

ELS 4 BASIC

Operating instructions



TRANSLATION OF THE ORIGINAL
OPERATING INSTRUCTIONS

ENGLISH

This manual describes the commissioning and use of
the cycle controller ELS 4 BASIC.

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Subject to technical changes without notice.

All safety regulations, in particular the CE directives, have been observed during production. The product was subjected to an extensive final inspection at the factory.

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DISCLAIMER

We have checked the contents of this publication for conformity with the hardware and software described. Nevertheless, deviations cannot be excluded, so that we do not assume any liability for the complete conformity. However, the information in this publication is checked regularly and necessary corrections are included in the following editions.

ADDRESSEE OF THE DOCUMENTATION

This documentation is intended for machine tool users and installation personnel. The brochure describes in detail the information required by the user for the installation and operation of the ELS controls.

SAFETY INSTRUCTIONS

This manual contains instructions that you must follow for your personal safety and to avoid damage to property. The instructions for your personal safety are highlighted by a warning triangle, instructions for sole material damage are without a warning triangle. Depending on the hazard level, the warning notices are displayed in descending order as follows:



DANGER

means death or serious injury,
if the appropriate precautions are not taken.



WARNING

This warning means that death or serious injury will result if the appropriate precautions are not taken.



CAUTION

with warning triangle means that a slight bodily injury may occur if the appropriate precautions are not taken

CAUTION

without a warning triangle means that damage to property may occur if the appropriate precautions are not taken.

ATTENTION

means that an undesirable result or condition may occur if the relevant instructions are not followed.

LICENCE CONDITIONS FOR SOFTWARE OF THE ELECTRONIC LEADSCREW CONTROL SYSTEM

In the following the company Rocketronics.de, owner Louis Schreyer is referred to as „LICENSER“ of the software.

I. Rights of Use

1. The LICENSER grants to the Customer a royalty-free, perpetual and non-exclusive right to use (license) the SOFTWARE contained in this archive (hereinafter referred to as „SOFTWARE“).

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5. The customer may not reverse engineer, decompile or disassemble the SOFTWARE. Otherwise §§ 69d, 69e UrhG remain unaffected.

II. warranty

1. The LICENSER warrants - in accordance with the provisions of §§ 434 ff BGB - that the SOFTWARE complies with the specifications listed by Rocketronics in the associated program documentation and that it has been created with due care and expertise. Nevertheless, according to the current state of the art, the complete exclusion of software errors is not possible.

2. The LICENSER shall correct any errors in the SOFTWARE which significantly impair the intended use. At the discretion of the LICENSER, the correction of the defect shall be effected, depending on the significance of the defect, by the delivery of an improved version of the SOFTWARE or by instructions for the elimination or avoidance of the effects of the defect. The Customer shall be obliged to take over a new SOFTWARE version offered to him by the Licensor in the course of error correction, unless this leads to unacceptable adjustment and conversion problems for him.

4. The customer has the right to demand a reduction of the license fee or to withdraw from the contract free of charge. In the event of withdrawal, the customer shall return the hardware with the SOFTWARE contained to the LICENSER.

5. In any case of negligent breach of contract by the Licensor, the liability shall be limited to the amount of the net purchase price for the associated hardware.

The warranty period shall be 24 months from delivery of the SOFTWARE.

NOTES

The ELS controls are simple cycle controls that allow fully automatic cycle machining with a conventional lathe. For this purpose, drives must be mounted on the axes of the machine and a rotary encoder for position feedback must be mounted on the main spindle. Equipped with these components, the machine can then be controlled in 2 axes. The ELS control generates control signals for the drive motors from the encoder signals. These are strictly coupled to the movement of the main spindle by the rotary encoder, thus creating an electronically controllable gear. This means that many operations can be carried out automatically and speed-dependently. In addition, the user can freely select the feed rate on the ELS where gear changes or change gears previously had to be made.

Possible application

The ELS control system allows various applications to be carried out automatically that were only possible manually before installation. With the ELS, the user can cut threads in all pitches, even tapered- or multi-threads. It is possible to turn radii and cones, inside and outside, radii in concave or convex with cutting radius compensation. Longitudinal and face cutting inside and outside are possible as well as parting and undercuts. It indicates positions and allows the exact approaching of positions.

The ELS turns a manual machine into an automatic machine with much higher benefits and allows more precise machining.

Notes on installation

The ELS control can only be used as a device if it is connected to a machine which has drive motors and spindle encoders. Only in combination with these parts an automatic machine is created. It must therefore be ensured by the user or installer that the entire machine complies with the legal guidelines after completion of the installation.



WARNING

It is essential that the control is integrated into the emergency stop function of the machine. This function must be designed in such a way that, after the emergency stop condition has been removed, it must be enabled by the user before the machine is ready for operation again. It must not be possible to restart the machine independently.

Intended use

The ELS controller is used to control stepper or servo motors (or similar drives) for operation on a lathe. Any other use is considered improper.

Supplied accessories such as power supply units, output stages, sensors or motors must only be used for their intended purpose.

Disclaimer

Rocketronics produces components that are used on a wide variety of lathes. The selection and application of Rocketronics products is the responsibility of the system designer or end user. Rocketronics assumes no responsibility for the integration of the products into the end system.

Under no circumstances may a Rocketronics product be integrated into a product or design as a safety controller. All products containing a component part manufactured by Rocketronics must include appropriate warnings and instructions for safe use and operation when handed over to the end user. All warnings provided by Rocketronics must be passed directly to the end user.

The user of this control must ensure that all necessary safety precautions have been taken and that they have been checked for correct operation to ensure safe operation of the machine. When a lathe is modified, a potentially dangerous device is modified. The automation of movements can cause damage to the machine, but also serious injuries to the operating personnel.



WARNING

If incorrect entries are made, the machine equipped with this control may make unexpected movements which can be fatal for the operating personnel. It is therefore the responsibility of the system designer or end user to ensure that the settings are correct and have been checked.

Qualified personnel

Qualified personnel must be able to correctly interpret and implement the safety instructions and warnings. They must also be familiar with the safety concepts of automation technology and have received appropriate training. Non-qualified interventions in the devices or failure to observe the warning notices in this documentation or the warning notices displayed by the device may result in damage to property or personal injury.

EU directives on product safety

The following EU directives have been observed:

2011/65EU	RoHS
2014/30/EU	Electromagnetic compatibility (EMC)
DIN EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
DIN EN 61326-1	Electrical equipment for measurement, control, and laboratory use - EMC requirements

Other applicable regulations

In addition to this technical manual, the following regulations must be observed:

- Accident prevention regulations
- Local occupational safety regulations

Safety regulations

- The ELS should only be used by authorised specialist personnel and in compliance with accident prevention regulations and the regulations of the electrical industry.
- Unqualified persons must not put the control unit into operation.
- The control unit is designed for operating temperatures of +5 to +40 °C and storage temperatures of -10 to +50 °C. The control unit must not be operated by unqualified persons. It must be protected from high humidity, vibrations and explosive gases.
- Before opening the device, it must be disconnected from the power supply.
- Connection and installation work may only be carried out when the device is de-energized. Assembly and use of equipment must be carried out in accordance with the standards of the Declaration of Conformity.
- When connecting motors to motor drivers, the correct polarity must be observed. Furthermore, the correct motor current must always be set on the driver. In order for the speed of the motor to be correctly controlled, the steps/revolution must also be set on the driver. This setting must also be adopted in the settings of the ELS.
- The respective configuration of the controller may only be operated with the motor types configured for it. Other or further uses do not correspond to the intended purpose.
- Currents and voltages: The ELS works with a low voltage of 12V, which can be provided by a power supply unit. Therefore, no special safety precautions are required on the output side.

The ELS is built in accordance with the recognised safety regulations and complies with the

standards and directives listed in the previous chapter.

Environmental conditions

Protection class:	IP20
Ambient temperature (operation):	+5 ... +40°C
Humidity (non-condensing):	0 ... 95
Ambient temperature (storage)	-25 ... +85°C

Safety and warning information

- Read the operating instructions before putting the device into operation and using it for the first time.
- The safety and accident prevention regulations applicable in the specific individual case must be applied.
- Before switching on the controller, make sure that the operating voltage specified on the device corresponds to the supply voltage.
- Proper and safe operation of the product requires proper transport, storage, installation and assembly as well as careful operation and maintenance.
- Do not use a damaged controller.
- Switch off the device immediately if it shows noticeable deviations from normal operation.
- Rocketronics.de guarantees the proper function of the device only if no changes are made in mechanics, electronics and software.
- The opening of the device as well as adjustment, maintenance and repair work may be carried out only by appropriately trained technical personnel.
- The controller may only be used for the purpose described in this operating manual. Any other use is considered improper. The manufacturer is not liable for any resulting damage. The risk for this is borne solely by the user.
- The controller may only be put into operation when it has been established that the complete machine into which the controller is to be installed complies with the provisions of the EU Machinery Directive as amended.

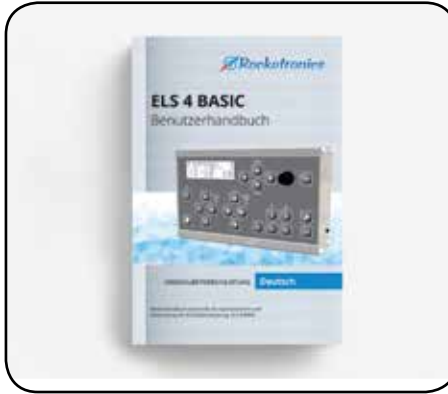
SCOPE OF DELIVERY AND ACCESSORIES

The scope of delivery of the ELS Basic includes a control unit.
Various components are available as accessories.



ELS Basic

Lathecontroller Basic-



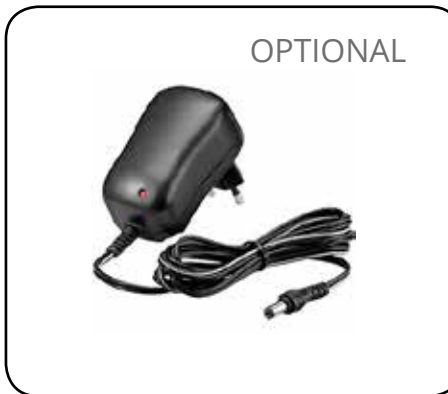
Manual

This Manual



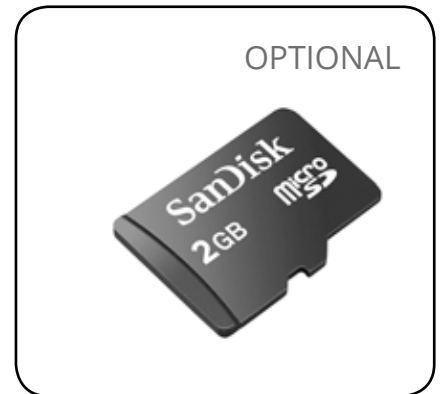
Wallmount

Typ WH-ELSBW
Adjustable wall mount



Power supply 12V/1A

Power supply with 12V und
1A, stabilized and short-circuit
protected

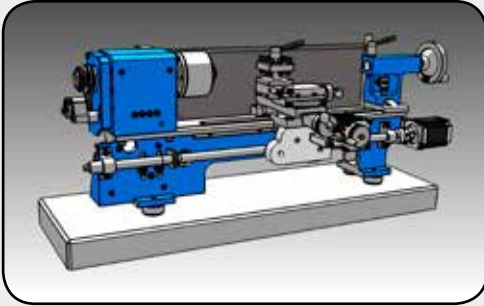


Micro-SD-Card

2 GB Micro-SD-Card for
software updates

- For environmental reasons, we do not supply a power supply unit or memory card because these elements are already present in many households and businesses.
- For wall mounting we recommend the wall mount adapted to the ELS. This is mounted to the ELS with two screws and available in our store.

BASIC REQUIREMENTS



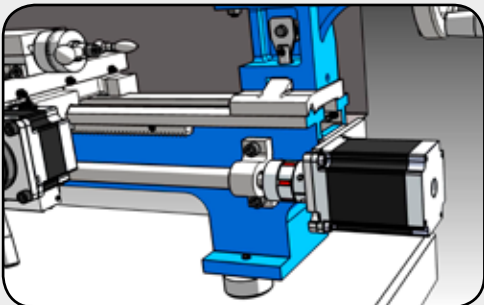
1. Lathe

The machine must have a lead screw and a cross slide. It must be possible to equip these spindles with drive motors. Simple so-called mechanic lathes are therefore not optimally suitable. The size is not limited.



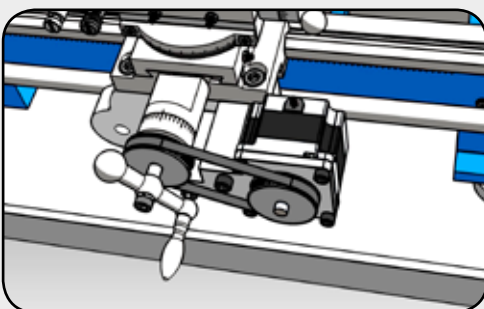
2. Rotary encoder on main spindle

Make sure that an encoder with quadrature signals is connected to the main spindle. This encoder should output 400 pulses per spindle revolution. More on this later.



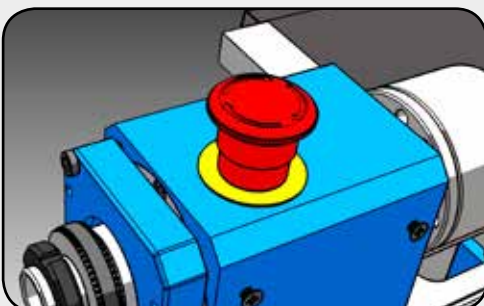
3. Drive on Z-axis

In order to control the longitudinal axis (Z), a sufficiently dimensioned controllable drive at the axis is necessary. A stepper or servo motor must be mounted here.



4. Drive on X-axis

To be able to control the transverse axis (X), a sufficiently dimensioned controllable drive on the axis is necessary. A stepper or servo motor must be mounted here.



5. Safety device

The complete machine must have an emergency stop device in which the ELS control must also be integrated. The ELS has inputs and outputs for this purpose. An automatic restart after the emergency stop has been triggered must be safely prevented!

The ELS Basic is a control system that sends signals to motors and can thus set the axes of a lathe in motion. In order for this movement, which is important for lathes, to take place synchronously with the spindle rotation, a feedback signal from the spindle is required. It provides the decisive signal.

The following components are required for a functional machine:

ENCODER

- An incremental encoder must be mounted on the main spindle.
- An incremental encoder generates pulses that indicate the rotation speed and direction. The signal must be differential, the encoder must therefore have connections A, A/, B and B/ and must be able to operate with 5V. An index signal is not necessary.
- We recommend the type AMT 103-V as it can be mounted on many shaft diameters and the pulse rate is adjustable.
- Select the pulse rate of the encoder so that [pulse rate] * [spindle speed] is < 1,200,000
Example: Speed=3000 rpm, 400 pulses/rev: 3000x400 = 1.200.000, which is fine.
- If the pulse rate is too high this can overload the control! The maximum possible speed can then be reduced.
- The following pulse rates are recommended with a ratio [spindle : encoder] of 1:1 and 2:1:

Max. Spindle-speed	Transmission	Impulserate Encoder	Settings in ELS	Product
2000	1:1	500	500	1.000.000
3000	1:1	400	400	1.200.000
4000	1:1	250	250	1.000.000
5000	1:1	250	250	1.250.000
6000	1:1	200	200	1.200.000
2000	2:1	250	500	1.000.000
3000	2:1	200	400	1.200.000
4000	2:1	125	250	1.000.000
5000	2:1	125	250	1.250.000
6000	2:1	100	200	1.200.000

- For installation via toothed belt and a transmission ratio deviating from 1:1, the pulse rate must be selected accordingly (see table above).
- The pulse rate delivered to the ELS per spindle revolution must be entered in the control settings before starting operation.
- Encoders can be connected directly to terminals or via the Rocketronics „Incremental Line Driver“ with an Ethernet patch cable (CAT5 or better, S-FTP e.g.) to the RJ45 connector. See also „Inputs

Encoders either have a fixed pulse rate or can be set.

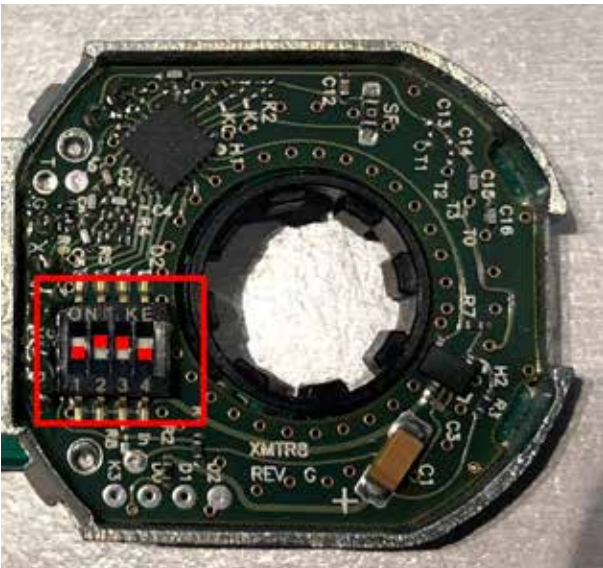
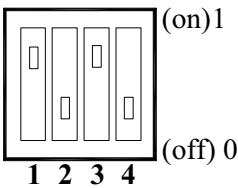
The frequently used adjustable encoder type AMT 103-V has 4 small switches to set the pulse rate. The manual contains a table showing the assignment of the pulse rate to the switch combination. Set the switches accordingly.

RESOLUTION SETTINGS

1 = On, 0 = Off

Resolution [PPR]	Maximum RPM	1	2	3	4
2048	7500	0	0	0	0
1024	7500	0	0	1	0
1000	7500	1	0	0	0
800	7500	0	1	0	0
512	15000	0	0	0	1
500	7500	1	0	1	0
400	7500	0	1	1	0
384	7500	1	1	0	0
256	15000	0	0	1	1
250	15000	1	0	0	1
200	15000	0	1	0	1
192	7500	1	1	1	0
125	15000	1	0	1	1
100	15000	0	1	1	1
96	15000	1	1	0	1
48	15000	1	1	1	1

DIP switch:
Example setting: 500 PPR



Combination for 400 pulses / revolution with AMT 103-V: 0 1 1 0

AXLE DRIVES

- Drive motors must be mounted on the X and Z axes.
- In order to be able to move the axes, the installed threaded spindles must be moved using stepper or servo motors. These are available in various sizes which must be selected to suit the machine.
- Stepper motors or so-called hybrid servo motors, or also „closed-loop stepper motors“ are recommended. Genuine AC or DC servo motors can also be used, but often have the disadvantage that they are more expensive and are designed for high speeds, which are rarely used during operation on the ELS. Hybrid stepper motors are therefore ideal for operation with the ELS because they drive more safely and generate more power thanks to position feedback.
- The motor systems almost always consist of a motor and a suitable output stage, also called driver. This output stage receives the drive signals from the ELS and converts them into current signals for the motor. The power amplifiers need their own power supply.
- The ELS outputs 5V step and direction signals at the outputs. You can use any type of motor that can be operated with these signals, most systems fall under this category. Examples are all stepper motor and servo output stages from Leadshine or identical.
- We recommend the direct connection or a 1:1 connection via toothed belt. Transmission ratios reduce the maximum feed rate, but increase the torque.
- Step rate: The maximum step rate of the ELS depends on the encoder pulses. It is therefore naturally limited. We recommend setting the motor output stages of the Z axis to 400 or 800 steps/revolution. The output stage of the X-axis can be set to 800 - 1600, depending on the thread pitch of the spindle.

We recommend mounting a hybrid servo motor (closed-loop stepper motor) on the Z axis and a stepper motor on the X axis.



Stepper motors are special motors which are able to carry out a rotation in 200 defined steps. These motors are driven by stepper motor drivers or output stages which convert the weak control signals into current for the motor coils and thus drive the motors.

Servomotors have a slightly different design, all have in common the fact that they have a device that reports the position of the motor, a feedback that allows the motor to be precisely controlled to a certain position. Servo motors achieve higher speeds than stepper motors, but together with the control electronics they are much more expensive than stepper motors. Since we do not need very high speeds for the ELS, it is sufficient in most cases to fall back on stepper motors. Servomotors also often require more than 800 steps per revolution, which is too much for operation with the ELS.

A middle way is the new hybrid servo motors, i.e. stepper motors with position feedback, so-called closed-loop systems. These have higher torques than normal stepper motors and are equipped with feedback. The matching output stages are also able to adjust the position between the steps, which leads to very precise drives. And the best thing is: step losses are excluded.

ed. All in all a very recommendable drive for the ELS. The disadvantage here, too, is the higher price.

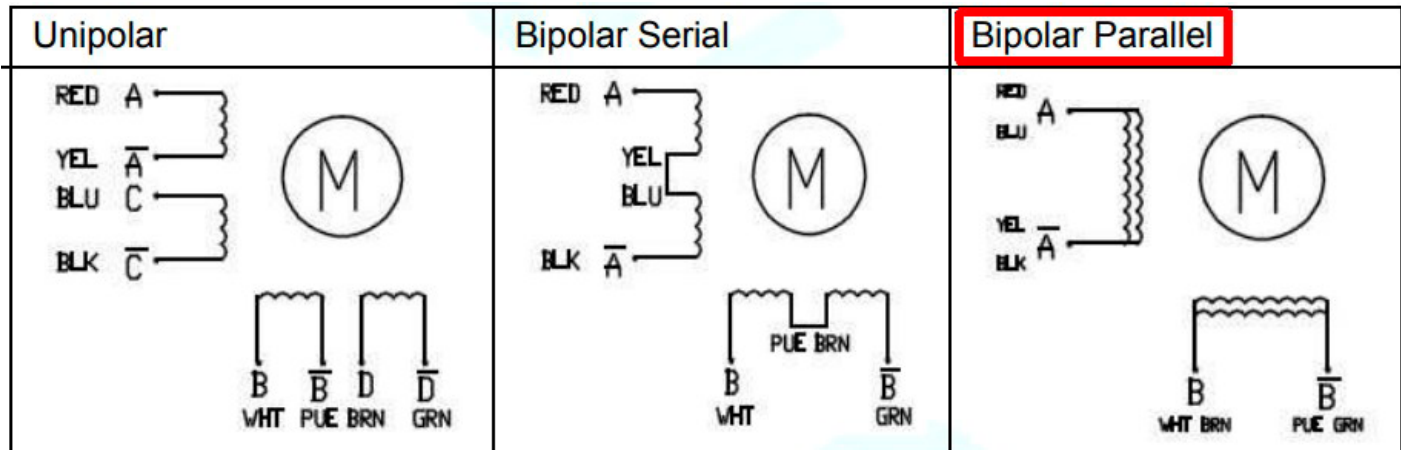
The ELS generates step and direction signals for motor drivers. A step pulse drives the stepper motor 1/200 revolution further, the direction signal determines in which direction the motor rotates. In this way, the ELS can precisely control the motors. If the motor is mounted on the lead screw, the ELS can precisely control the position of the carriage.

Normal stepper motors make 200 full steps per revolution, but the stepper motor output stages can divide these whole steps into smaller parts, so-called microsteps. This starts with half steps and ends with very small step widths. The smaller the sub-steps, the quieter and smoother the motor runs, the disadvantage being that the motor loses torque the smaller the step widths become, and that the controller has to deliver more impulses for this.

With the ELS, we use steps on the Z axis $\frac{1}{2}$ or $\frac{1}{4}$, i.e. 400 or 800 steps per revolution. More is not necessary and only unnecessarily limits the maximum possible feed rate. We can also use even finer steps on the X axis.

Motorcoils

Stepper motors and hybrid servo motors have two, three or four coils that can be connected to the output stage in different ways. Most stepper motors have 8 wires, for each coil 2. These coils can now be operated in series or parallel. One method is unipolar, which is quite rare since most power amplifiers support bipolar serial or parallel operation:



There are advantages and disadvantages for each method, you can write books about it, so we make it easy here: With the ELS we connect the motors Bipolar Parallel. This circuit gets the most torque and the highest speed out of the motors.



SELECTION OF RIGHT MOTOR

The stepper motor must provide sufficient torque to turn the lead screw in all positions. Depending on the machine, more or less power is required. In general it can be said that the necessary forces are smaller than e.g. on a milling machine.

For normal hobby machines with 400-600mm distance a Nema24 motor with 3-4A current should be sufficient. Larger machines might need more power.

Do not underestimate the force a motor can generate on a threaded spindle. A Nema24 motor with 2.2 Nm torque on a 4mm spindle generates a thrust of about 1400N, which corresponds to a weight of 140 kg pulling on the bed slide!

Step rate of the drive on the Z axis:

The control can only supply a finite clock rate, which is directly linked to the pulses of the spindle encoder. The recommended 400 pulses per revolution of the encoder and 400-800 steps/revolution of the stepper motor are used to ensure correct operation up to a spindle speed of 3000 rpm. If you deviate strongly from this, malfunctions may occur.

Transmission via toothed belt on the Z-axis

The available torque can be increased by a transmission, a smaller motor can be used, but at the expense of speed. Stepper motors have lower torques at higher speeds, the curve drops sharply at higher speeds. So if high speeds are required, it is more of a disadvantage to translate: In the end they do not necessarily get more torque.

Pay attention to backlash-free variants of timing belts, e.g. a HTD profile.

Only use transmission in straight ratios, 2:1, 4:1, etc.

The step rate on the motor driver should then be selected accordingly, see table below. Observe the maximum speed of stepper motors, this is usually in the range of 800-1400 rpm with a noteworthy torque. With a ratio of 2:1, only half the speed is available. At 700 rpm on a lead-screw with 2mm pitch, a maximum of $2 \times 700 = 1400$ mm/min feed rate is still possible.

In comparison, an untranslated drive delivers 2800 mm/min here.

X-Axis

The ELS does not require high speeds on the X-axis, so a transmission is easier there, and the step rate can also be set higher to increase the resolution even further. We recommend 1600 steps/rev at 1:1 and 800 steps/rev at 2:1 on the X-axis should almost always be possible. So a smaller motor can also be used, which often fits better on the X-axis.

Resolution

The number of steps of the drive should be adapted to the leadscrew pitch so that a resolution of at least 0.01 mm is achieved per step (leadscrew pitch/step rate). Refer to the tables below for step rate recommendations.

We are happy to help you with the design, please contact us if you have any questions!

MAXIMUM FEED SPEED

The maximum feed rate in mm/revolution is directly linked to the ratio of encoder pulses, motor steps/revolution and the thread pitch of the lead screw. The maximum feed rate is decisive for the maximum thread pitch you can produce. Please note, however, that threads with a pitch of more than 8 mm are very rarely turned.

Recommendation for step rate on the motor driver with direct drive 1:1 of the Z-axis

Screwpitch [mm]	Transmission	Steps/Rev on motor	Resolution per step [mm]
1	1:1	400	0,0025
2	1:1	400	0,005
3	1:1	400	0,0075
4	1:1	400	0,010
4	1:1	800	0,005
5	1:1	800	0,00625
6	1:1	800	0,0075
8	1:1	800	0,010

Recommendation for step rate on the motor driver with ratio 2:1 of the Z-axis

Screwpitch [mm]	Transmission	Steps/Rev on motor	Resolution per step [mm]
1	2:1	200	0,0025
2	2:1	200	0,005
3	2:1	200	0,0075
4	2:1	200	0,010
4	2:1	400	0,005
5	2:1	400	0,00625
6	2:1	400	0,0075
8	2:1	400	0,010

Keep in mind that conventional lathes on the Z axis rarely achieve a higher accuracy than 0.02-0.05mm. This is due to the long lead screw, which cannot achieve higher accuracy due to thermal expansion and inaccuracies. It is therefore unnecessary to set the resolution to a few micrometers.

The maximum feed speed is:

$$\mathbf{F_{max} = (4 \times Encoderimpulses \times Leadscrewpitch) / Motorsteps}$$

Example:

Encoderimpulses:	400 Impulses/rev
Motorsteps:	400 Steps/rev
Leadscrewpitch:	4mm

$$F_{max} = (4 \times 400 \times 4) / 400 = 6400/400 = 16\text{mm / rev}$$

If you now set a reduction ratio of 1:2, you halve F_{max} . This can be compensated by using 800 instead of 400 encoder pulses or by halving the steps of the motor, i.e. changing from half step to full step.

Unfortunately, this cannot be done arbitrarily, since at high speeds too many impulses are received by the controller and it no longer follows with the processing of the control signals. But up to a speed of 2000 rpm you should manage with 800 pulses/rev for the encoder.

As you see, there are a few settings which you can use to tune the performance. Use the steps/rev of the motors together with the impulses/rev of the encoder to find a good functioning system.

MOTOR-DRIVERS

To convert the control signals supplied by the ELS into motor current, we need a motor driver or motor output stage. These are small electronic devices that generate suitable signals to move the motor.



Most types have step and direction inputs, 4 output terminals for the motor connection and +VDC and GND connections for the supply voltage. Very often used are the drivers from a Chinese company called Leadshine. The company manufactures many different drivers, some of which are ideal for driving small to large stepper motors.

The output stages allow the operation with microsteps and also offer a way to limit the current. There are digital and analog power amplifiers from Leadshine. The analog drivers are older, but have the same precision as the newer digital ones. The motors run a little rougher because the digital drivers offer better signal processing and thus control the motors even more efficiently. We therefore recommend the use of digital motor drivers.

Connection of the drivers

All drivers have a connection for a power supply, which must be able to supply the required voltage and sufficient current for the motors. Usually there are 24, 36 or 48Volt, with large drivers it is also possible to drive directly with 230V mains voltage. Refer to the driver manual for more information.

Step and hybrid servo drivers also have connections for the motor coils.

For the control signals there are inputs for step, direction and enable. There are also RJ45-adapters that can be used to connect these signals via an Ethernet patch cable.

Hybrid servo drivers also have a connection for the motor encoder, which is indispensable for closed-loop feedback. You will need to connect that cable with an appropriate extension cable.



Examples for using RJ45-adapters on Leadshine Motordrivers



Setup of the drivers

Common to all motor drivers is the possibility to set them to the necessary parameters. Please refer to the documentation of the system, there you will find the settings. They are also printed on many drivers. As a rule, the following settings are necessary:

1. **Motor current** - The maximum current output to the motor must be set; if it is set too high, there is a risk of the motor overheating; if it is set too low, the motor will not supply sufficient torque.
2. **Steps per revolution** - Set the number of steps per revolution of the motor on the driver. This setting must then also be entered in the control settings.
3. **Current reduction** - It is often possible to set whether the holding current should be reduced to generate less heat when the drive is at rest. This should be activated.

Please refer to the documentation of the manufacturers of the components. All components purchased from Rocketronics are accompanied by corresponding documentation and pin assignments!

EMERGENCY-STOP

The complete machine must have an emergency stop device in which the ELS control must also be integrated. The ELS has inputs and outputs for this purpose. An automatic restart after the emergency stop has been triggered must be safely prevented!

An emergency stop of category 1 - controlled shutdown while maintaining the power supply - is required to carry out the shutdown. The energy supply is only to be interrupted after the machine has come to a standstill.

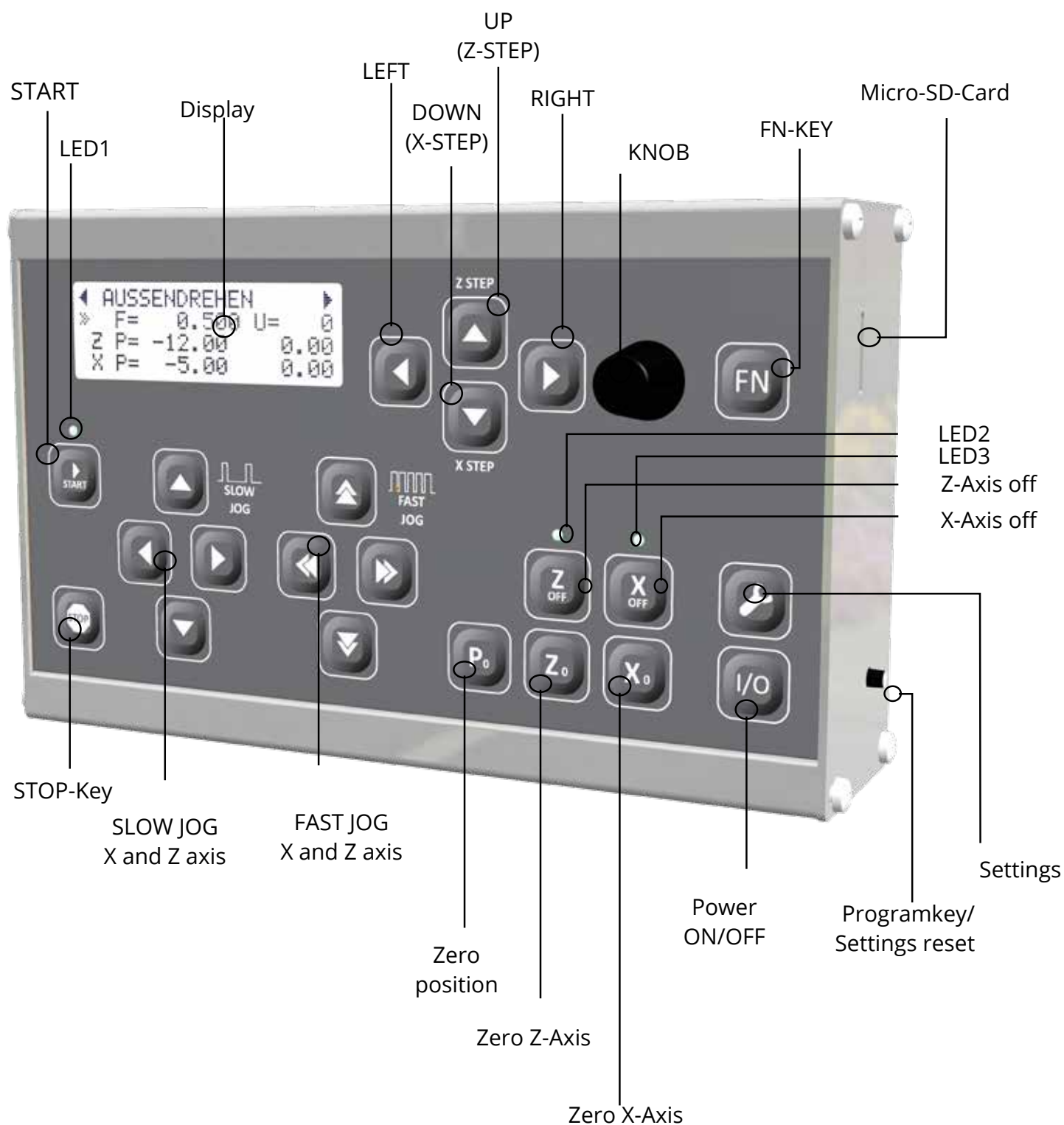
This procedure brings the spindle and drives to a standstill as quickly as possible. Only then can the power supply be interrupted..

Please refer to the EMERGENCY STOP description in the Digital Inputs chapter.

CONTROLELEMENTS

FRONT SIDE

The ELS keyboard has buttons for operation. In addition there are 3 LEDs in the keyboard, which are used to indicate states. In the manual, buttons are addressed with a symbol, e.g. START, and with the following designation:

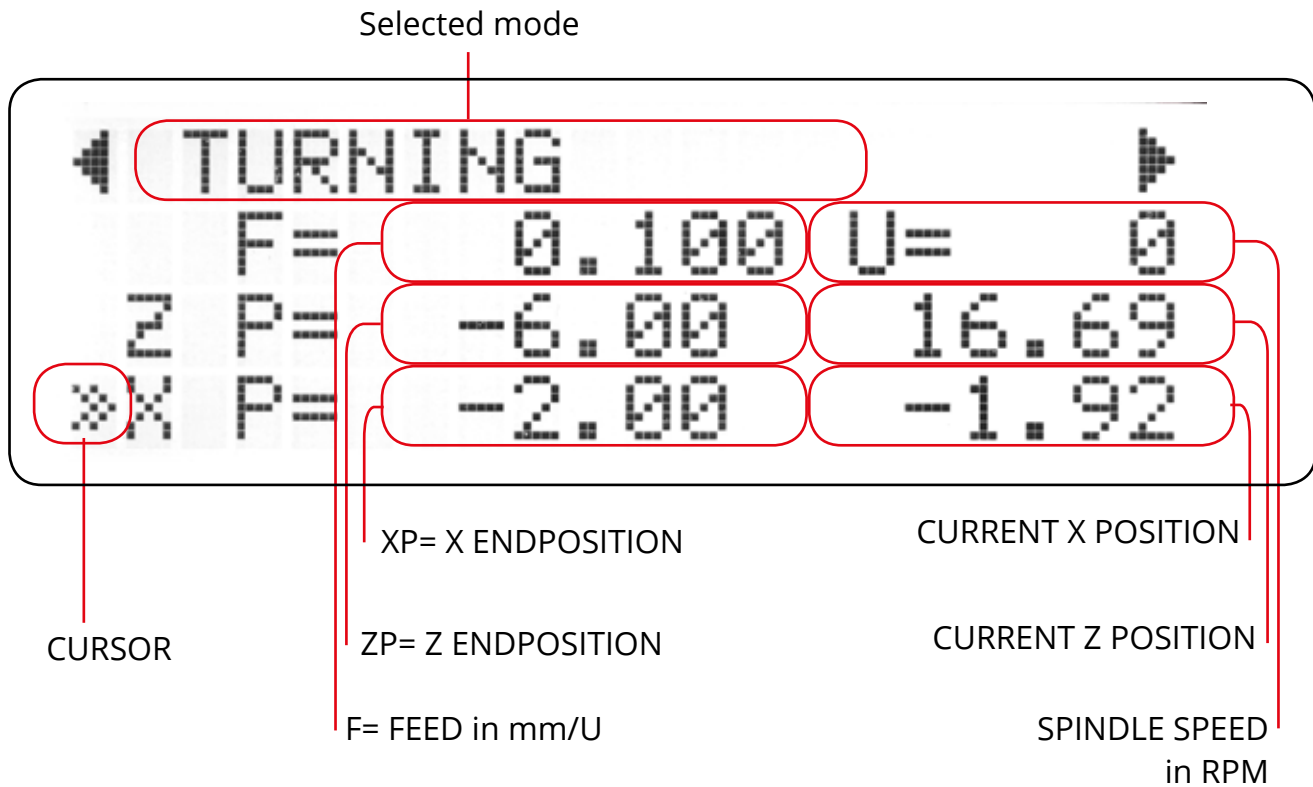


KEY FUNCTIONS

START	Start of a cycle. The LED above lights up when a cycle is active. Most cycles do not start until the spindle is already turning!
STOP	Stops a running cycle.
P0	Sets the selected input value to 0, e.g. feed rate, ZP or XP.
Z0	Sets the current Z position to 0, zeros the axis.
X0	Sets the current X-position to 0, zeros the axis.
Zoff	Disables the motor of the Z-axis (if the hardware allows it).
Xoff	Disables the motor of the X-axis (if the hardware allows it).
I/O	Switching the control on and off (press >2 sec. to switch off)
SETTINGS	Calls up the settings
FN	Function key for special functions.
Knob	<p>Used to enter values. By turning and simultaneously pressing the knob (push-button function) or turning and simultaneously pressing the button (push-button function).</p> <p>The input resolution can be reduced by pressing the FN key. This allows you to enter values in steps of 1, 0.1 or 0.01. In some cycles, the step-by-step is sensibly adjusted to 0.1, 0.01 and 0.001.</p>
LEFT	Switches the cycles to the left
RIGHT	Switches the cycles to the right
UP/ ZSTEP	<p>Moves the input cursor up on the display.</p> <p>Pressing the knob for a longer time switches the Z-axis to step mode where the axis can be moved step by step with the rotary knob.</p>
DOWN/ XSTEP	<p>Moves the input cursor down on the display.</p> <p>Pressing the knob for a longer time switches the X-axis to step mode where the axis can be moved step by step with the rotary knob.</p>
SLOW JOG	Four buttons to move the X- and Z-axis slowly.
FAST JOG	Four buttons to quickly move the X and Z axes.

DISPLAY-ELEMENTS

The LCD display shows the data on 4 lines. The standard display before the start of a cycle shows the basic data. The display changes depending on the mode.



The cursor shows the current value that can be changed with the rotary knob. It corresponds to the „cursor“ on the computer screen. The cursor can be moved with the up and down keys. Move it to e.g. the first line to change the feed rate.

Tip: Move the cursor further than the last line with the DOWN key to enter the parameter menu, where you will find special setting options for the individual cycles. With LEFT or RIGHT you leave the parameter menu.

LIGHT EMITTING DIODED (LED)

3 red LEDs are integrated in the keyboard foil:

LED1 indicates a running cycle

LED2 lights up when the Z axis was switched off with ZOFF.

LED3 lights up if the X axis was switched off with XOFF.

LED1 flashes during a software update.

If the update fails, LED2 lights up after the update process.

MICRO-SD-CARD-SLOT

The slot for a micro SD card is located on the right side of the housing. Such a memory card can be used to update the software of the controller. Thus a simple update without PC is necessary, directly at the installation location. See software update.

Commercially available memory cards of 2-32GB with FAT32 formatting are compatible.

PROGRAMKEY /SETTINGS RESET

On the right side of the housing there is also a small button.

For a software update this button is kept pressed when switching on.

Factory Reset:

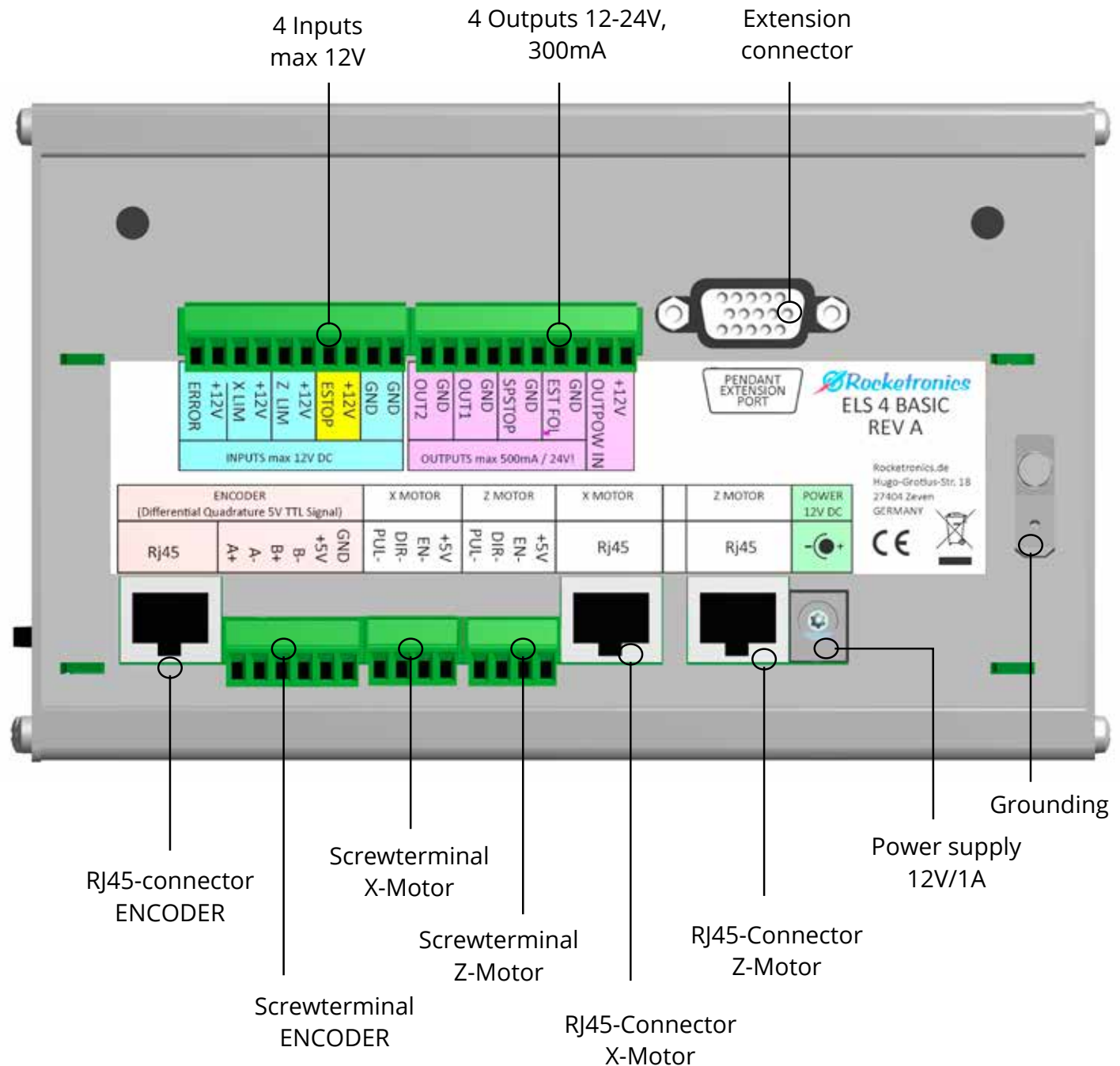
In normal operation this button can also be used to set the settings to factory defaults. The button is held for 7 seconds. A warning message in the display must be confirmed to reset the settings.

ATTENTION: This function deletes all settings deviating from the factory settings!

INPUTS AND OUTPUTS

Various inputs and outputs are available for connection to the machine.

- 2 inputs for 1 incremental encoder (RJ45 and screw terminal)
 - 2 inputs for 1 X-axis drive system (RJ45 and screw terminal)
 - 2 inputs for 1 X-axis drive system (RJ45 and screw terminal)
 - (ATTENTION: Either use RJ45 -OR- terminals, not both!)
 - 1 supply voltage input for 12V round plug
 - 4 digital inputs for emergency stop circuit, limit switches and error signals
 - 4 outputs for 12 or 24V (external) for switching purposes
 - 1 SUB-D 15 Expansion connector for an external control unit
 - 1 Ground connection
- All screw terminals are removable.
The terminal assignment is shown on the sticker.



SCREWTERMINAL DATA

The screw terminals are pluggable and can accept cables with the following cross-sections:

Solid (rigid)	0.14 mm ² - 1.5 mm ² AWG 28-16
Flexible	0.14 mm ² - 1.5 mm ² AWG 28-16
Flexible with wire end sleeve	0.25 mm ² - 1.0 mm ²
Stripping length:	7.0 mm
Maximum current:	8A
Screw thread:	M2
Tightening torque:	0.25 Nm



POWER SUPPLY

The control is operated with 12V DC voltage. The input is protected against reverse polarity and equipped with a self-resetting fuse which trips at 1.5A. The power supply should be able to supply approx. 1 A current.

The 6.3mm round plug is suitable for plugs with 2.1 or 2.5mm pins.
The pin is the positive pole.



EXTENSION CONNECTOR

Signals for an external control unit are output via a SUB-D-15-HD socket. The signals are used to control a 16-bit I/O expander that is addressed via a specially adapted 3.3V I2C bus. The assignment is suitable for the offered ELS expansion modules.



CAUTION

Only connect original accessories that are suitable for this control unit, otherwise the control unit could be damaged. The protocol and the bus system are not standardized! This is NOT a VGA connector for monitors!

GROUNDING

A 6.3mm flat plug is available for grounding the housing. The earthing should always be connected to ensure good interference immunity of the controller.



CONNECTION OF ENCODER

For the selection and setting of encoders, please refer to the ENCODER appendix in the manual. Two connections are available: screw terminals (X2) and RJ45 (X1). An encoder can be connected directly to the screw terminals, the encoder can be connected cleanly and shielded to the RJ45 connection using a commercially available Ethernet patch cable, and the differential line driver is designed to match.

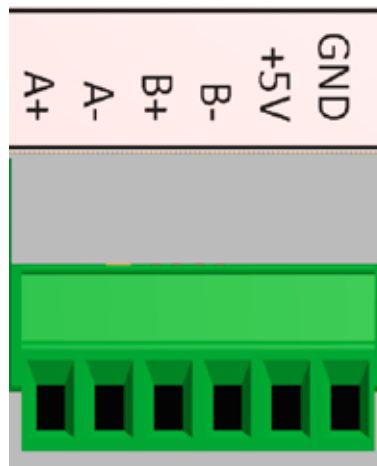
To ensure the interference immunity of the signals, the signal must be transmitted differentially, recognisable by the connections A+, A-, B+ and B-. Normal signals can be converted into a differential signal with the Rocketronics „differential line driver“. An index signal is not necessary and is not used.

CAUTION

Connect only 5V signals, otherwise the hardware may be damaged. Use either the terminals OR RJ45 for connection, not both at the same time!

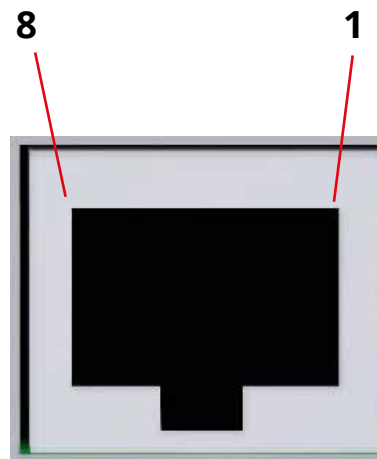
Pin assignment screw terminal Encoder from left to right:

Pin	Function
1	A+
2	A-
3	B+
4	B-
5	+5V
6	GND



Pin assignment RJ45 Encoder:

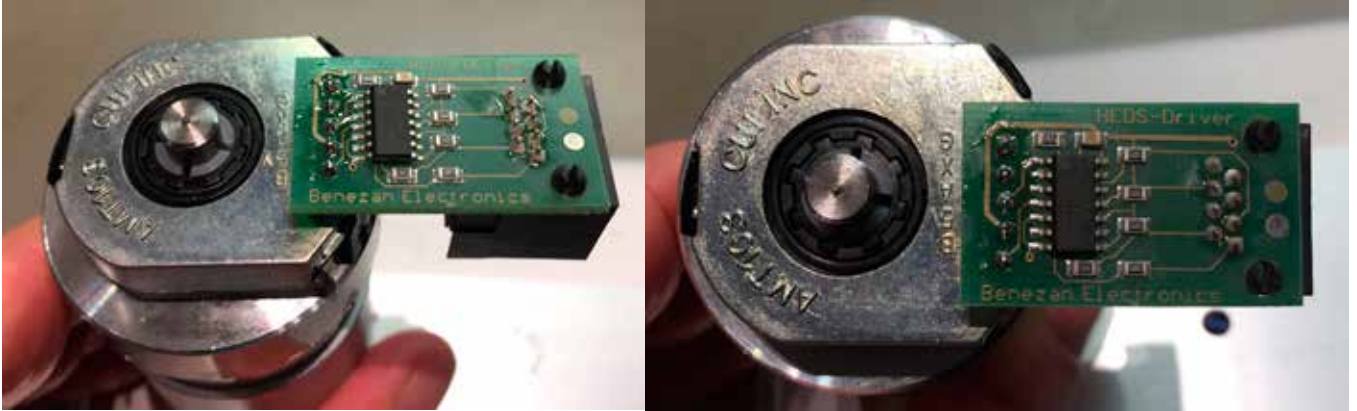
Pin	Funktion
1	GND
2	+5V
3	B+
4	nc
5	nc
6	B-
7	A-
8	A+



Encoder connection to differential line driver

Many encoders deliver only one non-differential signal, which has many disadvantages. To convert it into a differential signal you can use the differential line driver. This converts the AB signal into an A+A-B+B signal and thus significantly increases interference immunity. Another advantage of the driver is the possibility of connecting the encoder to the controller via a commercially available Ethernet patch cable. This provides a very cost-effective, simple shielded connection.

The line driver can be soldered directly to encoders of type HEDS or AMT103:



Encoder-Settings

Some encoder types can be set in the pulse rate, e.g. the type AMT103-V. Please refer to the section on the encoder in this manual and set the desired pulse rate. Other encoders have a fixed pulse rate and cannot be set.

For example: The PIB408 Encoder already delivers a differential signal and has an 8mm axis already installed.



MOST IMPORTANT:

The pulse rate of the encoder must also be entered in the controller settings!
See SETTINGS -> Encoder.

CONNECTION MOTORDRIVER

Please refer to the system documentation for selection and parametrization. The outputs provide step/direction signals with enable signal for X and Z axis. The output stages are FET open-drain outputs which connect to ground.

- Maximum switching voltage: +30V
- Maximum switching current: 200mA
- Maximum pulse length: 12 microseconds (adjustable)

CAUTION

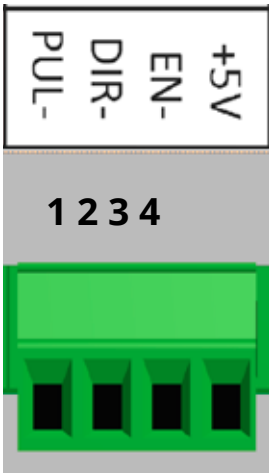
Observe the maximum voltage of 30V and the maximum current of 200mA! If these values are exceeded, the hardware may be damaged. The open drain outputs are not short-circuit proof! Connect cables only in a current-less state, otherwise the output stages can be damaged.

Connection:

Use either screw terminals or RJ45 jack for connection. The RJ45 connector is compatible with Rocketronics RJ45 driver adapters and allows clean connection of motor drivers with commercially available Ethernet patch cables.

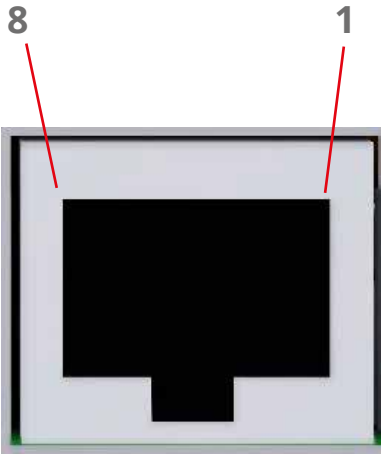
Terminal assignment screw terminal for X and Z axis:

Pin	Function	
1	PUL-	STEP
2	DIR-	DIRECTION
3	EN-	ENABLE
4	+5V	



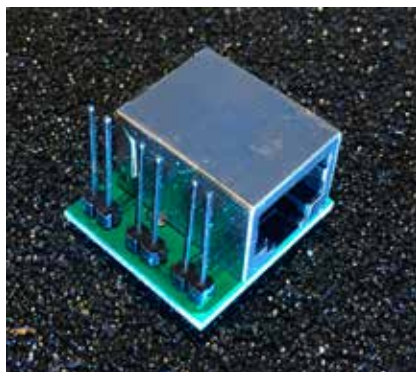
Pin assignment RJ45 socket for X and Z axis:

Pin	Name	Function
1	GND	GND (0V)
2	NC	NC
3	PUL+	+5V
4	DIR-	DIRECTION
5	DIR+	+5V
6	PUL-	STEP
7	ENA-	ENABLE
8	ENA+	+5V

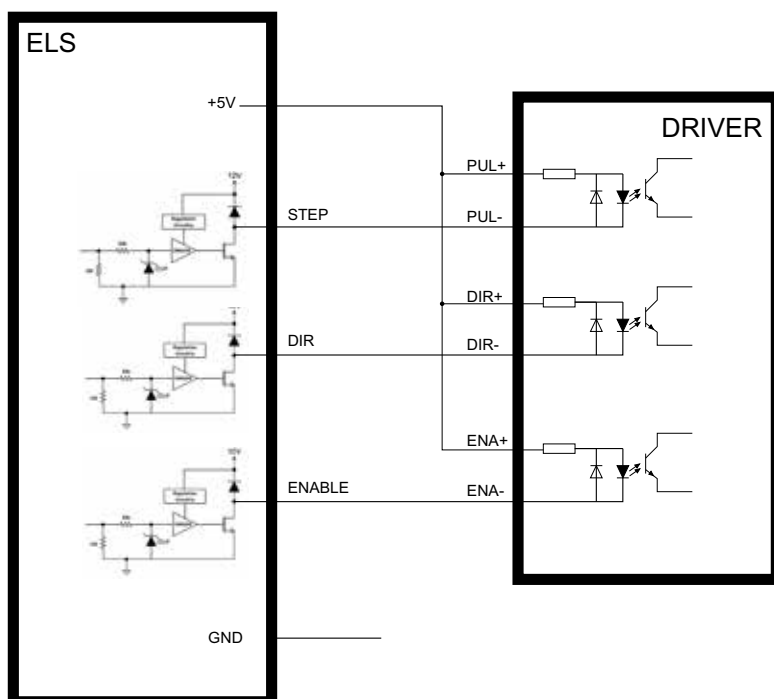


We offer small adapters for easy connection of leadshine drivers (and copies thereof). These are connected directly to the driver connectors and then provide a suitable RJ45 connector. Connect drivers and controls with an Ethernet patch cable very simple and create a clean and shielded connection.

The adapters are also available for ES-DHxxxx servo drivers!



Schematic representation of the output stages and connection to drivers:



DIGITAL INPUTS

The controller has 4 digital inputs that can be loaded with up to 12V. For easy connection, 12V is available next to each input terminal. If external power supplies are used, the earth terminals next to the input terminals can be used for the earth connection between the power supply and the controller. The inputs draw approx. 5mA current at 12V.

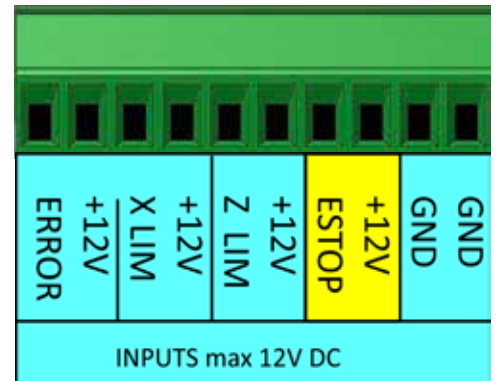
NOTE

All inputs are deactivated at the factory and must first be activated in the settings!

When activating the ESTOP input, make sure that you have a possibility to connect the ESTOP input, otherwise the control may be blocked! The ESTOP input is OPEN ACTIVE ex works (NC - „Normally Closed“). The inputs ZLIM, XLIM and ERROR are CLOSED ACTIVE (NO- „Normally Open“). The switching polarity can be changed for each input in the settings, see SETTINGS -> INPUTS.

Terminal assignment:

Pin	Name	Function
1	ERROR	Error signal Motor driver
2	+12V	
3	X LIM	Limit switch X-axis
4	+12V	
5	Z LIM	limit switch Z-axis
6	+12V	
7	ESTOP	ESTOP-circuit
8	+12V	
9	GND	GND (0V)
10	GND	GND (0V)



Both normally closed and normally open contacts can be used, or inductive proximity switches (PNP or NPN, 12V!). Terminals 9 and 10 (GND) can be used to connect the control ground to external power supplies or sensors.

Input 1: ESTOP

The input must be activated in the settings! Input for emergency stop signal. Connect a potential-free contact here, e.g. an emergency stop mushroom button or a relay contact of the emergency stop circuit. When the contact is opened, the control unit switches to a safe state. If the ESTOP input is activated and the state is tripped, the controller blocks; release can only take place after the emergency stop state has been eliminated! If the switching contact closes (NO) in the event of tripping, the polarity must be changed in the settings! See also EMERGENCY STOP

EMERGENCY STOP

The controller must be integrated into an emergency stop circuit in order to implement an emergency stop function.



DANGER

A non-existent or malfunctioning emergency stop circuit can result in death or serious injury. Ensure that the entire machine is in a safe state in the event of an emergency stop before using or handing over the machine.

An emergency stop of category 1 is required: Controlled stopping while maintaining the power supply in order to carry out the shutdown. The power supply is not interrupted until the machine has come to a standstill.

This procedure brings the spindle and drives to a standstill as quickly as possible. Only then can the power supply be interrupted.

The controller has some precautions to support integration:

- One ESTOP input for the emergency stop circuit
- A SPINDLE-STOP output to stop an inverter if necessary.
- An ESTOP-FOLLOW output that responds with a delay and stops the power supply.

Overview of the function:

The ESTOP input can be connected with max. 12V. The polarity of the input can be determined in the settings, NC operation is the default, i.e. the emergency stop switch is closed in normal operation and opens in the event of an emergency stop. If the emergency stop switch opens or the cable is interrupted, the emergency stop state is activated in the control, running cycles are aborted immediately, pulse generation is stopped and the drives are stopped. If the spindle of the machine is operated via an inverter, it can be stopped in a controlled manner via the simultaneously switched SPINDLE STOP OUTPUT, thus slowing down the spindle faster than if the voltage is simply interrupted!

After an adjustable time (ESTOP-FOLLOW DELAY), the output ESTOP-FOLLOW is switched, so that the power supply of the machine can be switched off via a coupling relay or contact. This switch-off does not necessarily have to take place, but can be implemented with this output if the risk assessment of the machine requires it.

If the operating voltage is not switched off, a release must only be given by pressing the STOP key after the emergency stop status on the control has been removed.

Cycles running at the time of the emergency stop are then NOT resumed but must be restarted manually.

The applicable regulations regarding the number and design of the emergency stop devices must be observed.

Input 3: Z LIM

The input must be activated in the settings! Input for limit switch of the Z axis. You can use potential-free contacts of a mechanical limit switch or inductive proximity switches (see below)
When the input is activated, the control switches to a safe state and ends running cycles until a release has been given with the STOP key.

Input 3: X LIM

Like Z LIM, only for X axis

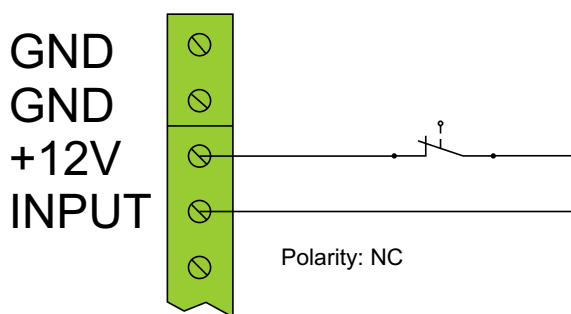
Input 4: ERROR

The input must be activated in the settings! input for an error signal, e.g. from the motor drivers. All cycles are immediately interrupted in the event of a trip until the fault condition has been rectified and a release with the STOP key has been given.

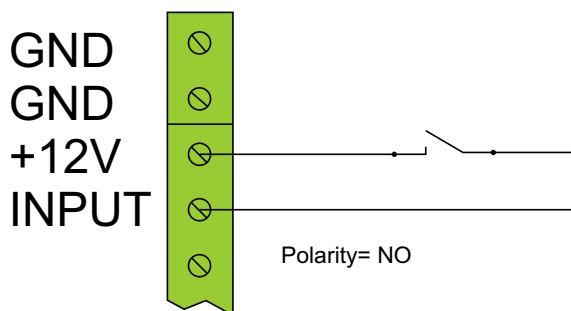
Wiring examples

In addition to the input connection, 12V is available, as are two GND terminals (GND) to ensure the power supply of sensors.

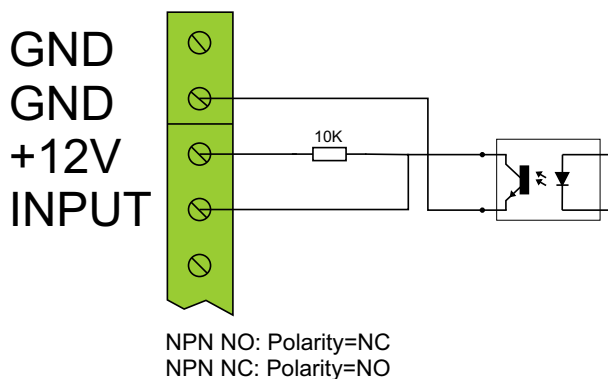
Mechanical NC contact



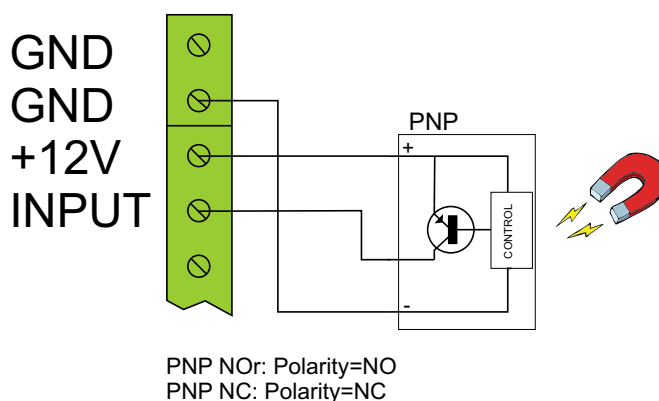
Mechanical NO contact



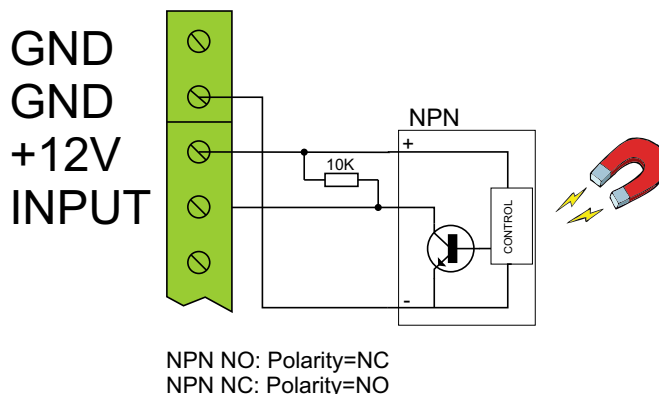
Optocoupler-Output (NPN) PULLUP-Resistor needed



Inductive sensor with PNP output



Inductive Sensor NPN-Output - PULLUP-Resistor needed

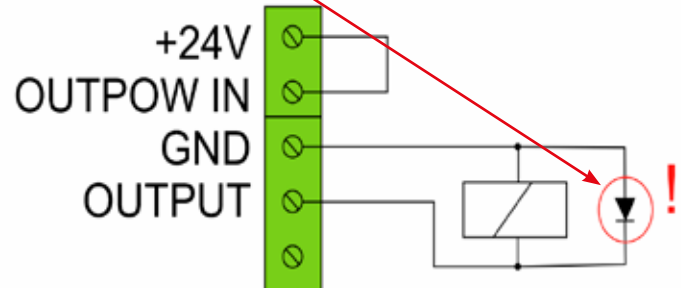


DIGITAL OUTPUTS

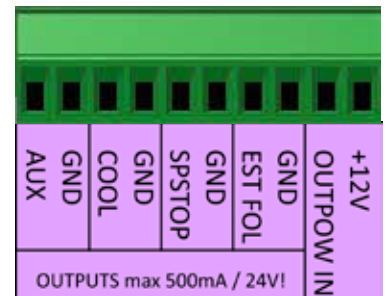
The controller has 4 digital outputs which can be used for control purposes.

Output voltage: Identical with voltage at OUTPOW IN, maximum 24V
Maximum output current: 500mA per output
All outputs are short-circuit proof. Resistive and inductive loads can be switched, on **inductive loads a flyback diode is mandatory!**

The output stages switch DC voltage which is applied to OUTPOW IN. You can bridge between +12V and OUTPOW IN, then 12V is switched to the outputs. If you want to use an external voltage it can be connected to OUTPOW IN. Up to 24V can be switched in this way.



	Name	Function
1	4: AUX	Output AUX
2	GND	GND, 0V
3	3: COOL	Cooling output
4	GND	GND, 0V
5	2: SP STOP	Spindle Stop
6	GND	GND, 0V
7	1: ESTOP FOL	ESTOP Follow
8	GND	Masse, 0V
9	OUTPOW IN	Power supply for outputs
10	+12V	+12V



Output 1: ESTOP FOLLOW

The output switches when an EMERGENCY STOP has been activated. It is possible to specify a delay time in the settings, then this output switches delayed after the emergency stop to switch off the power supply completely, for example after braking the drives.

Settings -> Outputs -> ESTOP FOLLOW Delay

See also EMERGENCY STOP

Output 2: SPINDLE STOP

This output is used to switch off the spindle. It is activated at the end of a cycle and after an emergency stop. The output is activated immediately after the emergency stop has been triggered and can thus stop the spindle in a controlled manner via a frequency converter. The duration of the switching signal can be set in the settings:

Settings -> Outputs -> SPINDLE STOP Switch duration

Output 3: COOL

This output is activated at the start of a cycle and can start cooling. A waiting time between activation of cooling and start of cutting can be set in the settings. This ensures that the coolant has reached the tool before the cut starts.

Settings -> Outputs -> COOL-OUTPUT DELAY

Output 4: AUX

Not used yet

CAUTION

Only apply DC voltage to the voltage input OUTPOW IN, otherwise the control may be damaged.

NOTE

All outputs are deactivated at the factory and must first be activated in the settings!

The voltage applied to OUTPOW IN is switched to the outputs. If the terminal is not connected, no voltage is output at the outputs! Connect OUTPOW IN with +12V or another DC voltage up to max. 24V.

GROUNDING, CABLE AND SHIELDING

Use cables of sufficient length, but shorten overlong cables if possible. The cross-section of the cables should be sufficiently dimensioned, especially the cables between driver and motor, where high currents flow.

1.0 mm² reaches up to 10A current

1.5 mm² reaches up to 15A current

2.5 mm² reaches up to 25A current

For better noise immunity it is important to use shielded cables.

If possible, use the RJ45 sockets to connect the drivers and the encoder, there are inexpensive adapters and panel feed-throughs available that allow the use of shielded patch cables.



If you use other cables please make sure that they are shielded. The shield is optimally connected to the control ground on one side only. There are several terminals with GND available, which can be used for the shield connection.

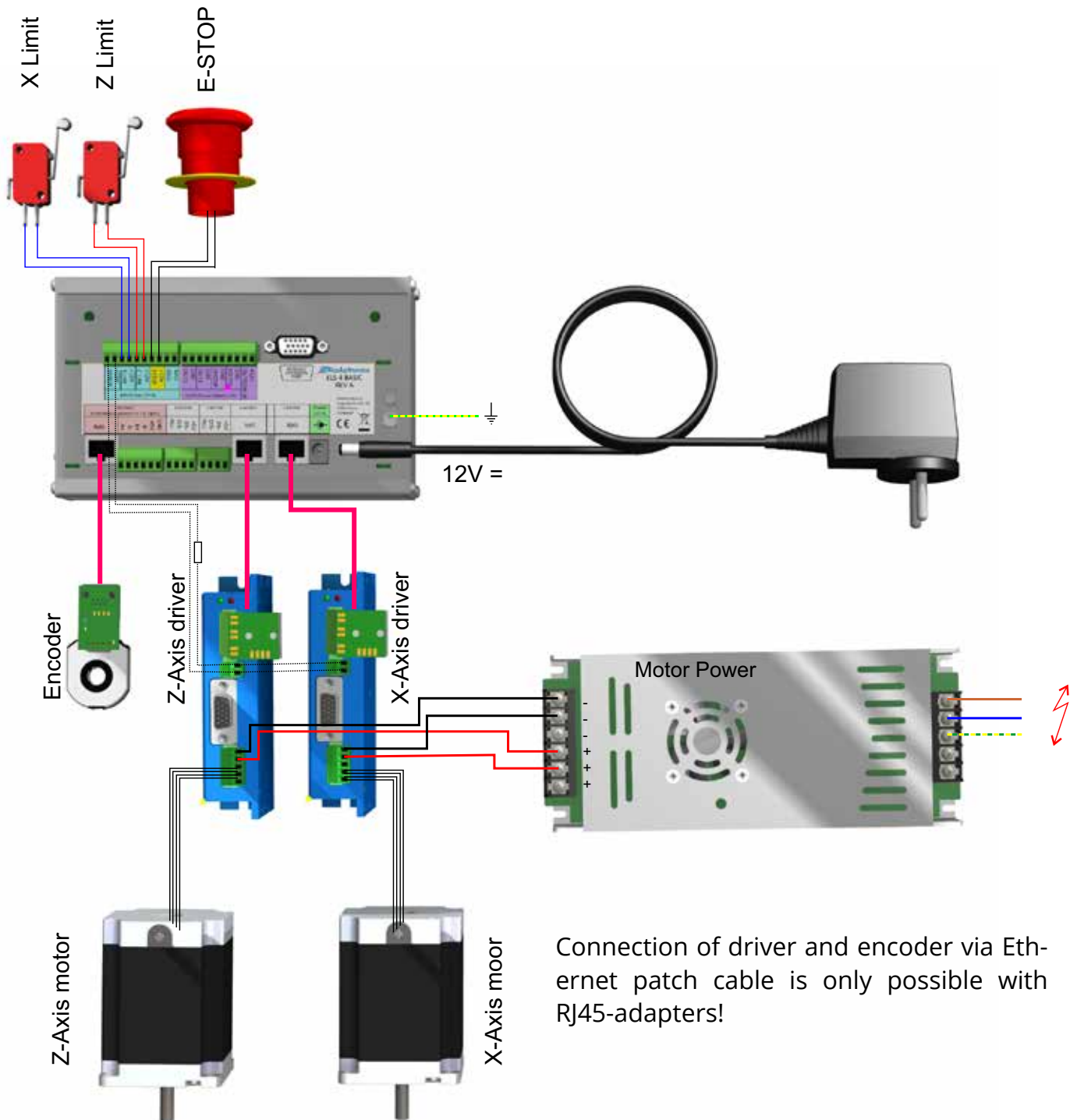
At the back of the housing there is also a 6.3mm flat plug for grounding, connect a cable for grounding the housing here. The rear panel is not anodized and therefore electrically conductive. A common connection of all cables shields to this point is ideal.

Common practice is to attach a stranded wire to the shield of the cable, with which the shielding can then be clamped.

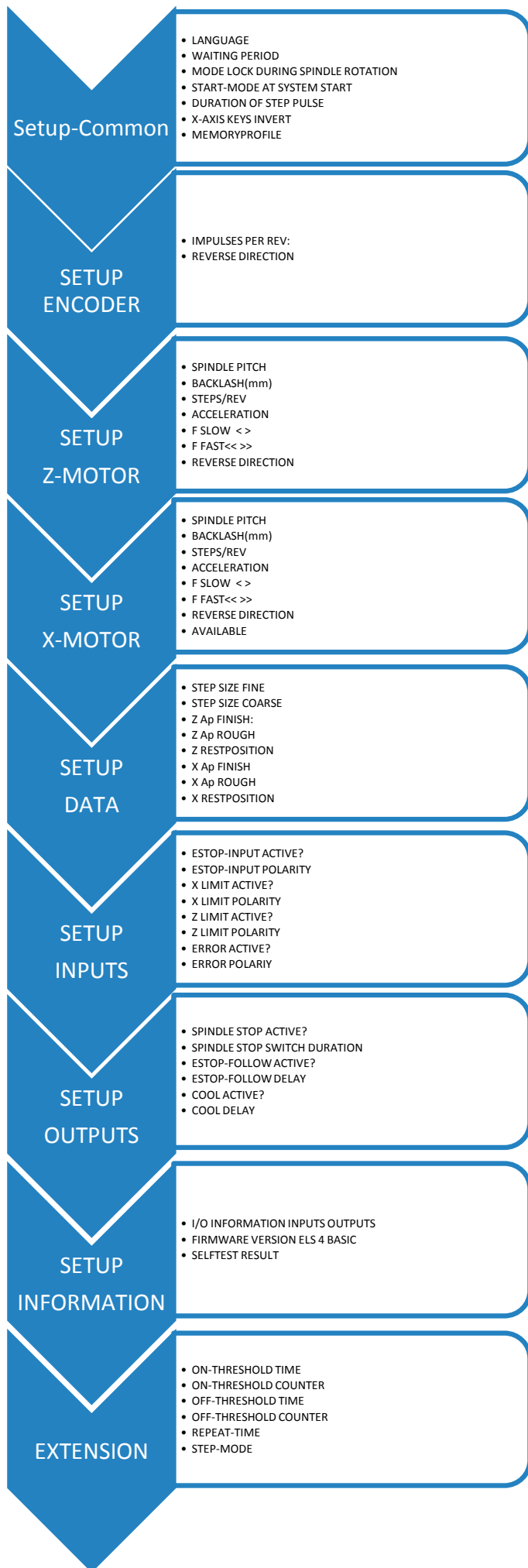
SYSTEM CONNECTION DIAGRAM

The system consists of controller, motor systems, encoder, power supply units and safety elements is wired as shown below (schematically shown)..

Encoders and motor drivers can be connected directly with patch cables as well as with multi-core cables. Driver error outputs can be connected to the error input. Please observe the notes on encoders and motor systems.i



SETUP



Press the SETTINGS button to recall the settings, which are divided into several groups containing different items.

The structure is as shown on the left.

Navigate from group to group with LEFT and RIGHT.

Within a group, select the elements with UP and DOWN

The settings are exited by pressing SETTINGS again. The settings are automatically saved.

SETUP GENERAL

Element	Description
LANGUAGE	Language selection, German or English
WAITING TIME BEFORE RETURN	Only for 1-axis operation: This is the time that is waited in automatic mode after reaching an end position until the carriage returns to 0. During this time, the stylus must be pulled back manually, otherwise an already cut thread will be destroyed. Recommended are 1000-2000 ms, who needs longer should possibly increase this time. irrelevant in 2-axis operation, because there it is retracted automatically.
MODE LOCK DURING SPINDLE ROTATION	If „ON“ is selected, the cycle cannot be changed while the spindle is turning. If „OFF“, this is allowed. It is recommended to use „ON“ otherwise the cycle may be changed accidentally while the spindle is turning.
START-MODE	The cycle to be set when starting the controller
DURATION OF STEP PULSE	The duration of the pulses sent to the stepper motor output stage. Normally 4µs are sufficient, if required also 8 and 12 µs are possible.
X-AXIS KEYS INVERT	This allows you to reverse the operation of the X-axis traverse keys, useful for inclined bed machines.
MEMORYPROFILE	The settings can be stored in 2 profiles, which can be selected here. The default profile is A, B can be used for special settings, for example, or when the control is used on two different machines.

SETUP ENCODER

Element	Description
Impulses/rev	<p>This is the number of pulses supplied by the spindle encoder per revolution of the spindle. If you use a gear ratio when connecting the encoder, this must be taken into account. Enter the real number of pulses per spindle revolution here.</p> <p>ATTENTION: Changes to the encoder pulses in the settings are not accepted until the controller has been restarted!</p>
REVERSE DIRECTION	Here the direction of the encoder can be reversed. Useful if the Z-axis moves in the wrong direction in gear mode.

SETUP Z-MOTOR

Element	Description
Spindle pitch	This is the pitch of the lead screw of the machine. In case of doubt, this must be remeasured.
Backlash	The backlash of the sled. Those who do not have an exact ball screw on their lathe will almost certainly have a backlash. The control compensates the backlash, so it is necessary to measure it and adjust it here.
Steps /rev	Number of steps required by the stepper motor to perform one revolution. Usually in the range 200-1600 and depending on the setting of the motor driver.
Acceleration	<p>The acceleration of the stepper motor in mms². This value cannot be calculated but must be determined by test.</p> <p>Stepper motors cannot be switched from 0 to 100, then they would inevitably block. The „electronic lead screw“ therefore moves all movements with an adjustable acceleration ramp.</p> <p>Values between 50 and 150 should be tried at the beginning.</p>
F Slow <>	The slow feed rate in mm/min. This is used when the Z axis is approaching material in automatic processes and when pressing the SLOW JOG keys.
F Fast <<>>	The fast feed rate in mm/min. It is used when the Z axis is retracted in automatic operations and when pressing the FAST JOG keys. A maximum of 4800 mm/min is possible.
Reverse direction	Reverses the direction of the motor

For more information on these settings, see the Appendix on motor design and adjustment.

SETUP X-MOTOR

Element	Description
Spindle pitch	This is the pitch of the lead screw of the machine. In case of doubt, this must be remeasured.
Backlash	The backlash of the sled. Those who do not have an exact ball screw on their lathe will almost certainly have a backlash. The control compensates the backlash, so it is necessary to measure it and adjust it here.
Steps /rev	Number of steps required by the stepper motor to perform one revolution. Usually in the range 200-1600 and depending on the setting of the motor driver.
Acceleration	<p>The acceleration of the stepper motor in mms². This value cannot be calculated but must be determined by test.</p> <p>Stepper motors cannot be switched from 0 to 100, then they would inevitably block. The „electronic lead screw“ therefore moves all movements with an adjustable acceleration ramp.</p> <p>Values between 50 and 150 should be tried at the beginning.</p>
F Slow <>	The slow feed rate in mm/min. This is used when the Z axis is approaching material in automatic processes and when pressing the SLOW JOG keys.
F Fast <<>>	The fast feed rate in mm/min. It is used when the Z axis is retracted in automatic operations and when pressing the FAST JOG keys. A maximum of 4800 mm/min is possible.
Reverse direction	Reverses the direction of the motor
Available	Select whether a motor is present on the X axis. If NO, the ELS moves in 1-axis mode.

For more information on these settings, see the Appendix on motor design and adjustment.

SETUP DATA

Element	Description
Step Size Fine	The step size in mm that is moved during the large step-by-step movement of the axes. In the step mode of the X or Z axis, the rotary knob must be turned WITHOUT the knob being pressed.
Step Size coarse	The step size in mm that is moved during the small step-by-step movement of the axes. In step mode the rotary knob must be pressed while turning the rotary knob.
Z Ap Finish	In automatic operations such as long turning, cutting is always carried out in two steps: several roughing passes and one final finishing pass, the thickness of the finishing pass in mm being indicated here.
Z Ap Rough	In automatic operations such as long turning, cutting is always carried out in two steps: several roughing passes and one final finishing pass. The maximum thickness of the roughing passes in mm is indicated here.
Z restposition	The waiting position in Z direction. To this point, the control always moves after an operation has been completed. If you want the axis to end exactly at 0.00, enter 0 here.
X Ap Finish	Finishing depth in X-axis direction
X Ap Rough	Roughing depth in X-axis direction
X restposition	Waiting position in X direction.

SETUP INPUTS

Element	Description
ESTOP Input active	Input for emergency stop circuit, switch or relay contacts ESTOP Activate or deactivate input
ESTOP Input polarity	Standard: Open Active (NC). Can be set to Closed Active (NO).
X LIMIT Input active	Input for X limit switch Activate or deactivate limit switch input
X LIMIT Input polarity	Standard: Closed Active (NO). Can be set to Open Active (NC).
Z LIMIT Input active	Input for Z Limit switch Activate or deactivate limit switch input
Z LIMIT Input Polarity	Standard: Closed Active (NO). Can be set to Open Active (NC).
ERROR Input active	Input for error signal Motor drive Activate or deactivate input
ERROR Input Polarity	Standard: Closed Active (NO). Can be set to Open Active (NC).

ATTENTION

ATTENTION: The activation of an input takes effect immediately after leaving the settings, the control reacts accordingly: When the ESTOP input is activated and the input is in the corresponding state, the EMERGENCY STOP state is activated. Ensure that a contact is connected to the input so that the state can be exited! Otherwise it is no longer possible to switch to normal operation.

FACTORY SETTINGS

The settings can be reset to factory settings by pressing the programming reset button on the right of the housing for approx. 7 seconds while the controller is running. You will then be asked whether the settings should be reset. With START you reset the settings, STOP cancels the process.



SETUP OUTPUTS

Element	Description
Spindle Stop active	Activate output for spindle stop signal (NO contact). The output becomes active at the end of a cycle or on abort.
Spindle Stop switch duration	Duration of the switching signal in milliseconds
ESTOP-FOLLOW active	Output following ESTOP input. Can be used to switch off voltage after the drives have come to a standstill.
ESTOP-FOLLOW delay	If an emergency stop signal has been detected at the Estop input, a delay can be set in motion after which the ESTOP output is switched. Time in milliseconds.
COOL-output active	Output for coolant pump, activated at cycle start.
COOL-output delay	Delay for starting a cycle. This time is waited after activation of the COOL output until a cycle is started. This ensures that the coolant has arrived at the tool before the cut starts.

SETUP INFORMATION

Element	Description
I/O Information	Shows the state of the inputs and outputs
ELS 4 Firmware Version	Firmwareversion
SELFTEST RESULT	Shows the results of the system selftest

EXTENSION

Element	Description
ON-THRESHOLD TIME	These settings allow the handwheel or handwheel extension to be adapted to the ELS4. The meaning of the parameters is described in the respective manual of the extension. Among other things, the sensitivity and response of the handwheel can be adjusted.
ON-THRESHOLD COUNTER	
OFF-THRESHOLD TIME	
OFF-THRESHOLD COUNTER	
REPEAT-TIME	
STEP-MODE	

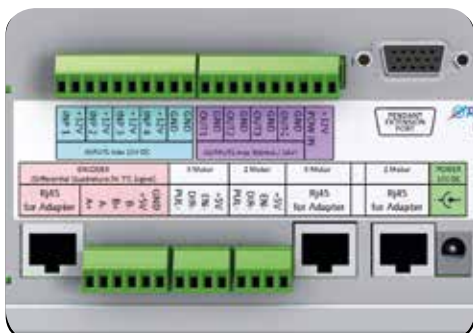
COMMISSIONING

PREPARATIONS



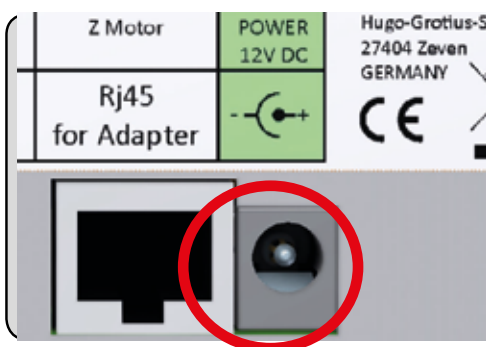
1. Mounting the control

Mount the controller on the wall, a support or on the machine so that you can operate the keys without moving the case. Optionally, you can purchase a suitable wall mount bracket for the ELS Basic.



2. Connection

Connect the emergency stop circuit, the motor output stages and the encoder to the rear terminals. Refer to the previous chapters for details.



3. Power supply

Then connect the power supply, pay attention to the correct voltage (12V) and polarity. The voltage input is protected against reverse polarity and fused.



4. Switch on

Switch on the ELS Basic at the power switch by pressing the button for approx. 1 second. To switch it off, press the button for approx. 2 seconds.

Running? Congratulations, now you can adjust and test the system!

CHECKLIST BEFORE COMMISSIONING

To facilitate commissioning, please check the following items in advance:

- ☐ The pulse rate of the encoder must be set correctly on the encoder, 400 pulses per spindle revolution are usually optimal.
- ☐ This pulse rate must also be adopted in the settings of the ELS (SETTINGS -> SETUP ENCODER -> IMPULSES/REV).
- ☐ The stepper or servo motors must be wired correctly to the output stages, see the data sheets and connection diagrams on the previous pages.
- ☐ The motordrivers must be connected to the appropriate power supply.
- ☐ The following settings must be made on the motordrivers of the step servo motors:
 - ☐ a) Adjust the current to suit the motor
 - ☐ b) Set step rate, 400, 800 or 1600 steps
- ☐ The step rate of the motordrivers must also be entered for the X and Z axes in the settings of the ELS!
- ☐ For both axes the parameters for step rate, acceleration and slow and fast movement must be entered. For acceleration, first start with 50, slow and fast travel with 300 mm/min or 1500 mm/min.
- ☐ Set the pitch of the threaded spindles on the Z and X axes.
(SETTINGS -> SETUP Z/X MOTOR -> SPINDLE PITCH)

Very important:

- **Set the encoder pulse rate on the encoder AND in the settings of the ELS.**
- **Set the step rate of the stepper motors on the motordrivers AND in the settings of the ELS.**
- **Setting the thread spindle pitches**

Then carry out the commissioning as described below, quick version:

1. Press the Z-axis JOG button and see if the axis is moving in the right direction. If the axis moves in the wrong direction, change the direction of rotation in the settings. This can be done separately for both axes (under SETTINGS -> Z MOTOR -> REVERSE DIRECTION).
2. Do the same for the X-Axis.
3. If the axes are moving correctly, switch to GEARBOX LEFT.
4. Switch on the spindle slowly and press the START button. Now the carriage should move to the left when the spindle rotates counterclockwise. If the slide moves in the wrong direction, go to the settings and change the direction of rotation of the incremental encoder (under SETTINGS -> SETUP ENCODER -> REVERSE DIRECTION).

IMPLEMENTATION OF THE COMMISSIONING

Please make sure that the motor and encoder parameters are correctly set in the settings before proceeding. The correct number of steps of the motors and the correct pulse rate of the encoder must be set.



DANGER

When moving, make sure that there is enough free travel so that the machine is not damaged! Use all protective measures of the machine as prescribed and ensure that there are no body parts in the travel path. Otherwise serious injury or death may result.

Once all safety measures have been taken, perform the following tests:

1. Check the connection to the Z axis motor.

Also use the JOG buttons to move the Z axis manually, the slide should move according to the buttons. Press LEFT to move the slide to the left. If it is the wrong way round, change to the settings under SETTINGS - Z-MOTOR -> REVERSE DIRECTION. Reverse the direction of rotation of the motor.

2. Check the connection to the X axis motor.

Also use the JOG keys to move the X-axis manually, the slide should move according to the keys. If you press the buttons pointing down, the X axis should move to the operator. If you press the up pointing buttons, the X axis should move away from the operator.

If it travels the wrong way round, you have to reverse motor direction in the settings under SETTINGS - X-MOTOR -> REVERSE DIRECTION.

3. Correct encoder direction

In some cases it may be necessary to reverse the direction of rotation display of the encoder. To check this, proceed as follows: Use the LEFT key or to change to the „GEARBOX LEFT“ cycle:

1. Use the UP and DOWN keys to move the cursor to „F“ (feed rate).
2. Set the feed rate with the knob to a value of 0.20 mm.
3. Move the cursor to „Z P“.
4. Press Z0 and P0 to set the Z position and Z end position to 0.
5. Remove the lock nut so that the carriage does not move when the lead screw is turned. Do not insert a turning tool! Do not insert a workpiece! Keep the distance to the chuck!
6. Start the spindle as slowly as possible.
7. Then press the START button on the ELS

The stepper motor of the Z-axis should now turn slowly as long as the spindle is turning. If you change the direction of rotation of the spindle, the stepper motor should now rotate the other way round.

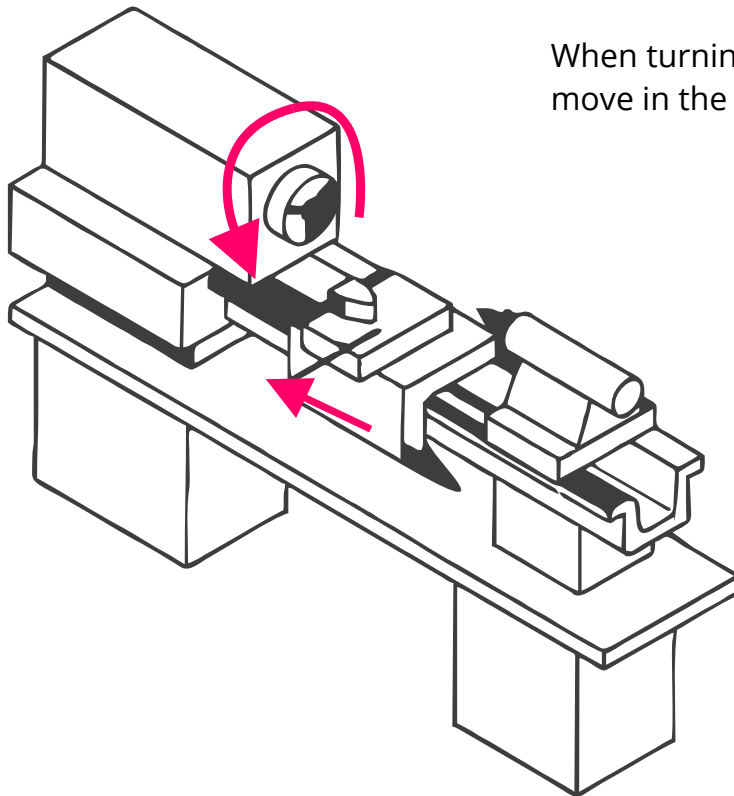
-> **Now snap the lock nut into place!**

If the spindle turns to the left, the slide should move in the direction of the chuck. If it does not, the encoder is set the wrong way round.

Remedy: Switch to SETTINGS -> SETUP ENCODER -> REVERSE DIRECTION and change the direction there. If the carriage then moves in the correct direction, the system will function correctly! Congratulations, you can now carefully experiment with higher speed and other feeds.

4. Check encoder angle value

Use the LEFT or RIGHT keys to change to the „ANGLE“ cycle:



When turning the spindle counterclockwise, the slide must move in the direction of the chuck in GEARBOX LEFT.

The correct function of the encoder can be easily tested:

1. Switch to the „ANGLE“ cycle.
2. Mark a point on the lathe chuck and set the angle on the control with P0 to 0.
3. Now let the spindle run for a while, at medium speed, max. 1000 rpm.
4. Stop the spindle and turn the chuck manually in the direction of rotation up to the mark.
5. Here the control must now display approximately 0°.

If it deviates strongly there is something wrong with the encoder:

- Is the number of pulses set correctly?
- Is the encoder connected to the spindle via a subtranslation? Is it possibly not correct or has a crooked ratio, e.g. 1:1.75?
- Does the connection possibly have slippage, e.g. due to loose toothed belts, not exactly running gear wheels?

It is strongly recommended to connect the encoder 1:1 to the spindle, if this is not possible then use straight ratios, 1:2, 1:4 e.g. Then select the number of pulses at the encoder accordingly, optimally 400 pulses arrive at the control per revolution afterwards. Avoid the use of gear wheels, this will lead to problems.

Every controller is checked for correct function before delivery. A defect is therefore almost impossible and does not manifest itself in inaccurate travel paths. Therefore, always check the system carefully; experience has shown that the fault usually lies in the connection of the encoder or the motors.

If you have any problems, please feel free to contact us at info@rocketronics.de . It is best to write down the setting values as well..

If the motors run correctly and the encoder provides correct values, the worst is already done, now only the speeds and acceleration have to be adjusted:

5. Checking the stepper motor parameters

First the acceleration of the Z-motor:

1. Stop the spindle
2. Change to the settings and set the value for F rapid traverse of the Z stepper motor to a value around 1000.
3. Move the Z-axis a few times to the left and right using the traverse keys.
4. If you notice that the motor is blocking, you must try to adjust it using the acceleration and rapid traverse values. If the motor blocks at the end of the acceleration ramp, it will spin too fast. If it blocks at the beginning, the acceleration is too high. This requires a few passes, you can switch to the settings at any time.

Then the values of the motor of the X axis:

Do the same for the X-axis, also move back and forth and adjust the values accordingly until nothing blocks in rapid traverse.

6. Checking the route

1. Mount a caliper gauge or a dial gauge on the Z-axis so that its displacement can be measured.
2. Move the carriage manually in the direction of the chuck.
3. Set the Z axis to 0 by pressing the Z0 key.
4. Set the measuring instrument to 0
5. Set ZP to -50mm and move manually with < to the chuck until the control stops at -50mm.
6. The measuring instrument should now display 50mm.

Repeat this also for the X-axis.

What to do if the measured path deviates from the set path?

Small deviations of a few hundredths are normal, because the spindles are more or less accurate, and even ex works their deviations can have.

If the deviation to 50 mm is more than 0.1 mm, something is wrong, check:

- Are the spindle pitches set correctly?
- Are these even right? Some machines have inch spindles! Measure exactly. Some spindles are also worn unevenly.
- Is the number of motor steps for the axes correct?
- If there are slight deviations which are different each time, steps may be lost, loosen all axle clamps, reduce the acceleration further as a test and check again.
- Are the motors slip-free on the shafts? Grub screws don't always hold this tight, better are keyslots with keys.
- Is there a transmission in the powertrain that may not have exact round numbers? Then adjust the number of engine steps until the result fits.
- Is the motor current set correctly at the output stage?

In case of problems, we are happy to help solve the problem.

If all tests are successful, the machine is ready for operation!

BASIC FUNCTIONALITY

The Electronic Leadscrew Control (ELS) is a cycle control for lathes and allows the automatic execution of turning operations and the free selection of the feed rate.

Relative travel distances

In contrast to many industrial controls, the ELS operates in a relative mode: The operation to be performed always starts from the zero point of the tool, i.e. relative to this zero point. The advantage of this approach is that there is no need to know the machine zero, and it also makes it easier to work without having to specify starting points.

Driving distances in X are always entered as such: As real travel distance, i.e. as radius, not as diameter!

This results in a very simple working method: Only three values must be entered for each cycle:

1. Feed rate (F)
2. Driving distance in Z (ZP)
3. Driving distance in X (XP)

There are still some additional settings that can be edited in a parameter menu for the respective cycle, but more about that later. With the three input values F, ZP and XP, the ELS can now be used to run any cycle that is offered.

Example:

A piece of raw material with a diameter of 50.14 mm is to be turned down to 40.00 mm over a length of 30.00 mm. So the material changes in diameter by 10.14 mm, in radius by 5.07 mm. We then enter -30.00 for the path in ZP, but -5.07 mm for the path in XP, since the decrease in X corresponds to this path. So you have to convert to radius for X!

This input as radius, or real distance, is the same in all cycles. This is true for the cutting depth of a thread or undercut as well as for the cutting depth for external turning. Therefore, when using the ELS, rethink and use the real cutting depth for XP.

Position display

The current actual position of the axes can be seen at any time in the Display. With the keys X0 and Z0 you can set the position to 0.

Input of values:

Values such as F, ZP and XP are entered using the rotary knob. The cursor (>>) on the left of the display indicates which value can currently be changed. Use the up and down keys to move the cursor to the value to be changed. Then turn the knob to change the value.

The button also has a push-button function: to fine-tune the increment of the changes, you can also press the push-button down before turning, it also has a push-button function. For further refinement, press the FN key and then rotate. So you can enter in steps of 1.0, 0.1, 0.01 and in some places also 0.001. The step sizes are adjusted according to what is to be entered.

Changing cycles

To change to another cycle, press the LEFT or RIGHT keys.

Move axes

To move the axes manually there are two control crosses, SLOW JOG and FAST JOG. SLOW JOG moves the axes slowly, FAST JOG moves the axes fast (rapid traverse). How fast and how slow can be set in the settings.

Move to positions

You can approach exact positions: The Z axis always stops moving from right to left at 0 and at ZP. Moving from left to right, it does not stop, you must always move to positions to the left so that the backlash of the leadscrew is always balanced. The X axis stops at 0 and at XP in the direction of material processing. For internal turning this is in the direction of the user, for external turning it is away from the user.

Step-by-step movement

You can also move the axes step by step using the STEPZ and STEPX keys. Press the STEPZ key for longer than 1 second to switch to the step mode of the Z axis. Press and hold the STEPX key to switch to the step mode of the X axis. You can then move step by step with the rotary knob in 0.1mm increments, press the rotary knob while turning you move in 0.01mm increments.

Manual movement

We recommend to leave the handwheels mounted, because then you can still drive manually. To allow this, you can deactivate the respective axes with XOFF and ZOFF, the motors are then switched to a freewheel and you can „crank“ by hand. In some cycles this can be done during a cycle, e.g. for thread repair or in gear mode.

Attention: As soon as you issue a movement command at the ELS, the axis is automatically reactivated!

Settings

You can set many parameters and thus adapt the control to your machine. To do this, press the SETTINGS button.

Parameter menu

In many cycles there is a parameter menu which allows further settings. For example, you can select the cutting strategy and the flank angle in the thread cycle and the taper ratio or the cutting radius in the taper cycle. You reach the parameter menu by using the DOWN key to navigate downwards beyond XP. You can exit the menu by navigating up again or by pressing the LEFT key.

Cooling/Lubrication:

After starting a cycle, the COOL OUTPUT is activated and the set delay is waited until the cut begins. LED1 flashes during the delay. After the end of the cycle, the output is switched off again.

General information on the cycles

- Before each operation, it is necessary to correctly set the X and Z axis zero points and check the entered feedrate, XP and ZP values.
- Before each operation, a release by START is necessary, also in the gearbox modes.
- Each cycle can be aborted immediately by STOP. With a STOP the axes are moved to the waiting position or to 0.0. If a complete stop is necessary, activate the EMERGENCY STOP function! Only then will the axes stop immediately and not move to a rest position.
- For all cycles except „GRINDING“, the spindle must run before starting the operation!
- You can also turn off the spindle during a cycle in progress, and after restarting the spindle, the machining will continue. Please keep in mind that the tool can be damaged, especially ceramic inserts often do not survive this undamaged.
- Thread cutting is possible up to 1200 rpm, all other cycles run up to 3000 rpm (exceptions: if the encoder on the spindle delivers different pulse rates than recommended)..
- Automatic spindle stop: After the end of a cycle and in case of an emergency stop, the SPINDLE STOP output is activated for the set duration (spindle stop switching duration), so that, for example, the spindle drive can be switched off after the end of the cycle if an input is available on the machine for this purpose.

SELECTION OF CUTTING PASSES

So that the tool or the material is not overloaded, cutting is usually carried out in several in-feeds, we speak of „passages“. Before each pass, the cutting edge is driven into the material by a certain amount in order to chip the material layer by layer.

The cutting depth during machining is called a_p , in the display we use **Ap**.

For rough roughing we use „Ap Rough“, for fine finishing we use „Ap Finish“, so that we know in which direction this is meant we put the letter before it.

There are four values in the settings that influence the cutting depth: X Ap Rough, X Ap Finish for cutting depths in X direction, Z Ap Rough and Z Ap Finish for Z direction.

Starting from the desired cutting depth, the control divides the individual depths per pass according to these setting values. The division is carried out so that „X/Z Ap Rough“ is never exceeded and is cut as a finishing pass with X/Z Ap Finish. Before the cut, the division is shown on the display, the user can change the number of roughing passes from 1-99 with the rotary knob, the depths are recalculated and displayed on-the-fly. As long as the number of cuts is greater than 1, a finishing pass is always inserted.

Example: External turning, cutting depth should be 5.00 mm, set to X roughing $A_p = 1.00$ mm, X finishing $A_p = 0.10$ mm. 5×0.98 mm + 0.1 mm is offered for cutting.

The cut is therefore divided in such a way that the set 1.00 mm is not exceeded during roughing but is used as well as possible, the last step being to cut the finishing pass with 0.10 mm.

Tip 1:

The number of passes can also be turned to 1, then 1x to full depth. This is useful if you want to turn to full depth again, e.g. when threading to remove the last hundreds of the material from the thread groove.

Tip 2:

In the parameter menu of many cycles, the finishing feedrate can be set, which is the feedrate for finishing. This allows you to set a different feed rate for the finishing operation than for the roughing operation, usually a slower one. Saves time on longer operations!

POSSIBLE CYCLES

The following cycles are available:

- Gearbox Left - Electronic gear Left
- Gearbox Right- Electronic gear Right
- Turning - External long turning
- Boring- Internal long turning
- Facing
- Parting
- Undercut
- External thread - Straight or tapered thread External
- Internal thread - Straight or tapered thread Internal
- Thread <0 - External thread Never exceeding 0
- External taper
- Internal Taper
- Convex outer radius (
- Concave outer radius)
- Convex inner radius (
- Concave inner radius)
- Concave groove - Round or elliptical grooves
- Straight Groove (Software Version 9 and higher)
- Grinding- Grinding and pushing with spindle angle stationary or rotating -
- Drilling - Drilling cycle
- Angle measurement on chuck

GEARBOX LEFT

Electronic gear with freely selectable feed rate. The motor is driven at the set feed rate, the spindle stops -> the motor also stops. This is identical with the condition before the conversion of the machine, the gear is now replaced by the ELS. If the spindle turns to the left, the carriage moves to the left, if the spindle turns to the right, the carriage moves to the right.

If the end position („Z P“) is < 0 , the slide also stops at the end position, but internally the control calculates the position so that, for example, the beginning of a thread is found correctly again in the thread cycle.

After changing to this cycle, the feed must first be started with START for safety reasons. The STOP key can be used to stop and restart the feed at any time.

GEARBOX RIGHT

The same, but the other way round, e.g. for left-hand threads.

Tip: In these GEARBOX-cycles, the X axis can be deactivated with XOFF to be able to feed manually in the X direction.

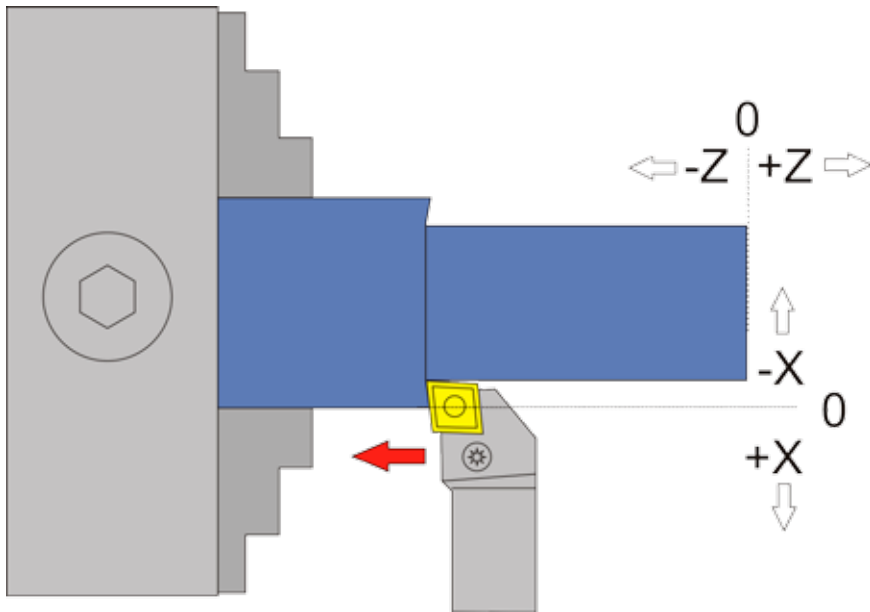
If the carriage moves in the wrong direction in one of the gear modes, you must reverse the direction in the encoder settings: Then switch to SETTINGS -> SETUP ENCODER -> DIRECTION REVERSE and change the direction there. If the carriage then moves in the correct direction, the system will function correctly.

Available parameters in the parameter menu:

- *DIRECT DRIVE* - Switches on a direct gear drive without any acceleration ramps. This allows to wind springs by hand for example. (Available in Software version 9 or higher)

TURNING

Straight chip removal in the longitudinal direction towards the chuck to reduce the diameter of a workpiece.



Moving axes and directions:

- X towards the chuck (-X)
- Z towards the chuck (-Z)

Required data:

- Feed F in mm/U
- ZP: Machining length in Z direction, must be zero or negative

Optional data

- XP: Cutting depth in X-direction, must be zero or negative.
- If XP=0, the material is only fed in the Z direction, e.g. for manual feed in the X direction.
- If XP >0, the number of cutting passes can be selected before the start of the process.

Available parameters in the parameter menu:

- *X AP FINISH* - depth of the last finishing pass in mm
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate (F) set in the cycle, the last finishing pass at the speed set here in the parameter menu. The setting allows fast roughing with F and subsequent slow finishing.

Limitations in dimensions: None

Maximum speed: 3000 rpm

The spindle speed can be freely changed during the cut. A stop can be made at any time by pressing the STOP button.

IMPORTANT: ALWAYS MAKE SURE THAT THE ZERO POINT IS SET CORRECTLY!

There are three possible variants:

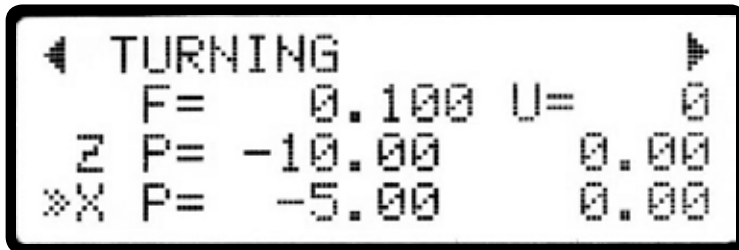
1. $ZP = 0$ and $XP = 0$ In this case, the movement after the START signal goes after a safety query to X 0,00 and then in -Z direction until the STOP key is pressed. START-STOP operation is possible while the vehicle is moving. Only when the STOP button is pressed does the movement abort, after which X and Z are reset to the stop position.
2. $ZP \neq 0$ $XP = 0$, therefore only one end position for Z is specified, no depth.
Here the movement goes directly after the START signal WITHOUT safety query to X 0.00 and then in -Z direction to the end point Z P. Then a reset to X 0.2 and back to Z 0.00 takes place, then the position for X and Z changes to the hold position.
3. $ZP < 0$ and $XP < 0$, so the values for length and depth are given here.
The control cuts fully automatically in several passes. After the START signal, the control first displays an overview of all the data for the individual passes. A new START command starts the cut, STOP aborts the process. After the last pass has been completed, the X axis is moved to +0.2 and the surface at the end of the workpiece is turned cleanly flat. Then the stop position is approached.

Selection of cutting passes

So that the tool or the material is not overloaded, cutting is usually carried out in several in-feeds, we speak of „passages“. Before each pass, the cutting edge is driven into the material by a certain amount in order to chip the material layer by layer. See the next page for an example .

EXAMPLE

External turning in several passes Example:
Selected are ZP= -10 and XP = -5

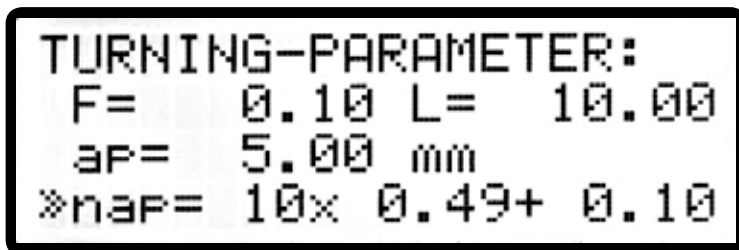


It should therefore remove 5mm of material, over a length of 10mm.

After starting the spindle and pressing START, the control first calculates the number of passes required. The set values for Maximum roughing thickness (X Ap roughing) and Finishing thickness (X Ap finishing) are used. This means that n passes are run with maximum roughing thickness, the last pass with finishing thickness. In principle, the last pass always takes place with finishing feed! The set value of the roughing thickness is not exceeded.

> In this example, X Ap Rough is set to 0.5mm and X Ap Finish is set to 0.1mm.

The display will then be as follows



What is displayed here?

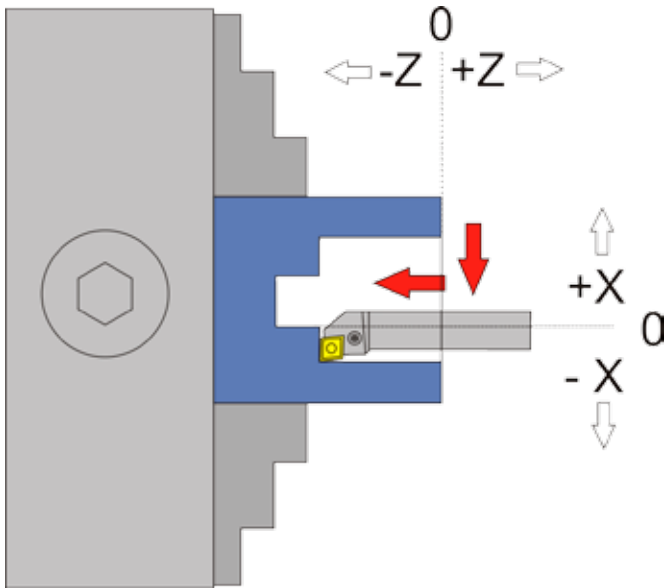
F = 0,10	The feed in mm/revolution
L = 10,00	The length of the cut in Z-direction
ap = 5,00	The total decrease of material thickness in X-direction
nap = 10x 0,49 + 0,10	The number of roughing passes and the strength of the last finishing pass. (nap = n x Ap)

So here 0.49mm are to be removed in 10 passes, the last pass is done with a finishing thickness of 0.10 mm. In total this results in a value of ap=5.00 mm. The total number of passes is 11: 10x roughing and 1x finishing.

Use the rotary knob to change the number of passes up or down, the cutting depths will be recalculated on-the-fly. This allows you to make changes quickly, but you must be careful not to overload the machine or material with excessive cutting depths. You can also reduce the number of passes to 1, then it will move directly to the end point, useful e.g. if you want to move one last pass to the maximum depth. If you like the values, press START to start the process. STOP cancels the process.

BORING

This mode is used to remove material in the longitudinal direction, but from the inside. Starting from the zero point, the lathe tool moves to $-XP$, then to $-ZP$, where the length corresponds to the depth of the material removed.



ATTENTION: $-X$ is ALWAYS in the removal direction, in this case $-X$ is towards the operator! This is the other direction as with external turning! To zero the X axis, always approach the operator and then set it to 0. This is the only way to ensure that the backlash is taken into account.

IMPORTANT: ALWAYS MAKE SURE THAT THE ZERO POINT IS SET CORRECTLY!

Moving axes and directions:

- X towards the operator ($-X$)
- Z towards the chuck ($-Z$)

Required data:

- Feed F in mm/U
- ZP : Machining length in Z direction, must be zero or negative

Optional data

- XP : Cutting depth in X-direction, must be zero or negative.
- If $XP=0$, the material is only fed in the Z direction, e.g. for manual feed in the X direction.
- If $XP > 0$, the number of cutting passes can be selected before the start of the process.

Available parameters in the parameter menu:

- *X AP FINISH* - depth of the last finishing pass in mm
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate (F) set in the cycle, the last finishing pass at the speed set here in the parameter menu. The setting allows fast roughing with F and subsequent slow finishing.

Limitations in dimensions: None
Maximum speed: 3000 rpm

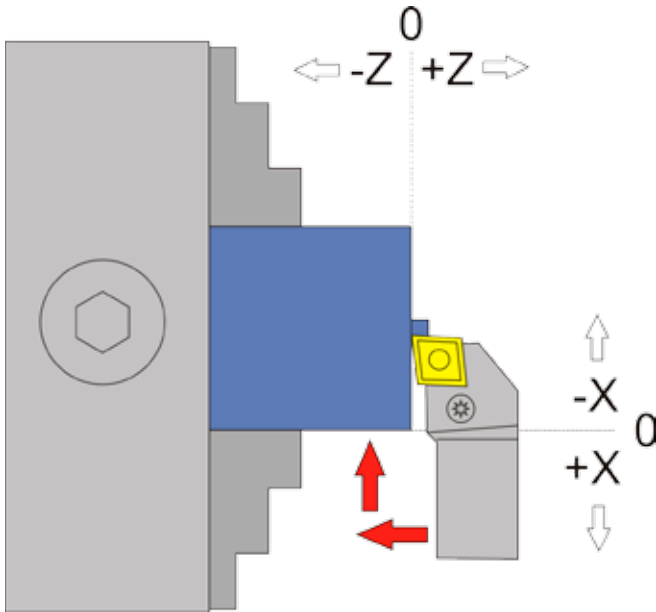
The speed can be freely changed during the cut. A stop can be made at any time by pressing the STOP button.

There are three possible variants:

1. $ZP = 0$ and $XP = 0$ so there are no endpoints at all specified, in which case the movement after the START signal goes to X 0,00 after a safety query and then in the -Z direction until the STOP key is pressed. START-Stop operation is possible while the vehicle is in motion. The movement is aborted only when the STOP button is pressed, after which X and Z are reset to the stop position.
2. $ZP \neq 0$ $XP = 0$, therefore only one end position for Z is specified, no depth. Here the movement goes directly after the START signal WITHOUT safety query to X 0.00 and then in -Z direction to the end point Z P. Then a reset to X 0.2 and back to Z 0.00 takes place, then the position for X and Z changes to the hold position.
3. $ZP < 0$ and $XP < 0$, so the values for length and depth are given here. the cutting is fully automatic in several passes. after the START signal, the controller first displays all the data for the individual passes in an overview and then starts again after a new start command. Here you can also abort by pressing the STOP key.

FACING

This mode is used to remove material from the face of the part. From the zero point, the turning tool moves to -Z, then to -X. ZP, corresponds to the depth of the material to be removed (ap) XP is the radius by which the part becomes smaller (r).



ATTENTION: -X is ALWAYS in the removal direction, in this case -X is therefore away from the operator. To zero the X axis, always approach the workpiece and set it to 0 to ensure that the backlash is taken into account..

IMPORTANT: ALWAYS MAKE SURE THAT THE ZERO POINT IS SET CORRECTLY!

Moving axes and directions:

- X towards the chuck (-X)
- Z towards the chuck (-Z)

Required data:

- Feed F in mm/U
- ZP: Machining length in Z direction, must be zero or negative

Optional data

- XP: Cutting depth in X-direction, must be zero or negative.
- If XP=0, the material is only fed in the Z direction, e.g. for manual feed in the X direction.
- If XP >0, the number of cutting passes can be selected before the start of the process.

Available parameters in the parameter menu:

- *X AP FINISH* - depth of the last finishing pass in mm
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate (F) set in the cycle, the last finishing pass at the speed set here in the parameter menu. The setting allows fast roughing with F and subsequent slow finishing.

Limitations in dimensions: None
Maximum speed: 3000 rpm

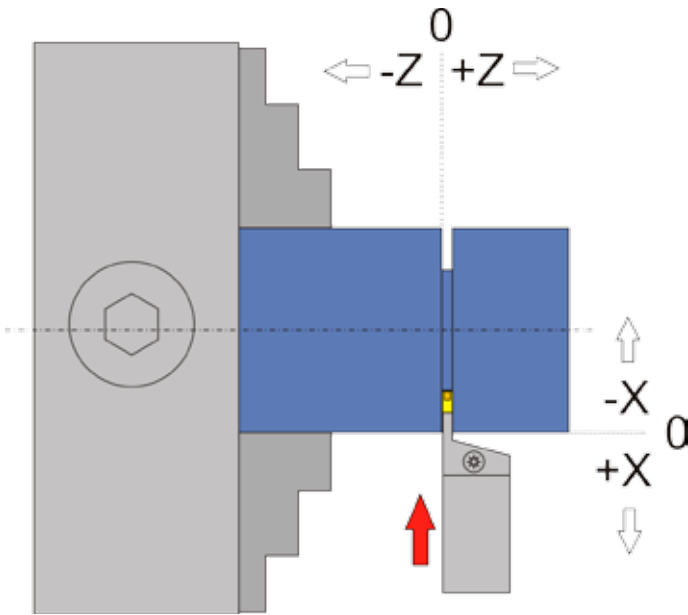
The speed can be freely changed during the cut. A stop can be made at any time by pressing the STOP button.

There are three possible variants:

1. $ZP = 0$ and $XP = 0$ so there are no endpoints at all specified, in which case the movement after the START signal goes to Z 0,00 after a safety query and then in the -X direction until the STOP key is pressed. START-Stop operation is possible while the vehicle is in motion. Only when the STOP button is pressed does the movement abort, after which X and Z are reset to the stop position.
2. $ZP = 0$ $XP < 0$, therefore only one end position for Z is indicated, no depth. Here the movement goes directly after the START signal WITHOUT safety query to Z 0,00 and then in -X-direction to the end point X P. Then a reset to Z 0,2 and back to X 0,00 takes place, then the position for X and Z changes to hold position.
3. $ZP < 0$ and $XP < 0$, so the values for depth and radius are specified. The cutting process is fully automatic in several passes. After the START signal, the controller first displays all the data for the individual passes in an overview and then starts after a new start command. Here you can also abort by pressing the STOP key. The same applies to the number of passes as written for „outside turning“.

PARTING

This mode is used to cut round workpieces. Starting from the zero point, the lathe tool travels here to -X after XP in the direction of the diameter center. ZP values in the Z direction are ignored!



ATTENTION: -X is ALWAYS in the removal direction, in this case -X is therefore away from the operator. To zero the X axis, always approach the workpiece and set it to 0 to ensure that the backlash is taken into account.

Moving axes and directions:

- X towards the chuck (-X)
- Z No movement

Required data:

- Feed F in mm/U
- XP: Machining depth in X direction, must be zero or negative

There are two possible variants:

1. XP = 0 so no end point is specified, in which case the movement after the START signal goes in the -X direction after a safety query until the STOP key is pressed. START-Stop operation is possible while the vehicle is moving. Only when the STOP button is pressed does the movement abort, after which X is reset to the stop position.
2. XP < 0, so values for depth are specified Here, after a safety query, the system automatically moves to XP at the set feed rate, and then retracts to the stop position. The movement can be aborted at any time by pressing the STOP key, then it is reset to the stop position.

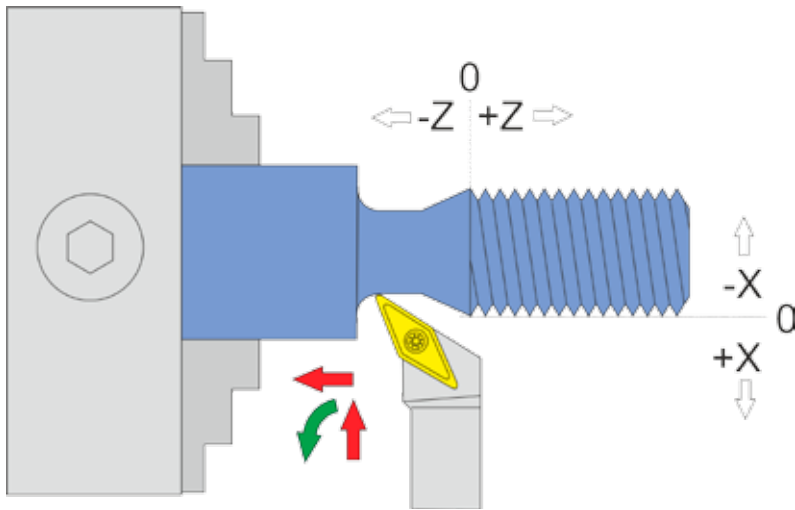
Values for ZP are ignored here! The Z axis is not moved in this mode.

Available parameters in the parameter menu:

- NONE

UNDERCUT

This mode is used for the automatic turning of undercuts according to DIN 76-1. Turning is done with pointed inserts, e.g. type VCGT..



An undercut is optimal at the bottom of threads. The undercut according to DIN 76-1 is initiated by a 30° incline, followed by a straight section that ends in a radius.

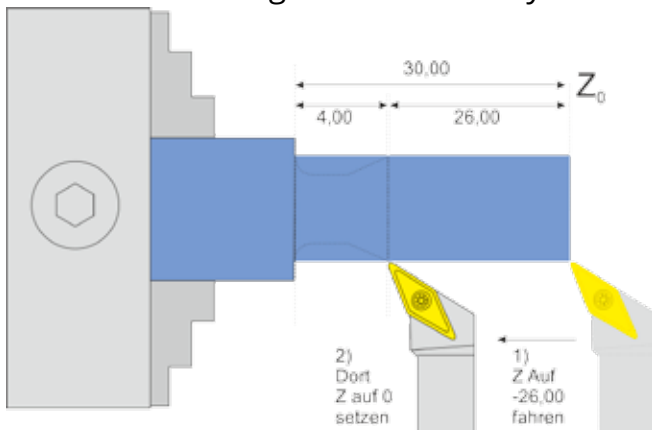
The dimensions are entered by changing the depth (XP). Since undercuts are usually used in threads, select the depth by the depth of the thread and add 0.5mm. The length of the undercut will then be calculated automatically to obtain the shortest possible undercut. If you want the undercut to be longer than the automatic has calculated, you can switch to ZP and simply increase the length.

Before the start of the cut, the number of passes is shown again, which can be changed quickly with the knob as usual.

Example:

A bolt end has been turned and is 30 mm long. A thread is to be cut with 0.97mm thread depth. We set the depth of the undercut to $XP=-1,50\text{mm}$. The length is then calculated by the ELS to $ZP=-3.47\text{mm}$.

So that we can place the undercut exactly at the end of the bolt, we increase the length to -4.00 mm. We then move from the zero point on the flat surface of the bolt in Z to -26.00, i.e. 4 mm before the end of the bolt. There we set Z to 0, our new zero point for the undercut. So we can turn the 4mm long undercut exactly to the end of the bolt!



Moving axes and directions:

- X towards the chuck (-X)
- Z towards the chuck (-Z)

Required data:

- Feed F in mm/U
- ZP: Machining length in Z direction, must be zero or negative
- XP: Cutting depth in X-direction, must be zero or negative.

Available parameters in the parameter menu:

The parameter menu allows quick access to useful settings. It can be reached by navigating down with the DOWN key. If you change from Feed -> ZP -> XP further down, you enter the parameter menu. Exit the menu by pressing the HIGH key or LEFT.

- *X AP FINISH* - Depth of the last finishing pass in mm.
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.
- *TOOL CORNER RADIUS* - The radius of the cutting edge, an important information to be able to rotate the radius and the slope exactly.

MAKING THREADS

The electronic lead spindle transforms your conventional lathe into a universal thread lathe. If you have motorized both axes, you can turn threads of all kinds, inside and outside, fully automatically.

It doesn't matter which flank angle you cut, or which type of thread. In addition to metric threads, imperial threads are also possible, as well as trapezoidal threads or pipe threads. Also tapered and multi-start threads are possible, as well as the repair of damaged threads (re-cutting).

The input required is the feed rate corresponding to the thread pitch. The thread depth is entered via XP, ZP defines the length of the thread.

The pitch of inch threads must be converted to mm. 24 threads per inch are e.g. $25.4 / 24 = 1.058 \text{ mm}$

The working principle of the ELS absorbs speed fluctuations of all kinds, you can also stop the spindle between cuts, move the slide back and forth using the travel keys, turn the chuck around, test the thread and then turn it again, all this is no problem, the thread groove is hit again and again.

Important: As long as the thread is not finished, you should not go over the permitted 1200 rpm on the main spindle, otherwise the position can get lost. Basically you shouldn't exaggerate the speed and should rather drive slower, then the necessary starting distance is shorter.

Before each start, you can select the number of passes and the depth of infeed, as in the other cycles, and change them quickly and easily by turning the knob. Set the number of passes to 1 to make a cut to full depth, this is often useful to remove the last material residues from the thread!

In order to achieve the correct feed rate at the zero point, a starting distance is required for the Z axis. The cutting edge is therefore positioned before the zero point around this starting distance in order to approach from there. This starting distance is calculated by the controller on the basis of the motor parameters, the speed and the desired acceleration before each pass. The greater the thread pitch and spindle speed, the greater the required starting distance. It is therefore recommended to reduce the speed for very high pitches in order to reduce the starting distance.

CUTTING STRATEGY

The ELS can turn threads with 4 different infeed methods:

1. Radial infeed with gradually decreasing infeeds
2. Simple flank infeed with even infeeds
3. Modified flank infeed with even infeeds
4. Alternating flank infeed with even infeeds

These are the methods currently used in industry, the last three are actually only feasible on CNC machines, or with the ELS!

Simply explained, for **radial infeed** the machine only feeds in X, i.e. both cutting edges are engaged, towards the end with a very large surface, which quickly leads to rattling, and often also to unattractive surfaces. Not recommended!

The simple **flank infeed** is therefore much better, whereby depending on the flank angle not only X but also Z is infeeded at the same time. This means that only the left side of the cutting edge is in contact, the chips flow off well and the surfaces becomes good. The disadvantage is the one-sided wear of the cutting edges and that the right side of the cutting edge may rub against the material and the surface on the side may become unattractive. This is the same method that one learns as a lathe operator by tilting the top slide in order to be able to then feed it at an angle.

It is absolutely necessary to enter the flank angle in the parameter menu!

The **modified flank infeed** is an extension. It cuts on both sides, but very little on the right side. This leads to better surfaces and good chip control, but is worse on weak machines than method no. 2. Recommended!

The **alternating flank feed** goes one step further and ensures the use of both cutting edges as well as step-by-step feed, which leads to low loads and good tool life. Unfortunately, this is only possible if you have a backlash-free drive on the Z-axis. This is not possible with trapezoidal threaded spindles, because the lock nut sometimes loses contact and the slide no longer remains in position. This mode is therefore reserved for those who have a recirculating ball screw on the machine.

On the next page you will find an explanation of the different methods.

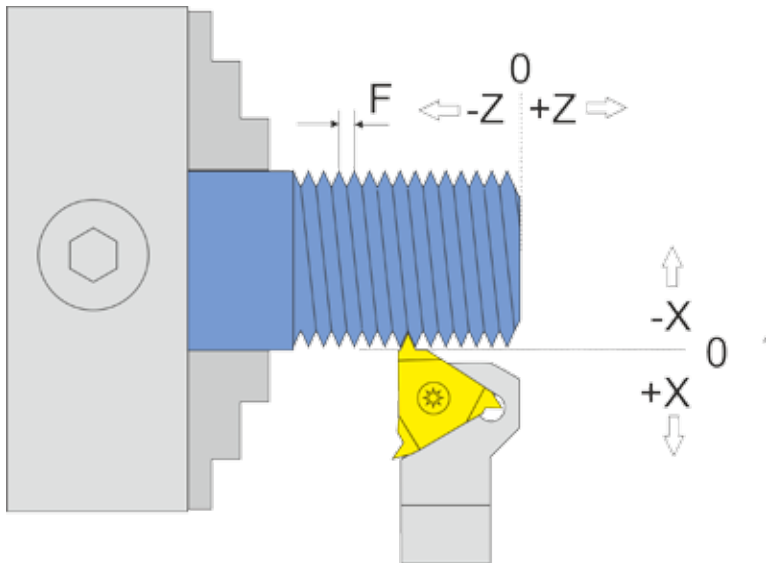
Available parameters in the parameter menu:

- *THREAD ANGLE* - flank angle of the thread. Usually 60° (metric) or 55° (inch), but everything can be set between 10 and 90°.
- *CUT MODE* - One of the Top Choices
- *CONE RATIO* - information required for tapered threads. See „Tapered threads“ later in this manual.
-

External threads

Starting from the zero point, the lathe tool moves to -X, then to -Z.

ZP = Thread length, XP = the thread depth (ap), F = the thread pitch.



ATTENTION: -X is ALWAYS in the removal direction, in this case -X is so away from the server! To zero the X axis, always approach the workpiece and set it to 0 to ensure that the backlash is taken into account.

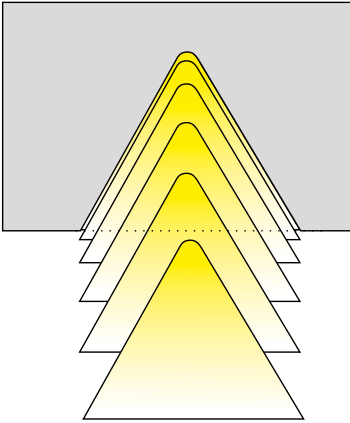
There are two possible variants:

1. $ZP < 0$ and $XP = 0$ so only one length is given, no depth. In this case, the trip after the START signal goes in -Z direction to ZP without interrogation. The slide stops there until the WAIT TIME (see Settings) has elapsed and the X axis is retracted manually, and then moves back to Z, stopping at a point before the zero point. Depending on the speed, this can be several mm, which it moves beyond 0. The X-axis is not moved but must be moved manually!
2. $ZP < 0$ $XP < 0$, so a length and a thread depth are specified. After the START signal, the controller first displays all the data for the individual passes in an overview and then starts again after a new start command. Here you can also abort at any time by pressing the STOP buttons. The return travel always takes place in X slightly above the zero point, because otherwise the cut thread would break. It also moves beyond 0 in the +Z direction.

This mode is suitable for turning threads from the zero point, but in this case the thread is moved beyond 0 because of the required starting distance, which in some cases prevents the use of the tailstock. If you are unsure, it is advisable to do a test run at the desired speed, leaving XP at 0 so that no infeed is made.

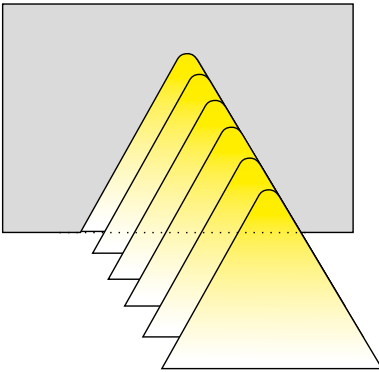
If you want to run without any starting distance, the mode „THREAD <0“ must be selected, this mode does not last beyond 0, but you have to make sure to keep it far enough.

Radiale infeed



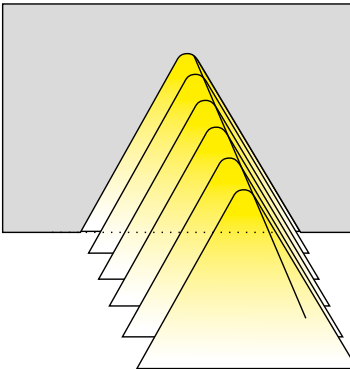
- Smaller infeed increments
- Multi-tooth plate inserts
- Infeed only in X direction
- For fine threads $P < 1.5\text{mm}$
- The most frequently used heavy-duty chip control
- High to very high cutting forces
- Uniform tool wear

Flankinfeed



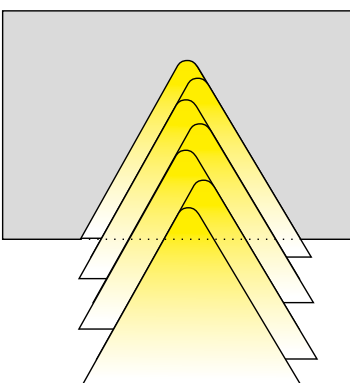
- Uniform cut depths
- Use when modified flank infeed is not possible.
- Thread pitches $> 1.5\text{mm}$
- Poor surfaces possible on the right side
- Good chip control
- Reduced cutting forces, less vibration
- Uneven tool wear (only one side)

Modified flank infeed



- Uniform cut depths
- Preferred to use!
- High surface quality
- Good chip control
- Reduced cutting forces, less vibration
- Uniform tool wear
- Long service life

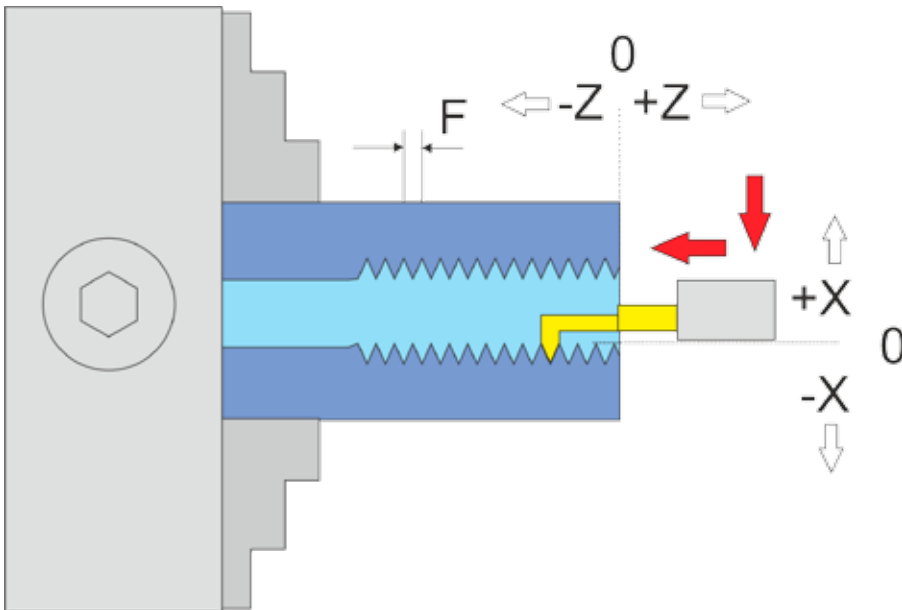
Alternating flank infeed



- Uniform cut depths
- Only possible with backlash-free threaded spindle on the Z axis! (recirculating ball screw, e.g.)
- For large thread profiles and pitches
- High surface quality
- Good chip control
- Reduced cutting forces, less vibration
- Uniform plate wear
- Long service life

INTERNAL THREADS

This mode is used for automatic turning of internal threads. This mode moves beyond 0 when resetting in Z direction! Attention: Maximum speed is 1200 rpm!



Starting from the zero point, the turning tool moves to -X, then to -Z.

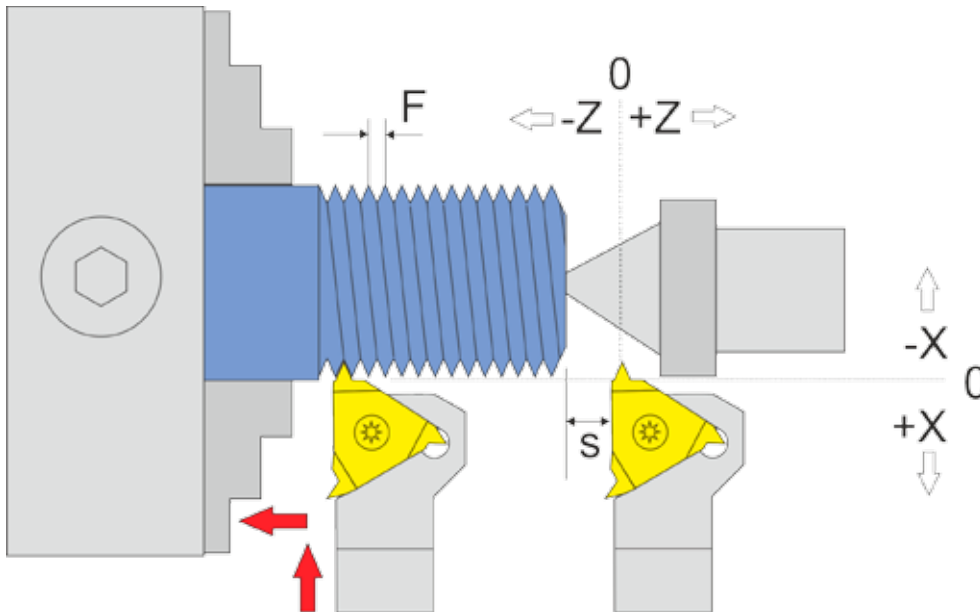
ZP = Thread length, XP = the thread depth (ap), F = the thread pitch.

ATTENTION: -X is ALWAYS in the removal direction, in this case -X is *towards the operator*! This is the other direction than with the external thread! To zero the X axis, always approach the operator and then set it to 0, this is the only way to ensure that the backlash is taken into account.

The procedure is otherwise the same as with the external thread.

THREAD <0

This mode is used for the automatic turning of threads. This mode does NOT go beyond 0 when resetting in Z direction! Attention: Maximum speed is 1200 rpm!



This mode is like „external thread“, except that the Z axis is never moved beyond 0.

Since the stepper motor on the Z-axis requires a certain distance to accelerate to the nominal feed rate, it needs a „start-up“ to the thread. This path is indicated as „S“ in the graphic above. The longer the higher the feedrate and the higher the spindle speed, the longer the path will be.

If the zero point is set in this mode directly at the workpiece edge, the first threads become very narrow, and only at the end of the acceleration path does the thread pitch correspond to the set nominal feedrate value F. The first thread pitch is then set at the end of the acceleration path. It may therefore be necessary to remove the first threads after the thread is ready.

This mode does not go beyond 0 when pulling back in Z-direction and thus prevents collisions with the tailstock.

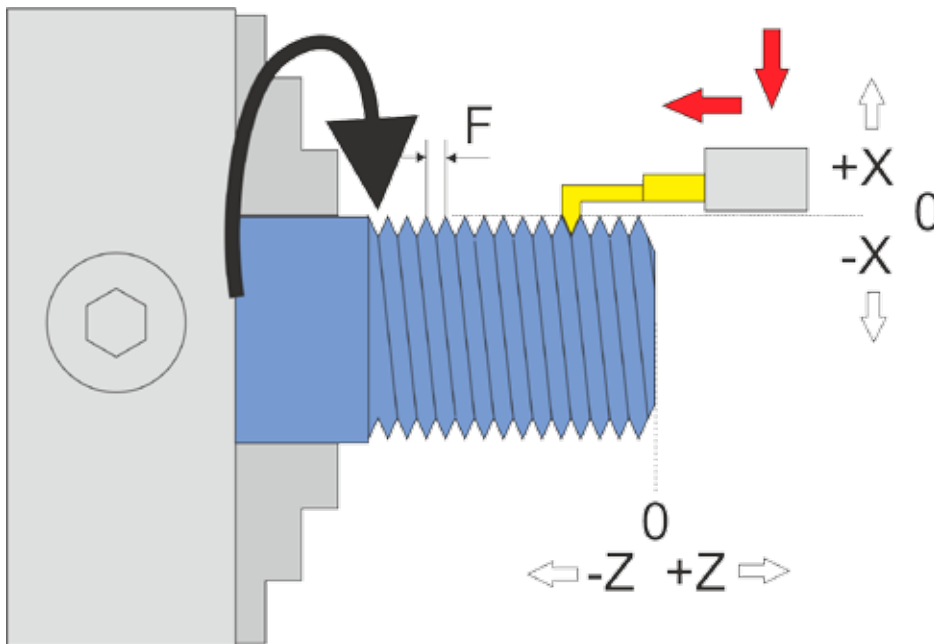
Re-Cut thread at full depth

If the thread does not quite fit after the cut, you can start a new pass and simply turn the number of passes to 1, then another pass is made at maximum depth, often this is enough to remove the missing last hundredths and make the thread fit. Some material is not suitable for turning and has to be turned several times to full depth until it fits. This is where trial and error helps.

LEFT THREADS

This is not a separate mode, but there are several ways to turn a left-hand thread:

1. Turn the turning steel around and let the spindle turn clockwise. Then you can turn the external left-hand thread in the external thread mode.
2. Use an internal thread turning tool and place the opposite end of the workpiece. Then you use the internal thread mode(!) to turn an external left-hand thread when the spindle is turning clockwise. In internal thread mode, the thread is fed to the operator, which in this case produces an external thread. Somewhat tricky, but easy to do. The zero point in X must then of course be set moving towards the operator, as is usual in internal modes.



MULTI-START THREADS

Proceed as follows to produce a multiple-start thread:

1. Set the angle to 0 in ANGLE MODE.
2. Switch to thread mode and cut the first thread.
3. Switch back to angle mode and manually rotate the chuck to the desired angle. This would be 180° for a 2-course thread, 120° for a 3-course thread, and so on. Then set the angle to 0.
4. Return to thread mode and cut again, you will see that the new track is next to the first.
5. Repeat for all threads. If the thread does not fit completely, it can be repeated as required.

THREAD REPAIR

If you have accidentally moved something in between, e.g. by removing the workpiece from the chuck and the thread was not yet finished, you can find the position on the thread again.

The procedure is to place the cutting edge over the material and then start a thread cut if the pitch is correct. The spindle is stopped in the middle and the cutting edge is positioned manually so that it sits exactly in the existing thread groove. Then you move the cutting edge out again by hand, restart the spindle and end the cycle. Then the cutting edge in Z is exactly right:

1. Set the ELS in the parameter menu for external threads to „Radial infeed“.
2. Set the correct thread pitch
3. Place the thread chisel in Z on the zero point.
4. Set the thread length (ZP), set XP to 0.
5. Now position the lathe tool in the X-direction slightly above the existing surface so that no material is removed when moving.
6. Now start the spindle very slowly and press Start.
7. The bit is then positioned, and after a short waiting period, the control unit starts moving. When the chisel is about half its length, stop the spindle!
8. Now switch off the X-axis with Xoff and turn the turning tool on the cross support and on the top slide so that it stands exactly in the existing thread groove.
9. Pull the chisel out of the groove all the way only in the X direction.
10. Start the spindle again, the cycle continues and the process is completed.
11. At the end, move with the jog keys in the Z direction over the thread to be repaired and position X so that it is on the top of the material, then zero the X axis. Drive Z to zero point.
12. Now you can cut the thread, set the desired depth in XP, which you can then either drive in one train or in several infeeds.

TAPERED THREADS

The ELS can also turn tapered threads inside and outside. To do this, the raw material must first be transformed into a taper using the taper function. Usually, taper threads are defined by a cone ratio in addition to pitch and flank angle, e.g. 1:16.

For the definition of the cone ratio see the appendix.

In order for this to work exactly, the thread modes have been given a new parameter called „cone ratio“.

In the thread modes, XP is used to enter the thread depth, ZP for the thread length. To define the cone shape, use the parameter „Cone ratio“, which is usually also indicated for the thread. This way it can be accepted immediately.

If the cone ratio is set to 1:0, no cone is defined, anything greater than 1:0 creates a tapered thread!

1:0 is preset after a restart.

The cone modes also have this parameter so that for taper threads you can first turn a cone with e.g. 1:16 and then directly afterwards the suitable thread. The parameter „cone ratio“ remains the same as it was set in one of the modes. This is described in detail in the cone modes.

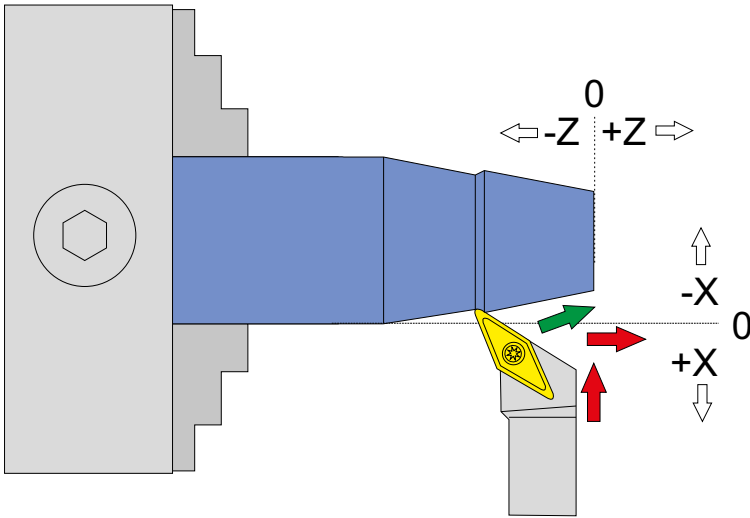
In the case of tapered threads, the cutting edge in Z must be zeroed exactly to the front edge of the cone. Otherwise it is turned like a normal thread, the ELS ensures the correct infeed.

In other words, all you have to do is change the cone ratio parameter to cut a tapered thread! More is not necessary.

See the next section for more details.

EXTERNAL CONE

This cycle is used to cut external cones at any angle. The X and Z axes are moved simultaneously.

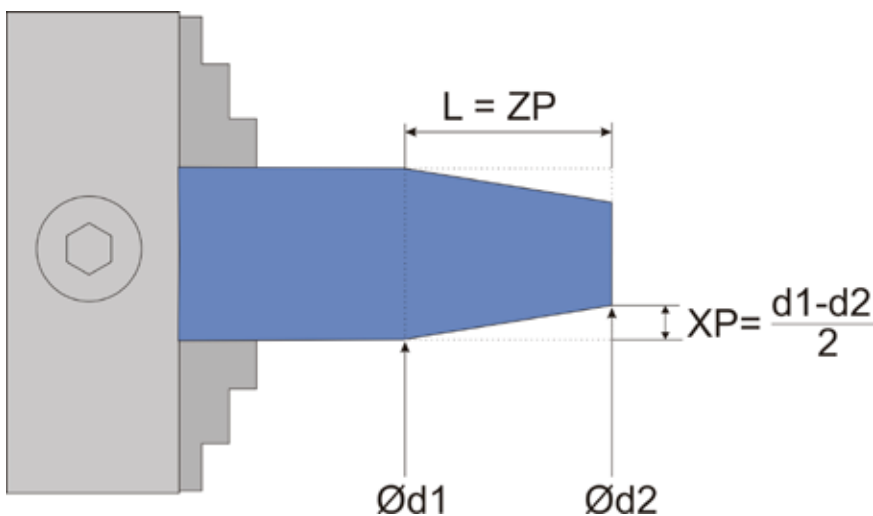


The cuttings of external cones is only possible with a drive on the X axis. The control compensates the radius of the cutting edge of the tool. This goes so far that completely round indexable inserts can also be used. The radius must be entered correctly in the parameter menu. The setting is „Tool Corner Radius“.

Due to the Tool Corner Radius compensation, the X axis travels slightly beyond -XP! Even in the Z direction, a small excess of the ZP path can occur.

An important prerequisite for turning cones is a precisely measured backlash of the X-axis set in the control system. This can be measured with a dial gauge and must then be entered in the settings.

A cone is defined by 2 diameters D1, D2 and the length L:



The controller expects two specifications:

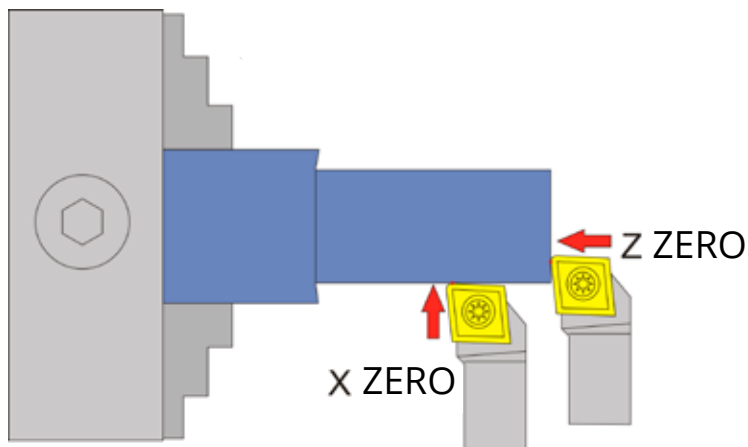
ZP – This corresponds to the length of the cone.

XP – The distance in X by which the cone tapers, i.e. $(d1-d2)/2$

Procedure for cone turning:

- Turn the raw material to diameter d1 before starting. Use this to zero the X-axis by jogging the X-axis to the depth you just cut after the cut with the jog-keys. Since the last depth reached is still set in XP, the X-axis stops there. Reaching XP set the X-Axis to 0, then jog to the end of the material and zero the Z axis on the face surface.
- Always drive from right to left to compensate for the backlash! Then set the desired values for the Cone in ZP and XP and start.
- Before starting the process you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the angle and corresponds to the real depth in the material.

Due to the cutting radius compensation, it is important to zero the axes in this way:



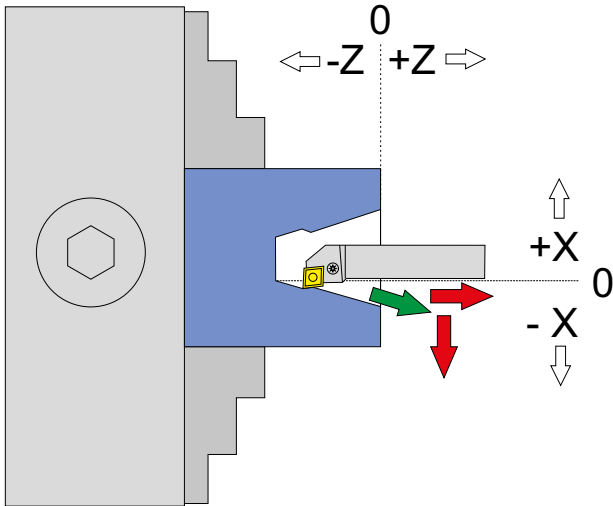
Available parameters in the parameter menu:

The parameter menu allows quick access to useful settings. It can be reached by navigating down with the DOWN key. If you change from Feed -> ZP -> XP further down, you enter the parameter menu. Exit the menu by pressing the UP key or LEFT.

- *TOOL CORNER RADIUS* - The radius of the cutting edge, very important for correct radius compensation.
- *X AP FINISH* - Depth of the last finishing pass in mm.
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.
- *CONE RATIO* - Optionally the size of the cone can be specified. (See appendix on the topic). If you change the cone ratio, the ELS also recalculates the XP. If you change the length ZP with the cone ratio set, the cone ratio remains the same, XP is recalculated. So you can easily make the cone longer without changing the cone angle!

INTERNAL CONE

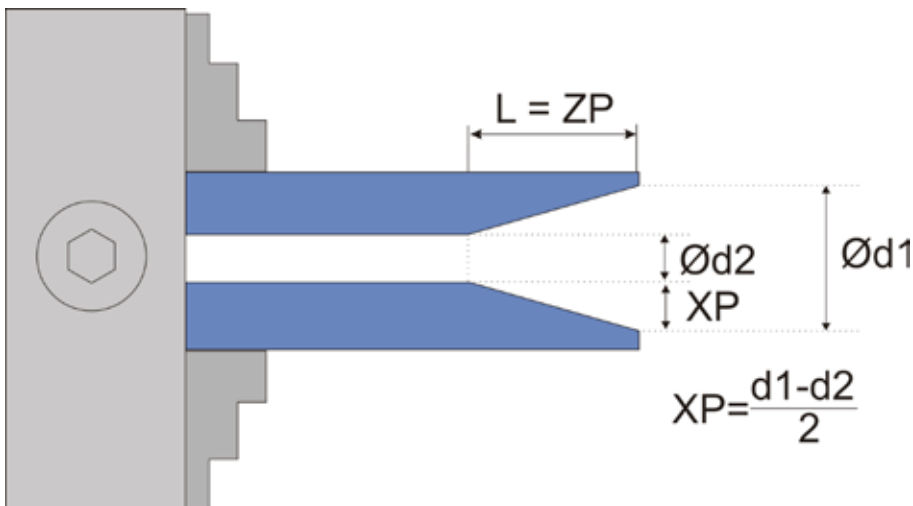
This mode is used to cut inner cones at any angle. The X and Z axes are moved simultaneously.



The cutting of inner cones is carried out in the same way as the turning of external cones. Only the reversal of direction of the X-axis has to be considered here, as always with internal turning -X is here again in the direction of the removal, i.e. towards the operator! +X is away from the operator.

An important prerequisite for turning cones is a precisely measured backlash of the X-axis set in the control system. This can be measured with a dial gauge and should then be entered in the settings.

A cone is defined by 2 diameters D1, D2 and the length L:



The controller expects two specifications:

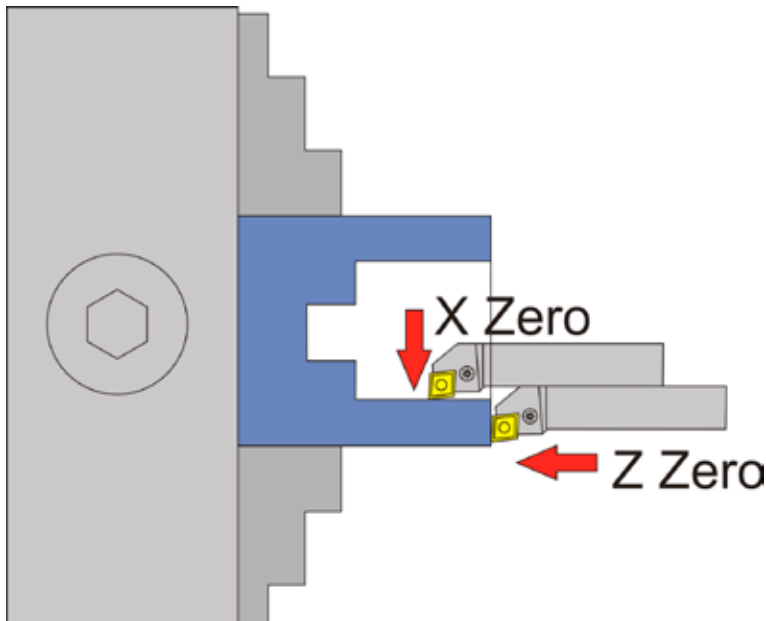
ZP – This corresponds to the length of the cone.

XP – The distance in X by which the cone tapers, i.e. $(d1 - d2)/2$

Procedure:

1. Before starting, turn the raw material to diameter d2.
2. Then zero the X axis to the inside of the material. Always approach the operator.
3. Then return to the end of the material and zero the Z axis. Always drive from right to left to compensate for the backlash!
4. Then set the desired values for ZP and XP and start.
5. Before starting the operation, you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the angle and corresponds to the real depth in the material.

Due to the cutting radius compensation, it is important to zero the axes in this way:



Available parameters in the parameter menu:

The parameter menu allows quick access to useful settings. It can be reached by navigating down with the DOWN key. If you change from Feed -> ZP -> XP further down, you enter the parameter menu. Exit the menu by pressing the UP key or LEFT.

- *TOOL CORNER RADIUS* - The radius of the cutting edge, very important for correct radius compensation.
- *X AP FINISH* - Depth of the last finishing pass in mm.
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.
- *CONE RATIO* - Optionally the size of the cone can be specified. (See appendix on the topic). If you change the cone ratio, the ELS also recalculates the XP. If you change the length ZP with the cone ratio set, the cone ratio remains the same, XP is recalculated. So you can easily make the cone longer without changing the cone angle!

RADIUS TURNING IN GENERAL

The ELS can also turn radii. Convex and concave inner and outer radii are possible. The radii may be circular or elliptical in shape. Thus a lot of curvatures are possible, there are no limits to the imagination.

The radius of the tool is compensated when turning radii. This is important so that the result is accurate. The radius of the cutting edge must be specified in the parameter menu under Tool Corner Radius. The compensation for some operations in X and Z direction moves further than the set values would suggest, please note this during planning.

In addition, the backlash of the X axis must be accurately measured and entered.

Moving axes and directions:

- X towards the chuck (-X)
- Z towards the chuck (-Z)

Required data:

- Feed in mm/rev
- ZP: Length of machining in Z direction, must be negative.
- XP: Cutting depth in X-direction, must be negative.
- Tool Corner Radius in mm (accessible via parameter menu)
- Correctly set backlash on both axes

Limitations in dimensions: None

Maximum speed: 3000 rpm

The speed can be freely changed during the cut. A stop can be made at any time by pressing the STOP button.

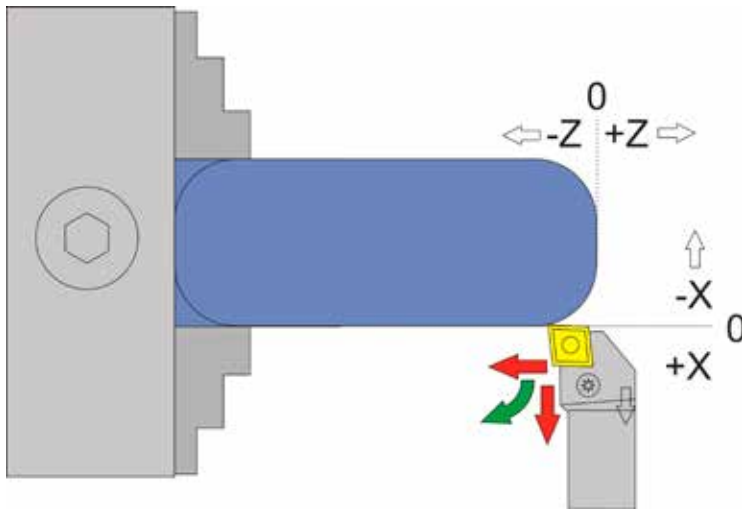
In all radius cycles the following parameters are available in the parameter menu:

The parameter menu allows quick access to useful settings. It can be reached by navigating down with the DOWN key. If you change from Feed -> ZP -> XP further down, you enter the parameter menu. Exit the menu by pressing the UP key or LEFT.

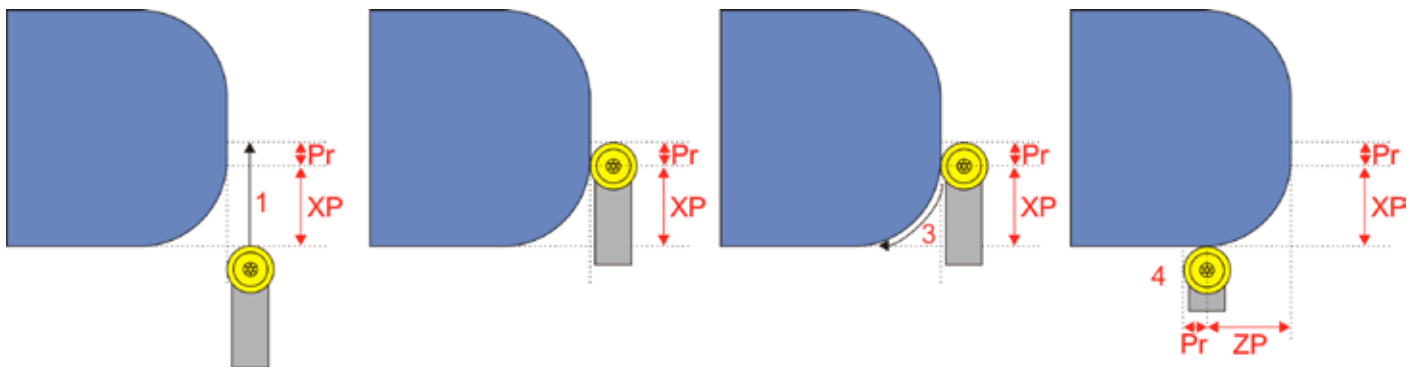
- *TOOL CORNER RADIUS* - The radius of the cutting edge, very important for correct radius compensation.
- *X AP FINISH* - Depth of the last finishing pass in mm.
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.

E-RADIUS) EXTERNAL RADIUS KONVEX

This mode is used to create convex outer radii. The X and Z axes are moved simultaneously. In addition to round radii, elliptical radii are also possible.



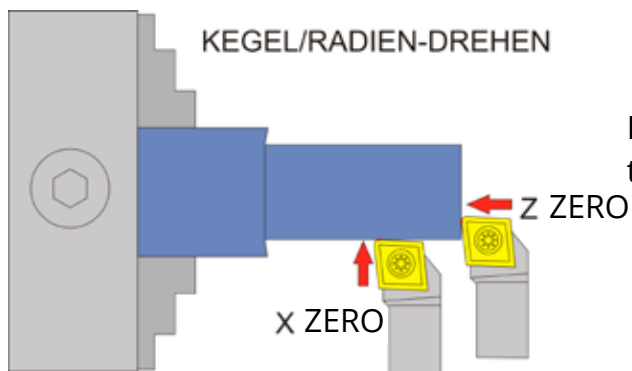
The cutting radius correction requires that this process is carried out beyond XP and ZP! The exact procedure is shown below, for clarification with a round insert:



Pr = cutting radius

1. Tool is moved beyond XP by the amount of the cutting radius.
2. Tool then stands deeper than XP
3. Z is delivered, contour is traversed
4. The movement ends beyond ZP by the amount of the cutting radius.
5. Then the reset to 0.0 or to the set derivative position takes place.

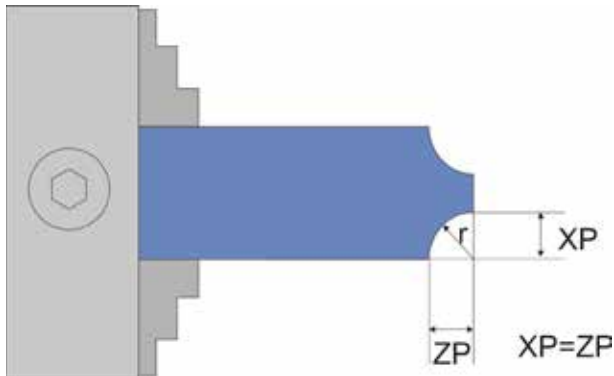
With small cutting radii, the distance that must be travelled further is therefore small, but it must be considered if at the end there is an obstacle.



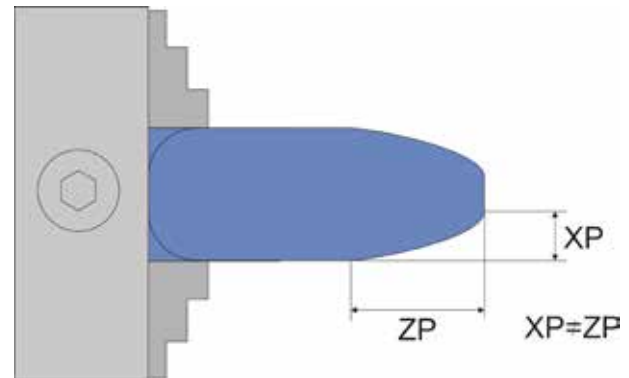
Due to the cutting radius compensation, it is important to zero the axes in this way:

The radius is defined here by the values ZP and XP:

Circular radius: $XP=ZP$



Elliptic radius: $XP \neq ZP$



So you can adjust the shape of the Radii by selecting the values for XP and ZP. Circular radii are achieved by equal values of XP and ZP.

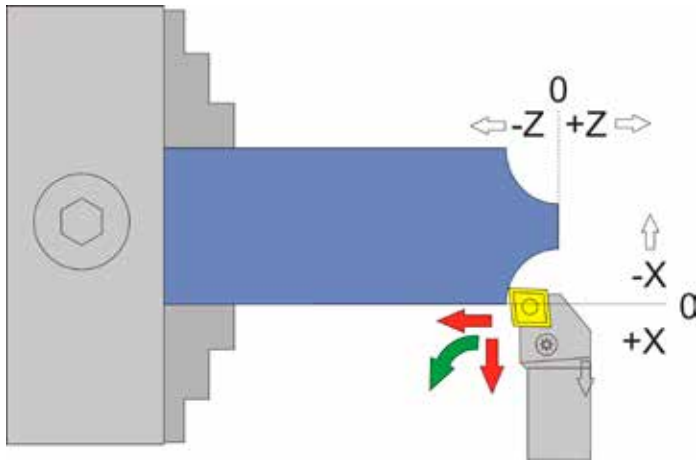
XP can also be larger than ZP, resulting in a flat elliptical radius.

Procedure:

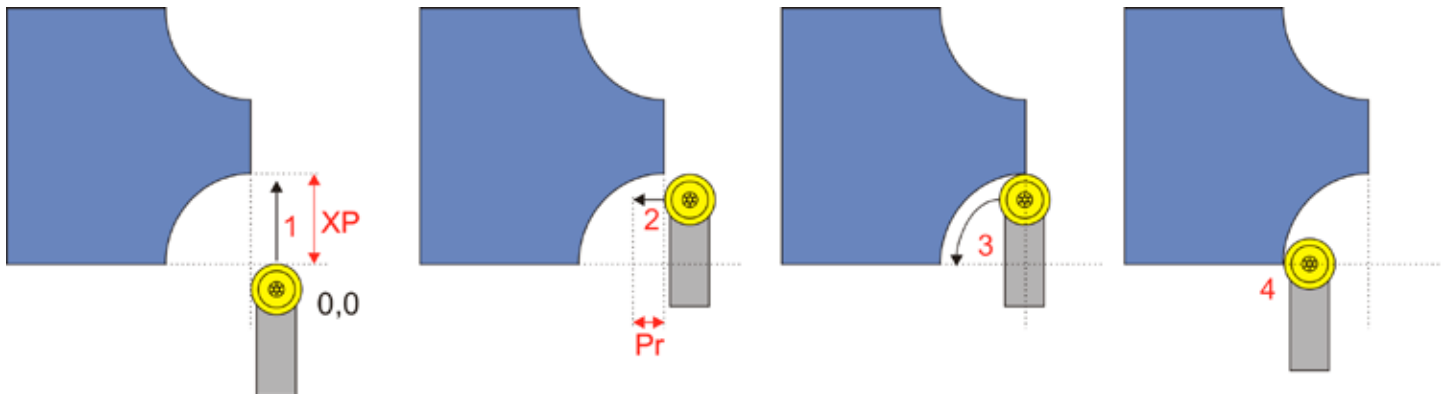
1. Turn the raw material to the desired diameter before starting.
2. Use this cut to zero the X-axis: The depth you just cut is still in XP. Use the JOG key to move the X-Axis to the depth you just cut. It will stop there after reaching the point. There you can zero the X-Axis to have the exakt point of the material surface.
3. Then return to the end of the material and zero the Z axis there. Always drive from right to left to compensate for the backlash!
4. Then set the desired values for ZP and XP and start. Before starting the process you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the radius and corresponds to the real depth in the material.

E-RADIUS (EXTERNAL RADIUS CONCAV

This mode is used to rotate concave outer radii. The X and Z axes are moved simultaneously. In addition to round radii, elliptical radii are also possible.



This operation does not go beyond XP and ZP. For clarification, the exact route is shown below:

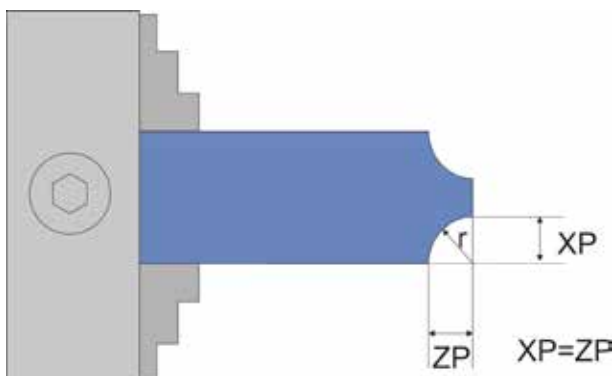


P_r = cutting radius

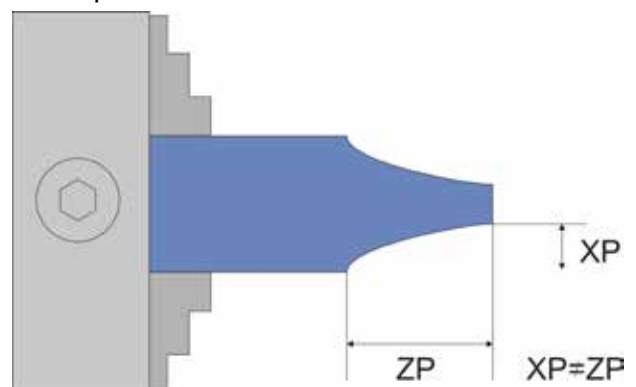
1. Tool is moved to $-X_P$
2. Tool is being moved to the left by the Tool Corner Radius P_r into the material Contour is being traversed
3. The traverse ends at $-Z_P$, the tool then stands beyond 0 by the amount of the cutting radius.
4. Then the reset to 0.0 or to the set resting position takes place.

The radius is defined here by the values Z_P and X_P :

Circular radius: $X_P = Z_P$



Elliptical radius: $X_P \neq Z_P$

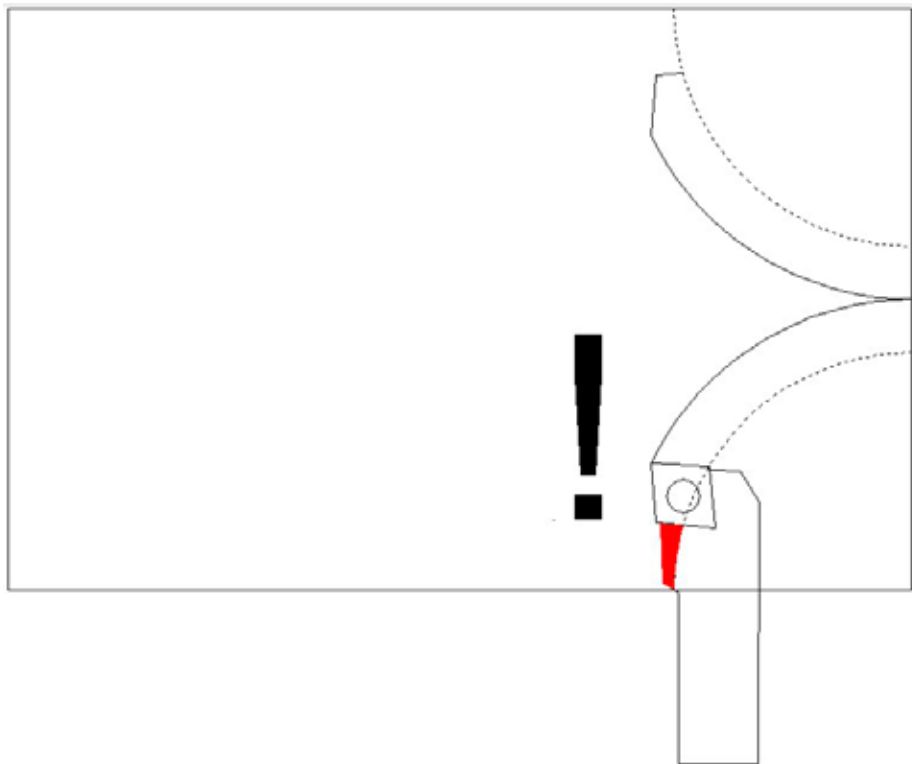


So you can adjust the shape of the Radii by selecting the values for XP and ZP. Circular radii are achieved by equal values of XP and ZP. XP can also be larger than ZP, resulting in a flat elliptical radius.

Procedure:

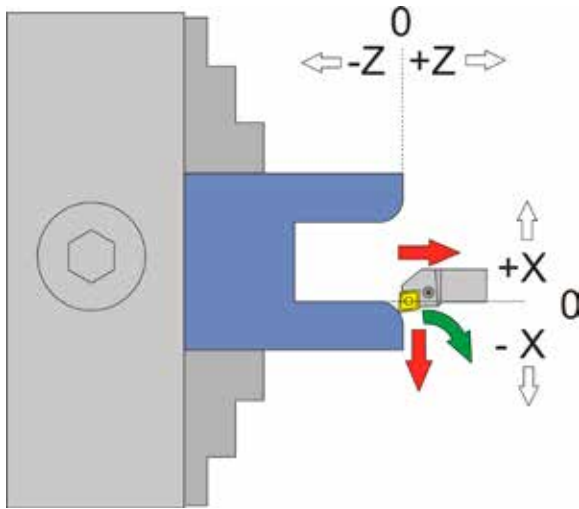
1. Turn the raw material to the desired diameter before starting.
2. Use this cut to zero the X-axis: The depth you just cut is still in XP. Use the JOG key to move the X-Axis to the depth you just cut. It will stop there after reaching the point. There you can zero the X-Axis to have the exakt point of the material surface.
3. Then return to the end of the material and zero the Z axis there. Always drive from right to left to compensate for the backlash!
4. Then set the desired values for ZP and XP and start. Before starting the process you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the radius and corresponds to the real depth in the material.

ATTENTION: Due to the shape, collisions of the tool with the raw material can occur during large infeeds (red area at the bottom of the image). This can happen especially with circular radii, so choose the plunging depth carefully.

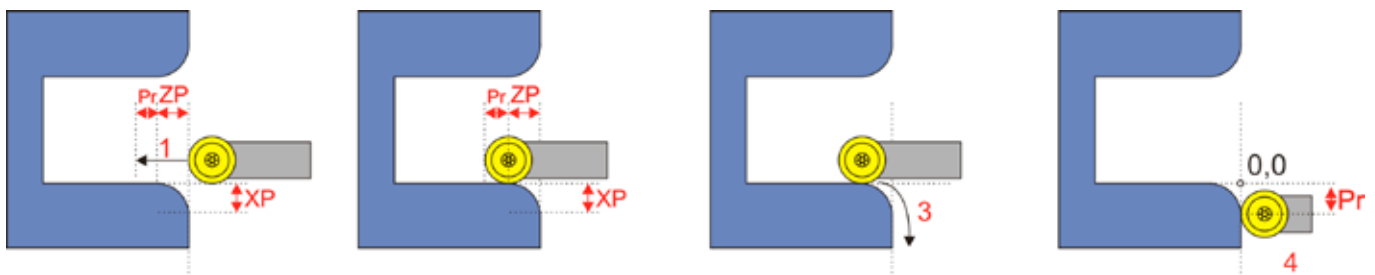


I-RADIUS) INTERNAL RADIUS CONVEX

This mode is used to rotate convex inner radii. The X and Z axes are moved simultaneously. In addition to round radii, elliptical radii are also possible.



The cutting radius correction requires that this process is carried out beyond XP and ZP! The exact procedure is shown below, for clarification with a round insert:



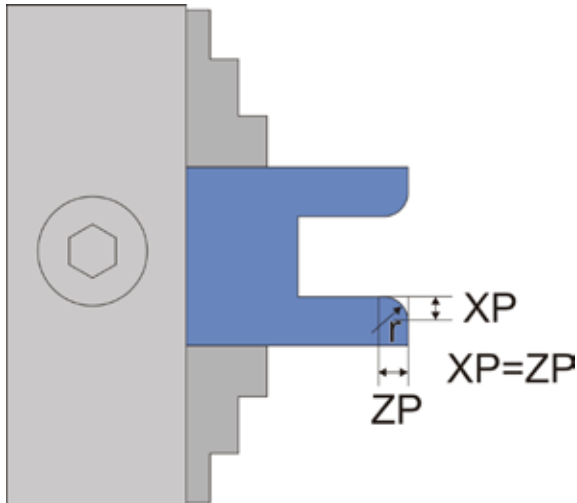
Pr = cutting radius

1. Tool is moved beyond ZP by the amount of the cutting radius.
2. The tool then stands lower than ZP!
3. Contour is traversed
4. The travel ends by the amount of the cutting radius further beyond XP.
5. Then the reset to 0.0 or to the set resting position takes place.

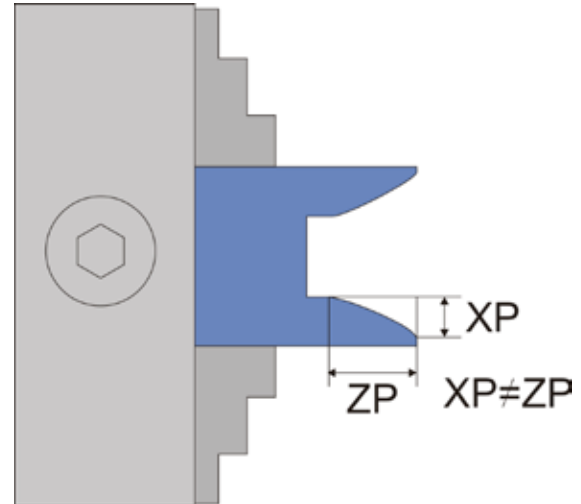
With small cutting radii, the distance that must be travelled further is therefore small, but it must be considered if at the end there is an obstacle.

The radius is also defined here by the values ZP and XP:

Circular radius: $XP=ZP$



Elliptical radius: $XP \neq ZP$

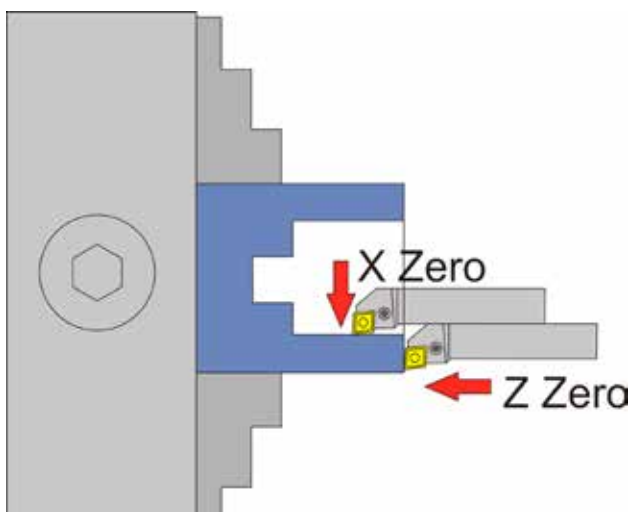


XP may also be larger than ZP, resulting in a flat elliptical radius.

Procedure:

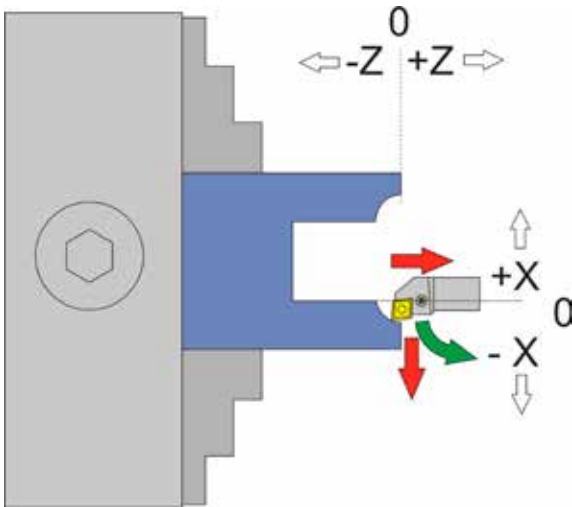
1. Turn the raw material to the desired diameter before starting.
2. Use this cut to zero the X-axis: The depth you just cut is still in XP. Use the JOG key to move the X-Axis to the depth you just cut. It will stop there after reaching the point. There you can zero the X-Axis to have the exact point of the material surface.
3. Then return to the end of the material and zero the Z axis there. Always drive from right to left to compensate for the backlash!
4. Then set the desired values for ZP and XP and start. Before starting the process you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the radius and corresponds to the real depth in the material.

Due to the cutting radius compensation, it is important to zero the axes in this way:

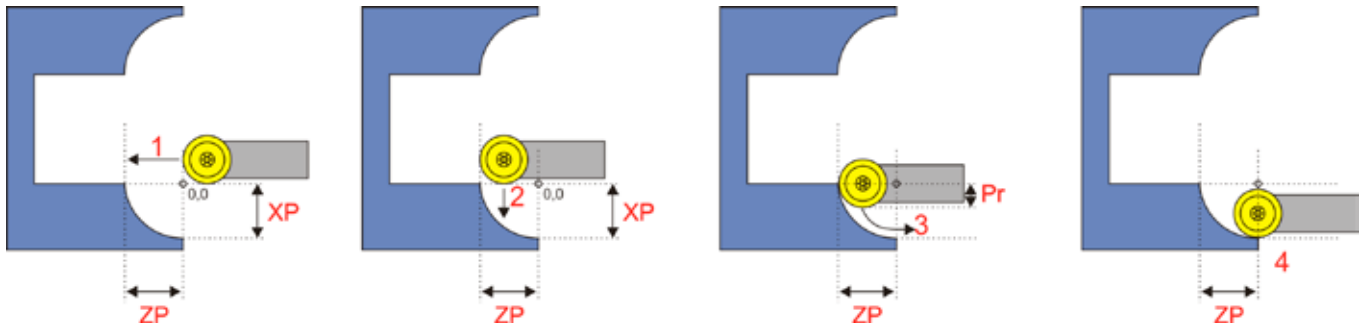


I-RADIUS (INTERN RADIUS CONCAV

This mode is used to rotate convex outer radii. The X and Z axes are moved simultaneously. In addition to round radii, elliptical radii are also possible.



This operation does not go beyond XP and ZP. For clarification, the exact route is shown below:



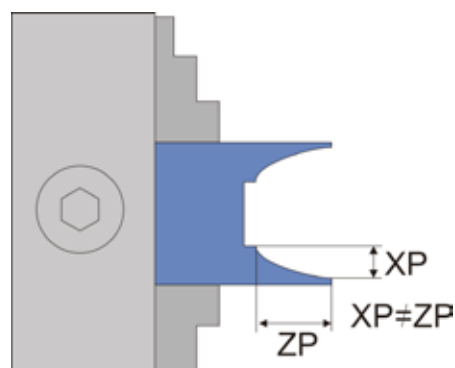
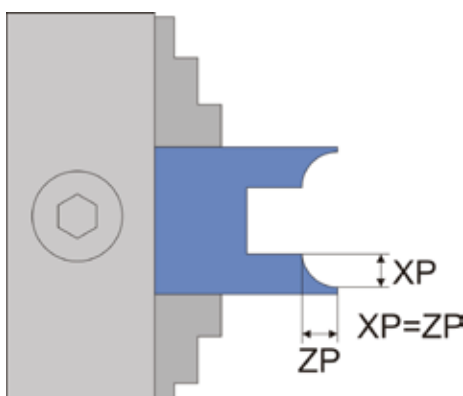
Pr = cutting radius

1. Tool is moved to $-ZP$
2. Tool is being moved forward by the Tool Corner Radius Pr into the material
3. Contour is being cut
4. The traverse ends at $-XP$, the tool is then still in the Z direction by the amount of the cutting radius beyond 0.
5. Then the axes move to 0.0 or to the resting position.

The radius is defined here by the values ZP and XP :

Circular radius: $XP=ZP$

Elliptical radius: $XP \neq ZP$

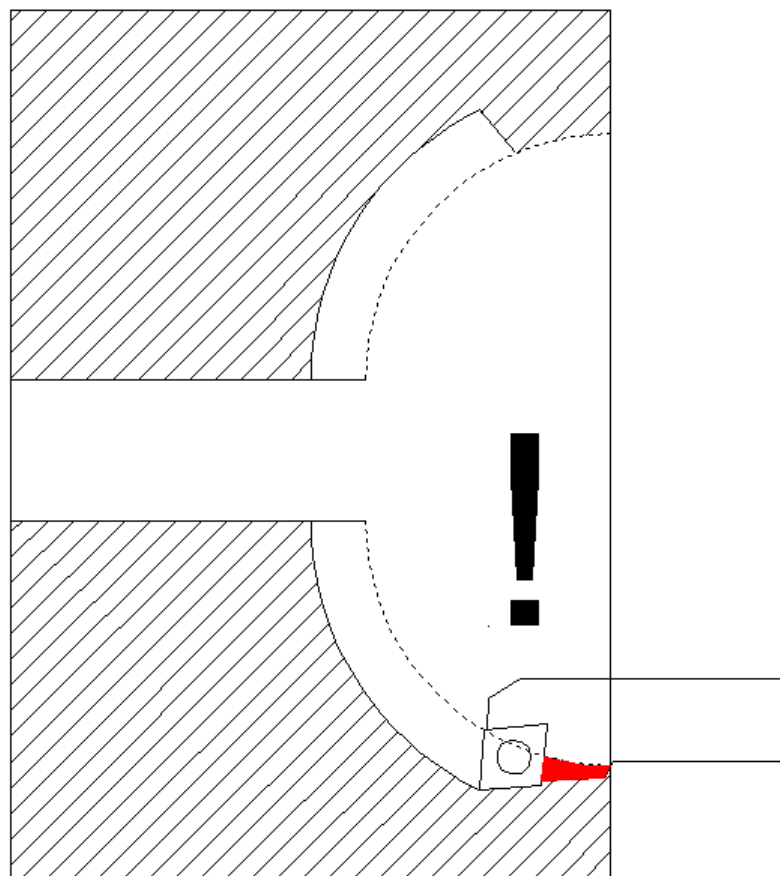


So you can adjust the shape of the Radii by selecting the values for XP and ZP. Circular radii are achieved by equal values of XP and ZP. XP can also be larger than ZP, resulting in a flat elliptical radius.

Procedure:

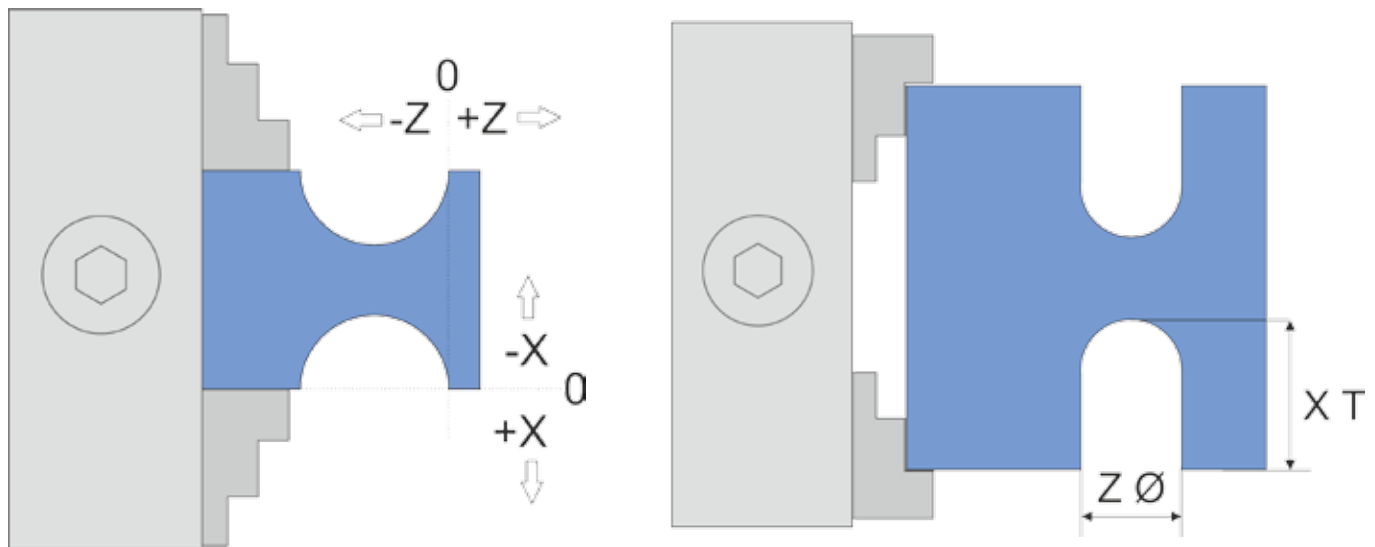
1. Turn the raw material to the desired diameter before starting.
2. Use this cut to zero the X-axis: The depth you just cut is still in XP. Use the JOG key to move the X-Axis to the depth you just cut. It will stop there after reaching the point. There you can zero the X-Axis to have the exakt point of the material surface.
3. Then return to the end of the material and zero the Z axis there. Always drive from right to left to compensate for the backlash!
4. Then set the desired values for ZP and XP and start. Before starting the process you can select the number of passes and the cutting depth per pass. The depth is displayed converted to the radius and corresponds to the real depth in the material.

ATTENTION: Due to the shape, collisions of the tool with the raw material can occur during large infeeds (red area at the bottom of the image). This can happen especially with circular radii, so choose the cutting depth carefully.



GROOVE

This mode allows a circular or elliptical groove to be cut on a shaft. It can be used to produce, for example, rope pulleys or track rollers.

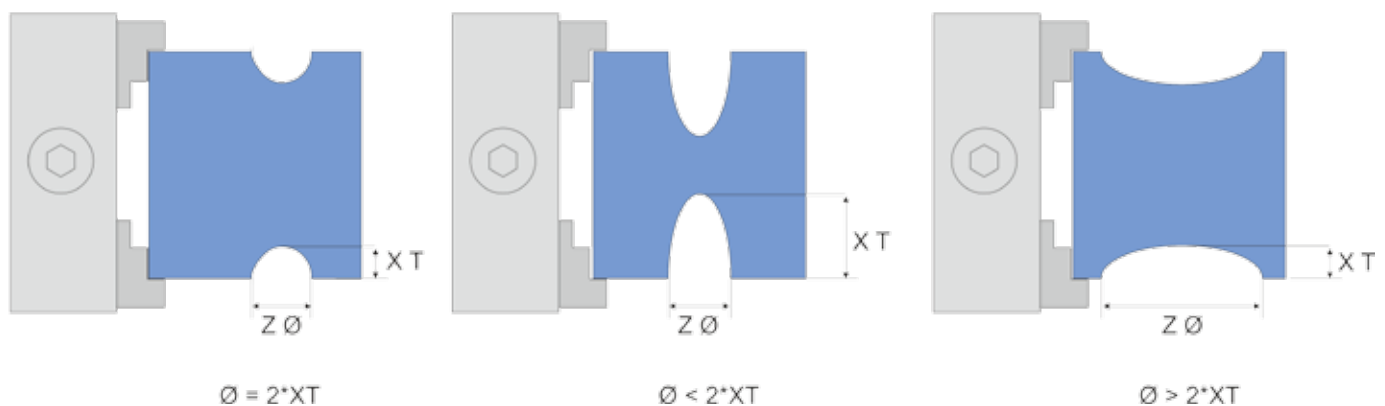


ATTENTION: Machining is only possible with round inserts!
We recommend the type MRMN with e.g. 1 mm cutting radius.



Important settings: The correct setting of the backlash of the X-axis is very important, otherwise a paragraph may appear at the bottom of the groove. In addition, the cutting radius of the insert must be set correctly in the parameter menu.

The entries in this mode indicate the diameter of the groove in the Z direction and the depth in the X direction! Circular grooves are cut by making the diameter in Z equal $2 \times XT$ (so to speak diameter = $2 \times \text{Radius}$). Elliptical grooves will appear if you make the values different:



- Left is diameter = $2 \times \text{Radius}$ so it is a *circle*
- In the middle you can see a pointed *ellipse*
- A *flat ellipse* is shown on the right.

Cutting strategy for groove

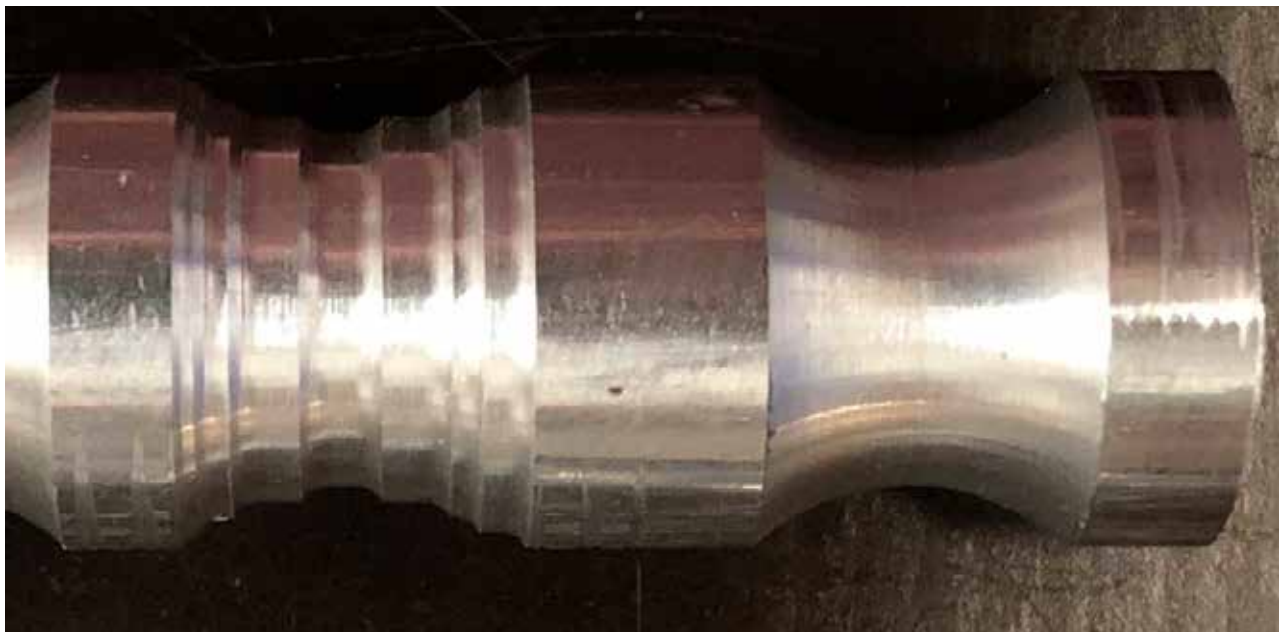
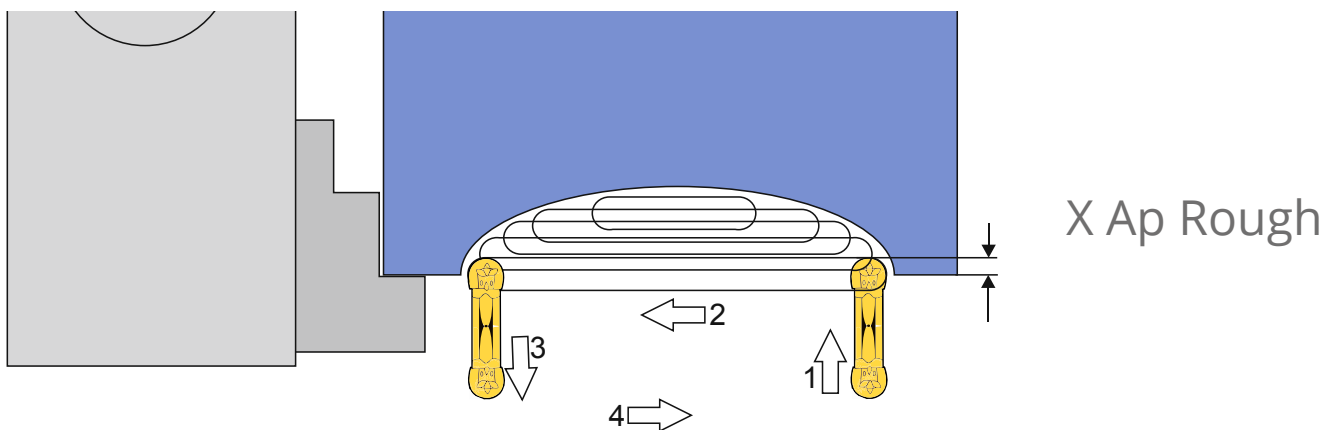
The cut is carried out in several infeeds, as usual adjustable in the other modes. The roughing contour is roughly traversed line by line and then the finish contour is turned in one pass in the last pass. The ELS calculates the correct position of the sheath for each pass.

ATTENTION: The calculation can take some time with large contours, this is noticeable at pauses which the control inserts before the infeed.

The cut is made gently in several passes, the number and depth can be easily selected before the cut.

Principle of cutting:

- The rough contour is cut in n steps. The cutter will dive into the material and move to the left. The image below shows how this is done.
- After roughing it will cut the finish cut in one take to cut the end contour.



Links: Roughing finished
Rechts: Finished contour

Available parameters in the parameter menu:

The parameter menu allows quick access to useful setting values. You reach it by navigating down with the DOWN key. If you change from Feed -> ZP -> XP further down, you enter the parameter menu. Exit the menu by pressing the HIGH key or LEFT.

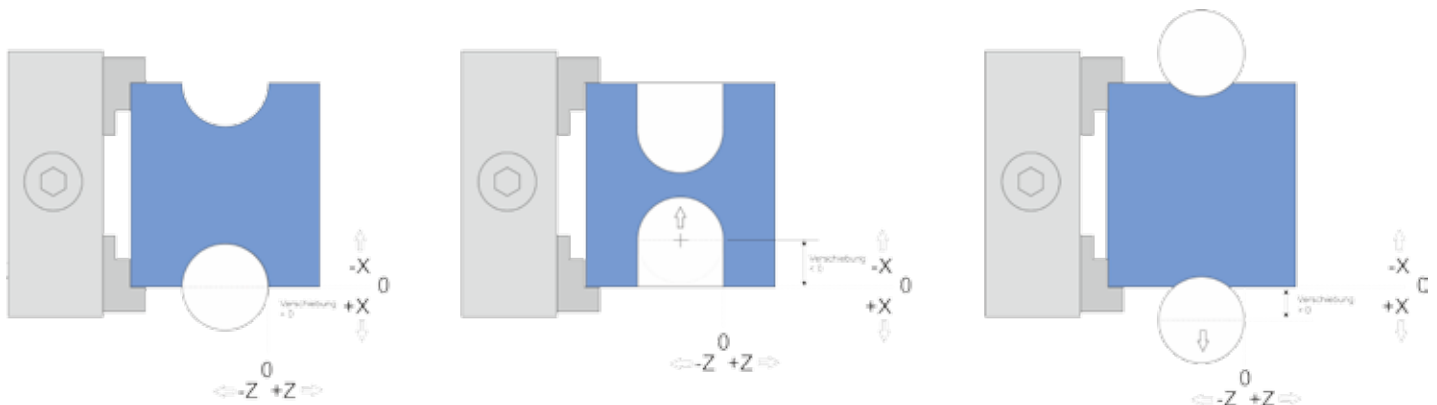
- *TOOL CORNER RADIUS* - The radius of the cutting edge, very important for correct radius compensation.
- *XAP FINISH* - Depth of the last finishing pass in mm.
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.
- *X OFFSET* - Defines the offset of the contour into or out of the material.

Groove offset for deep or flat grooves

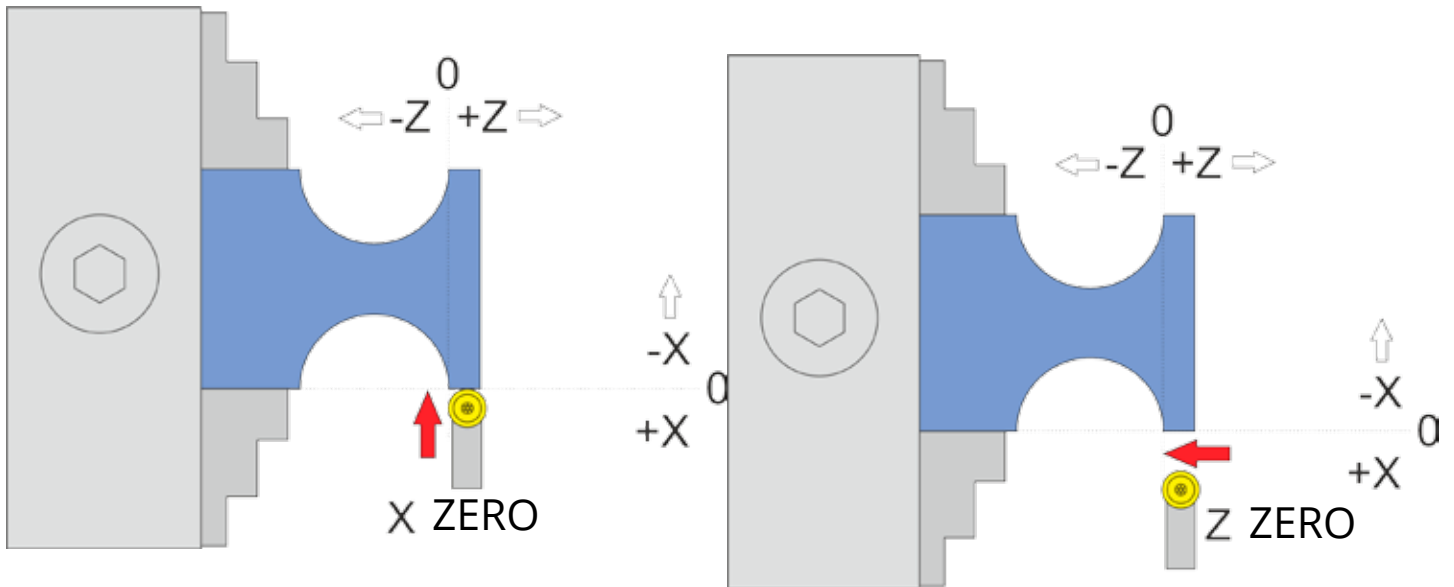
Normally grooves are always cut by XT into the material. If the groove is to be deeper or flatter, the contour can be shifted. With „X Offset“ in the parameter menu you find a setting for a shift of the contour in X direction. Both negative and positive movements are possible.

- If „X Offset“ is zero, the contour is cut normally (left).
- If „X Offset“ is set to a negative value, the contour moves further into the material (center).
- If „X Offset“ is set to a positive value, the contour is „pulled“ out of the material (right).

In the latter case, please note that the Z zero point of the contour is not shifted, the contour starts further to the left than in the zero point. If an exact position of a flat circular contour is necessary, it is recommended to determine the points beforehand using CAD drawings.



Zeroing is done as follows:

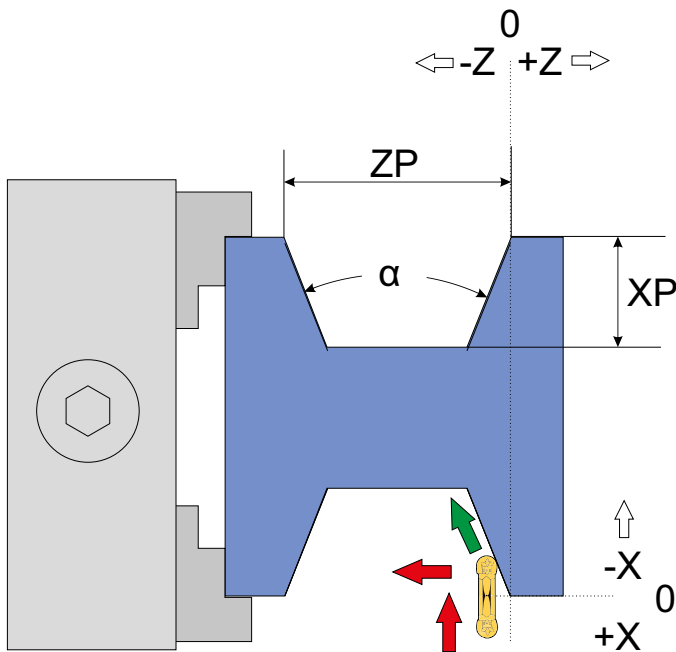


Possible grooves:



STRAIGHT GROOVE (VERSION 9 AND HIGHER)

This mode allows a straight groove to be cut on a shaft, with a selectable slope of the sides of the groove. It can be used to produce, for example, V-Belt pulleys.



The straight groove is defined by ZP , XP and the slope angle of the flanks: The value ZP defines the width of the groove, XP the depth of the groove.

In the parameter menu you can select from 8 standard V-Belt sizes: SPZ, SPA, SPB and SPC. These have predefined slope angles of 34° or 38° . Attention: If a predefined type is selected, ZP and XP have fixed values, you cannot edit them!

Additional to these standard sizes you can also freely select the slope angle of the sides of the groove in the parameter menu at "VBELT TYPE". 0° creates a rectangular groove, 180° is no groove at all. When a custom angle is selected you can also edit ZP and XP to your needs.

Caution must be taken when defining a custom shape: The bottom width of the groove (d) has to be at least as wide as the tool width. A warning is issued before the cut when this is not the case. You then need to adjust the size of the groove to be able to cut it. The width of the bottom is dependent of Angle, ZP and XP .

ATTENTION: Machining is only possible with a tool with a maximum width smaller as he bottom of the groove. We recommend the type MRMN with 1 mm cutting radius or LCMF, LGTN etc.



Available parameters in the parameter menu:

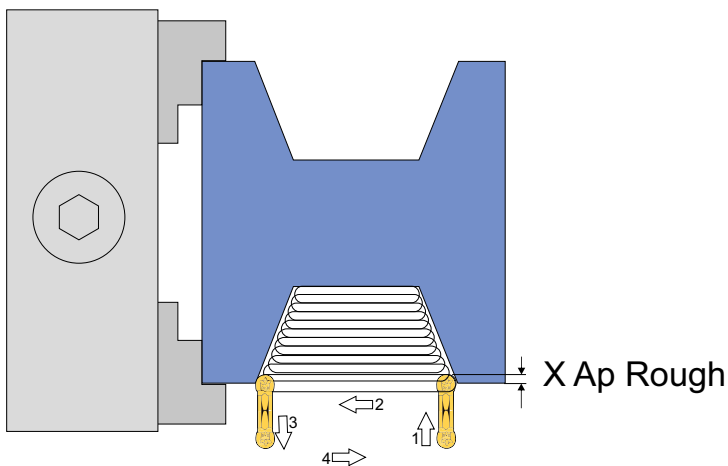
(Access the parameter menu by pressing the PARAM-Button)

- *V-BELT TYPE* - Type of V-Belt, either SPZ, SPA, SPB or SPC, with 34° or 38°. You can select the type with the turning knob. If you dial further that the last predefined type you will see a custom angle, starting with 0°. You can then select a custom flank angle of 0-180°. Only when a custom angle is selected you can change values for ZP and XP. If a predefined type is selected ZP and XP is fixed.
- *TOOL WIDTH* - Width of the cutting tool in mm
- *TOOL CORNER RADIUS* - The corner radius of the cutting tool. Cutting radius (r) and tool width (d) have a relation as $d \geq 2r$.
- *X Ap Finish* - depth of last infeed (finishing pass) in mm
- *FINISH FEED RATE* - Speed of the finishing pass, either as a percentage of the feed rate set, or if it continues to exceed 100%, also in discrete values in mm/revolution. The roughing pass is then carried out at the feed rate set in the mode, the last finishing pass at the speed set here in the parameter menu. So you can roughen quickly and finish slowly to save time.

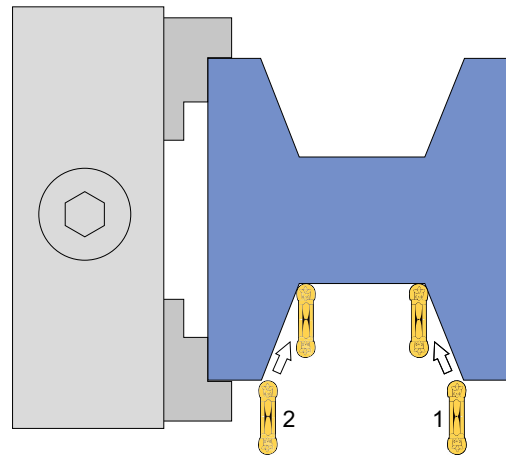
The cutting procedure is as follows:

In Phase 1 it clears the groove, roughing out in straight cuts from right to left. The depth of each cut is selectable as in all other cycles. The cutting speed in to the material is the same as selected on the Parting cycle. After roughing out the groove it comes to phase 2: It cuts the flanks, first the right flank then the left flank, using the cutting depth selected with X Ap Light (In the parameter menu)

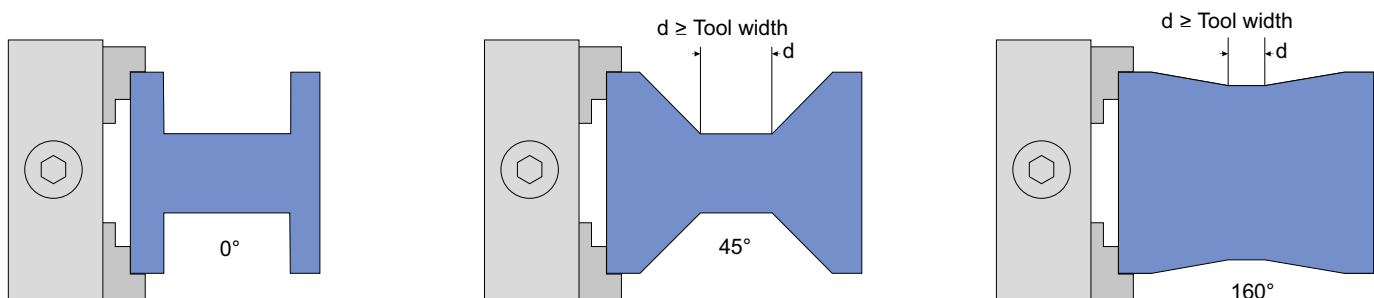
Phase 1: Clear groove



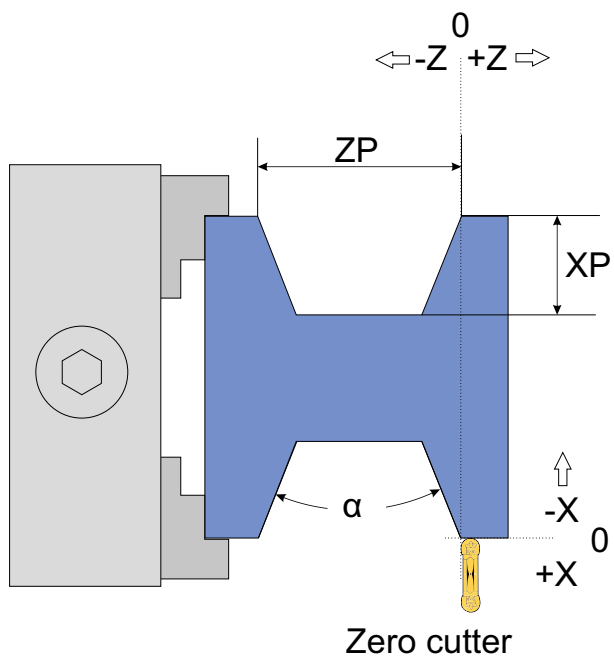
Phase 2: Cut flanks



Examples for custom angled grooves.



Zero the cutter as shown here:

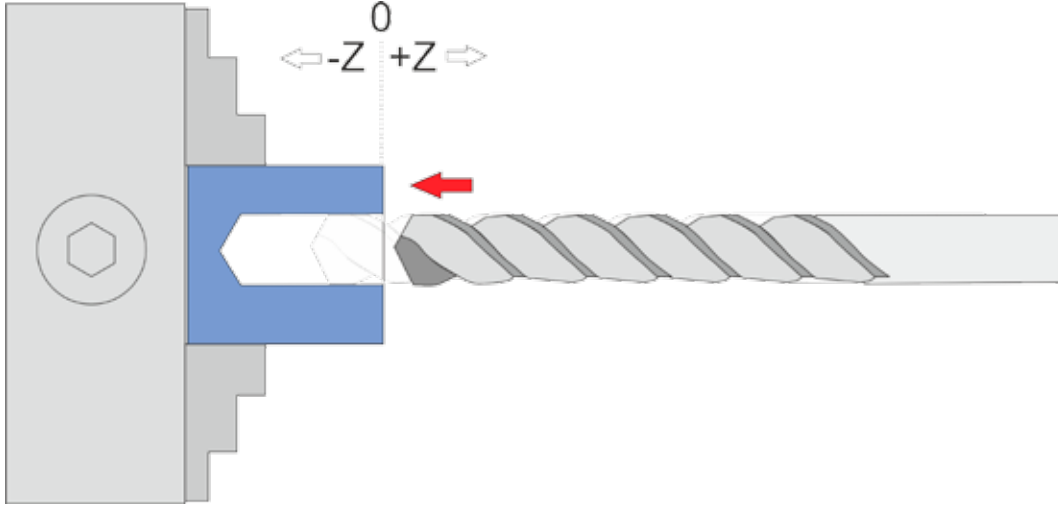


Included Standard V-Belt Types and sizes:

Type	Width (ZP)	Depth (XP)	Flank-Angle
SPZ 34°	9.70	11.00	34°
SPA 34°	12.70	13.80	34°
SPB 34°	16.30	17.50	34°
SPC 34°	22.00	23.80	34°
SPZ 38°	9.70	11.00	38°
SPA 38°	12.70	13.80	38°
SPB 38°	16.30	17.50	38°
SPC 38°	22.00	23.80	38°

DRILLING

This mode is used for drilling with the tool holder. To do this, a drill bit must be centered in the tool holder and clamped, i.e. it is NOT drilled with the quill as usual. Apart from the somewhat time-consuming centering, this has many advantages, as in this mode it is possible to drill very precisely and, by using the setting parameters in the parameter menu, to drill with different retraction strategies.



Set the Z axis to 0, then enter the desired drilling depth ZP. The feed rate is given in mm/rev.

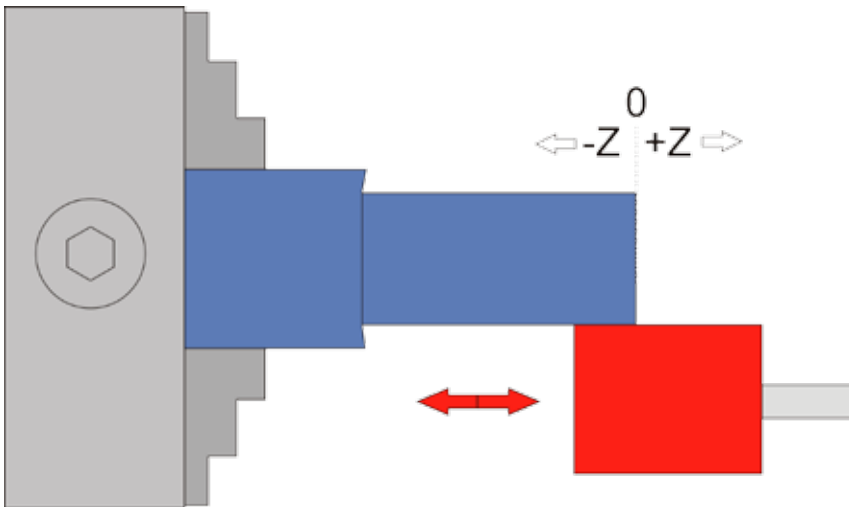
Pressing the START button starts the process, pressing the STOP button stops it, entries made in XP are ignored, the X-axis does not move in this mode!

Available parameters in the parameter menu:

- *DEPTH OF CUT* - The infeed per pass in mm
- *RETRACT DEPTH* - Either total retraction, where the hole is completely retracted from the drilled hole after each infeed, or a discrete retraction width in mm, which is then used as a chip breaking retraction only for a short distance.
- *IDLE TIME* - The waiting time in seconds after each retraction.
- *Z AP FINISH* - depth of last infeed (finishing pass) in mm

GRINDING

This mode is used for grinding, where up and down is moved in Z direction, the path is defined by ZP, the feed speed by F.



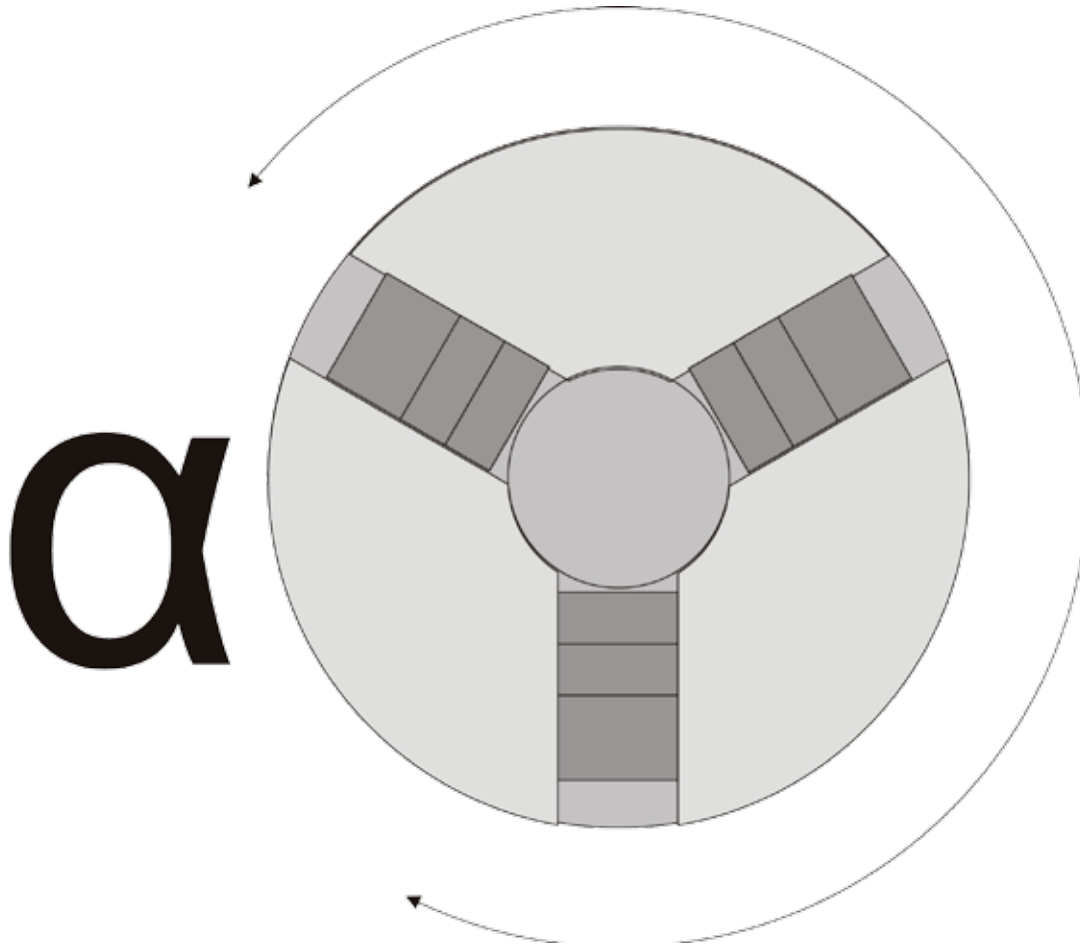
Set the Z axis to 0, then enter the desired path at ZP. Press START to start the process, press STOP to stop it.

ATTENTION: This mode works with both stationary and rotating spindles, so it is also possible to use it for making keyslots when the spindle is left stationary!

You can also specify a path in X with XP. After starting, you can specify the number and depth of infeeds, as in the other modes. If XP is less than 0 here, the X axis will be advanced at each pass. This allows automatic grinding or grooving. The latter, however, requires a very strong drive on the Z axis!

ANGLE

In this mode, the angle of the lathe chuck is displayed.



This can be used to use the lathe chuck as a dividing head, but also for multiple threads. The angle is reset to zero with P0.

Proceed as follows to produce a multiple-thread thread:

1. Set the angle to 0 in this mode.
2. Switch to thread mode and cut the first thread.
3. Switch back to angle mode and manually rotate the chuck to the desired angle. This would be 180° for a 2-course thread, 120° for a 3-course thread, and so on. Then set the angle to 0.
4. Return to thread mode and cut again, you will see that the new track is next to the first one
5. Repeat for all gears. If the thread does not fit completely, it can be repeated as required.

TIPS FOR USE

APPROACH POSITIONS EXACTLY:

With the ELS, it is very easy to move to a certain position: To do this, set the end position to the desired value and then move manually with the travel keys < > << >> coming from the right. The axis then stops at the end position, even if it is set to 0. This can also be extended if, for example, you realize that it was not enough yet, you simply turn the end position further and drive back there. By the way, you can cross the end position again by pressing the travel keys again!

SET THE ZERO POINT ON THE WORKPIECE SURFACE:

Setting the zero point correctly is essential for success. In order to hit the surface of a workpiece very precisely, you can scratch the surface with the jog keys. To do this, you should select the stepwise feed (with XSTEP/ZSTEP and the rotary knob) close to the workpiece and always move from right to left and from the operator to the workpiece.

But if you have a few tenths of material left, it's easier and more accurate: You set the Z-axis and X-axis so that they move a little bit into the material and set the axes there to 0. Then you turn a length once with external turning, and then with face turning the face side. This gives you the surface exactly on X0 and Z0, as well as two machined surfaces on which you can measure exactly.

DRIVE FROM WAITING POSITION TO 0

After each function, the ELS sets the axes to the set waiting position. If this is not equal to 0, the axes are at a value above 0. If you would like to move an axis to 0, set the end position to 0 and move to it from the right. The axis then stops at 0. Pressing the move key again overruns the point again.

PRECISE EXTERNAL TURNING MADE EASY

To rotate a shaft to an exact dimension, proceed as follows: Set the axes to 0 as described in „Setting the zero point on the workpiece surface“. Then measure the outside diameter (preferably with a micrometer) of the machined end. To get to the nominal value you have to calculate how much in radius you have to remove to get to the nominal value:

Example:

Measured value= 40,34mm

Set value= 34,00 mm

Difference= 6,34 mm

Radius= $6,34/2 = 3,17\text{mm}$ <- Enter this value at „XP“!

You enter the calculated value as XP for external turning, so the X axis travels this distance in several infeeds into the material. For ZP, enter the desired length and start the pass. At the end, the diameter should correspond exactly to the desired value.

Tip: You can drive a last additional finishing run again by restarting the cycle and setting the number of passes to 1.

SPECIAL DIMENSIONS BY CHANGING THE SETTINGS

Sometimes it is necessary to produce something out of line, e.g. a screw conveyor with a very high pitch. In such cases, you can „play“ with the settings to get there. For example, in the settings you can temporarily halve the number of encoder pulses to double the feed rate. Of course you have to take the change into account.

Also at settings, drive of Z-axis can be reversed temporarily, e.g. to turn right side. Of course you have to keep in mind that the Z-axis then moves exactly the other way round than usual, even when moving manually!

MOVING THE X AXIS MANUALLY IN GEAR MODE

In gear mode, the X axis can be deactivated with the XOFF key to move it manually.

SOFTWAREUPDATE

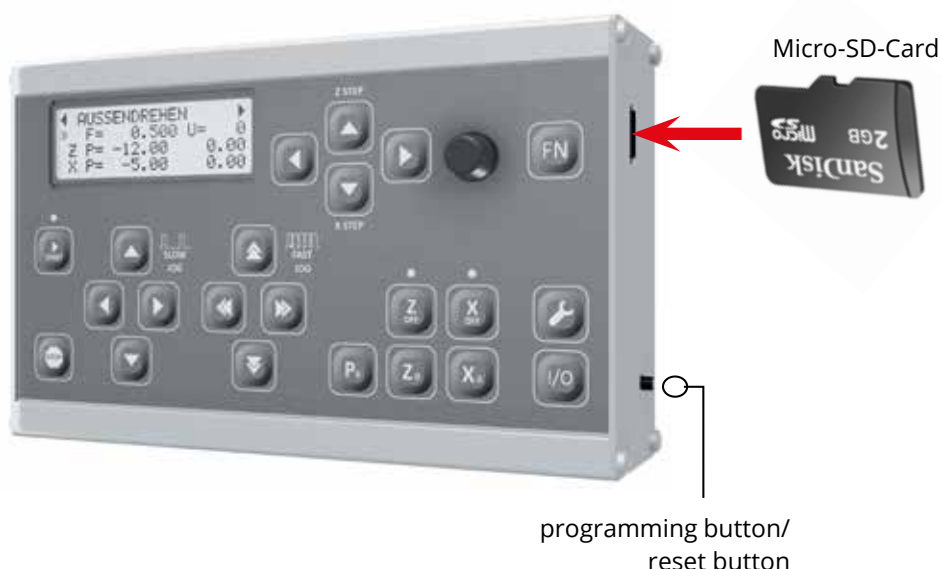
The control software is constantly being further developed and can be updated very easily. It is transferred to the controller by means of a micro SD card, the controller can remain connected.

1. From the website <https://www.rocketronics.de/en/category/software/els-firmware/els4> you can download the latest software as a package. There you will also find the changes that have been made.
2. Save the included files to a micro SD card.
3. Insert the memory card into the card slot on the right side of the housing.
4. Switch off the control unit.
5. Press the small programming button on the right of the housing and switch on the controller.
6. Release the button again.
7. The software is now loading, you hear a clicking sound and LEDs 2 and 3 flash alternately. If everything works fine, the controller switches to the newly loaded program after approx. 8 seconds. If an error occurs, you will hear several tones. The number of tones indicates the error:

1. Invalid card type
2. Invalid Bootdate
3. Read error
4. Cluster not found (card defective)
5. Wrong program
6. Wrong CPU
7. Encryption error

You can use micro SD cards from 2 - 32 GB memory size, the card must be formatted with FAT16 or FAT32, NTFS or other do not work. The firmware file must be stored in the main directory, do not store it in a subfolder.

The data must be stored in the first 2 GB of memory, if there is already more than approx. 1.5 GB of data stored on the card, delete it first and then save the update file on the card.



APPENDIX 1 DEFINITION OF CONE RATIO

The cone ratio V describes the difference between the largest and smallest diameter of the cone:

The cone ratio is defined by :

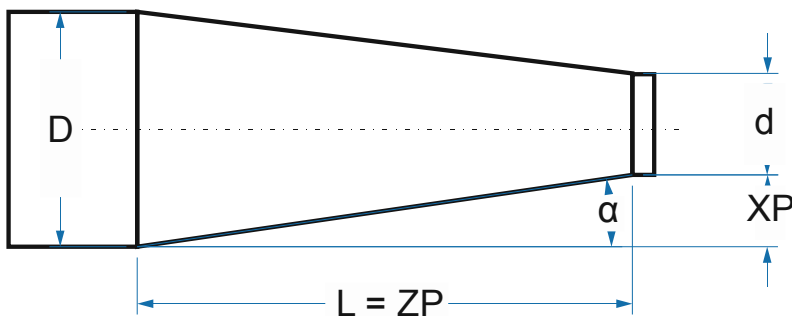
$$V = \frac{L}{D-d}$$

or to write it in ELS sizes:

$$V = \frac{ZP}{2XP}$$

XP from the cone ratio:

$$XP = \frac{L}{2V}$$



The flatter the cone, the larger V becomes, the denominator $(D-d)$ then becomes smaller and smaller. What do we do with a straight piece, with $D=d$? A straight piece would not be defined with $D=d$, division by 0, in the ELS it is therefore defined as 1:0!

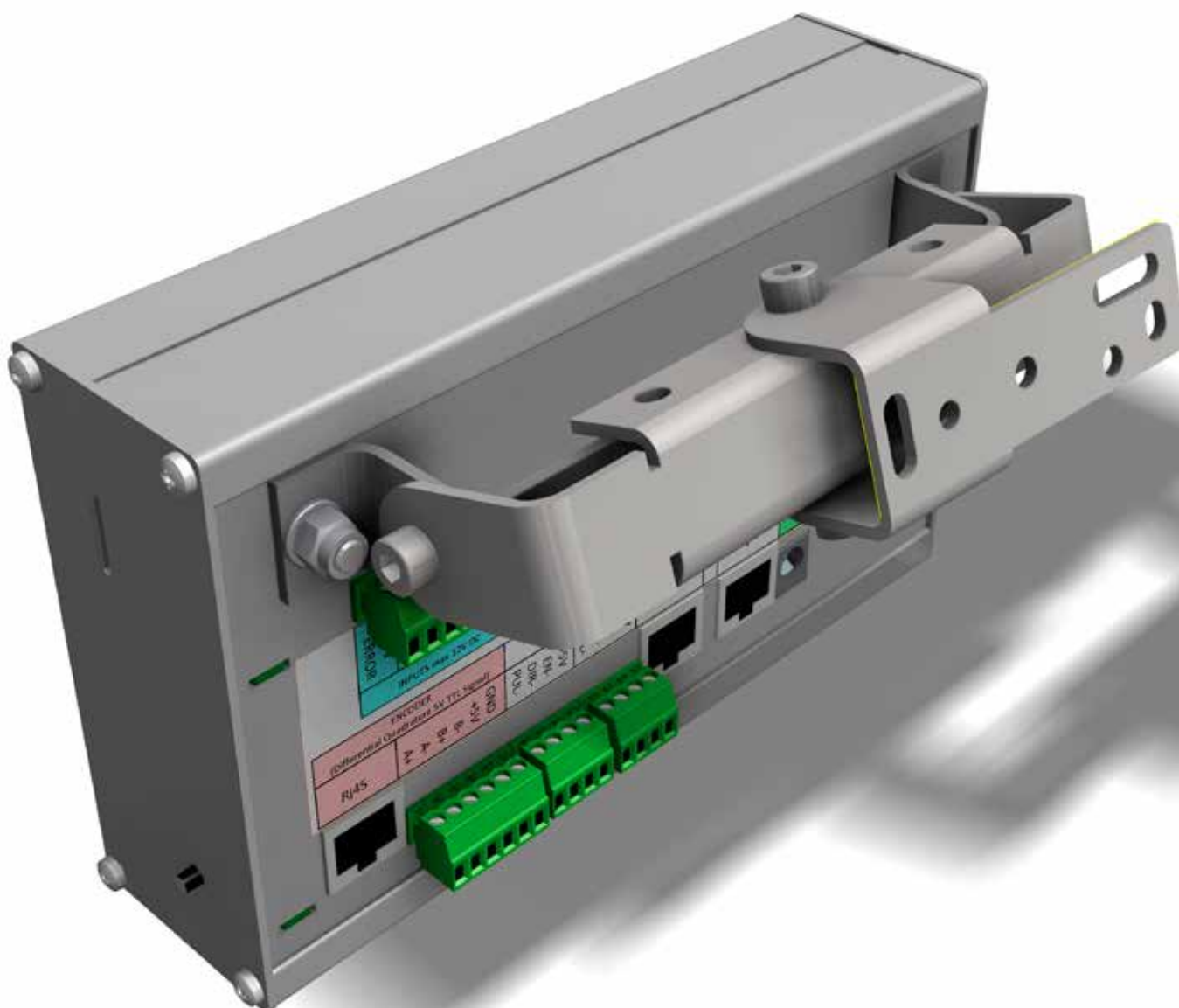
If the cone ratio is set to 1:0, no cone is defined, anything greater than 1:0 produces a coned thread! 1:0 is preset after a restart.

You can read off common cone conditions from table books, usual are e.g.

MK1	1:19,047
MK2	1:20,020
MK3	1:19,922
SK30/40	1:3,429
HSK	1:9,98
Hydraulicfittings	1:16

APPENDIX 2: WALL MOUNTING

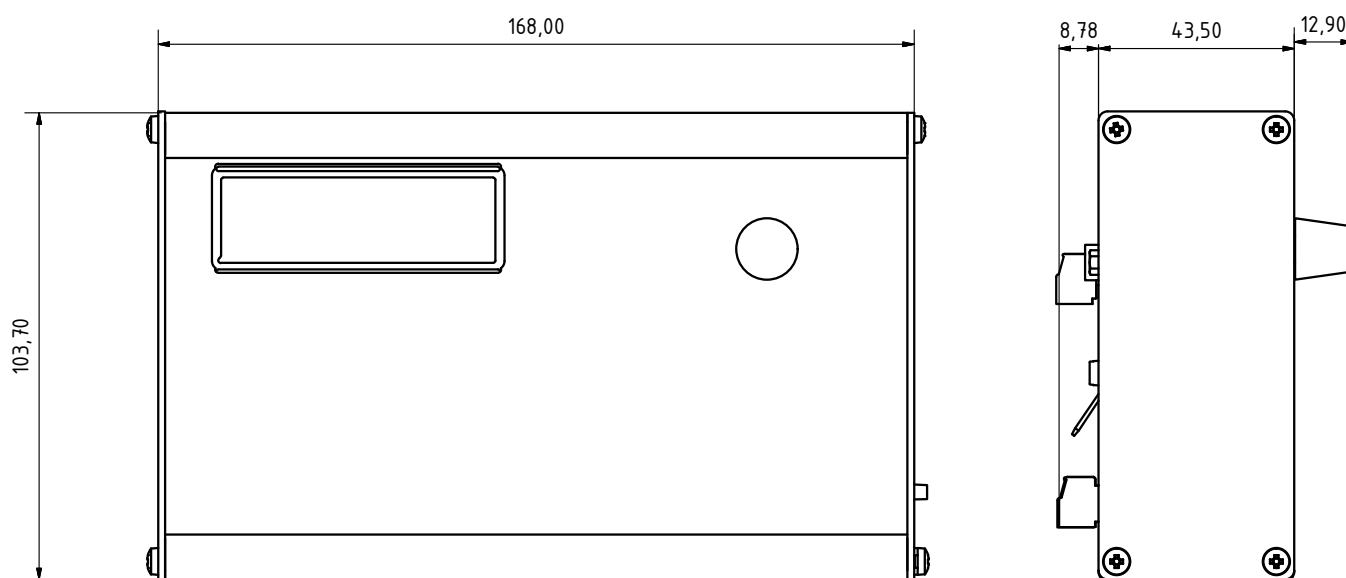
On the back there is a retaining bracket for wall mounting. In addition, a wall mount is available that can be adjusted in all axes and mounted with screws.



APPENDIX 3: TECHNICAL DATA

Dimensions	ca. 168x104x65 mm
Weight	350 g
Operating voltage	12V DC stabilized
Current consumption	Max. 1 A
Max. speed	3000 rpm
Max. speed threading	1200 rpm
Smallest step size	0,01mm way in Z- und X-Axis
Smallest possible thread pitch	0,001mm
Max. manual feed rate	4800 mm/min ⁽¹⁾
Motor outputs	2, Screw and RJ45
Digital-inputs	4 screw
Digital outputs	4 (12V, max 300mA)
Encoder inputs	1, Screw or RJ45
Maximum feed rate	ca. 20 mm/rev ⁽¹⁾

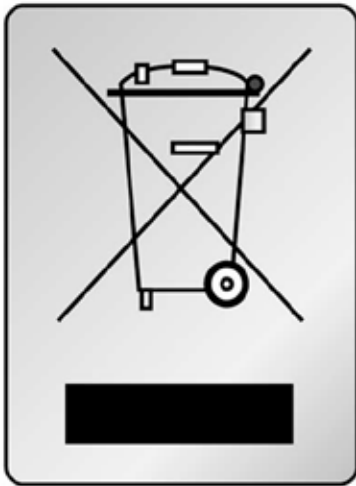
⁽¹⁾ Depending on encoder and motor setting



DISPOSAL

This device must not be disposed of with household waste!

Help saving the environment: Please remove the screws on the side of the case and disassemble the unit in aluminium case parts and electronic parts. The aluminium case can be recycled much easier when separated from the electronic parts. Dispose the electronic parts in the appropriate disposal services. Of course you can also dispose it completely.



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WEEE-Reg. Nr. DE 35691149

Changes for Software version 9 or higher

- 35: Added description of flyback diodes for outputs
- 39: Added new settings section for handwheel extension
- 56: Added new cycle Straight groove
- 57: Added new parameter menu description for gear mode
- 78: Changed image
- 95: Added Straight Groove cycle