagnetic compatibility
Used harmonized standards	
EN 61800-3:2012-09 (B1:2014-02)	Adjustable speed electrical power drive systems Part 3: EMC requirements and special test methods

Place and Date: Pfungstadt, 11.11.2016

Legally binding signature:

This Declaration does not contain any assurance of properties in the meaning of product liability.
The notes on safety and protection in the operating instructions must always be observed.

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BIC: COBADEFF508

3 Product identification

All versions of the stepper motor controls TSP10 are uniquely identified by the type name (order name).
Please, find further details in the ***chapter 15 Ordering code***.

After powering on, the firmware version of the stepper motor control TSP10 is indicated as a flashing code. e.g., 1x flash, break, 2x flash = version 1.2

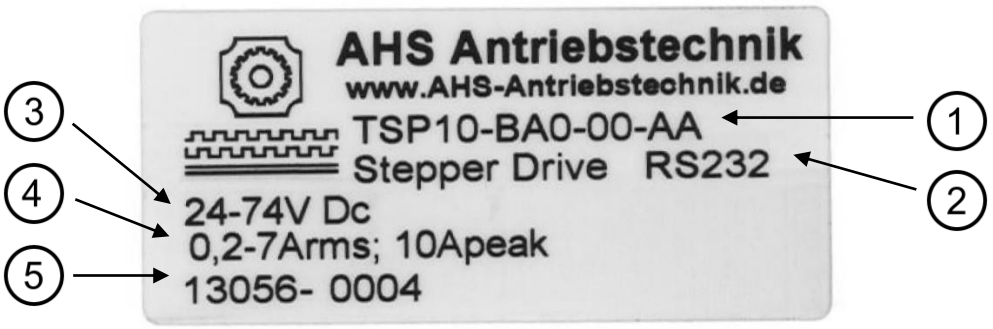
INFO

Since all stepper motor controls TSP10 are equipped with a serial RS232 interface, the firmware version can be displayed by the set-up program ***TopSuite*** as well.

Type name and other data are shown on the name plate of the device.

3.1 Name plate

The name plate is at the side of the case.
The name plate shown in the picture belongs to the standard version of the basic device.



1	Type name (order name)
2	Version of the stepper motor control
3	Operating voltage
4	Maximum output current (rms, peak)
5	Serial number

3.2 Scope of supply

The stepper motor controls TSP10 are delivered with mating connectors to connect the supply voltage and the motor wires.

Supply voltage:	Phoenix Contact FKCT 2,5/4-ST
Motor connector:	Phoenix Contact FKCT 2,5/5-ST

3.3 Accessories

Cable for serial interface (article AHS No. KAB-TSP-232)

Heatsink (article AHS No. HS-TSP)

4 Technical data

4.1 Electric data

Supply voltage	24 - 74 V_{DC}
Motor current **Number of selectable values**	0.2 to 7.0 A_{rms} 16 *
Motor current @ ambient temperature **without heat sink**	3.2 A at 25 °C 1.6 A at 45 °C
with heat sink	7.0 A at 25 °C 3.5 A at 45 °C
Permissible heat sink temperature	Max. 60 °C (forced cooling may be necessary)
Permissible ambient temperature **Operation** **Storage**	0 °C to +50 °C –55 °C to +70 °C
Humidity	10-90 %, non-condensing
Chopper frequency of power stage	20 kHz
Input signals	Step Direction Enable DE1 ... DE10 (customisable)*
Input interface	RS232
Output signals	Enabled DA1 ... DA4 (customisable)*
Idle current reduction	off (motor current always on 100%) after 0.1 s at 50% after 1... 3000 ms (adjustable) * at 0... 100% (adjustable)*
Max. input frequency	500 kHz
Adjustable step resolution	200 bis 10000*
Preset numbers of steps	200, 400, 500, 800, 1000, 2000, 5000, 10000
Operating lights	Two-Colour-LED
Fault protection	Short circuit (phase to phase, phase to zero conductor) and over temperature

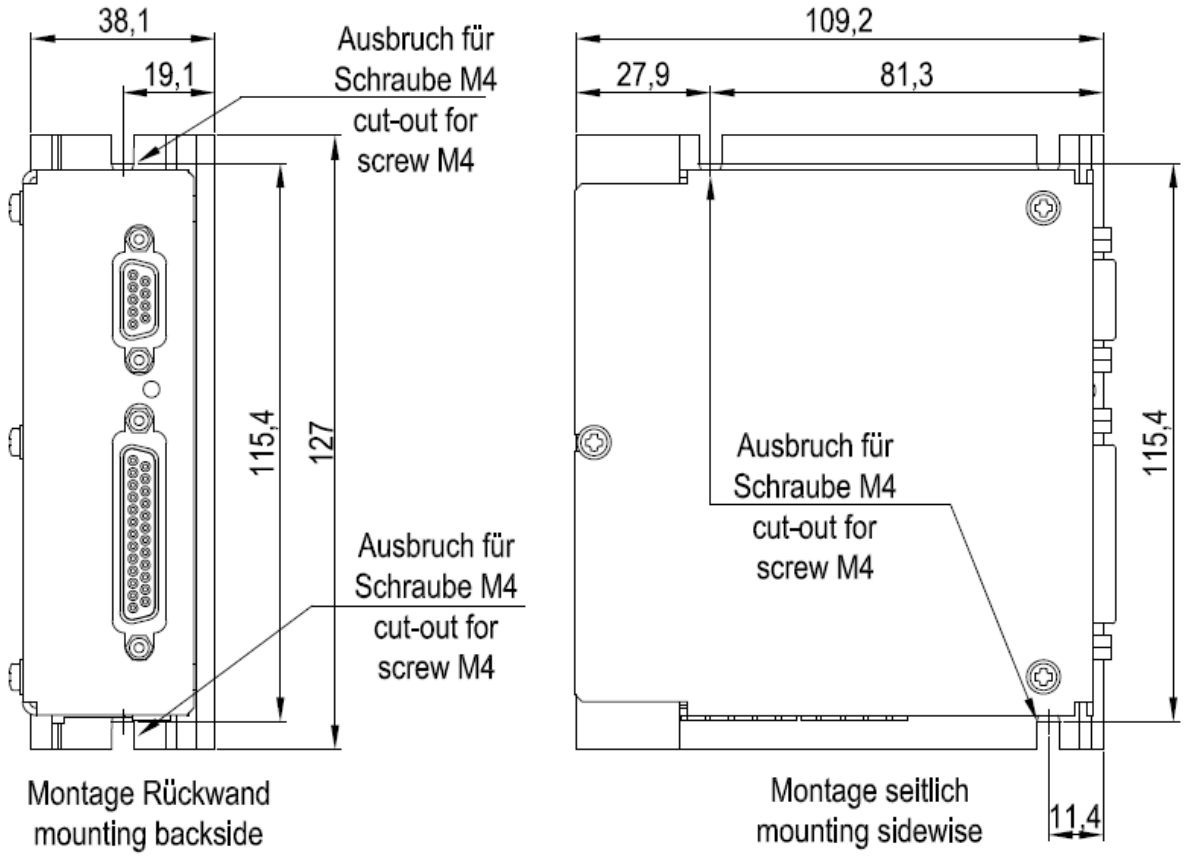
***** *set additional values via the RS232 interface*

4.2 Mechanical data

The case of the stepper motor control TSP10 consists of two parts which are joined and screwed together. A part of the case is designed as a heatsink bracket including cut-outs to mount the TSP10 in the switchboard.

Case material: Aluminium
Overall weight: 500 g

The exact dimensions of the stepper motor control TSP10 are given in the dimensional drawing.



all dimensions in mm

5 Mechanical installation

NOTICE

Powerful magnetic fields may affect parts in the TSP10. This may damage the stepper motor control or the connected motor.

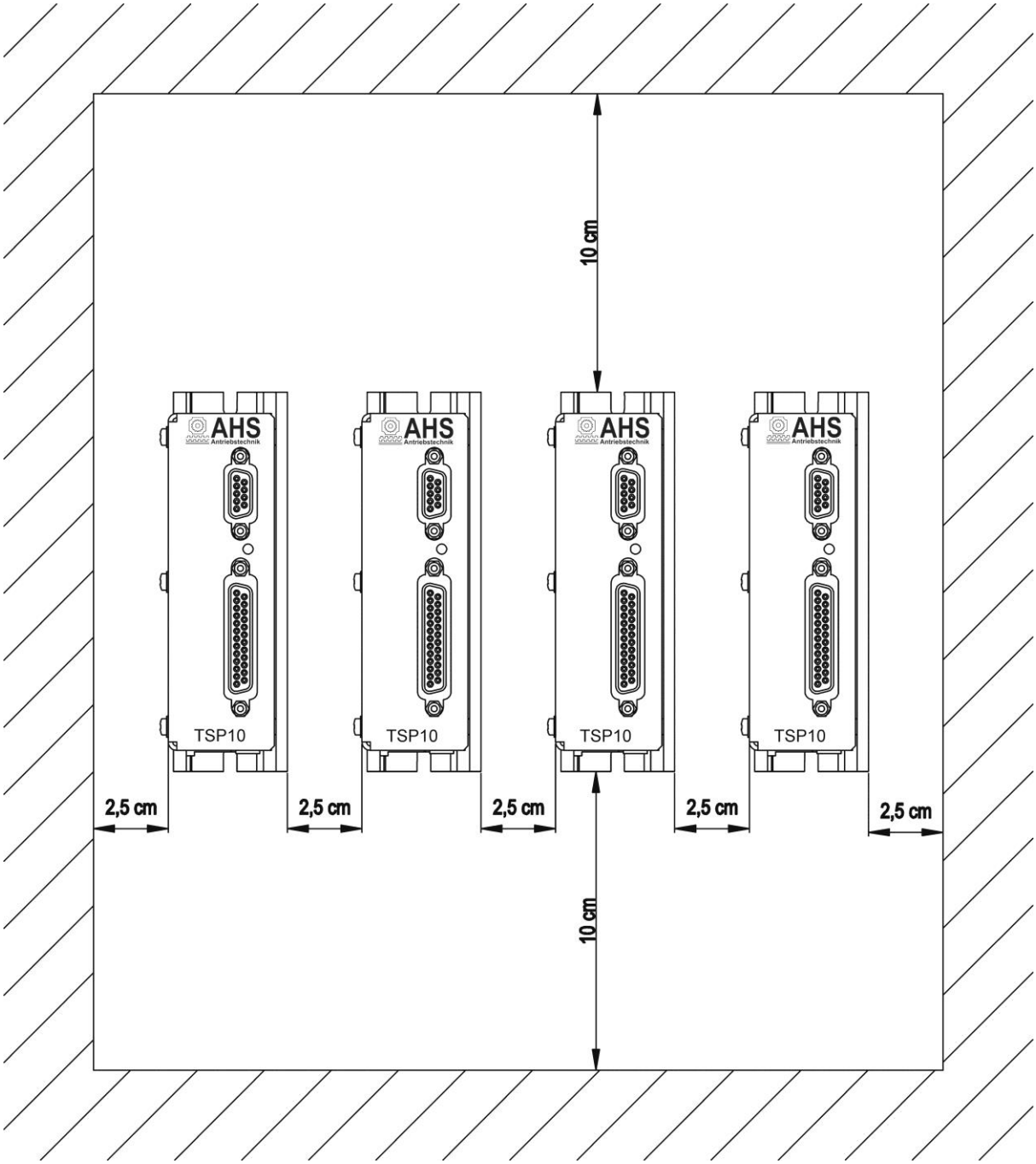
- Mount any devices which generate magnetic fields far enough away from the TSP10 and/or shield magnetic fields.

5.1 Switchboard assembly

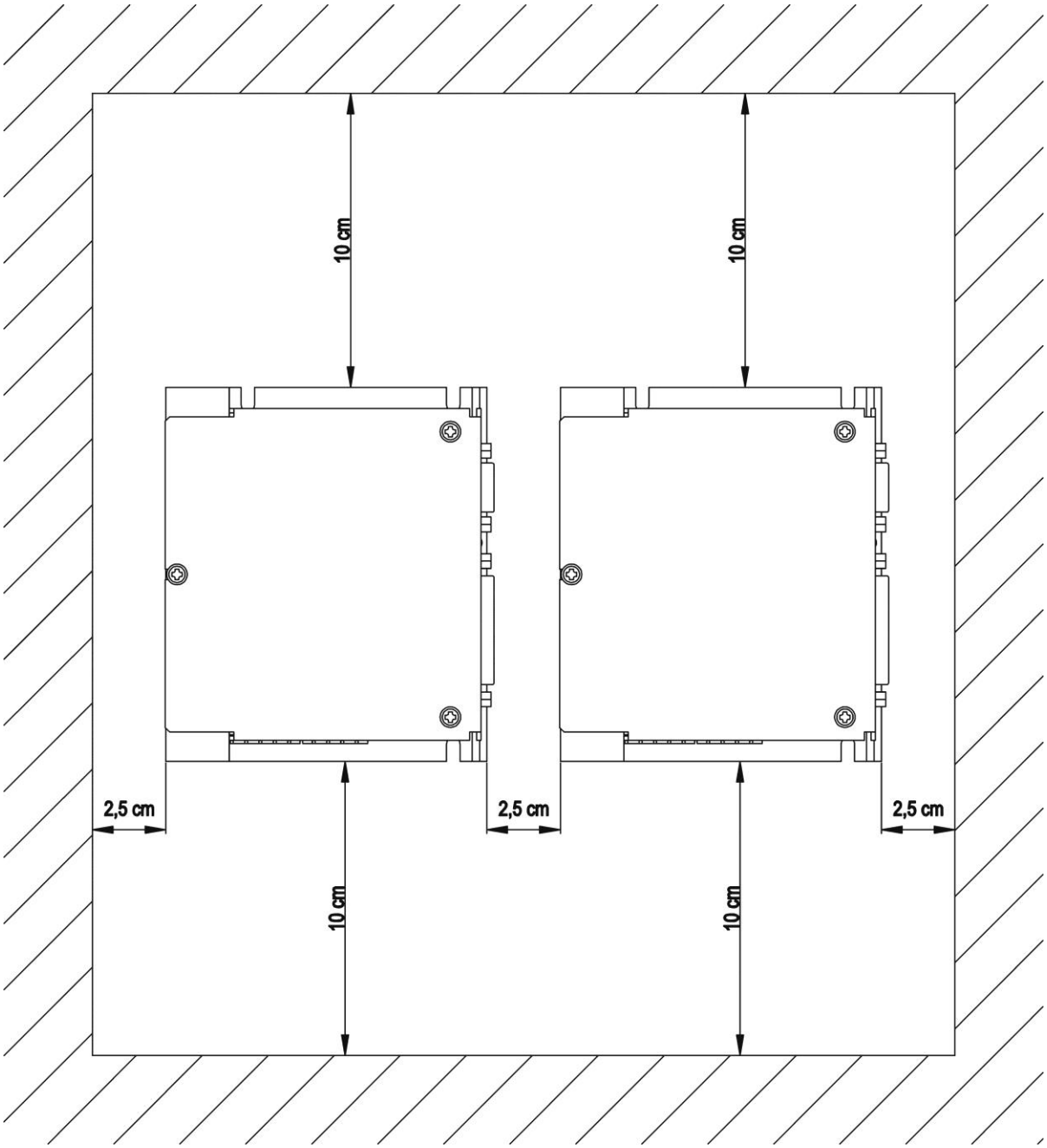
The stepper motor control TSP10 is usually fastened with M4 screws on a mounting surface of the switchboard. The cut-outs for the screws are arranged in such a way that the TSP10 may be mounted at the back of the device or at its side.

Observe the following requirements for assembly:

- The mounting surface should be level and able to carry sufficient load to bear the device's 500 g of weight.
- Powerful shocks, vibrations or impacts may not affect the stepper motor control TSP10.
- Mount the device vertically aligned. Horizontal alignment impairs the cooling.
- Leave at least 10 cm of space above and below the device and at least 2.5 cm on either side.
- Do not cover the airing drillings of the TSP10 case.
- Arrange the cooling/airing of the switchboard in such a way that the case temperature of the TSP10 does not rise above 60 °C.
- The inside temperature of the switchboard (ambient temperature for the TSP10) may not rise above 50 °C.



This illustration shows how to mount the TSP10 at the back of the device.
The measures given indicate how much space should be left.
The shaded area may be occupied by other devices or the switchboard wall.



This illustration shows how to mount the TSP10 at the side of the device.
The measures given indicate how much space should be left.
The shaded area may be occupied by more devices or the switchboard wall.

5.2 Cooling and permissible motor current

NOTICE

The stepper motor control TSP10 shuts down when overheating.
This may damage the machine.

- Observe the following notes on how to cool the stepper motor control TSP10.
- Design your machine to avoid damage from automatic shutdown of the stepper motor control.

INFO

When designing your machine, consider in general the automatic shutdown of the stepper motor control.
The motor will also shut down, for example, if the motor current exceeds the permissible peak value.

The thermal loss from the stepper motor control TSP10 is mainly a function of the motor current and the chosen current reduction.
This means that the highest permissible motor current is a function of the cooling of the TSP10.

A part of the case is turned into a heatsink bracket to dissipate thermal loss. The cut-outs to mount the TSP10 in the machine are in this part of the case.

The TSP10 may be mounted at the back wall or the side wall of the device.
In addition, the top and bottom of the case are provided with airing holes to permit cool air to flow through the TSP10.

If the TSP10 is mounted on a mounting plate, the surface for dissipating the thermal loss is larger.
The cooling surface may be enlarged by applying the heatsink by AHS Antriebstechnik GmbH as well (***chapter 3.3 Accessories***). Screw the heatsink at the side of the case. Mount the TSP10 in this case at the back side of the case.

This results in many options for cooling the stepper motor control.

INFO

Heat transfer to the mounting plate or the heatsink is improved by the use of thermal pad or paste.
Coating layers on the mounting plate may block the heat transfer. Remove any coating from the mounting surface, if possible.

A few examples follow on how the highest permissible motor current depends on the cooling. The stated motor currents are effective values.

Assembly without cooling plate and heat sink		
	Ambient temperature	Highest permissible motor current
Free convection	25 °C	3.2 A
	45 °C	1.6 A
With fan	25 °C	7.0 A
	45 °C	3.5 A

Assembly on cooling plate *		
	Ambient temperature	Highest permissible Motor current
Free convection	25 °C	5.0 A
	45 °C	2.5 A
With fan	25 °C	7.0 A
	45 °C	5.0 A

** Size the cooling plate (mounting plate) in the switchboard in such a way that the temperature of the TSP10 case does not rise above 60 °C.*

Assembly with heat sink		
	Ambient temperature	Highest permissible Motor current
Free convection	25 °C	7.0 A
	45 °C	3.5 A
With fan	25 °C	7.0 A
	45 °C	7.0 A

INFO

Check the temperature of the TSP10 case by direct measuring with a temperature sensor while the plant is running. In addition, you may display the device temperature in the parameterization programme ***TopSuite***. This measured value is used for shutdown because of overheating.

6 Electric installation

⚠ CAUTION Connecting or separating live wires and connections may lead to arcing. This damages wires and contacts and may injure people.

- Connect or disconnect electric contacts only when the supply voltage is switched off.

⚠ CAUTION Improper installation of the stepper motor control may destroy the stepper motor control or connected devices, or people may be injured by electric shock.

- The stepper motor control may be installed only by specialist staff trained in electrical engineering.

The stepper motor control TSP10 has four terminals to connect external components:

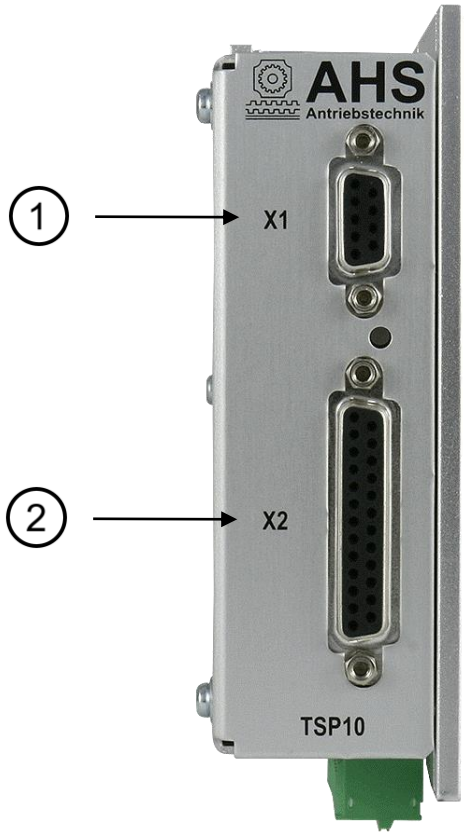
- supply voltage (X3)
- motor connection (X4)
- signal inputs and outputs (X2)
- RS232 interface (X1)

The following paragraphs specify the connector configuration and the typical wiring.

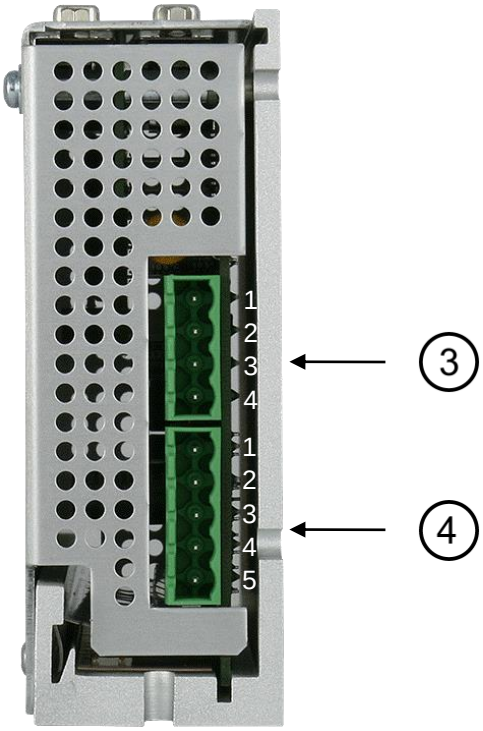
The stated wire cross sections, the implementation of the wiring and methods of grounding and shielding are complying with the general state-of-the-art and are sufficient for most applications.

INFO Special applications, operating conditions and system configurations or standards and regulations may require to connect the TSP10 in a manner not described in the following paragraphs. In particular standards and regulations will then override the information given here.

6.1 Connections



Front side

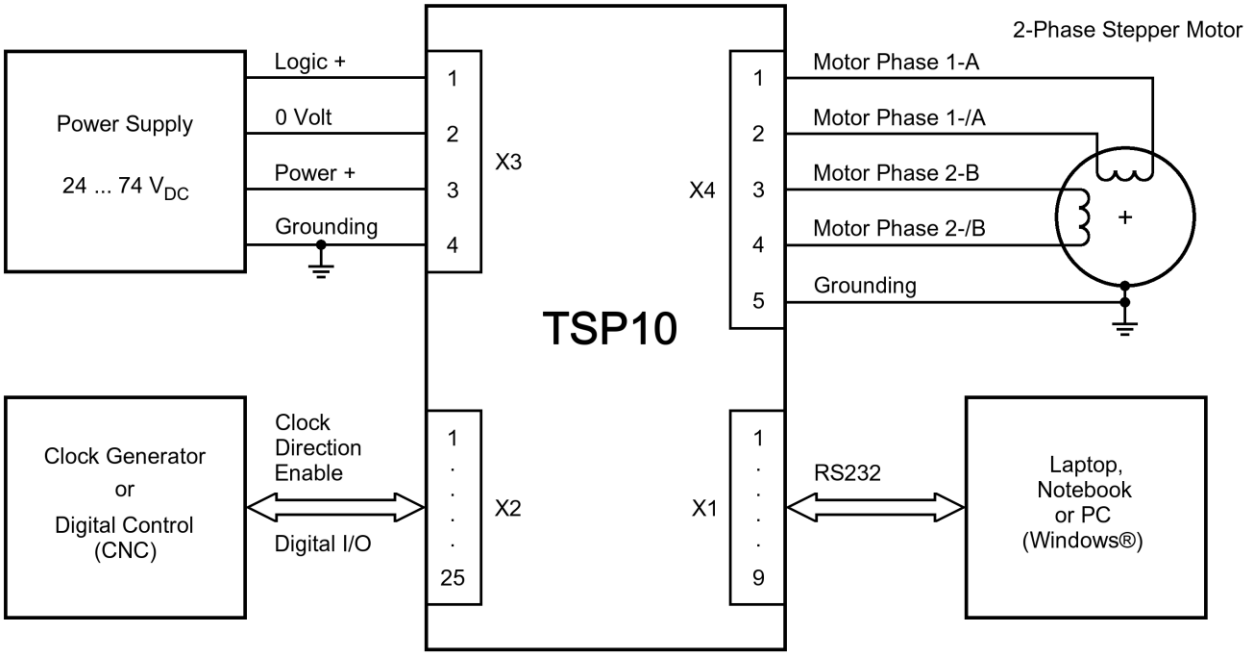


Bottom side

No.	Connection	Position and construction
1	**RS-232 interface**	X1, front side, Sub-D-Socket 9p
2	**Signal inputs and outputs**	X2, front side, Sub-D-Socket 25p
3	**Supply voltage**	X3, bottom side, FKCT 2,5/4-ST
4	**Motor connection**	X4, bottom side, FKCT 2,5/5-ST

6.2 Connections

The shielding of the wiring and the grounding of the TSP10 cabinet are not displayed!



The following paragraphs specify the signal configuration of the connections and provide notes on wiring.

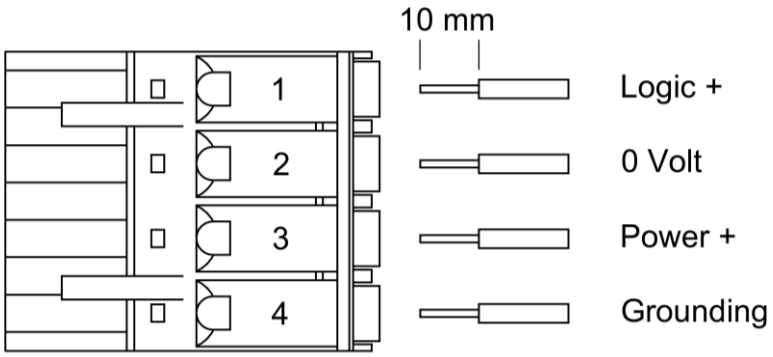
Using the signal inputs and outputs depends on the mode of operation of the stepper motor control. Please, find details in ***chapter 9 Mode of operation: Step and direction*** and ***chapter 10 Mode of operation: Execute profiles***.

Observe the following during installing to avoid electric interference by operating the TSP10:

- Use shielded and twisted cable for the signal and capacity connections.
- Ground the shields extensively with shield clamps at both cable ends or
- Mount a well-grounded rail near the stepper motor control TSP10 to which you extensively apply cable shields and shield clamps.
- Continue the wire shields to the TSP10, not spending more than 1 m of cable between the grounding rail and the TSP10.
- Connect the case of the TSP10 extensively conducting with the machine ground. Remove any coating from the mounting surface.

6.3 Supply voltage

X3 – supply voltage		
Terminal No.	**Line**	**Description/ Notes**
1	Logic +	+24 ... +74 volt
2	0 Volt	Ground this connection externally
3	Power +	+24 ... +74 volt, max. 7 A
4	Grounding	Connected with the case in the device



Supply voltage plug

INFO

Do not solder the wire ends! Solder "flows" under pressure and may loosen the connections after some time.

A supply voltage unit with one output voltage is enough to feed the stepper motor control TSP10. No electronically controlled supply voltage unit is required.

The logic stage of the TSP10, however, may be run at a lesser voltage, regardless of how the power stage is supplied. If you do not need a separate supply, you may bridge terminals 1 and 3 in the plug.

If the full power of the TSP10 is required, the supply voltage unit should be able to feed a peak current of approx. 7 A.

The stepper motor control TSP10 does not provide continuous power for the motor but applies connected power transistors. The motor current is controlled by the step width modulation of the switching signals, using the motor inductance for power storage.
This operation mode results in a very good electrical efficiency, i.e. the stepper motor control transfers most of the consumed power to the motor and only little power is lost from the TSP10. The current drawn from the supply voltage is not continuous, though, but pulsed.

The wiring between the charging capacitor of the supply voltage unit or an external storage capacitor and the TSP10 should not be too long so that the TSP10 is able to consume the pulsed current from the charging or storage capacitor. At a supply voltage of 24V, a storage capacitor of 100000µF is recommended.

Observe the following requirements to connect the TSP10 to the supply voltage:

- Use cables with a cross section of 1.5 mm².
- Use twisted pair cables as ***0 volts*** and ***power +*** wires (terminals 2 and 3).
- Use ***logic +***, ***0 volts*** and ***power +*** wires (terminals 1, 2 and 3) wrapped with a braided shield.
- Ground the shielding extensively with shield clamps.
- The ground wire (terminal 4) may run inside or outside the cable shielding.
- The ground wire (terminal 4) may not be twisted with the other wires.
- The ground wire (terminal 4) may not be longer than 1 m.
- The wire between the charging capacitor of the supply voltage unit and the TSP10 may not be longer than 1 m, for longer wires, install an external storage capacitor.
- The wire between the storage capacitor and the TSP10 may not be longer than 1 m.
- Protect the wire with a 10 A safety fuse (non-automated) with carrier characteristics between supply voltage unit and storage capacitor.

NOTICE

If the peak value of the supply voltage is exceeded, the stepper motor control will be destroyed.
Even brief excesses of the peak value (power spikes) can destroy the stepper motor control.

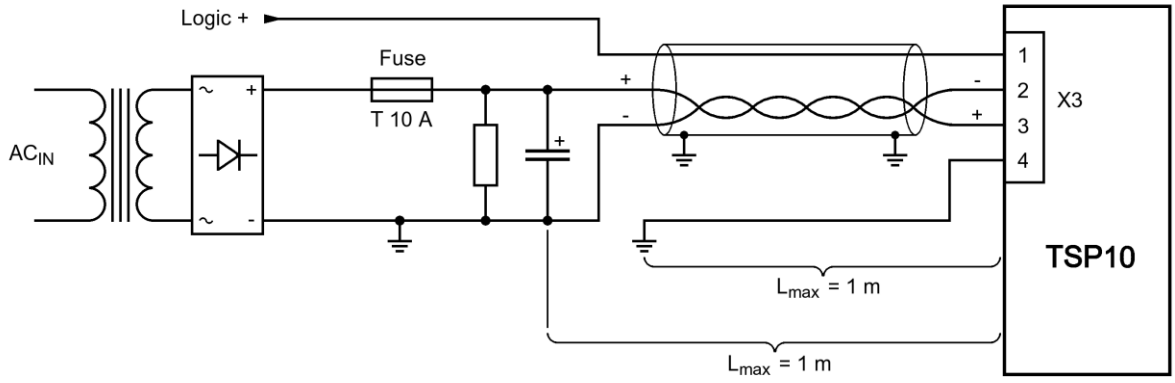
- Observe the requirements for the supply voltage and make sure that the peak value of the supply voltage is never exceeded.

INFO

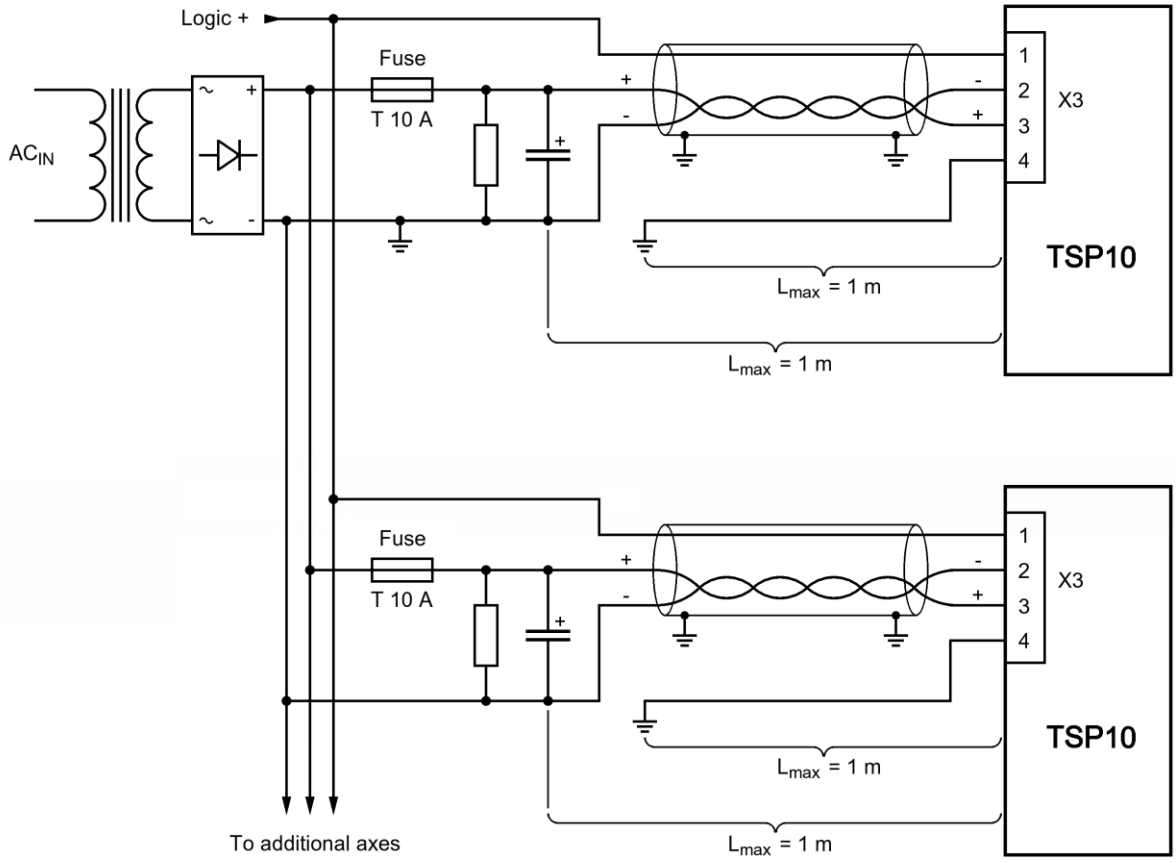
Its operation mode causes the stepper motor control to feed power back from the decelerating motor to the supply voltage.
In high inertia applications this may increase the supply voltage the more, the stronger the motor is decelerating and the longer this deceleration takes. Hence, the supply voltage unit must be able to accept the back-fed energy without the output voltage rising too much.
A simple, disarrayed supply voltage unit may require adding a circuit that delimits the rising of the supply voltage below the peak value.

These illustrations show how to connect the supply voltage to the TSP10.

If you do not need separate supplies of logic and power stages, bridge the terminals 1 and 3 in the connector X3 (not shown).
For applications with several axes, it is better to provide each cable with a fuse between supply voltage unit and each TSP10 than to loop the supply voltage through from device to device.
The ground wire (terminal 4) may be in the cable shielding, too.



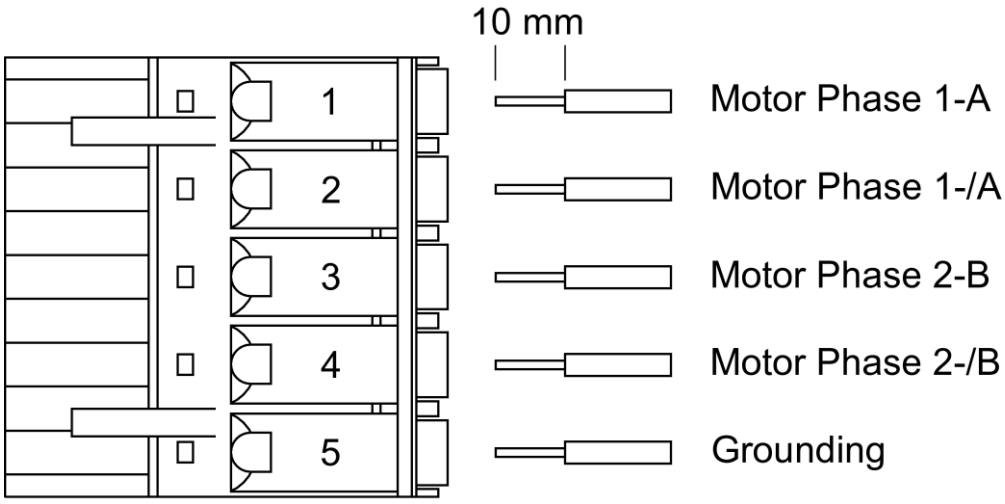
supply voltage of a single axis



supply voltage of several axes

6.4 Motor connection

X4 - motor connection		
Terminal No.	**Line**	**Description/ Notes**
1	1-A	motor phase 1-A
2	1-/A	motor phase 1-/A
3	2-B	motor phase 2-B
4	2-/B	motor phase 2-/B
5	Grounding	Connect with the motor case



Motor cable plug

INFO

Do not solder the wire ends! Solder "flows" under pressure and may loosen the connections after some time.

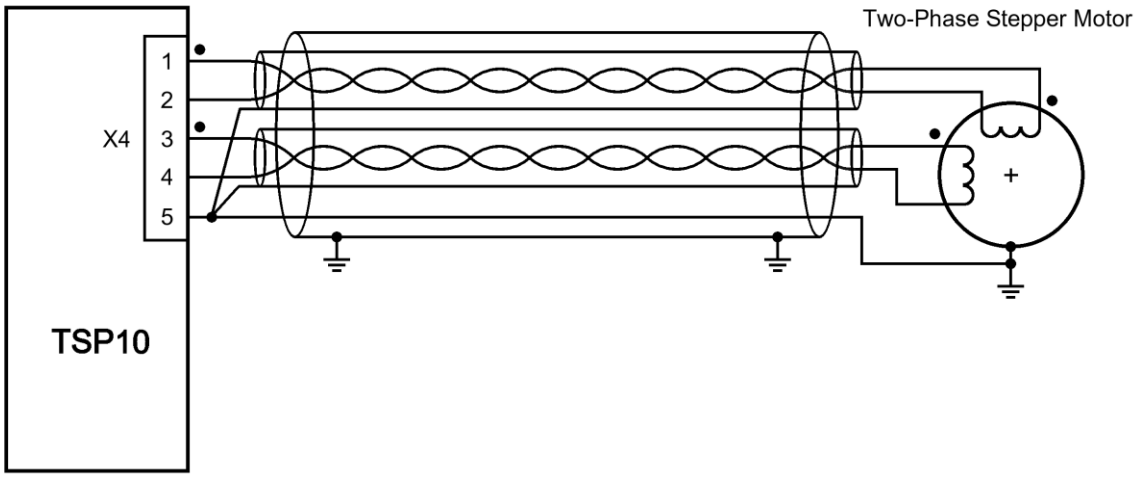
As described in ***chapter 6.3 supply voltage***, the stepper motor control TSP10 applies switched power transistors and uses the motor inductance for power storage.
The motor circuits are alternately connected with or separated from the operating voltage with a switch frequency of 20 kHz. The transistors switch very quickly on and off to keep shift losses low.

Without any shielding, the motor circuits assume the function of aerials, emitting signals into their environment which may cause malfunctions of other electronic devices.

Strictly observe, hence, the notes on the shielding of motor cables and the grounding of the TSP10 case.

Observe the following requirements when connecting a 2-phase stepper motor with the stepper motor control TSP10:

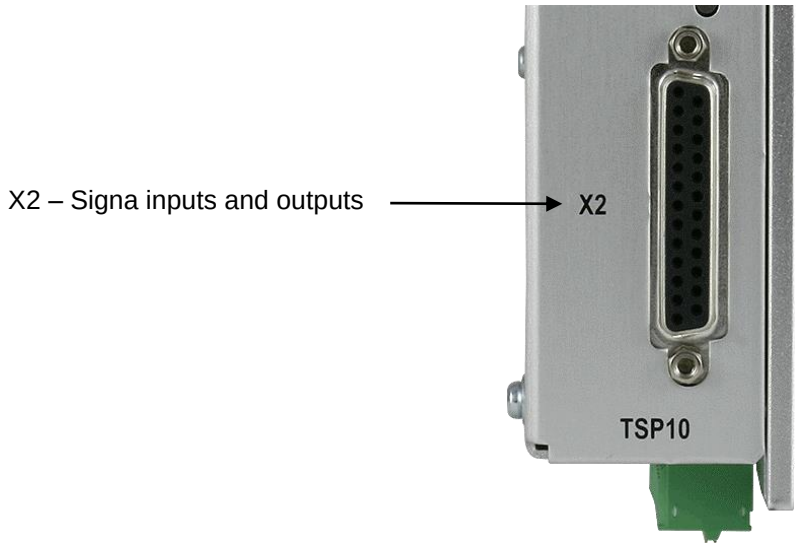
- Use cables with a cross section of 1.0 mm² to 1.5 mm².
- Use twisted pair cables as ***motor phase 1-A*** and ***motor phase 1-/A*** wires (terminals 1 and 2).
- Use twisted pair cables as ***motor phase 2-B*** and ***motor phase 2-/B*** wires (terminals 3 and 4).
- The **ground wire** (terminal 5) may not be twisted with the other wires.
- Connect the ***ground wire*** (terminal 5) with the motor case.
- Use wires (terminals 1 to 5) that are wrapped with a braided shield.
- Ground the shielding extensively with shield clamps.
- For longer motor cables it is advantageous if both twisted pairs are shielded in addition.
- Connecting the internal shields of the twisted pairs with terminal 5 of the motor connector.
- If the motor cable is longer than 20 m, please, ask your distributor.



Implementation of the motor cable for the best noise rejection

6.5 Signal inputs and outputs

X2 - signal inputs and outputs		
Terminal No.	**Signal**	**Description/ Notes**
1	GND-DE	Reference potential of the inputs DE1 - DE10
2	Enable +	Enable or disable the motor current
3	Direction +	Input to control the direction of motor rotation
4	Direction -	Input to control the direction of motor rotation
5	Enable -	Enable or disable the motor current
6	Clock -	Clock pulse input, 1 pulse = 1 step
7	GND-DA	Reference potential of the outputs DA1 - DA4
8	Clock +	Clock pulse input, 1 pulse = 1 step
9	DE1	Digital input
10	DE2	Digital input
11	DE3	Digital input
12	DE4	Digital input
13	DE5	Digital input
14	DE6	Digital input
15	DE7	Digital input
16	DE8	Digital input
17	DE9	Digital input
18	DE10	Digital input
19	5 - 24 V external	Collectors of the output transistors for DA1 - DA4
20	Activated (collector)	Transistor turned on at activated motor current
21	DA1	Digital output (emitter)
22	Activated (emitter)	Transistor turned on at activated motor current
23	DA2	Digital output (emitter)
24	DA3	Digital output (emitter)
25	DA4	Digital output (emitter)
Case	Shielding	Use shielded cable



Signal connection

There are two groups of signal input devices:

- signal input devices with two contacts
- signal input devices with common reference potential

There are two groups of signal output devices as well:

- signal output devices with two contacts
- signal output devices with common reference potential

All signal inputs and outputs are opto-isolated and their function may be customised with the set-up program ***TopSuite***.

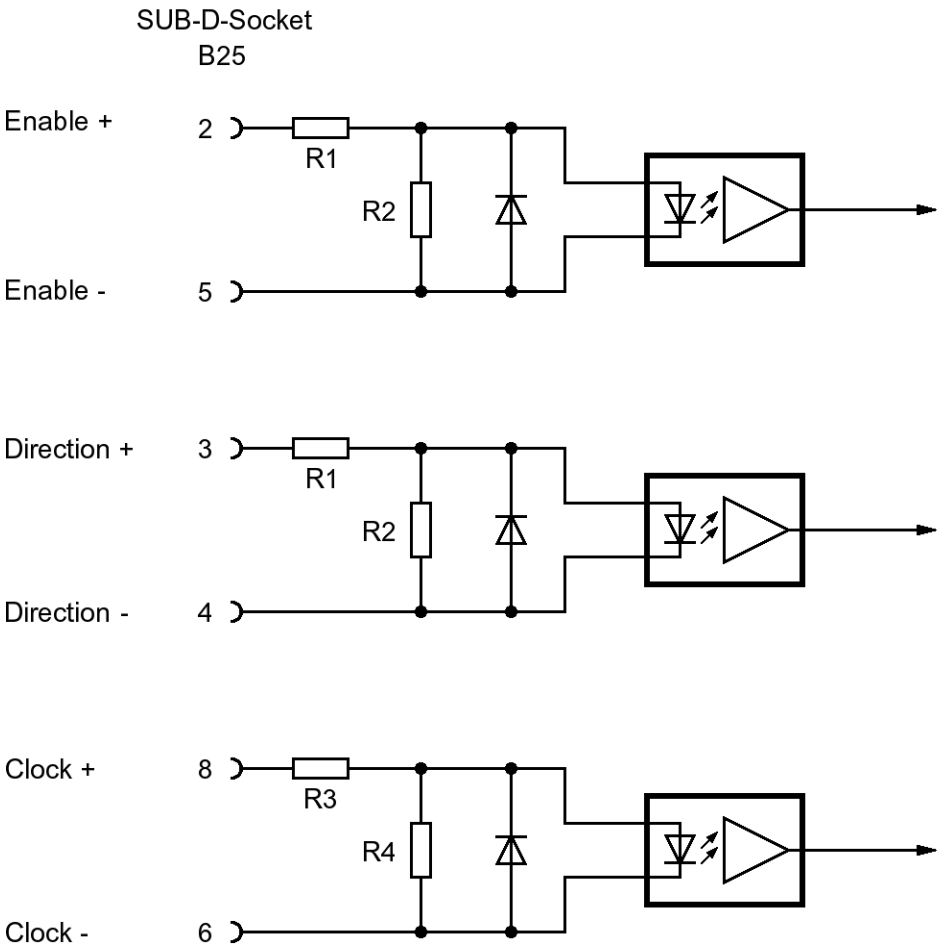
The factory setting of the signal inputs and outputs is set so that only the two contacts signal group is necessary to operate the TSP10 with step and direction signal.

If the factory setting is used, it is not necessary to set the signal functions with the set-up program ***TopSuite***.

Please, find more details on how to connect and use the signal inputs and outputs in ***chapter 9 Mode of operation: Step and direction*** and ***chapter 10 Mode of operation: Executing profiles***.

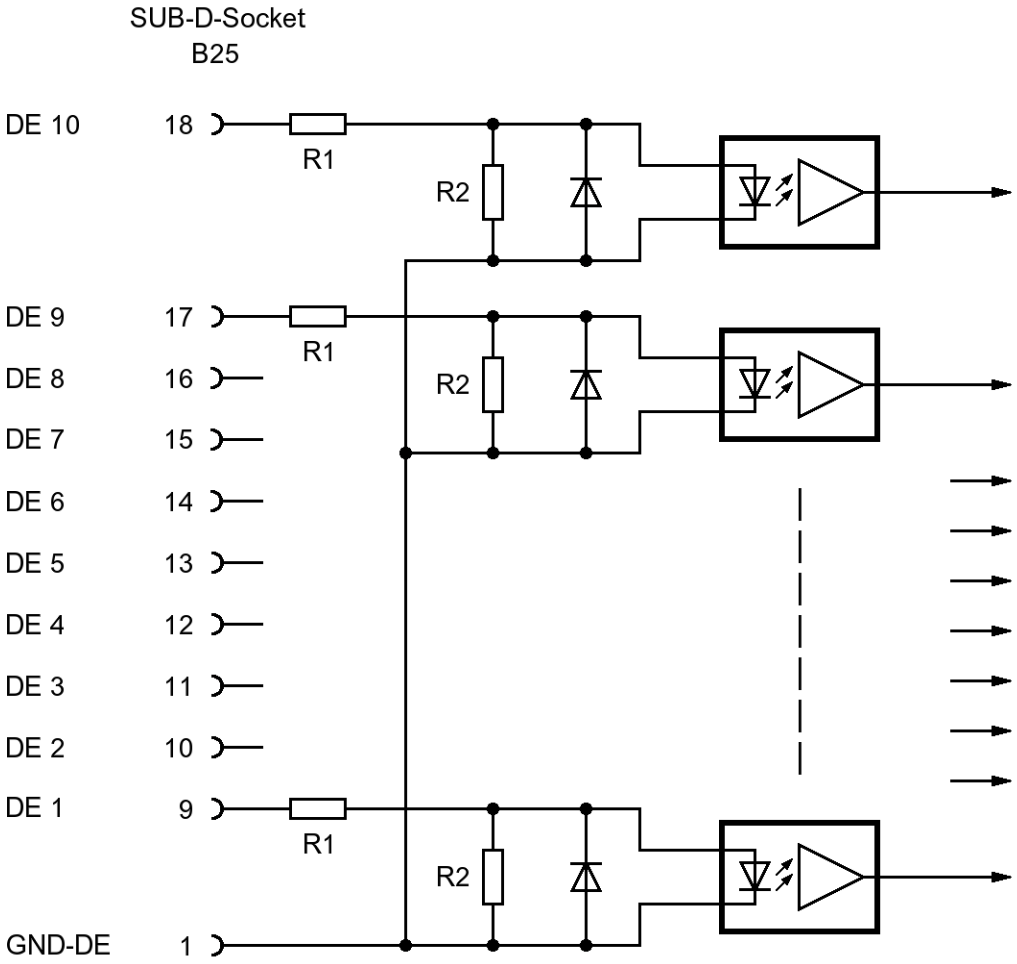
The following pages show the wiring principle of the signal inputs and outputs, the actual implementation may deviate in details from the shown version.

Signal input devices with two contacts



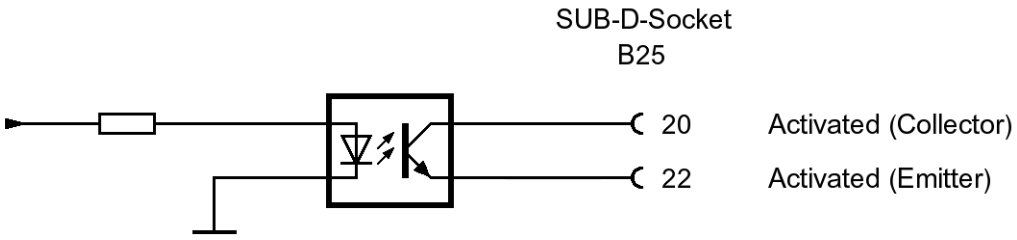
	5-volt input	24-volt input
R1	330 Ohm	2.53 kOhm
R2	1 kOhm	1 kOhm
R3	470 Ohm	2.67 kOhm
R4	1 kOhm	1 kOhm

Signal input devices with common reference potential

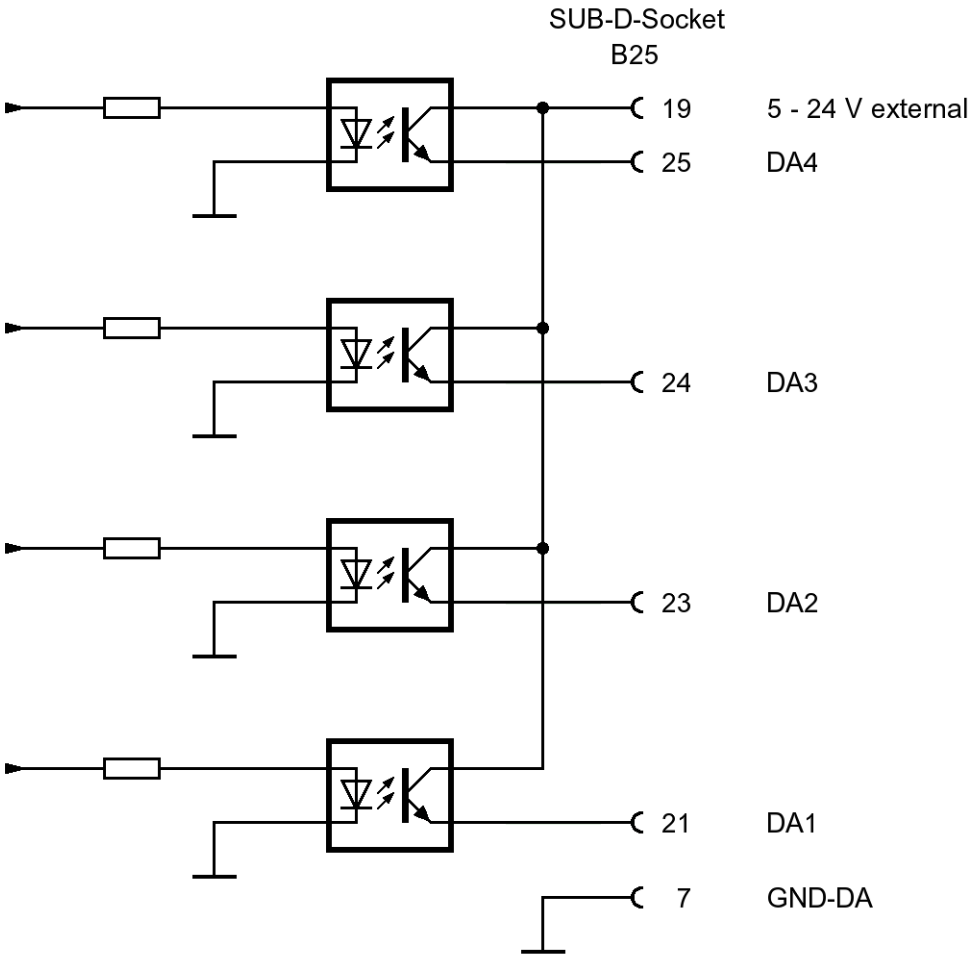


	5-volt input	24-volt input
R1	330 Ohm	2.53 kOhm
R2	1 kOhm	1 kOhm

Signal output devices with two contacts



Signal output devices with common reference potential



6.6 Serial interface

X1 - serial interface (no galvanic isolation)		
Terminal No.	**Signal**	**Description/ Notes**
1	DCD	Indicates the connection with the device
2	TXD	Send data
3	RXD	Received data
4	DTR	Not used
5	GND	Reference potential for all signals

Serial interface

The serial interface helps to set the device parameters with the parameterisation software ***TopSuite***.

Use of the parameterisation software ***TopSuite*** requires a computer with serial interface and Windows® operating system.
Connect the TSP10 and the computer or laptop with a 1:1 cable including plug and jack (item AHS KAB-TSP-232).

Please, find more details on how to use the parameterisation software ***TopSuite*** in ***chapter 9 Mode of operation: Step and direction*** and ***chapter 10 Mode of operation: Executing profiles***.

INFO

The mode of operation ***step and sense*** can be run without the parameterisation software ***TopSuite*** (see ***chapter 7 Parameter setting*** and ***Chapter 10 Mode of operation: Step and direction).***

7 Parameter setting

The following parameters may be set at the stepper motor control TSP10 BA to adapt to different stepper motors and applications:

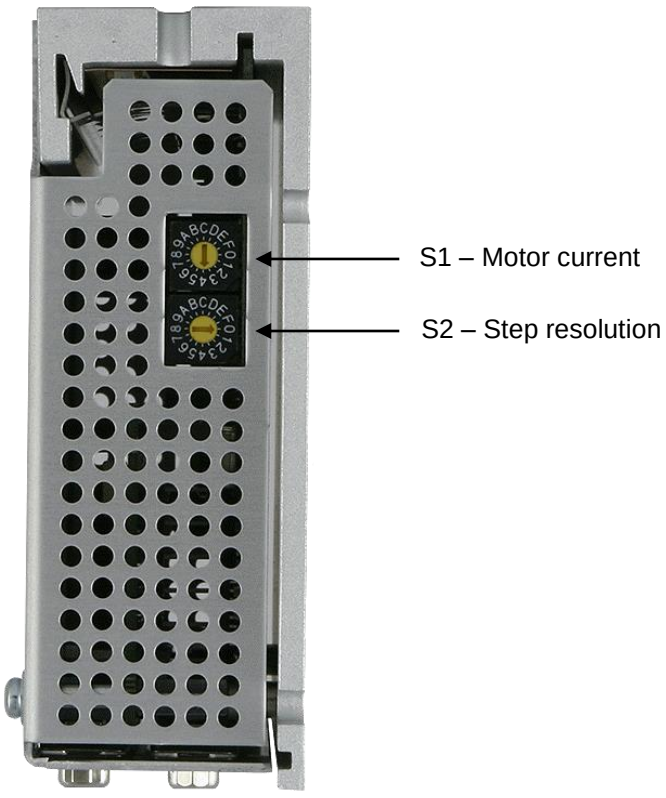
- motor current
- step resolution
- idle current reduction (motor current and waiting time)

Set the parameters at the two rotary switches on the top side of the device. You may find the setpoint tables on the following pages.

The parameter values of the switch positions 1... F are preset.
The value of the switch position 0 is not included in the TSP10 BA ROM and may be changed and saved again with the parameterisation software ***TopSuite***.

The following options for setting the parameters result:

- without parameterisation software: S1/S2 = positions 0 ... F, setpoints from the tables
- with parameterisation software: S1/S2 = position 0, values may be set at random



Rotary switches for setting the motor current and the step resolution

7.1 Motor current

Without parameterisation software

Set the motor current with the rotary switch S1 according to the following table:

Switch S1 Position	Motor current [A_{rms}]
0*	0,2*
1	0,4
2	0,7
3	1,0
4	1,5
5	2,0
6	2,5
7	3,0
8	3,5
9	4,0
A	4,5
B	5,0
C	5,5
D	6,0
E	6,5
F	7,0

** *Switch S1 on position 0 = factory setting.*

With parameterisation software

The value of the motor current is preset for the switch position 0.
The parameterisation software ***TopSuite*** helps to change this value and to save it in the TSP10-BA.

Set value range: 0... 7.0 A_{rms}

NOTICE If the rated current of the motor is exceeded, the motor may be destroyed by demagnetization or overtemperature.

- Set the output current of the stepper motor control TSP10 not beyond the rated current of the motor.

7.2 Step resolution/idle current reduction

Without parameterisation software

The selection switch for the step resolution (S2) also sets the waiting time until the current is reduced.
The motor current is reduced to 50 % when the waiting time expires (position 0... 7).
The switch positions 8 to F do not reduce the current.

S2 position 0... 7 waiting time = 0.1 seconds, current reduced by 50%
S2 position 8 ...F current not reduced

Switch S2 Position	Revolutions per steps (parts of a full step)	Idle time	Current reduction
0*	10000 (1/50)	100 ms	50 %
1	200 (1/1 = full step)	100 ms	50 %
2	400 (1/2 = half step)	100 ms	50 %
3	500 (1/2,5)	100 ms	50 %
4	800 (1/4)	100 ms	50 %
5	1000 (1/5)	100 ms	50 %
6	2000 (1/10)	100 ms	50 %
7	5000 (1/25)	100 ms	50 %
8**	10000 (1/50)	-	100 %
9	200 (1/1 = full step)	-	100 %
A	400 (1/2 = half step)	-	100 %
B	500 (1/2,5)	-	100 %
C	800 (1/4)	-	100 %
D	1000 (1/5)	-	100 %
E	2000 (1/10)	-	100 %
F	5000 (1/25)	-	100 %

***** *Switch S2 on position 0 = factory setting.*
*** Step resolution as for switch position 0, but no current reduction.*

With parameterisation software

The values of step resolution, waiting time and current reduction are preset for the switch position 0.
The parameterisation software ***TopSuite*** helps to change and save these values in the TSP10 BA.
The value of the step resolution is copied to switch position 8.

Step resolution: 200 ... 25 600 (value must be divisible by 50)
Waiting time: 1... 3 000 ms
Reduced motor current: 0%... 100% of the nominal value

All values may be independently set.

8 Operation lights

The stepper motor control TSP10 has a two-colour LED on the front side which informs about the operating state.

LED display

LED display	Descirption/ Notes
Green, blinking	after powering on the TSP10, the firmware version is indicated as a blinking code. e.g., 1x blinking, break, 2x blinking = version 1.2
Orange, briefly on, repeated after 3 s.	TSP10 powered on but not enabled
Green, permanently on	Motor current on, motor stopped
Orange, blinking	Motor current on, motor is running
Red, blinking	TSP10 turned off because of an error. The blinking code indicates the type of error. 4x blinking = over temperature 7x blinking = over current

9 Mode of operation: Step and direction

This mode of operation can be initiated without the parameterisation software ***TopSuite***.

You only have to connect two input signals to the signal plug X2:

- step signal
- direction signal

The enable input is disabled ex works, i. e. the motor current is switched on right when the stepper motor control TSP10 BA is ready for operation.

An output signal of the TSP10 BA is also available at the plug X2:

- enabled

This signal indicates that the motor current is enabled.

The step and the direction signal are generated by an external clock generator.
Every arriving step & direction triggers the TSP10 to turn the motor one step further. The closer the step & direction follow each other, the higher is the motor speed.
The sense in which the motor turns is determined by the direction signal.

Every stepper motor control has a certain inertia moment and cannot follow any clock rate, hence. If more speed is desired, adapt the change of the clock rate to the accelerating potential of the driving mechanism. These acceleration and deceleration ramps have to be generated by the external clock generator.

Set predefined step numbers and motor currents with the rotary switches at the device.

In the parameterisation software you may enable the ***enable*** signal input and set other than the predefined step figures and motor currents (see ***chapter 7 Parameter setting***).

INFO

The stepper motor control TSP10 BA does not permit setting the effective sense of the enabling signal. Hence, the following applies:

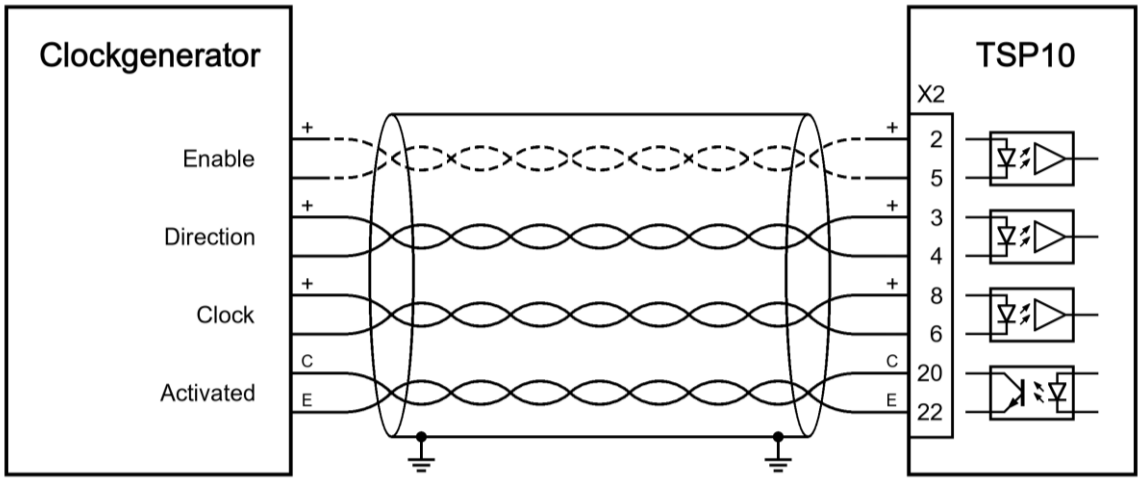
Enable = optical coupler on

If you use the enabling signal, consider the waiting time between applying the enabling signal and the first active step & direction.

If the motor is not enabled, the rotor position may be any, the motor may be turned by hand, for example. As soon as the motor current is powered on and the enabling signal is applied, the rotor revolves into the position given by the TSP10. Only if this position is safely reached, the following step & direction can be correctly converted into steps.
Hence, a waiting time of approx. 415 ms for the transient to the initial position is intended after applying the enabling signal.
If the enabling signal is disabled (factory setting), the waiting time matches that which applies when the operating voltage of the TSP10 is switched on.

9.1 Signal connection

X2 - signal inputs and outputs		
Terminal No.	**Signal**	**Note/description**
2	Enable +	Enable or disable the motor current The enable input is disabled ex works, i.e. the stepper motor control TSP10-BA is active right after power-up and the motor current is switched on. The parameterisation software ***TopSuite*** helps to enable the enable input and to save this setting in the TSP10 BA. In this case an enabling signal is required to switch on the motor current. The effective sense of the enabling signal cannot be set. The following applies: Optical coupler on = motor current on Optical coupler off = motor current off The waiting time between applying the enabling signal and the first step & direction is approx. 415 ms. Any step & direction arriving during the waiting time are ignored.
5	Enable -	
3	Direction +	Input for controlling the motor's direction If the motor circuits have standard wiring, the motor revolves clockwise if no current passes through the optical coupler. Revert the motor's direction by exchanging both connector wires of a motor phase: 1-A and 1-/A or 2-B and 2-/B. If you exchange the wiring of both motor phases, the sense does not change. The direction signal has to be stable for at least 50 µs before the active step & direction flank.
4	Direction -	
8	Clock +	Pulse input, 1 pulse = 1 step The active countable flank appears if the current is switched off by the optical coupler.
6	Clock -	
20	Enabled (collector)	Transistor closed for enabled motor current This signal is useful to monitor faults, for example. If the stepper motor control shuts down because of a fault, this transistor is also switched off.
22	Enabled (emitter)	
Case	Shield	Use shielded cable



Connection of a clock generator to the TSP10

The illustration shows the least required wiring between clock generator and TSP10.
The driver circuits for the signal wires are not shown. Both connections of the respective input optical couplers are available, opening various possibilities for driver circuits. Note as well the information on how to implement the circuits of the signal inputs and outputs (***chapter 6.5 Signal inputs and outputs***).

Reject noise by using twisted wire pairs and arranging all signal wires in a shielding. You may reject noise even more effectively if the twisted wires pairs are shielded in addition (not shown).

NOTICE

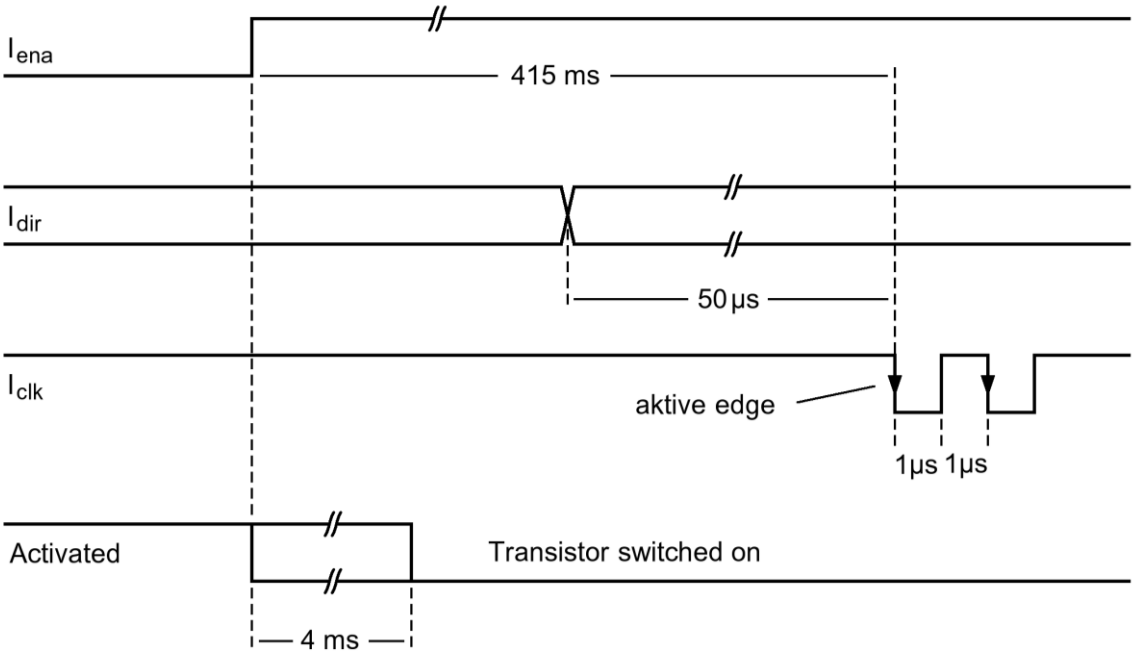
The signal input devices of the TSP10 are available as 5 V or 24 V versions. If you connect 24 V signals to 5 V inputs, the signal input of the TSP10 may be damaged.

- Check whether the signal levels of the electronic control agrees with the signal levels of the TSP10 inputs. This is important in particular when exchanging devices.

INFO

The signal inputs to initiate profiles are also enabled if the TSP10 is controlled by step and direction.
Leave these inputs open and connect no wires to reject noise. Please, find more information in the ***chapter 10 Mode of operation: Executing profiles***.

9.2 Signal Timing



The signal waveform refers to the currents in the input diodes of the optical couplers so that the representation is independent from the used driver circuit.

High level = power on
Low level = power off

I_{ena} = current in the enable input
I_{dir} = current in the direction input
I_{clk} = current in the clock input

If the enabling signal is used, keep a waiting time of approx. 415 ms until the first step & direction. Any step & direction which arrive during the waiting time are ignored and lost.

The output signal **enabled** is switched no later than 4 ms after applying the enabling signal (transistor on) to indicate that the motor current is on.

If the enabling signal is disabled (factory setting), you may use the signal ***enabled*** to initiate the waiting time. Now applies: waiting time = approx. 415 ms after ***enabled***.

The direction signal has to be stable for at least 50 µs before the next step & direction (high or low).

The least period for the high or low level of the step & direction signal is 1 µs.
This yields a highest clock rate of 500 kHz.

10 Mode of operation: Executing profiles

In this mode of operation the stepper motor control TSP10 relocates according to profiles that are initiated by input signals. Set the profiles in easy steps in the parameterisation software ***TopSuite*** and save them in the stepper motor control.

Executing a single profile is enough to relocate from the *start position A* to the *target position B*.

Achieve more advanced motion sequences by associating a next profile with every profile which is initiated immediately after or after a waiting time.
It is not necessary that the motor is idle to start a next profile, a transition to the next profile is also possible at a given speed.

Depending on the configuration of the profiles, the stepper motor control may also operate in speed mode.

The characteristic features of this mode of operation are:

- 50 customisable profiles
- start of the profiles by input signals
- simple relocation (one profile)
- advanced motion (a sequence of profiles)
- speed mode

The motor position is processed in a 32-bit variable (32 bits integer) of the ***steps*** unit. This creates a value range from 80000000h to 7FFFFFFFh for the position, corresponding to – 2 147 483 648 to + 2 147 483 647 (decimal).

This is the full value range if the profiles provide absolute positions.

However, you may also set distances (relative positioning), then the widest distance you may set is 80000000h (-2 147 483 648 steps) or 7FFFFFFFh (+ 2 147 483 647 steps).

If several profiles are successively executed across very great distances, the 32-bit variable may overflow. This does not impair the execution of profiles when relatively positioning. The absolute position is lost, though.

INFO

A stepper motor control runs smoother at higher step resolutions. The TSP10 allows setting the step resolution to match your application as closely as possible. You achieve smooth running of the motor by enabling the function ***Smoothing***. The TSP10 then pastes intermediate steps, resulting in a motor running like at a high step resolution.

INFO

The signal input devices for ***Step and direction*** are also enabled when profiles are initiated. The relocation resulting from Step and direction is added to the profiles. This may be useful in special applications. If you do not use this function, do not wire those inputs to avoid noise.

10.1 Input and output signals

10 digital signal input devices, DE1 to DE10, are available in the signal plug X2 to control relocations. You may connect switches (limit, reference or stop switches) or outputs of a control.
5 signal output devices, DA1 to DA5, at the connector X2 supply the status information of the TSP10. The control is able to use them for monitoring relocations.

Allocate the input and output functions to the connections of plug X2 using the parameterisation software ***TopSuite***.

The essential input functions are:

- limit switch
- reference switch
- stop switch
- enable signal
- start profiles
- start homing

The following status signals are available:

- Ready
- Enabled
- Target reached
- Fault

All signal inputs and outputs are isolated by optical couplers. For more on the connector configuration and wiring, see ***chapter 6.5 Signal inputs and outputs***.

Use shielded signal wires to connect the electronic control and the TSP10 to avoid noise.
The same is recommended for the connection of limit, reference and stop switches.

NOTICE

The signal input devices of the TSP10 are available as 5 V or 24 V versions. If you connect 24 V signals to 5 V inputs, the signal input of the TSP10 may be damaged.

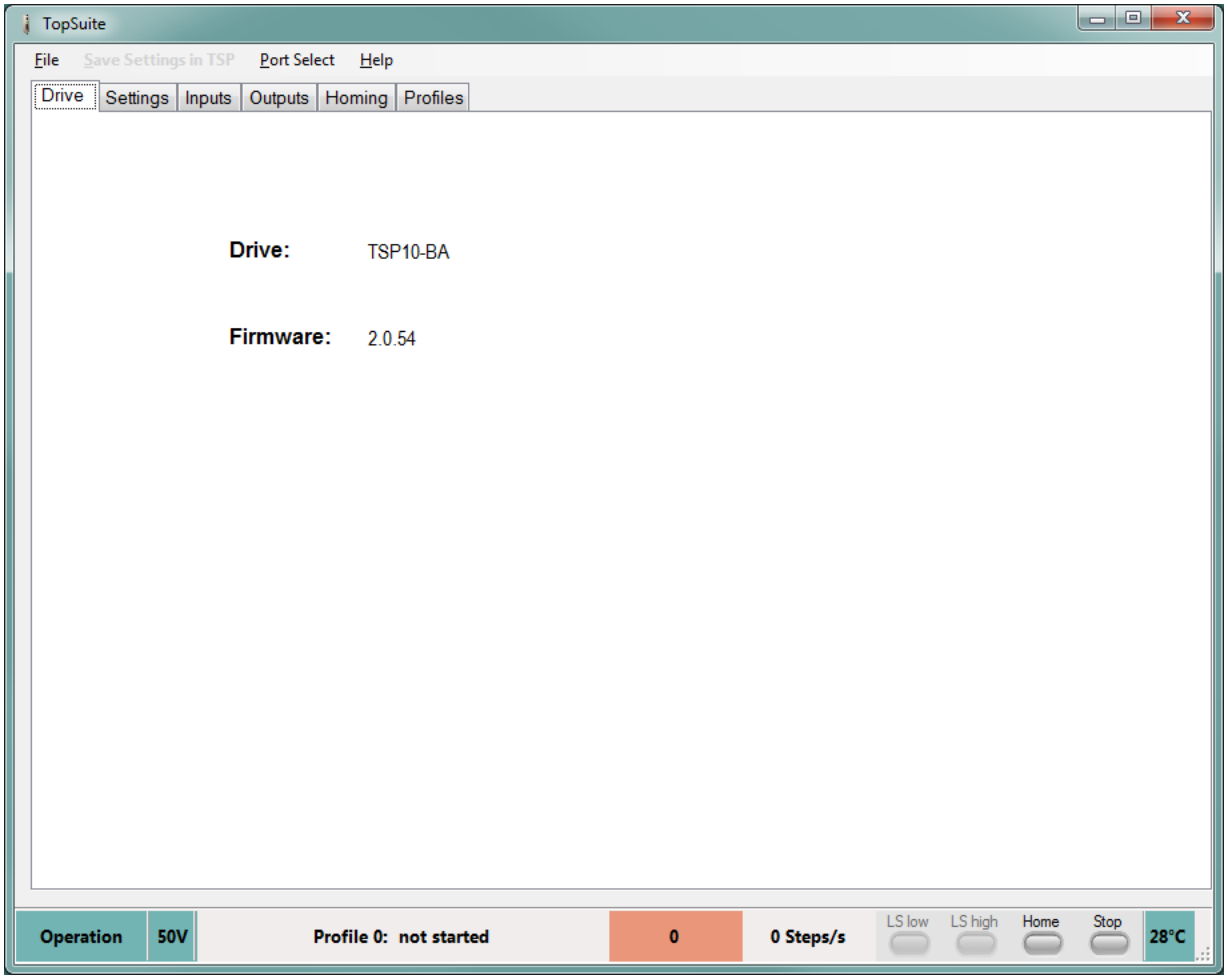
- Check whether the signal levels of the electronic control agrees with the signal levels of the TSP10 inputs. This is important in particular when exchanging devices.

10.2 Configuration

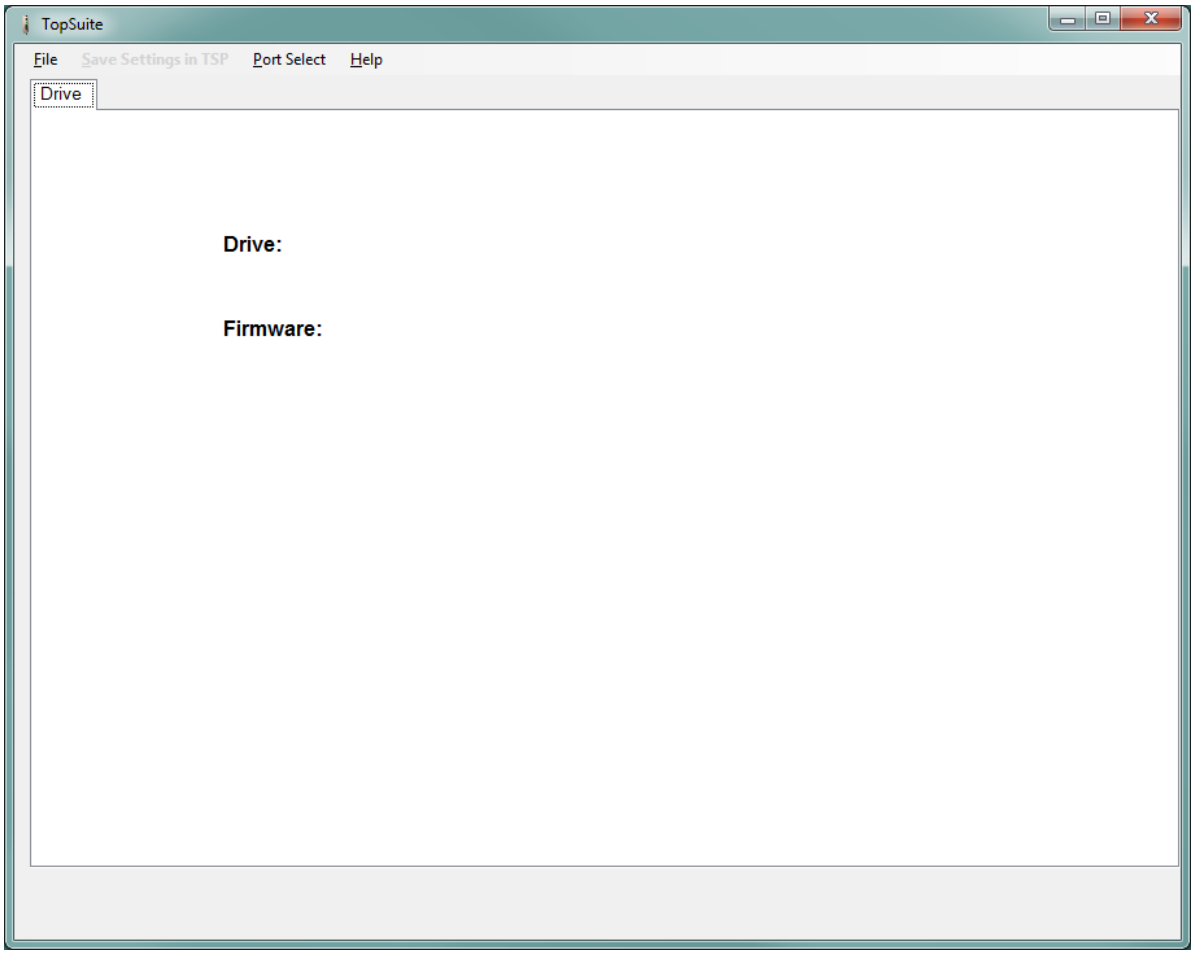
To set the operation parameters, connect the serial interface of your PC to the serial connection of the TSP10 with a data cable.

For safety's sake, do not connect any motor before commissioning the TSP10.

Switch on the supply voltage of the TSP10 and launch the parameterisation software ***TopSuite*** on your PC. The initial page of the parameterisation software appears.



Initial page when connected to the TSP10



Initial page without connection to the TSP10

If the TSP10 was not identified (right image), select another serial interface by clicking the ***Select interface*** button, check the data cable and the supply voltage of the TSP10. Pay attention to the LED display of the TSP10.

Load an available configuration file and transmit to the TSP10 or save the current configuration in a file by clicking the ***File*** button.
You may also update your firmware or enter the user.

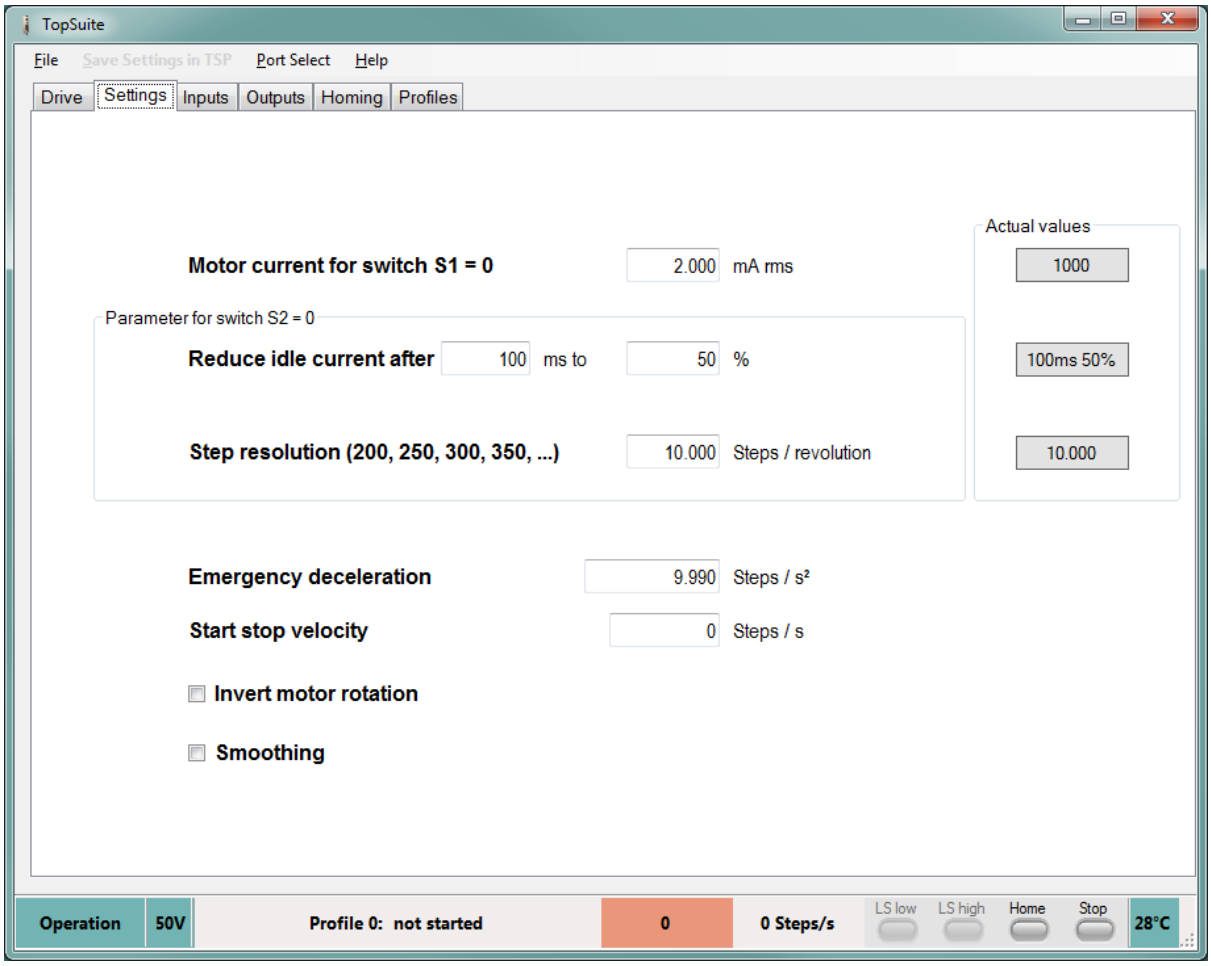
Set all parameters of the TSP10 individually on the pages ***Settings, Inputs, Outputs, Profiles*** and ***Homing***.

INFO

Any changed parameters that were not saved by clicking the ***Save settings*** button are lost when the TSP10 is powered off.

10.2.1 Settings

On this tab you can set all generally applying parameters.
Click the ***Save changes*** button to permanently save the changed parameters in the TSP10.



Settings *Tab*

Motor current for switch S1 = 0

The value entered on this tab of the motor current is effective for the switch setting ***S1 = 0***. Set the motor current in mA.

Adjustable value range: 0... 7.0 A_{rms}

(For motor currents at the switch settings 1 ... F see ***chapter 7.1 Motor current***).

NOTICE If the rated current of the motor is exceeded, the motor may be destroyed by demagnetization or overtemperature.

- Set the output current of the stepper motor control TSP10 not beyond the rated current of the motor.

Parameters for switch S2 = 0

The values of the idle current reduction and the step resolution entered on this tab apply to the switch setting ***S2 = 0***.
The value of the step resolution is forwarded to the switch position 8.

Reduce idle current

To reduce the thermal load of the stepper motor, reduce the motor current for the idle motor. The holding moment generated by the motor will then decrease as well, however.
The motor current is reduced as soon as the motor is idle and no step & direction are received within the given waiting time or no profile is initiated.
If the load is post-oscillating, a longer waiting time makes sense.

Set the waiting time until switching to the reduced motor current in ms.
Set the value of the reduced motor current in percent of the set motor current.

waiting time:	1... 3000 ms
reduced motor current:	0%... 100%

Step resolution

Enter in steps per revolution. The entered value has to be divisible by 50.

Step resolution:	200... 25 600 steps/revolution

Emergency deceleration

If the limit switch is reached while a profile is executed, the profile is cancelled and the motor is stopped with the emergency deceleration ramp. The deceleration value from the current profile is not used.
Set in steps/s².

Since the motor decelerates steadily, the distance run after the limit switch responded may be computed using the equations $s = \frac{1}{2} a t^2$ and $v = a t$. For a given available braking path, compute the necessary setpoint for the emergency brake ramp with these equations.
No initial start or stop speeds set are considered.

Braking path:	$s = \frac{1}{2} V^2/a$
Emergency brake ramp:	$a = \frac{1}{2} V^2/s$

Example:
The profile speed is 8 000 steps per second and the distance from the limit switch to the mechanical stopper is 500 steps.

From $a = v^2/2s$ results a value of 64 000 steps per second² for the emergency brake ramp.

Note that the motor may not be able to follow too strong deceleration and run beyond the distances computed in the given equations. The mechanical stopper should, hence, be sized accordingly.
A step loss may be possible during a too powerful deceleration, demanding a new homing.

Start/stop velocity

At the start of the profile, the acceleration ramp jumps to the set speed, and when stopping, the acceleration ramp jumps from the set speed to zero.
You may, hence, achieve a quicker start and avoid extended driving at very low speed. Set the start and stop speed in such a way that the motor is able to follow the jump without losing steps.
Enter in steps/s.

Invert motor revolution

If you select this field, the motor revolution is inverted.
You may adapt the motor revolution to the machine this way without changing the wiring.

Smoothing

If you select this field, the TSP10 pastes intermediate steps into all stepping motions, smoothing the current curve in the motor. Noise and vibrations are clearly reduced by this function and the torque feed of the motor is improved.

When executing profiles, the step frequency of the motor is computed by the internal microcontroller and converted into a relocation, using the acceleration ramp.
The controller operates at a cycle rate of 20 kHz, hence, the relocation follows this pattern. If the step frequency does not fit precisely to this grid, beat frequencies may occur: the more pronounced, the lower the step resolution is chosen. Beyond a step resolution of approx. 4000 steps per motor revolution, the amplitude of the beat frequencies is negligible.
If the step resolution is low, beat frequencies may cause the motor to run unstably.

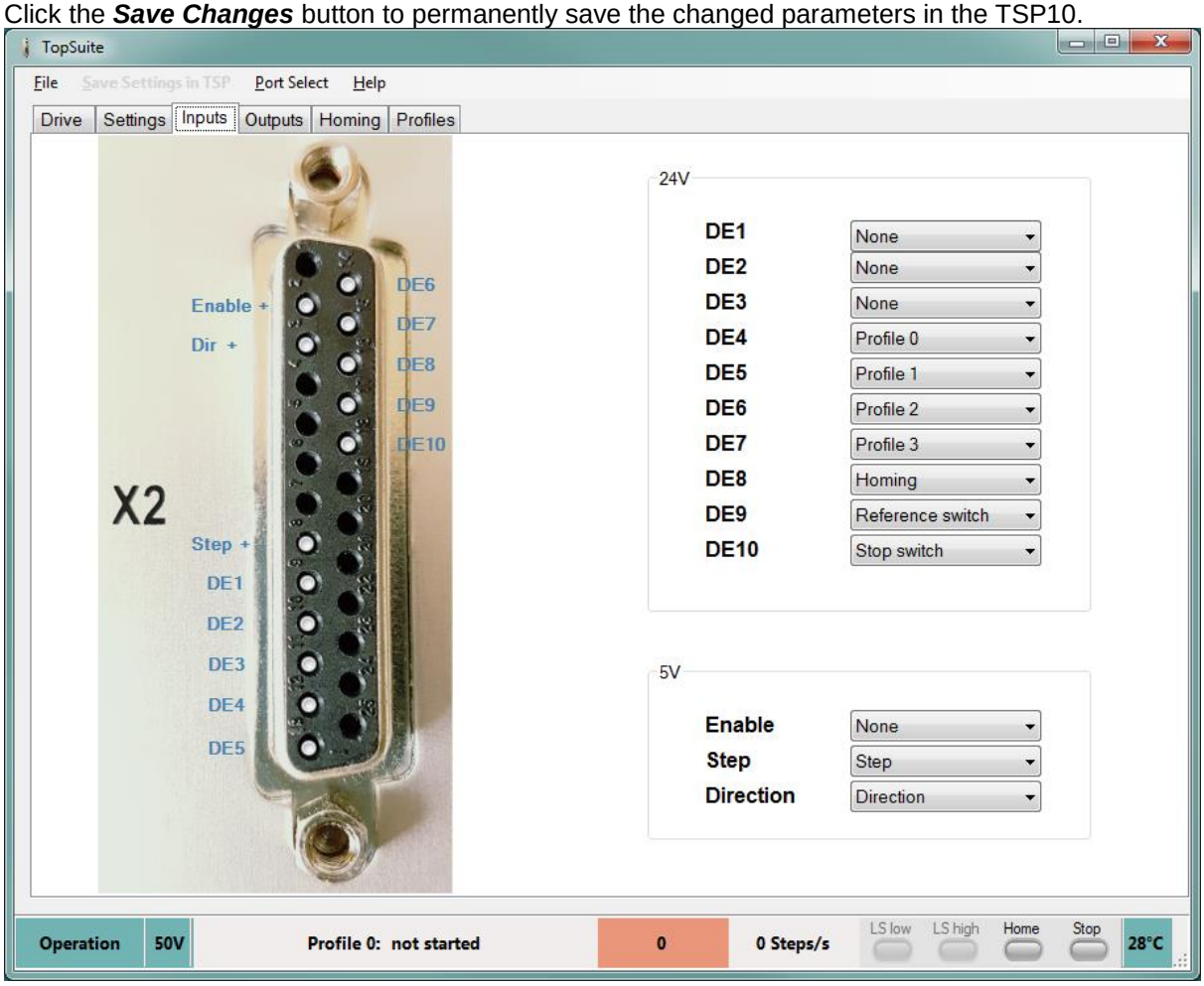
This problem may be solved by activating the smoothing function, and you may run the stepper motor control at the desired step resolution.

INFO

The smoothing function also affects the clock input of the TSP10.
Enabling this function also produces a very smooth running of the motor when it is controlled with step and direction signal.

10.2.2 Input functions

Any of 14 functions may be assigned to the signal inputs DE1 to DE10.
Click the ***Save Changes*** button to permanently save the changed parameters in the TSP10.



Inputs *Tab*

Input DE1... DE10

None

The input is disabled and has no function.

Limit switch low, limit switch high

Both limit switch functions can be used to safely delimit the travel path.
The limit switch has to operate as an opener. The motor can move if the input voltage is applied at the input. Removing the input voltage or interrupting the signal wire prevents the motor from moving in the corresponding sense. If the interruption occurs while the motor moves towards the limit switch, the motor decelerates down the **emergency brake ramp** and stops. The motor current remains enabled. Moving in the opposite sense is still possible.
Down and **up** refer to the value range of the motor position. Lower values mean **down**, higher values mean **up**. The lowest number is - 2 147 483 648 (= 80000000h) and the highest number is + 2 147 483 647 (= 7FFFFFFFh).

Reference switch

The reference switch has to operate as a closer. While the contact is closed, the signal input device is connected to the input voltage. The TSP10 provides several homing options (see ***chapter 10.2.6 Homing***).

Stop switch

The stop switch has to operate as a closer. Applying the signal voltage to the input (evaluation of the flank) cancels a running profile. The driving mechanism decelerates down the brake ramp of the current profile and cancels the profile. The motor current remains enabled.
Pressing the stop switch also cancels homing.
Several inputs may be assigned to the stop switch function (OR link).

Profile 0, Profile 1, Profile 2, Profile 3

Launch the profiles 0 to 3 via the accordingly configured input.
Launch by applying the signal voltage at the input (evaluation of the flank). If several inputs are selected for the start of the same profile, any input can launch the profile (OR link).

Homing

Launch homing by applying the input voltage (evaluation of the flank). If several inputs are selected to launch homing, any input can launch homing (OR link). The TSP10 provides several homing options (see ***chapter 10.2.6 Homing***).

Enable

Other than the enable input in the group of two contact signal inputs, an input DE1... DE10 may also be configured as enabling signal.
Then the motor current is not switched on as soon as the TSP10 is ready for operation but only when the input voltage is applied to the enable input. If the input voltage is disabled, the motor current is switched off again. If several inputs are configured as enable inputs, the signal voltage has to apply at all accordingly configured inputs to enable the motor current (AND link).

Profile 0 jogging, Profile 1 jogging, Profile 2 jogging, Profile 3 jogging

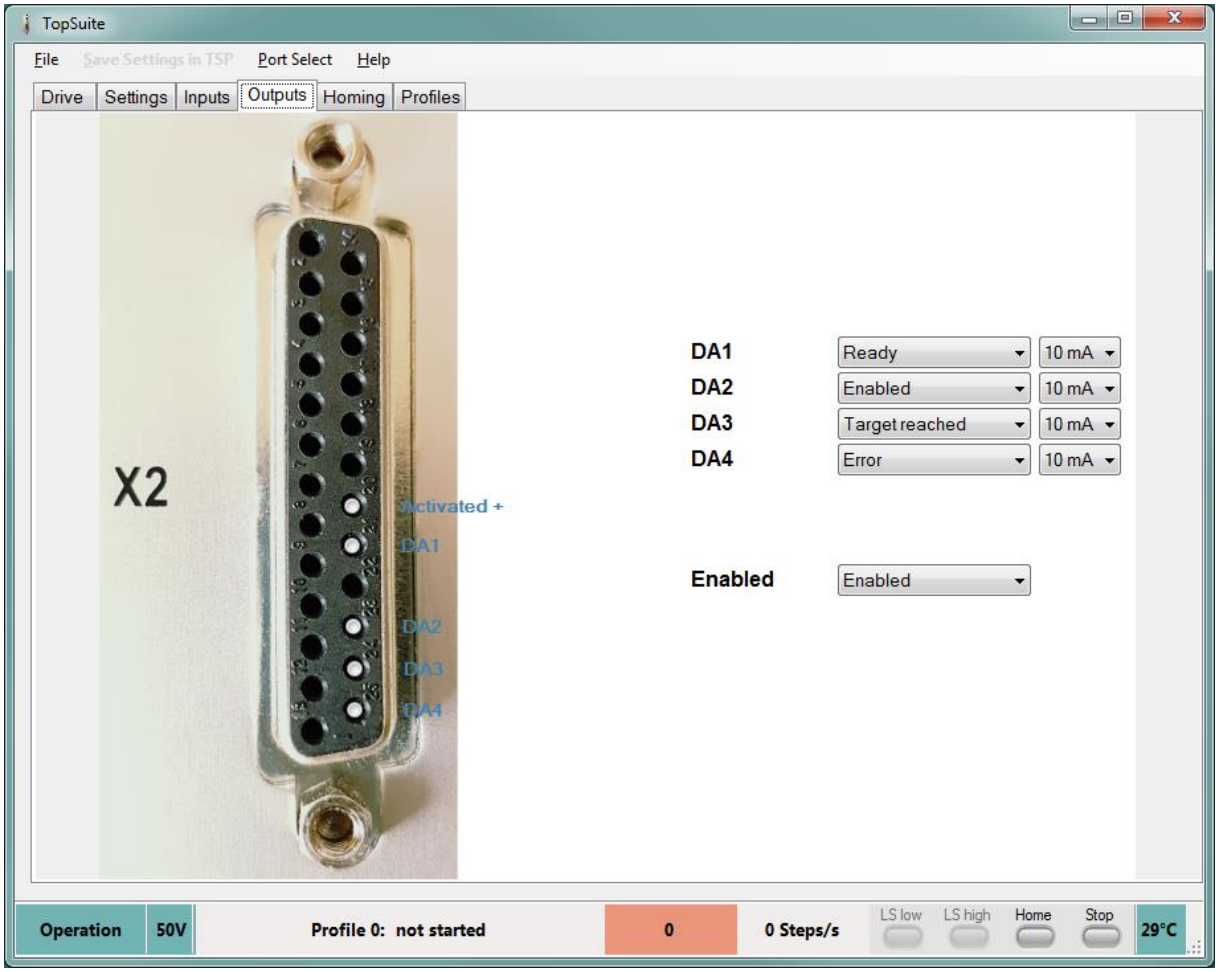
Applying the input voltage launches the profile while disabling the input voltage cancels the profile. If the input voltage is long enough applied, the profile is regularly terminated. If a profile is cancelled, a new profile can be initiated only if the motor has decelerated to zero. If several inputs are set to launch the same profile, any input can initiate the profile (OR link).
The ***jogging*** function controls the travelled path directly via the input.

Enable, step, direction inputs

These functions are inseparably associated for two-contact signal inputs.
The ***enable*** input can be disabled.

10.2.3 Output signals

Any of 4 functions can be assigned to the signal outputs DA1 to DA4.
In addition, you may set the highest output current in 4 steps.
Click the ***Save Changes*** button to permanently save any changed parameters in the TSP10.



Outputs *Tab*

Output DA1... DA4

None

The output is disabled and has no function. The output is also disabled if the highest output current is set at 0 mA.

Ready

The signal is set when the initialization of the TSP10 is finished.

Enabled

The signal is set while the motor current is switched on.

Target reached

The signal is set when a profile or homing was successfully executed. The signal is disabled at the start of a profile or of homing. The signal remains disabled if the profile or homing is abnormally terminated.

Error

The signal is set if the stepper motor control has shut down because of an fault. The fault number is indicated as a flashing LED signal (see also ***chapter 8 Operating lights***).

Output enabled (X2 pin 20 and 22)

The function is inseparably associated at the two-contact signal outputs.
The signal is set while the motor current is switched on.

10.2.4 Profiles

Set the parameters of the profiles on this tab.
Click the ***Save Changes*** button to permanently save any changed parameters in the TSP10.

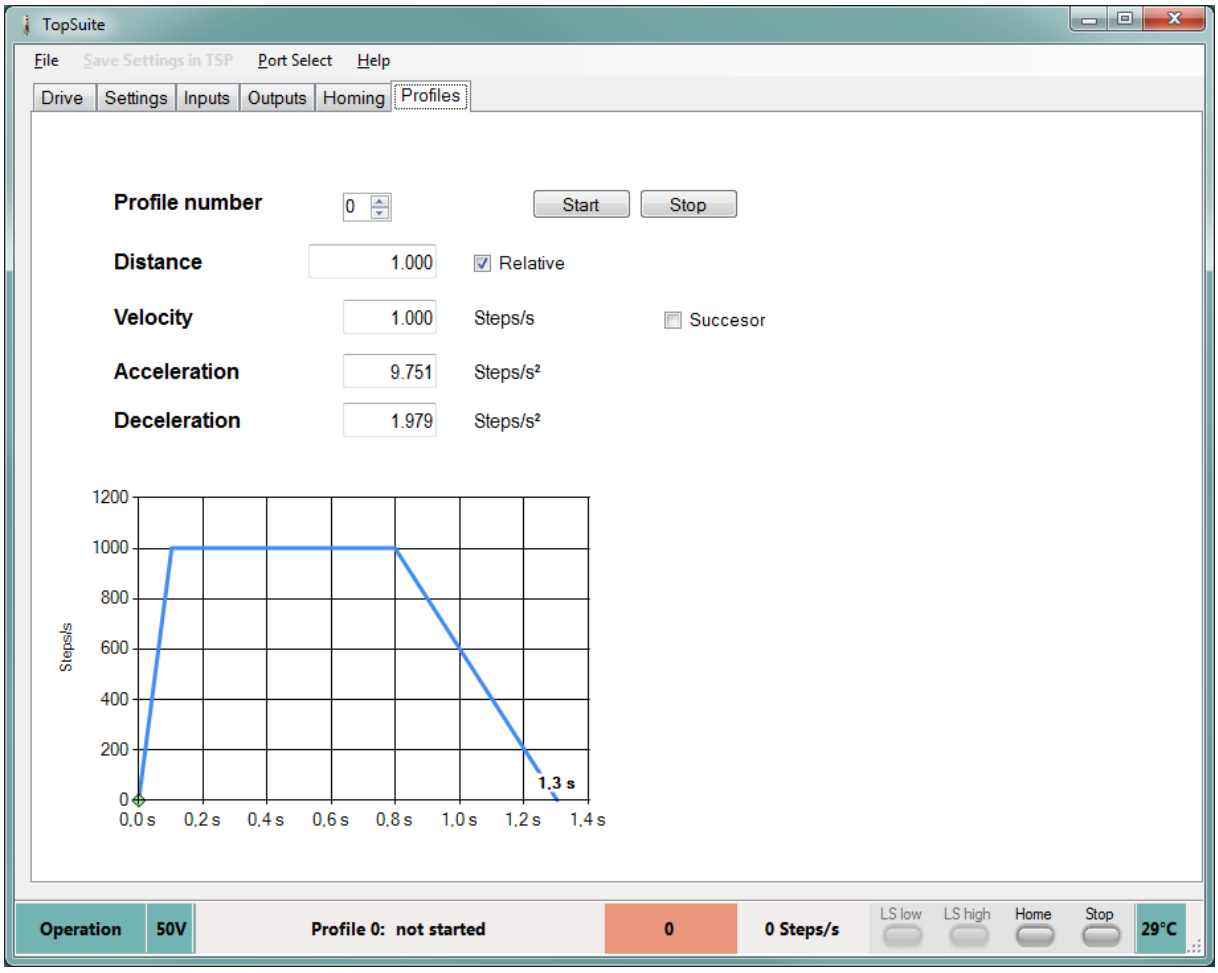
A relocation is usually described by the curve of speed over time. The travelled distance corresponds to the surface under the speed curve. Using steady acceleration and deceleration values generates a trapezoid speed curve.

Concatenating profiles, you may produce advanced motion sequences. Concatenate by assigning the next profile to every profile which automatically starts at the end of the current profile. If the last profile of this sequence has no next profile, the motion sequence is finished.

If a profile has a copy of itself as its next profile or has the next profile in a sequence that reinitiates the current profile, then the result is a motion sequence which does not automatically end. However, the motion sequence can be terminated by the stop switch or a stop signal.

A profile which has a copy of itself as its next profile allows the stepper motor control to operate in speed mode. The motion is either initiated by an input and terminated by the stop signal or the input function ***jogging*** is used.

The end of this chapter lists a few sample profiles.



Profiles *Tab*

Icon

An icon beside the profile number shows the curve of speed over time to illustrate the programmed profile.

Start/stop buttons

In the standard operation mode of the machine, a profile is started by an input signal and a relocation is abnormally terminated by the stop switch or a stop signal.
The indicated profile can be initiated by manually clicking the ***Start*** button, the motion sequence is terminated by clicking the ***Stop*** button. Then the driving mechanism brakes with the deceleration of the current profile and stops.
The motor current is not switched off.

Profile number

The profile number may range from 0 to 49 and can be selected with the small arrow keys.
The current parameters of the selected profile are indicated.

Target position (absolute), distance (relative)

You may set the target position either as an absolute position by selecting the ***Absolute*** field (absolute positioning). The absolute position is defined by the reference point.
Or you may select the ***Relative*** field (relative positioning) and enter a distance which the motor has to travel. The starting point is the current position.
Confirm the entered value of the target position or the distance with the Enter key.

The target position is processed in a 32-bit variable (32 bits integer) in ***steps***.
The value range for the target position is, hence,

- 2 147 483 648 to + 2 147 483 647, corresponding to 80000000h to 7FFFFFFFh (hexadecimal).

These are the entire value range available for absolute positioning and the widest selectable distances from the current position available for relative positioning.

If several profiles are successively run across very great distances, the 32-bit variable may overflow. This does not impair the execution of profiles when relatively positioning. The absolute position is lost, though.

Velocity

Enter in this field the highest velocity that the driving mechanism may reach when executing the profile.
Enter in steps/s.
Confirm the entered velocity with the Enter key.

The entered velocity is reached only if the distance is far enough and the acceleration was selected high enough.
If the velocity is not reached, a profile with shutdown at the end results in a triangular rather than a trapezoid speed curve.

Acceleration, deceleration

Enter acceleration values in steps/s².
Confirm the entered values with the Enter key.

If the acceleration values are too high, the driving mechanism cannot follow the speed curve and will lose steps. Make sure that the entered values fit to the accelerating power of the driving mechanism. The accelerating power is essentially a function of the motor current and the inertia moment of the load and the motor.

Waiting time

A waiting time can be pasted into the current profile before the next profile is initiated. When the target position is reached, the driving mechanism stops and launches the next profile not immediately but only when the waiting time has expired.
The ***waiting time*** field is only enabled if you select the ***next profile*** field and deselect the ***Next profile without stop*** field. Now enter the waiting time in ms (milliseconds).
Confirm the entered value with the Enter key.

Next profile

If another profile should be executed after the end of the current profile, select the ***next profile*** field and choose the number of the next profile with the small arrow keys.

Next profile without stop

If the next profile should be initiated without the motor stopping in the current target position, select the ***Next profile without stop*** field. In this case the motor passes the target position at the entered ***Target velocity***.
If you do not select this field, the motor stops at the target position before the next profile may start after the waiting time, if any.

Target velocity

If a ***Next profile without stop*** is executed, you have to set the velocity that the motor should have when the target position of the current profile is reached.

Target velocity = ***Actual task's velocity***

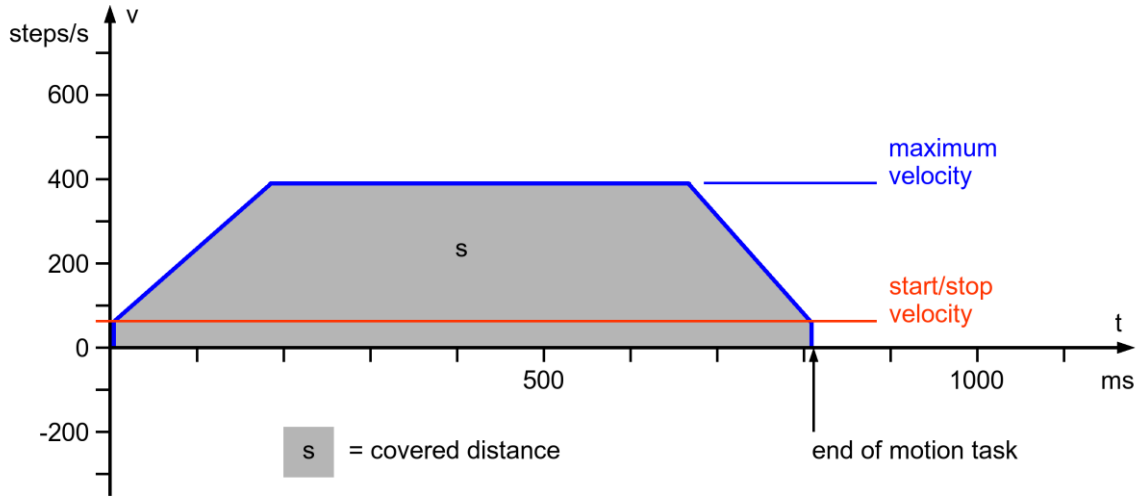
The motor drives to the target position at the speed set in the ***Velocity*** field. It accelerates or decelerates to the velocity of the next profile only when the next profile is run. Acceleration and deceleration use the parameters of the next profile.

Target velocity = ***Next profile velocity***

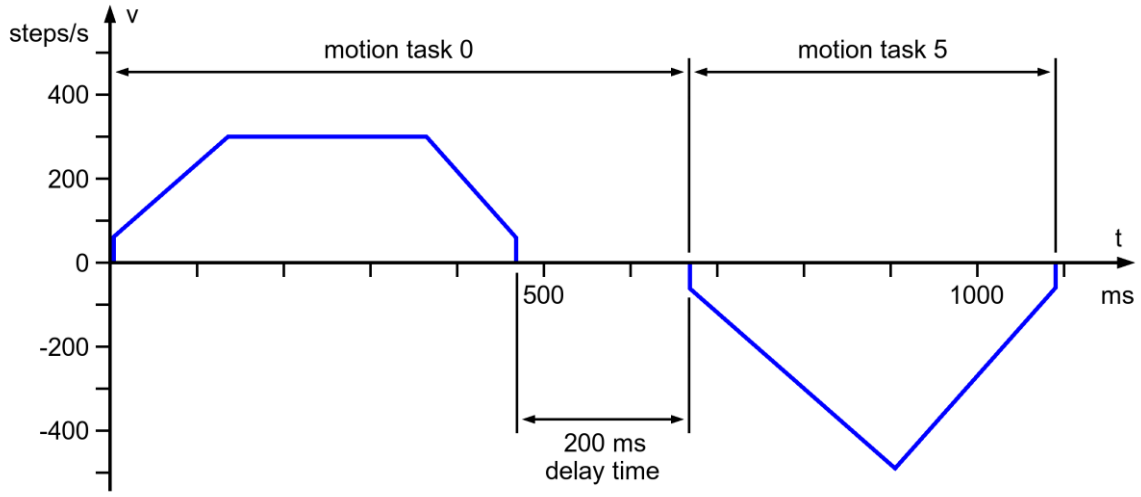
The motor is accelerated or decelerated to the speed of the next profile before the target position of the current profile is reached. When the target position is passed, the motor has already assumed the speed of the next profile. Acceleration and deceleration use the parameters of the current command.

10.2.5 Sample profiles

Relocations are represented by the curve of speed over time. The distance covered corresponds to the surface under the speed curve. For negative speed, the covered distance is negative as well.

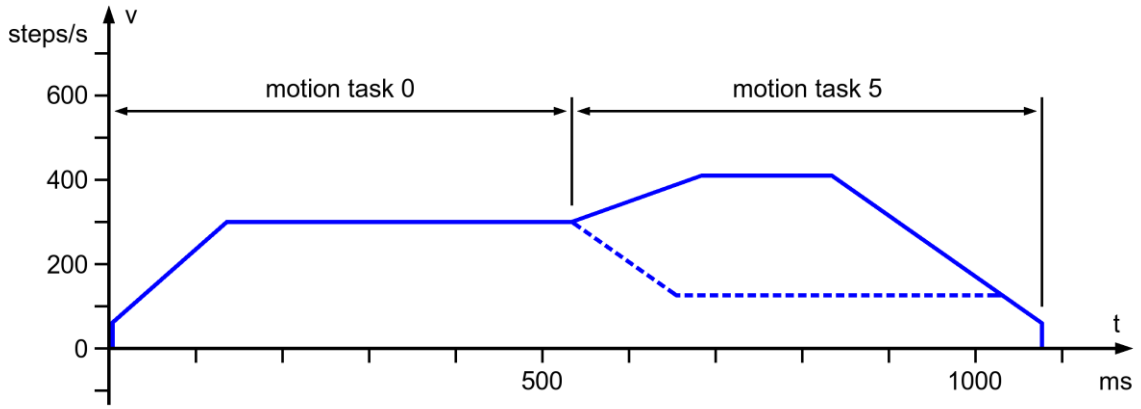


A simple profile (here: motion task) for relocating from position ***A*** to position ***B*** (absolute positioning) or for covering the distance ***s*** (relative positioning). The covered distance ***s*** (distance from position ***A*** to position ***B***) corresponds to the surface under the blue curve.
The acceleration was chosen smaller than the deceleration.



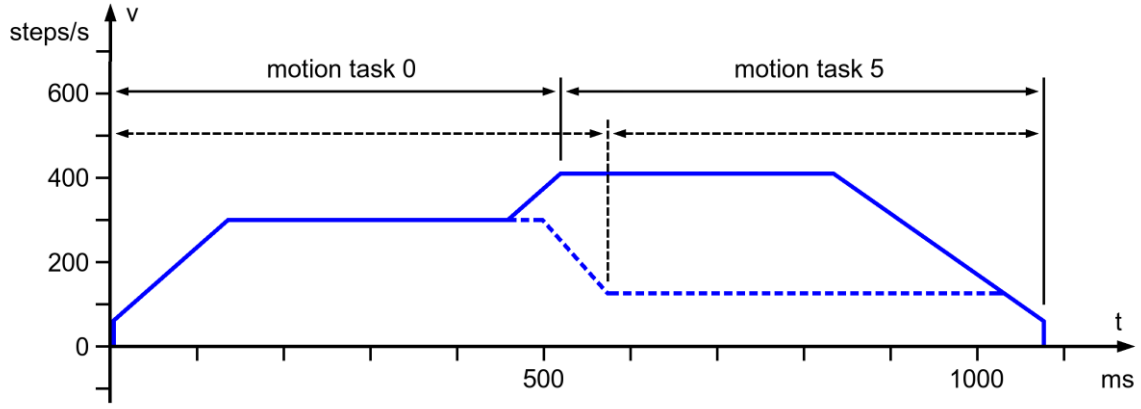
Profile (= motion task) 0 with waiting time (= delay time) and next profile (= motion task) 5.

The motor covers a certain distance upward (position counter incrementing), waits for 200 ms when the target position has been reached and covers the same distance downward (position counter decrementing). A higher speed was set for the return travel which is not reached because the distance is too short. Hence, the speed curve has a triangular waveform.



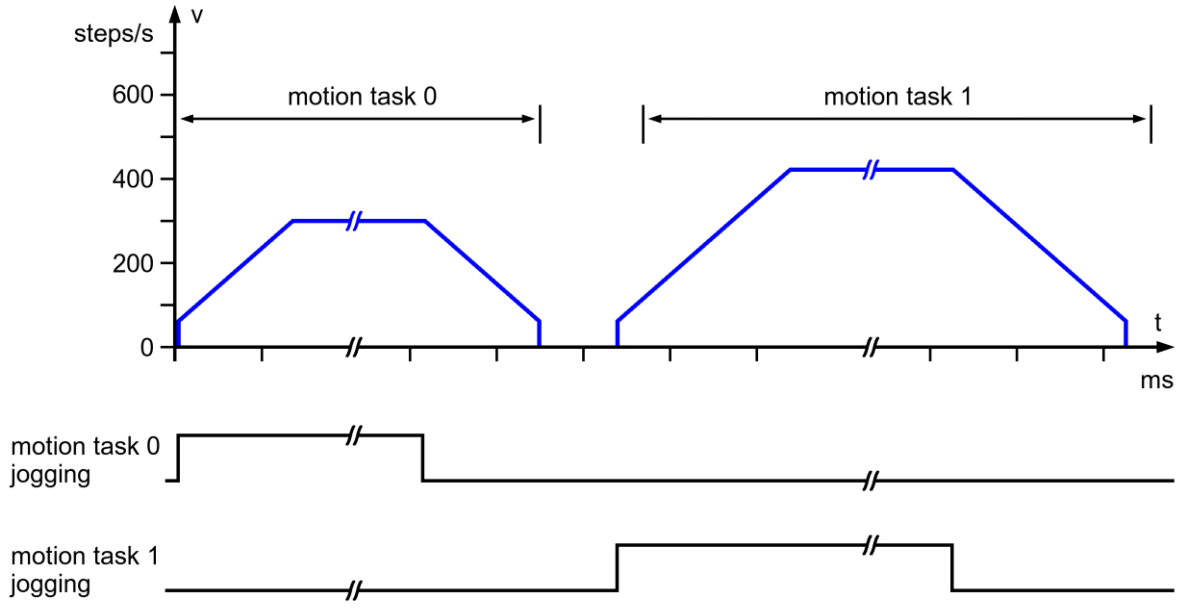
Profile (= motion task) 0 with next profile (= motion task) 5, without stop, target speed from profile 0

Profile 0 is terminated without stop. When the motor reaches the target position, it has the speed entered in the ***Velocity*** field of profile 0 and the next profile (profile 5) is initiated without delay. After profile 5 was started, that speed is assumed (sketched line) which was entered in the ***Velocity*** field of profile 5. The ***Acceleration*** and ***Deceleration*** values of profile 5 are used.



Profile (= motion task) 0 with next profile (= motion task) 5, without stop, target speed from profile 5

Profile 0 is terminated without stop.
This configuration allows assuming the speed (sketched line) entered in the ***Velocity*** field of profile 5 before the target position is reached. The ***Acceleration*** and ***Deceleration*** values of profile 0 are used. When profile 5 is initiated, the motor has already reached the speed which was entered in the ***Velocity*** field of profile 5.



Speed mode

The TSP10 also allows running the stepper motor controlled by speed.
In the example above, the profile 0 was set as follows:

Distance = 100 steps (relative positioning)
Velocity = 300 steps/s.
Acceleration = deceleration = 2 300 steps/s²
Next profile = profile 0
Next profile without stop
Target velocity = Actual task's velocity

This setting reinitiates profile 0 every time the distance of 100 steps has been passed and the motor reaches the defined speed.
If you have initiated the profile with the input function ***Profile 0***, you may terminate the motor's movement with the stop switch. The input function ***Profile 0 jogging*** was used in the example shown.
Since the profiles 0 to 3 may be initiated by input signals, you may set four different speeds.
Negative speeds are generated by a negative distance.

INFO

Realise advanced motions of the stepper motor control TSP10 by concatenating profiles. When a sequence of profiles is run, the parameters of each current and next profile are evaluated. If the settings conflict, e.g., if a profile at positive speed is terminated without stop but the next profile demands a negative speed, the motor may not move as anticipated

- Make sure that defined distances and speeds are physically plausible and that the motor is able to follow the speed curve

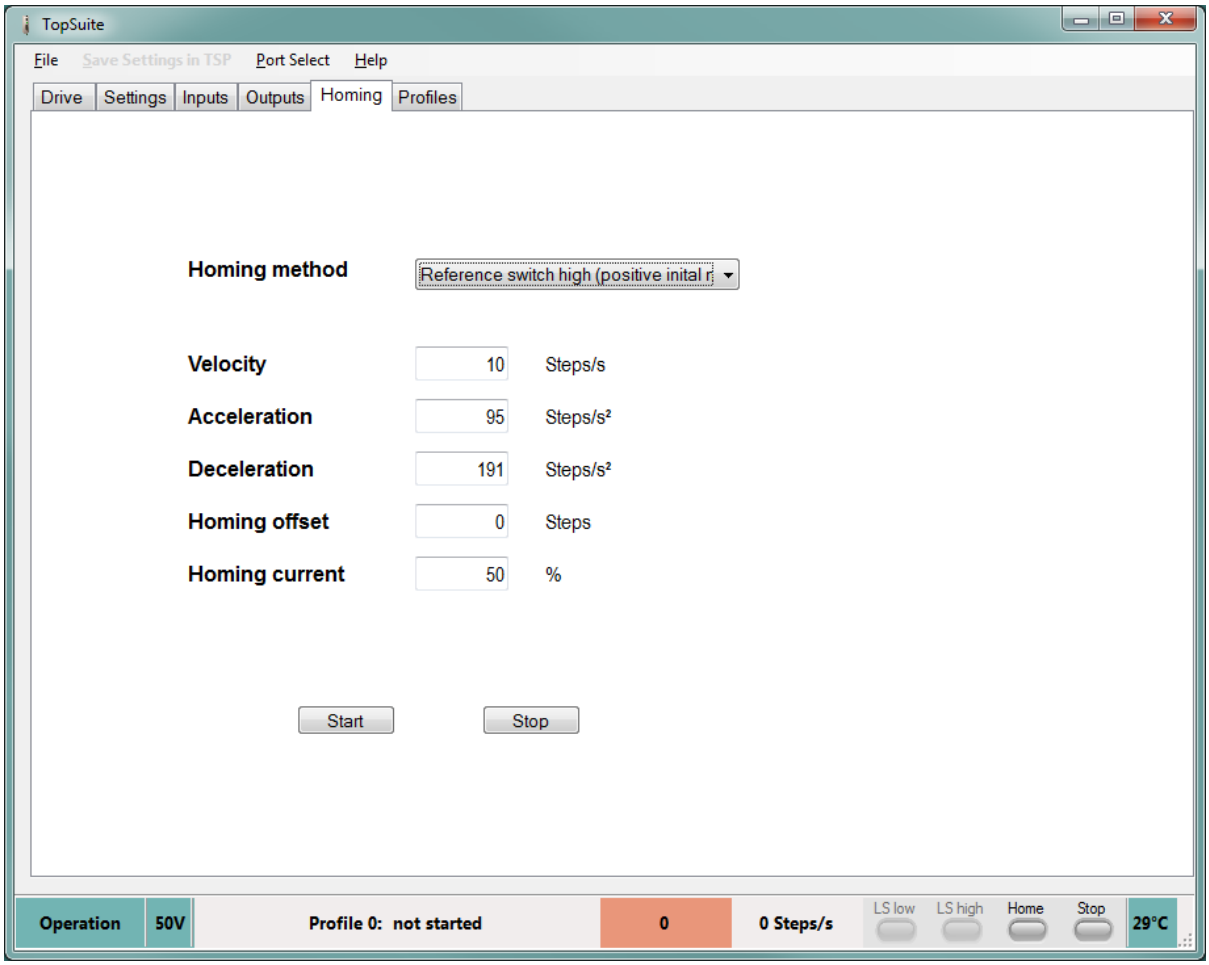
---

10.2.6 Homing

Execute homing to determine the absolute position of the motor.
The stepper motor control TSP10 provides 9 different methods.

- Current position
- Lower limit switch
- Upper limit switch
- Lower reference switch (positive direction)
- Upper reference switch (positive direction)
- Lower reference switch (negative direction)
- Upper reference switch (negative direction)
- Lower mechanical limit
- Upper mechanical limit

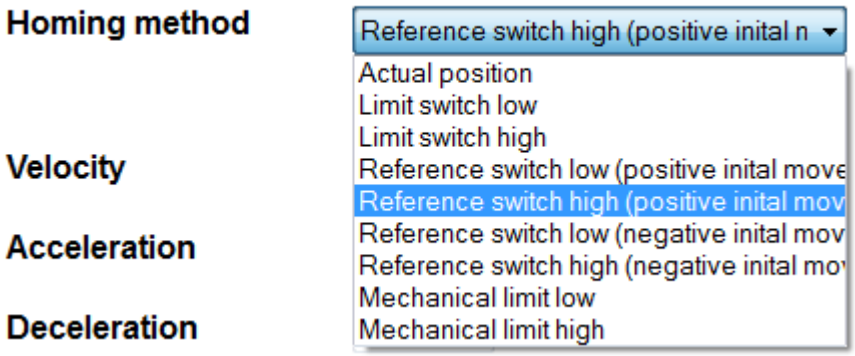
Set the parameters for homing on this tab.
Click the ***Save Changes*** button to permanently save changed parameters in the TSP10.



***Homing** tab*

Method

Select a method for homing and set the necessary parameters.



*Selecting the **method***

Velocity, acceleration, deceleration

The parameters ***Velocity, Acceleration*** and ***Deceleration*** are defined like those of the profiles. Thus the curve of speed over time when homing matches that of the profiles. The entered **start and stop speed** values are also used to generate the speed profile.

Ref. position

When the reference point is reached, the motor position is set on the value of the ***Reference position*** field. Enter the ***reference position*** in ***steps***.

Reference position = - 2 147 483 648... + 2 147 483 647 (corresponding to 80000000h... 7FFFFFFFh).

Current

For homing, enter the motor current as a fraction of the motor current entered on the ***Settings*** tab in ***percent***.

Current value = 0... 100%

Max. distance

This entry is used only for the ***lower mechanical limit*** and ***upper mechanical limit*** methods. Enter the ***Max. distance*** in ***steps***.

Max. distance = 0... 2 147 483 647 (corresponding to 0h... 7FFFFFFFh).

Confirm each entered value with the Enter key.

Start/stop buttons

Homing can be initiated or terminated either by input signals or by clicking the ***Start*** and ***Stop*** buttons. Abnormal termination causes the driving mechanism to brake with the set deceleration and stop. The motor current is not switched off.

Basic default for homing

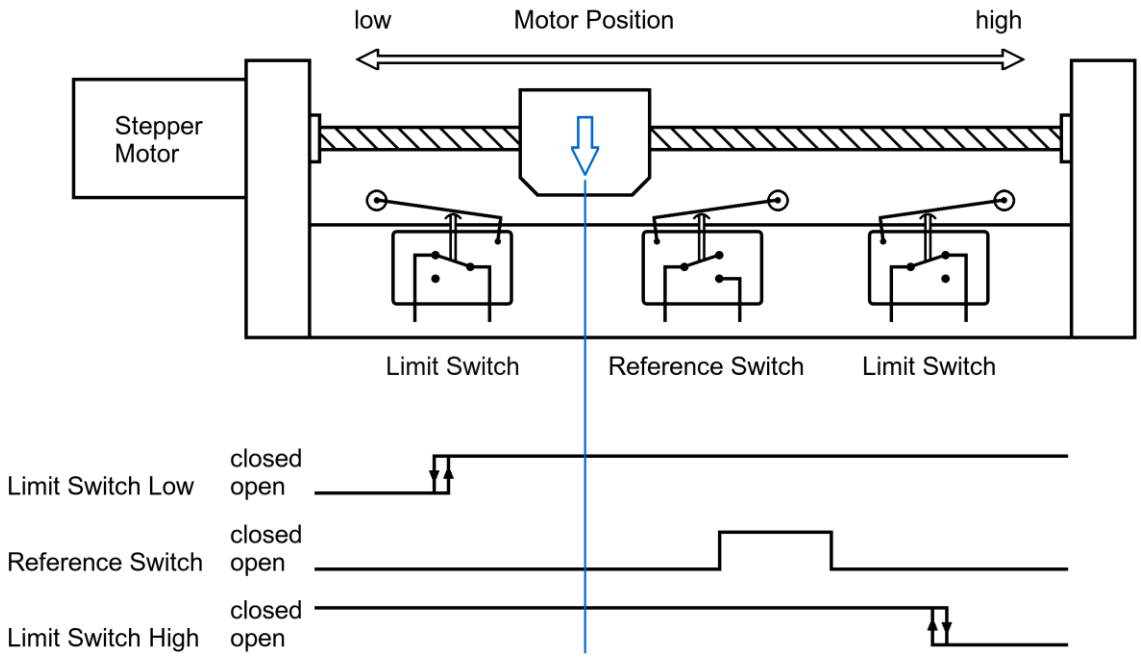
- The motor current has to be switched on for homing. This also applies to the **Assume the current position** method.

- The limit switches have to work as openers (see also ***chapter 10.2.2 Input functions***). The limit switches used as transmitters for the reference point must have a switching hysteresis.
  The switching hysteresis is the distance which the switch cam has to cover between opening and closing of the switch contact. The position for opening the switch contact has to be closer to the mechanical limit than the position for closing the contact. Mechanical switches have as a rule such a switching hysteresis.
  If you use electronic sensors as limit switches, make sure that they have a suitable switching hysteresis.

- The reference switch has to work as a closer (see also ***chapter 10.2.2 Input functions***).
  A switching hysteresis is not necessary.

- **Down** and **up** refer to the value range of the motor position and not to the physical structure or sense of the motor.
  Lower values mean **down**, higher values mean **up**.
  The lowest number is - 2 147 483 648 (= 80000000h) and
  the highest number is + 2 147 483 647 (= 7FFFFFFFh).

- **Positive direction** means that the position counter is **incrementing**.
- **Negative direction** means that the position counter is **decrementing**.



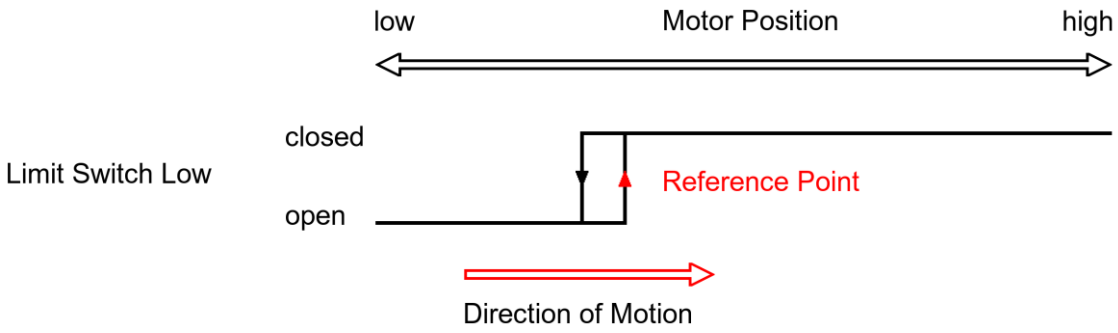
Typical configuration of the limit switches and the reference switch

Method: current position

When homing starts, the motor position is set to the value in the ***Ref. position*** field. The motor does not move.
Homing runs as well if the driving mechanism is set on the limit switches. No other parameters than ***Ref. position*** and ***Current value*** are used.

Method: lower limit switch

- The initial direction is negative if the motor is not set on the lower limit switch.
- The motor position is set to the value of the ***Ref. position*** field when the motor leaves the limit switch.
- After homing, a relocation is initiated, then the motor is at the reference position.
- If the limit switch is reached during relocation (contact opens), homing is abnormally terminated and the motor is not at the reference point.
  Hence, it is important that the position which opens the switch contact is closer to the mechanical limit than the position that closes the contact (switching hysteresis).

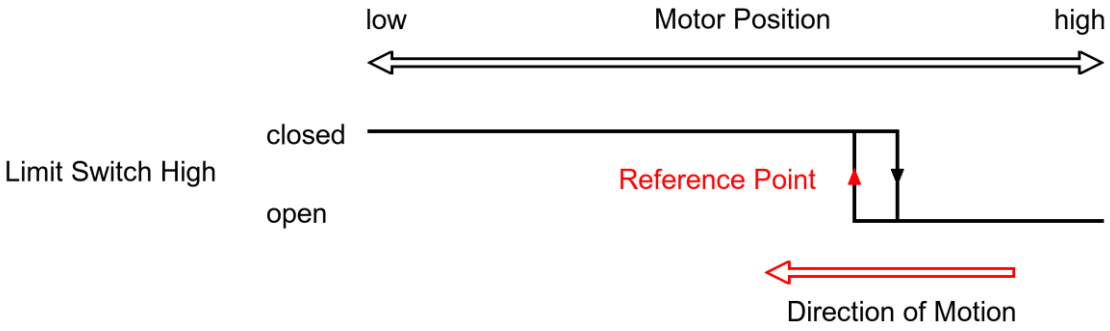


Assuming the reference point when the lower limit switch is left

Homing to the lower limit switch	
Start	If the motor is on the lower limit switch, continue at (3), otherwise at (1).
1	The motor starts in the negative direction.
2	The limit switch is reached, the motor decelerates down the emergency brake ramp until shutdown.
3	The motor starts in the positive direction to leave the limit switch.
4	When the limit switch is left, the reference position is assumed and the motor decelerates until shutdown.
5	Relocation to the target **Reference position** is initiated**.**
End	The motor is at the reference position. Homing was successfully concluded.

Method: upper limit switch

- The initial direction is positive if the motor is not on the upper limit switch.
- The motor position is set to the value of the ***Ref. position*** field when the motor leaves the limit switch.
- After homing, relocation is initiated, then the motor is at the reference position.
- If the limit switch is reached during relocation (contact opens), homing is abnormally terminated and the motor is not at the reference point.
  Hence, it is important that the position which opens the switch contact is closer to the mechanical limit than the position which closes the contact (switching hysteresis).

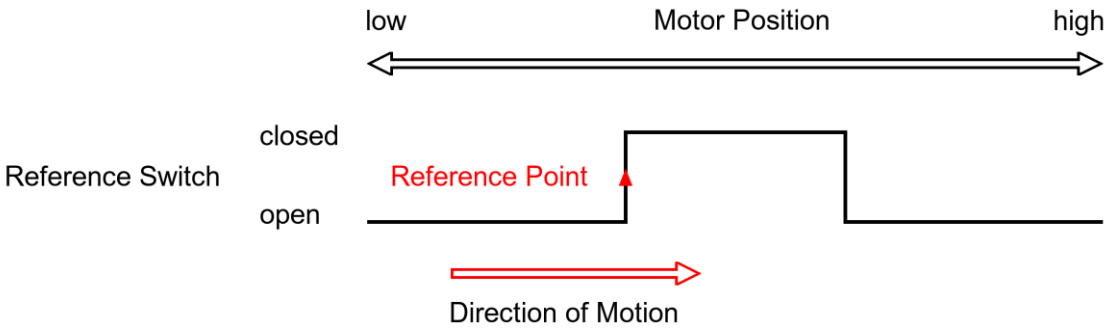


Assuming the reference point when the upper limit switch is left

Homing to the upper limit switch	
Start	If the motor is at the upper limit switch, continue at (3), otherwise at (1).
1	The motor starts in the positive direction.
2	The limit switch is reached, the motor decelerates down the emergency brake ramp until shutdown.
3	The motor starts in the negative direction to leave the limit switch.
4	When the limit switch is left, the reference position is assumed and the motor decelerates until shutdown.
5	Relocation to the target **ref. position** is initiated**.**
End	The motor is at the reference point. Homing was successfully concluded.

Method: lower reference switch (positive direction), (negative direction)

- The selected initial direction is positive (negative). The actual initial direction is additionally identified by the position of the motor when homing starts.
- The motor position is set on the value of the ***Ref. position*** field when the motor reaches the lower edge of the reference switch in the positive direction.
- After homing, relocation is initiated, then the motor is at the reference position.

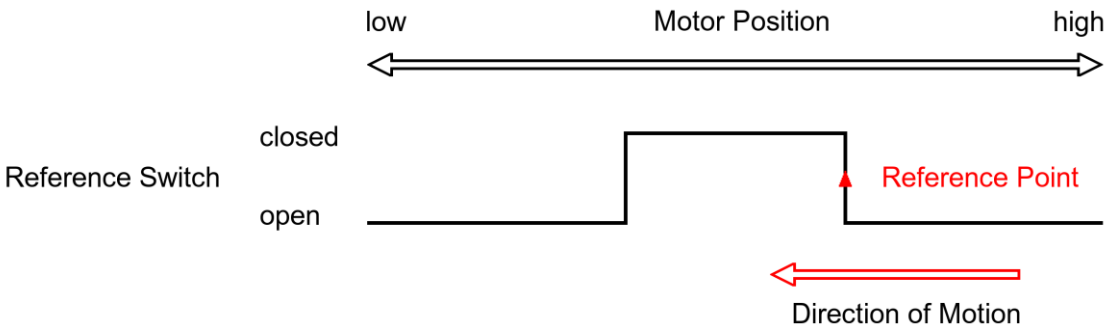


Assuming the reference point when the lower edge of the reference switch is reached

Homing to the lower edge of the reference switch		
Start	The motor starts in the positive or negative direction according to the setting and the current motor position.	
1	When the limit switch in the direction is reached, the motor decelerates down the emergency brake ramp to shutdown and restarts in the opposite direction. When another limit switch in the direction is subsequently reached, homing is abnormally terminated. In this case homing was not successful and the motor is not at the reference point.	
2	The reference switch is reached from above. The motor continues to leave the reference switch in the negative sense.	The reference switch is reached from below. The motor decelerates to shutdown and starts in the negative sense to leave the reference switch.
3	The motor leaves the reference switch in the negative sense and brakes to shutdown.	
4	The motor starts in the positive sense towards the lower edge of the reference switch.	
5	When the lower edge of the reference switch is reached, the reference position is assumed and the motor brakes to shutdown.	
6	Relocation to the target **Ref. position** is initiated.	
End	The motor is at the reference point. Homing was successfully concluded.	

Method: upper reference switch, positive direction (negative direction)

- The selected initial direction is positive (negative). The actual initial direction is additionally identified by the position of the motor when homing starts.
- The motor position is set on the value of the ***Ref. position*** field if the motor reaches the upper edge of the reference switch in the negative direction.
- After homing, relocation is initiated, then the motor is at the reference position.

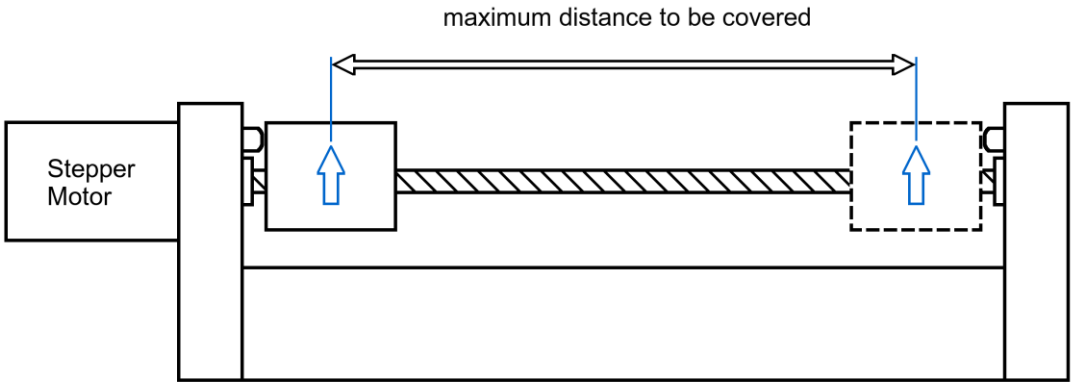


Assuming the reference point when the upper edge of the reference switch is reached

Homing to the upper edge of the reference switch		
Start	The motor starts in positive or negative direction according to the setting and the current motor position.	
1	When the limit switch in the direction is reached, the motor decelerates down the emergency brake ramp to shutdown and restarts in the opposite direction. When another limit switch in the direction is subsequently reached, homing is abnormally terminated. In this case homing was not successful and the motor is not at the reference point.	
2	The reference switch is reached from below. The motor continues to leave the reference switch in the positive sense.	The reference switch is reached from above. The motor decelerates to shutdown and starts in the positive sense to leave the reference switch,
3	The motor leaves the reference switch in the positive sense and brakes to shutdown.	
4	The motor starts in the negative sense towards the upper edge of the reference switch.	
5	When the upper edge of the reference switch is reached, the reference position is assumed and the motor brakes to shutdown.	
6	Relocation to the target **Ref. position** is initiated.	
End	The motor is at the reference point. Homing was successfully concluded.	

Method: lower mechanical limit, (upper mechanical limit)

- The initial direction is negative (positive).
- The motor position is set on the value of the ***Reference position*** field when the motor has covered the distance set in the ***Max. distance*** field and decelerated to shutdown.
- The reference position may deviate from the mechanical limit by as much as + - 2 full steps. Please, see the notes on the next page.
- If the motor may assume any position when homing starts, set the value of the ***Max. distance*** field at least at the longest possible distance so that the motor can reach the limit.
- Set the ***Current*** value (motor current) and ***Velocity*** in such a way that the motor is not damaged when hitting the limit.
- There should not be any limit switches. Nevertheless, homing is also performed if limit switches are present. In this case the motor brakes when the longest distance is reached while the limit switch is open, though not with the selected **deceleration** but down the **emergency brake ramp**.

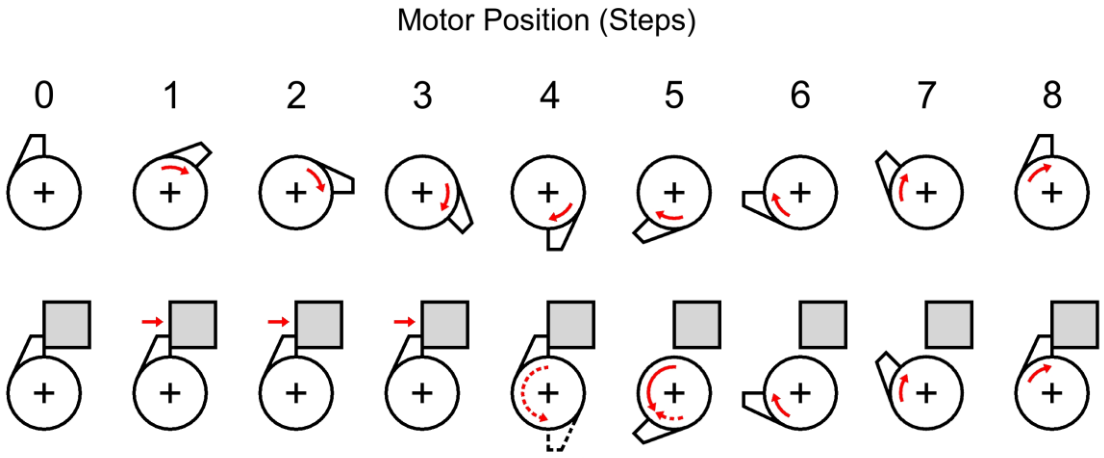


Example of the definition of the maximum distance between lower and upper limit

Homing to the lower (upper) mechanical limit	
Start	The motor starts in the negative (positive) direction.
1	The ***max. distance*** is covered, the motor decelerates to shutdown.
2	The motor position is set on the value of the ***Ref. position*** field***.***
End	The motor is at the reference point. Homing was successfully concluded.

Homing accuracy

The motor usually reaches the mechanical limit before the distance entered in the ***Max. distance*** field is covered. It cannot pursue the set position any further, resulting in the response shown in the following image.



Response of the stepper motor at the mechanical limit

A stepper motor with only one pair of poles was selected to simplify the example. One full step of such a motor results in a 90 degree turn. The half steps shown in the picture generate a 45 degree turn. Accordingly, a full turn is achieved after 8 half steps (upper row in the image). The lower row shows the response at the limit.

Step	Description
0	The motor is right at the mechanical limit. If there is no load on the motor, the torque feed is zero. Now the reference position would have no fault.
1	The set position was switched on by half a step. The motor cannot follow the setting and presses against the limit. Fault = half a step.
2	The set position was switched once more by half a step. Now the motor presses with the highest torque against the limit. Fault = a full step.
3	The set position was further switched by half a step. Now the motor presses with the same torque as in step 1 against the limit. Fault = three half steps.
4	The position of the motor is unstable. Any bit of negative torque may cause the motor to turn backward to the sketched position. Either the motor is at the limit, then the reference position is two full steps behind the limit, or the motor position has turned by 180 degrees, then the reference position is two full steps ahead of the mechanical limit. Fault = plus or minus two full steps.
5	At the latest when this step is accomplished, the motor turns backward to the indicated position. If the motor had already turned to the 180 degrees position, it advances half a step to reach the indicated position. Fault = three half steps.
6.7	The motor turns in each case half a step forward and further approaches the limit. Fault = two half steps (step 6) or half a step (step 7).
8	The eighth step returns the motor to its initial position. The reference point would not have a fault now.

11 Commissioning

For the initial startup, disconnect the load of the motor, if possible, so that it may freely revolve. Mount the motor in such a way that it cannot come loose and cause damage if there are jerky movements.

Observe the following important safety notes!

⚠ WARNING Unintentional movements of the driving mechanism may damage people or objects.

- Assess the risk of your machine and take suitable measures to make sure that unintentional movements will not cause damage to persons or objects.
- To safely shutdown the driving mechanism, aldistances interrupt or switch off the supply voltage. Switching the stepper motor control off by the ***enable*** input is not a safe method of interruption for emergency failures.

⚠ CAUTION Connecting or separating live circuits and connections may lead to arcing. This damages circuits and contacts and may injure people.

- Connect or disconnect electric contacts only when the supply voltage is switched off.

NOTICE The signal input devices of the TSP10 are available as 5 V or 24 V versions. If you connect 24 V signals to 5 V inputs, the signal input of the TSP10 may be damaged.

- Check whether the signal levels of the electronic control agrees with the signal levels of the TSP10 inputs. This is important in particular when exchanging devices.

NOTICE If the rated current of the motor is exceeded, the motor may be destroyed by demagnetization or overtemperature.

- Set the output current of the stepper motor control TSP10 not beyond the rated current of the motor.

11.1 Commissioning with step and direction signal

Requirement

The machine or plant is prepared for the integration of the TSP10 (***chapter 5 Mechanical installation***). The electric wiring is prepared for the connection of the TSP10 (***chapter 6 Electric installation***).
The supply voltage of the TSP10 is switched off.

Procedure

1. Take the device from the transport package and check for damages.
   Damaged devices may not be commissioned! This applies in particular if any connectors or jacks are broken or if the case is very deformed. There is a hazard of ultimate destruction of the device or other connected devices.

2. Check with the help of the order name on the name plate whether the stepper motor control corresponds to the desired version (***chapter 15 Ordering code***). Examine thoroughly whether the signal input devices are designed for 5 V or 24 V (***chapter 9.1 Signal connection***).

3. Integrate the device into your plant and connect the supply voltage, the motor wires and the signal wires for step and direction.

4. Set the desired step resolution and the current reduction (***chapter 7.2 Step resolution/idle current reduction***).

5. Set the motor current (***chapter 7.1 Motor current***). During initial startup you should set a smaller motor current than you intend for normal operation. This lowers the risk of damage to your machine.

6. Power on.

7. Observe the LED display of the TSP10. First, the version number of the device firmware (***chapter 8 Operating lights***) is indicated by the flashing LED. Then the TSP10 switches the motor current and is active (factory setting). If the motor is small and the motor current is low, you may manually check whether the motor produces a torque.

8. Set low frequency steps and check whether the motor turns.

9. Invert the ***direction*** signal and check whether the motor reverts its direction.

10. Switch off the supply voltage.

11. Connect the load again to the motor.

12. Power on again, the TSP10 is ready for use.

If any faults occurred during startup, follow the notes in ***chapter 12 Fault recovery***.

11.2 Startup with profiles

Requirement

The machine or plant is prepared for the integration of the TSP10 (***chapter 5 Mechanical installation***). The electric wiring is prepared for the connection of the TSP10 (***chapter 6 Electric installation***).
The supply voltage of the TSP10 is switched off.
The parameterisation software ***TopSuite*** is installed on your PC.

Procedure

1. Take the device from the transport package and check for damage.
   Damaged devices may not be commissioned! This applies in particular if any connectors or jacks are broken or if the case is very deformed. There is a hazard of ultimate destruction of the device or other connected devices.

2. Check with the help of the order name on the name plate whether the stepper motor control corresponds to the desired version (***chapter 15 Ordering code***). Examine thoroughly whether the signal input devices are designed for 5 V or 24 V (***chapter 9.1 Signal connection***).

3. Integrate the device into your plant and connect the supply voltage, the motor wires and the signal wires for step and direction.

4. Connect your PC to the TSP10 using the serial cable.

5. Turn the switch S1 (motor current) to position 1.
   This sets the motor current to the smallest non-customisable value (see table in ***chapter 7.1 Motor current***).

6. Power on.

7. Observe the LED display of the TSP10.
   First, the version number of the device firmware (***chapter 8 Operating lights***) is indicated by the flashing LED. Then the TSP10 switches the motor current and is active (factory setting).

8. Launch the parameterisation software ***TopSuite*** on your PC.

9. Set the operation parameters for checking the TSP10 or load them from a file.
   During initial startup you should set a smaller motor current than you intend for normal operation. This lowers the risk of damage to your machine.

10. Save the parameters in the device.

11. Switch off the supply voltage and wait until the LED display goes out.

12. Power on.

13. Check with the parameterisation software ***TopSuite*** whether the parameters were correctly saved in the device.

14. Turn the switches S1 and S2 to the position 0.
    This sets the values of motor current, step resolution and current reduction which you have defined during parameterisation.

15. Begin checking. Check by suitable parameterisation and setting of profiles:

    - direction of the motor (positive and negative distance)
    - torque feed of the motor (motor current/acceleration)
    - signal inputs
    - signal outputs

16. Set the final operation parameters or load them from a file.

17. Save the parameters in the device.

18. Switch off the supply voltage.

19. Connect the load again to the motor.

20. Power on again, the TSP10 is ready for use.

If any faults occurred during startup, follow the notes in ***chapter 12 Fault recovery***.

12 Fault recovery

The stepper motor control TSP10 switches off to protect itself if internal measured values reveal a fault state. The output signal ***enabled*** (***chapter 6.5 Signal inputs and outputs, signal connection, output signals***) is deleted and the fault number is indicated by a blinking code of the two-colour LED on the front side of the device (***chapter 8 Operation lights***). The colour of the two-colour LED changes to red.

4x blinking, break, 4x blinking, break... indicates fault number = 4.

12.1 Disconnection after fault, fault list

The following table lists all fault messages and notes on fault recovery.

Fault		
No.	**Message**	**Description/recovery**
4	Overtemperature	The TSP10 has shut down because the limit temperature of the device was reached. The output signal ***enabled*** is deleted. The cause is insufficient cooling of the TSP10. Improve the cooling of the TSP10 (***chapter 5.2 Cooling and permissible motor current).***
7	Overcurrent	The TSP10 has shut down because the limit output current was reached. The output signal ***enabled*** is deleted. A possible cause may be a short circuit between two motor phases or between a phase and ground. Switch off the supply voltage. Pull the motor cable from plug X4 and power on again. Some configurations may require that you apply the enabling signal to enable the TSP10. If the fault message does not appear any more, check the motor cable for any short circuits between the conductors and for any short circuits between conductors and shield. Check whether the motor connector X4 is properly allocated. Check the (disconnected) motor for any short circuits between the phases or between the phases and the motor case.

12.2 Faulty response

Observe these notes if the TSP10 does not indicate a fault, yet the driving mechanism does not respond as expected.

The supply voltage is switched on, but the LED display remains dark.
Power for the logic stage is too low or not available. Check whether the circuits are properly connected to the plug X3 and whether the plug is firmly plugged. Check whether the power meets the requirements (***chapter 6.3 supply voltage***).
The LED display briefly flashes every 3 seconds. The motor has no torque.
The TSP10 is ready but not enabled. The factory setting disables the enable input, the TSP10 is at once enabled after powering on and the motor current is switched on. Check with the parameterisation software ***TopSuite*** whether the enable input is enabled. Disable the enable input and check whether the motor current is switched on (LED display is green). Re-enable the enable input if it is supposed to be used. Check whether the enabling signal is present and corresponding to the input specifications.
The LED display is green (or flashes yellow). The motor has no torque.
The TSP10 is enabled (and the control signals are recognised), but there is not enough or no motor current. Check whether there is power for the power stage that meets the requirements. Check whether the wires are properly connected to the plug X3 and whether the plug is firmly plugged (***chapter 6.3 supply voltage***). Check whether the rotary switch S1 is set on the right position (***chapter 7.1 Motor current***). If the switch position 0 is used, check with the parameterisation software ***TopSuite*** whether the value of the motor current is properly set.
The LED display is green The motor has a holding moment but does not rotate.
The control signals are not recognised. Check whether the version of the TSP10 signal inputs (5 V or 24 V) fits to the output signals of your control or clock generator. Check whether the wires are properly connected to the plug X2 and whether the plug is firmly plugged (***chapter 6.5 Signal inputs and outputs***). Make sure that the clock signal of your clock generator corresponds to the specific requirements for power and time. You may test a 5-V clock input of the TSP10, e. g., with a (properly poled) 4.5-V battery. Unless an extremely high step resolution is selected, repeated jogging should produce a noticeable turn of the motor shaft.

The motor does not respond to the direction input.
The direction signal is not recognised. Make sure that the direction input is properly wired and that the signal corresponds to the specific requirements for power and time. You may test the 5-V direction input, e.g., with a (properly poled) 4.5 V-battery. When you do so, run the motor at a low clock rate.
The motor turns in the wrong sense.
The effect of the direction input cannot be set directly. Invert the direction by exchanging both connected wires of a motor phase. Switch off the supply voltage. Exchange at X4 the motor wire 1-A against 1-/A or 2-B against 2-/B. If the wires of both motor phases are exchanged, the direction is not inverted. Or: Use the parameterisation software ***TopSuite*** to customise the sense of the motor to the machine without changing the wiring (***chapter 10.2.1 Settings***).
The motor does not reach the expected position.
Check whether the step size set in the TSP10 agrees with the step size set in your control. Check whether the motor stops or loses steps because it is burdened too much by too high acceleration or load torques. Consider that the torque curve of a stepper motor is a function of the supply voltage of the control and the wiring of an 8-pole motor (parallel or serial). Check whether the motor works in the resonance area. The operation noise may give clues. Use a higher step resolution to avoid low speed resonance (below approx. 120 min-1). Or: Enable the function ***Smoothing*** in the parameterisation software ***TopSuite*** (***chapter 10.2.1 Settings***). If small stepping errors add up when driving back and forth, check whether your control keeps the necessary waiting time of the direction signal before the first step of a new movement is forwarded (***chapter 9.2 Signal timing***). Check whether the signals in the clock and direction inputs are corrupted by noise.

INFO

If you conclude that the stepper motor control TSP10 is faulty, do NOT simply replace it with another and power on again.
Check, instead, the configuration of the supply voltage unit and its wiring.
Improper supply voltage is the most frequent reason for control faults.

13 Maintenance and cleaning

The stepper motor control TSP10 is maintenance-free.
In the device are no elements which have to be calibrated or maintained.
Do not open the case. Opening the case voids any warranty.

Remove superficial dust or dirt from the device with clean, dry low-pressurised compressed air.

14 Repair and disposal

14.1 Dismantling

If you want to dismantle the stepper motor control (repair, exchange, disposal), proceed as follows:

1. Switch off the supply voltage.
2. Wait until the supply voltage of the logic and the power stages has dropped below 40 V.
3. Wait until the temperature of the case has dropped below 40°C.
4. Remove all electric connections from the device.
5. Loosen the mounting screws and remove the stepper motor control.

⚠ WARNING High electric voltage may cause hazardous electric shock to people.

- Measure the voltage at the supply voltage connection (**X3**) of the TSP10 and wait until the voltage has dropped below 40 V before you touch the electric connections of the stepper motor control.

⚠ CAUTION When active, the heatsink can be heated to more than 60 °C.

- Measure the temperature of the heatsink and wait until the stepper motor control has cooled down to less than 40 °C before you touch the device.

14.2 Repair

The stepper motor control TSP10 may be repaired only by authorised staff or the manufacturer. Opening the case voids any warranty.

If you are a customer of a manufacturer who integrated the stepper motor control TSP10 into a machine, please, contact the machine manufacturer for repairs.
If you have received the stepper motor control TSP10 directly from a distributor, contact this distributor to receive information on the fastest access to repair and exchange.

14.3 Disposal

According to WEEE-2002/96/EG directives etc., the manufacturer takes back old devices and accessories for correct disposal. The sender pays for shipping.

Send the devices to this address:

AHS Antriebstechnik GmbH
Im Waldfrieden 1
64319 Pfungstadt

15 Ordering code

TSP10-BA0-00-AA = standard version of the basic device

TSP10 Type code

T	S	P	1	0	-	B	A	0	-	0	0	-	A	A

Drive Series

Max. Output Power = 10 A_{peak}

Basic Device (Step & Direction, RS232)	BA
Profibus	PB
Profinet (in preparation)	PN
Analog (+/- 10 Volt)	AN
ModBus	MB
CAN-Bus	CB

Standard (no feedback)	0
Encoder RS422/TTL	E
Encoder HTL	H
Encoder Biss-C	C

Digital Inputs = 24V; Step & Direction = 5V	00
Digital Inputs = 5V; Step & Direction = 5V	05
Digital Inputs = 24V; Step & Direction = 24V	24

Standard	AA
Customization	XX
Follow up identifier DSM9	09

Note: Not all combinations of the type code are possible.

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