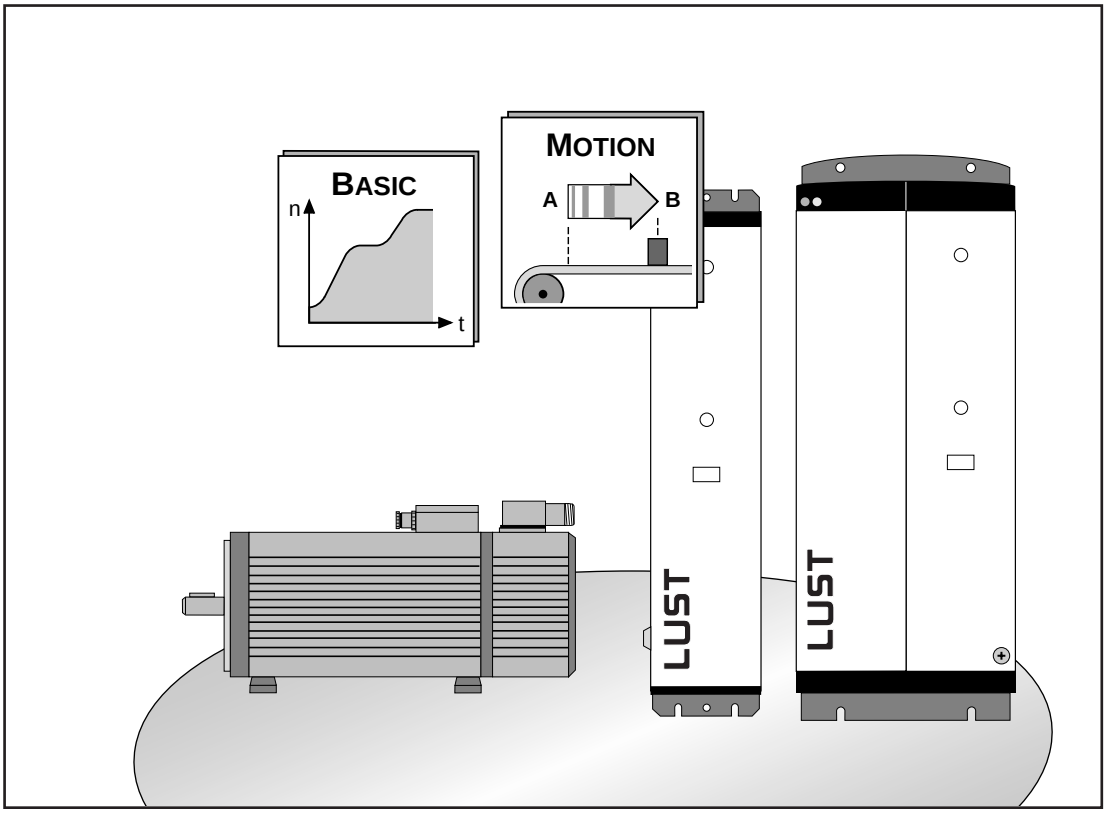
LUST
ANTRIEBSTECHNIK

MASTERCONTROL MC7000

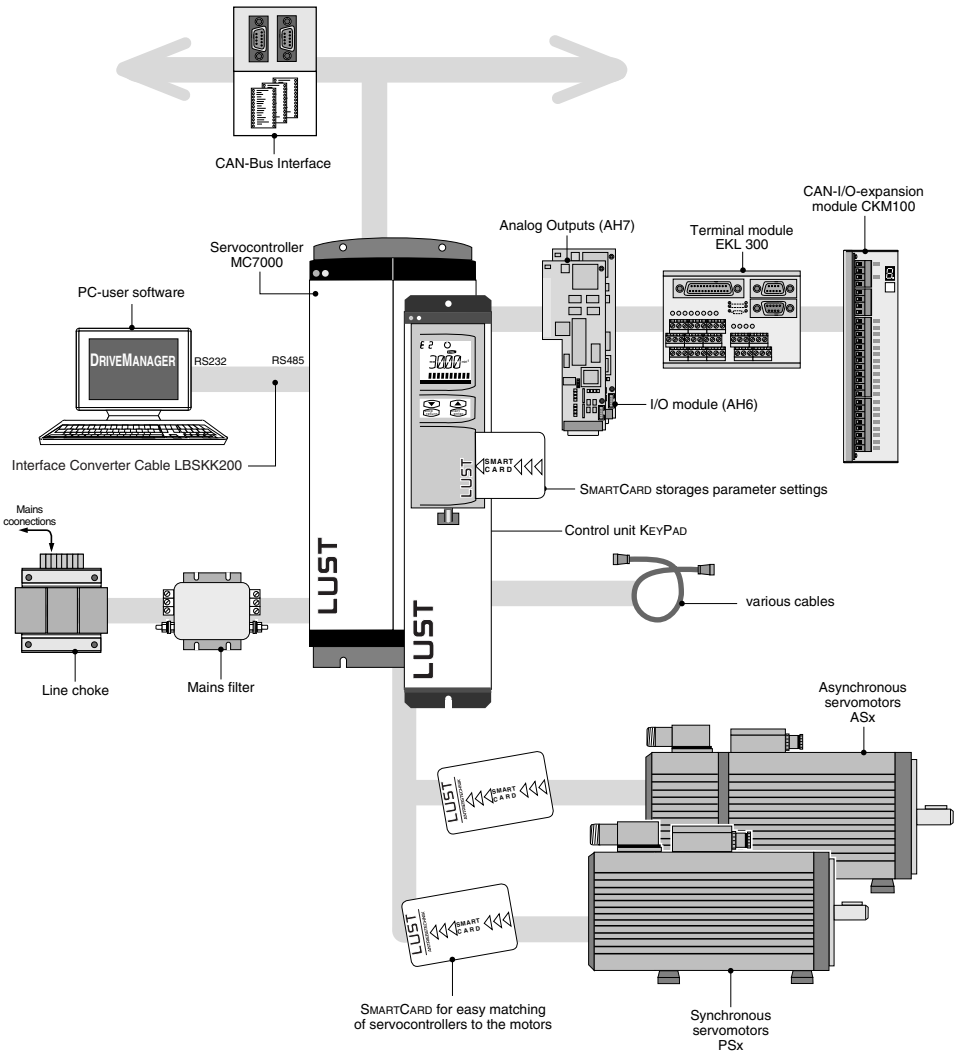
EN

Servocontrollers from 2 to 64 A

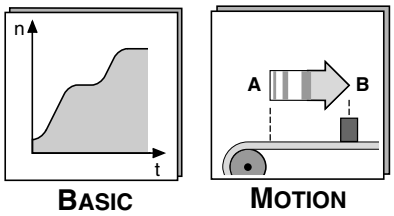


Operation Manual BASIC/MOTION

The MASTERDRIVE drivesystem



Operation Manual
for servocontrollers
of the MC7000 series
with BASIC application package
or MOTION application package



Valid as of software version: V3.0

ID no.: 0808.22B.1-02
Version: June 2001

Dear Customer!

Thank you for the trust you have placed in us by purchasing the LUST MasterDrive drive system.

Installation and commissioning should be carried out by trained personnel. Please take the time to read these instructions carefully in advance. If you follow all the instructions, you will save yourself much time and many questions at the commissioning stage.

Another reason it is essential to read the Operation Manual is because incorrect use of the equipment can damage the servo drive as well as other parts of the system. There is, in addition, a danger of physical injury from the rotating parts of the drive and the high operating voltage present!

If, after reading the instructions, you still have questions, do please contact us:

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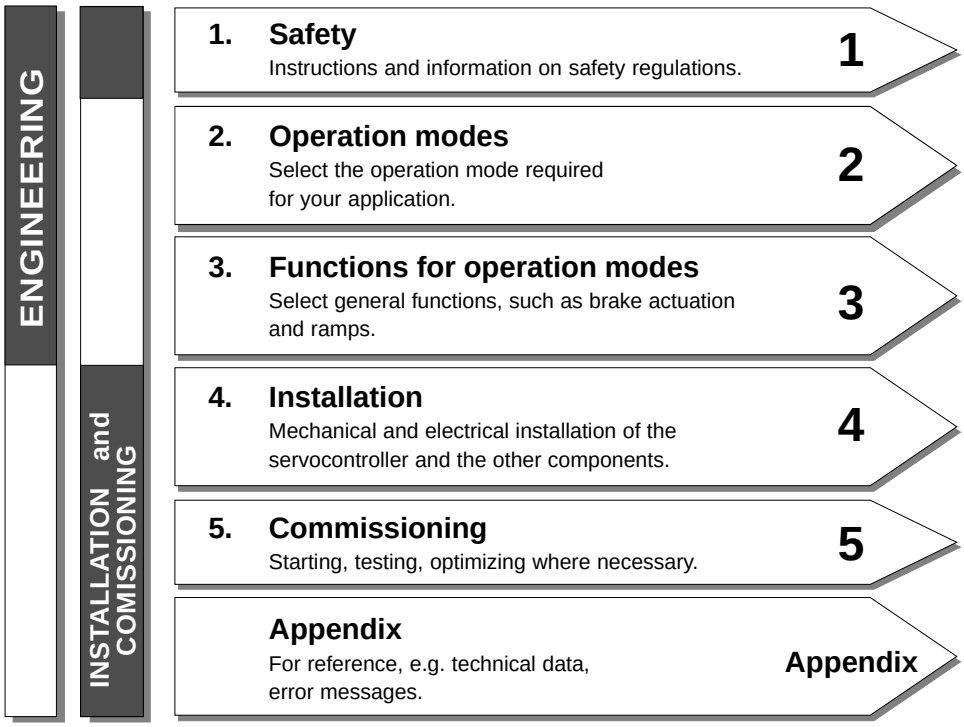
How to use this manual

The manual is designed to allow you to commission the servo drive into operation in a short space of time. Just follow the instructions given in the individual chapters:



Pictograms and their meanings

⇒ Danger! Risk to human life from electric shock.

⇒ Danger! Risk to human life from rotation of the drive.

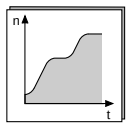
⇒ Important! It is essential to observe these points.

⇒ Prohibited! Incorrect operation may cause damage to equipment.

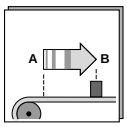
⇒ Useful note or tip.

Special points of note and rules
of thumb are enclosed in boxes like this.

Table of contents



BASIC



MOTION

5 Commissioning of the drive system

Appendix

A Technical data

B KeyPad operation

C Diagnosis and fault rectification

D Parameter list, Basic application package

1 For your safety

1.1 Safety instructions

While in operation, servo drive surfaces can be conductive, uninsulated, sometimes also moving or rotating, and hot. This means that a servo drive presents a danger to human life.

To prevent serious physical injury or major material damage, only qualified persons familiar with electrical drive equipment may work on the devices. Only those persons who are familiar with mounting, installing, commissioning and operating servo drives and have appropriate professional qualifications are considered qualified. Those persons must read the Operation Manual carefully before installation and commissioning, and follow the safety instructions.

(cf. IEC 364 and CENELEC HD 384 or DIN VDE 0100 and IEC Report 664 or VDE 0110 and national accident prevention regulations or VBG 4).

Repairs to the components of the servo drive may only be carried out by the manufacturer or by a repair workshop approved by the manufacturer. Unauthorized opening and incorrect intervention could lead to physical injury or material damage.

1.2 Intended use

Servo drives are components that are intended for installation in electrical systems or machines. The inverter may not be commissioned (i.e. it may not be put to its intended use) until it has been established that the machine complies with the provisions of EC Directive 89/392/EEC (Machinery Directive); EN60204 is to be observed.

Commissioning (i.e. putting the device to its intended use) is only permitted in compliance with the EMC Directive (89/336/EEC).

In addition to the Low Voltage Directive 73/23/EEC, the harmonized standards of the series prEN 50178/DIN VDE 0160 in conjunction with EN 60439-1/DIN VDE 0660 part 500 and EN 60146/DIN VDE 0558 are applicable to the servo drives.

The technical data and the instructions concerning connection conditions are given on the name plate and in the documentation, and are to be observed under all circumstances.

Servo drives are to be protected against impermissible stress. In particular, components may not be bent, nor may insulation distances be altered, during transport and use. Servocontrollers and servomotors contain components that are vulnerable to electrostatic accumulation and can therefore easily be damaged if incorrectly handled. Ensure that electrical components are not mechanically damaged or destroyed.

When work is being carried out on live servo drives, the applicable national accident prevention regulations (e.g. VBG 4) are to be observed.

Electrical installation is to be carried out in accordance with the relevant regulations (e.g. wire cross-section, fuses, grounding lead connection). Other details are contained in the documentation.

Electronic devices are fundamentally not fail-safe. Users are themselves responsible for ensuring that the drive is rendered safe if the device fails.

If the servo drive is used for special applications (e.g. in areas subject to explosion hazard), the required standards and regulations (e.g. EN50014 and EN50018) must always be observed.

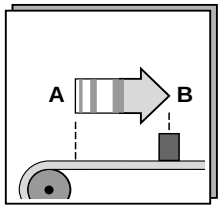
2 Operation modes

The MASTERCONTROL MC7000 is a highly flexible digital drive controller. The application packages, comprising specific device hardware and software, provide the servocontroller with the necessary functions to perform a wide variety of drive tasks. In this way you can be sure of obtaining a servocontroller which is specially equipped to meet the requirements of your specific task.

Each application package offers one or more operation modes. This allows you to activate the specific functions you need for your application, and to commission the servo drive into operation quickly and easily.

1. Select operation mode

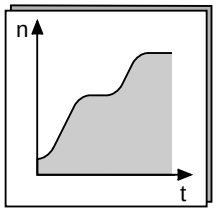
- This chapter describes the various operation modes. Select the most suitable one for your application.
- The descriptions of the other operation modes will then be of no relevance to you.



MOTION

BASIC-operation modes plus:

- **Stepper motor mode**
- **Electronic gearing**
- **Point-to-point positioning**



BASIC

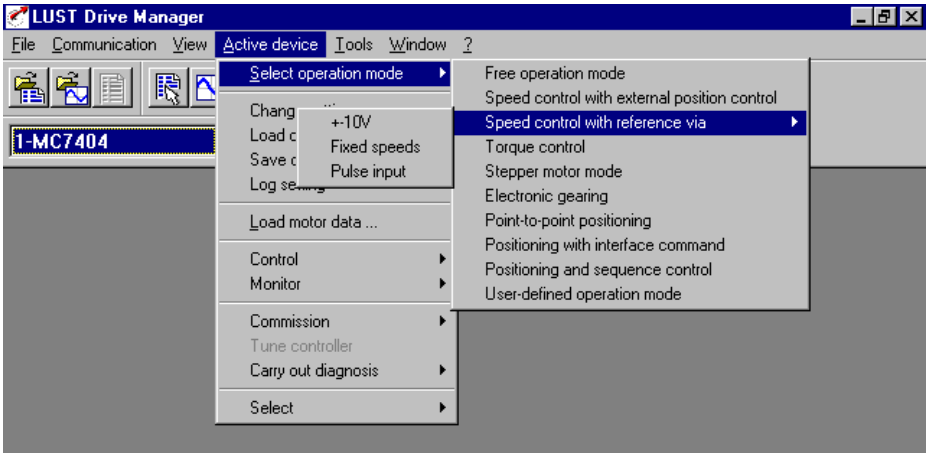
Operation modes:

- **Speed control with external position control**
- **Speed control with ± 10 V reference generation**
- **Speed control with fixed speeds**
- **Speed control via pulse input**
- **Torque control**

BASIC and MOTION application packages

2. Select functions

- Check which of the functions from chapter 3 are useful or necessary for your application.



DRIVEMANAGER PC user software

*Screenshot: The operation modes are activated with the DRIVEMANAGER by selecting **Select operation mode** from the **Active device** menu.*

2.1 Speed control with external position control

This mode is suitable
- to shift several axes three-dimensionally with one external path control;
- to move to any positions at various speeds.

In “speed control with external position control” mode the MC7000 can be directly linked to a controller (NC) which calculates the reference positions and executes the position control. The NC delivers a speed reference via the ± 10 V interface to the MC7000, which in turn returns the actual position of the axle by way of the encoder simulation.

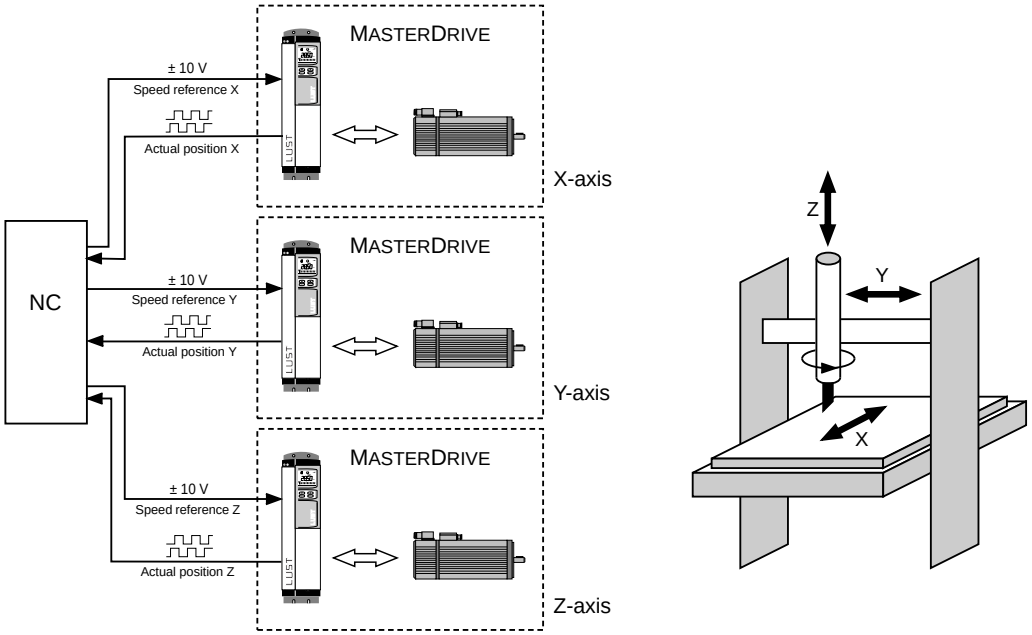


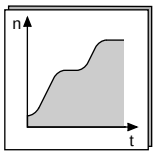
Diagram: Example of a 3-axis path control

Features:

- Only one encoder is required for torque, speed and position control. This saves on additional encoders and cabling.
- Resolution of analog inputs: ISA0 12-bit, ISA1 11-bit
- Analog input ISA0 sampling cycle ISA0: 8 kHz
- Short sampling cycles of the control circuits, resulting in high control accuracy of the drive:
  Torque control: 16 kHz
  Speed control: 8 kHz

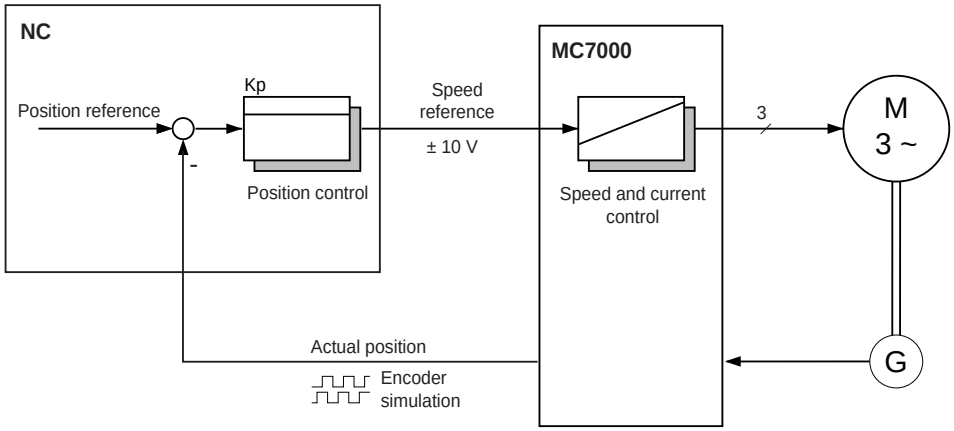
The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Parameter-controllable encoder simulation
- Brake actuation
- Torque reduction.



BASIC

Block diagram of the control structure



Practical tips:

The position controller in the NC should be used purely as a P-controller, with no I-component, as otherwise the controlled system will become unstable, leading to oscillation of the axle. As a result, speed reference errors caused by offset and drift would not be corrected and so lead to tracking errors.

Example:

Scaling of analog input:	10	V	corresponding to 3000 rpm
Offset:	100	mV	corresponding to 30 rpm
Gain of position controller Kp:	4000	rpm	

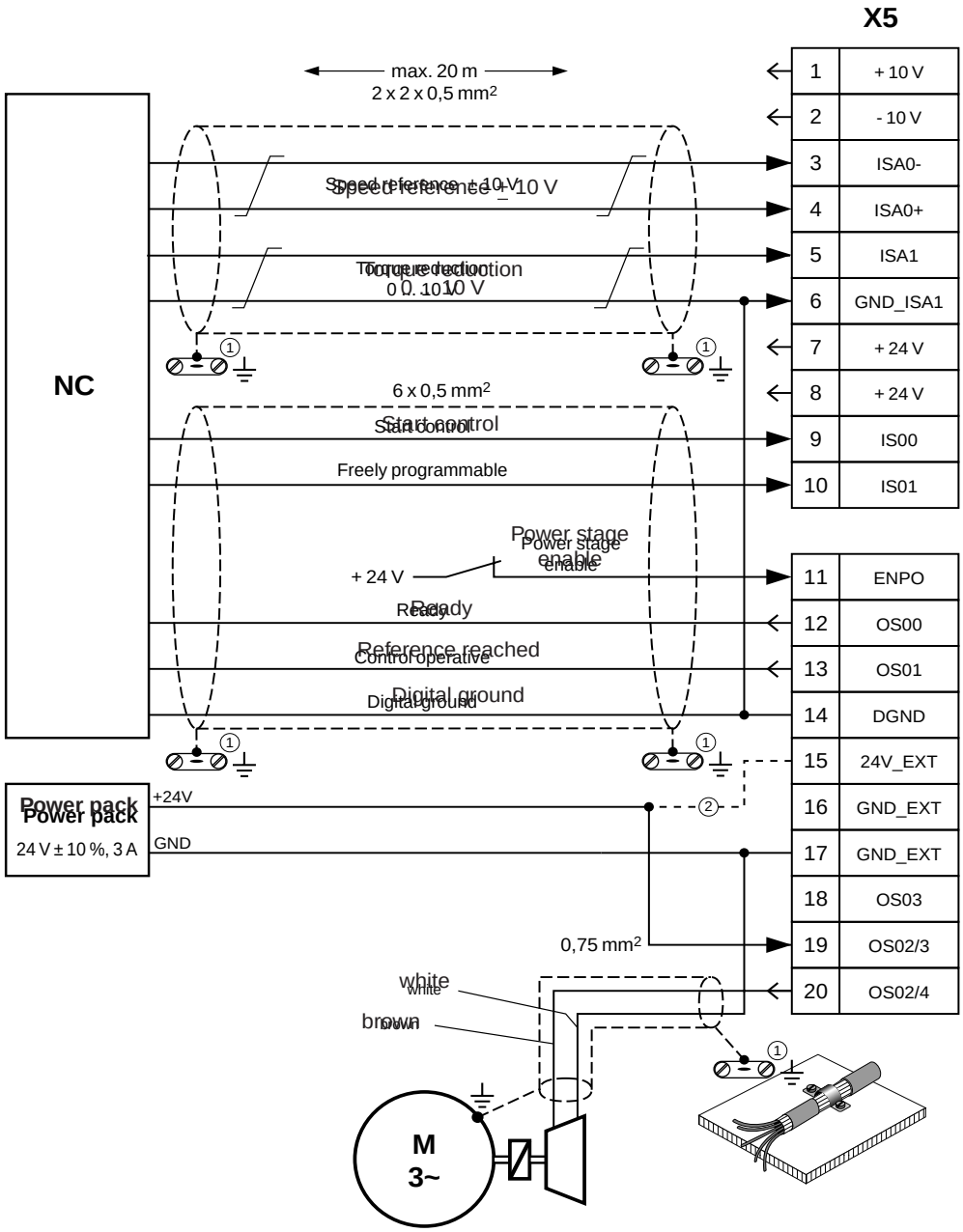
This results in a tracking error of 30/4000 revolutions = 2.7° on the motor shaft.

It is therefore important to compensate for the speed reference **offset**, which is composed of the offset of the controller analog input , the voltage drop on the connecting cable and the offset of the MC7000 analog input. This compensation cannot be effected in the MC7000, but only in the controller (refer to the manual for the controller used).

Speed reference **drift** can be corrected by adding a small I-component, limited to a maximum amplitude of approx. 100 - 300 mV (to prevent instability of the axle); refer to the manual for the controller used.

The **noise** of the analog speed reference can be damped by the speed reference filter SCTF of the MC7000 (see page 5-6). If the value of the speed reference filter is changed, the dead times in the position control circuit also change. So, if your controller has a predictive speed reference pre-control it should be adapted accordingly (refer to the manual for the controller used).

Wiring for speed control with external position control



① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

Note: For specification of control terminals see Appendix A.4.

2.2 Speed control without external position control

In this operation mode there are three ways of setting references for the servocontroller:

- analog via ± 10 V interface
- digitally with fixed pre-programmed references, or
- digitally via the pulse input.

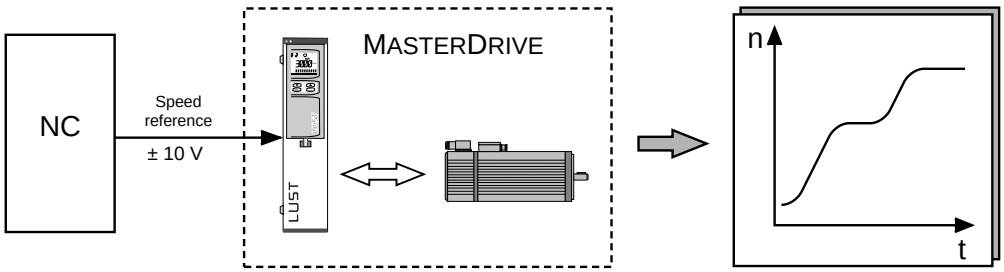
Features:

- Only one encoder is required for torque and speed control. This saves on additional encoders and cabling.
- Resolution of analog inputs: ISA0 12-bit, ISA1 11-bit
- Analog input ISA0 sampling cycle: 1 kHz
- Short sampling cycles of the control circuits, resulting in high control accuracy of the drive:
  Torque control: 16 kHz
  Speed control: 8 kHz

2.2.1 Speed control with ± 10 V reference generation

This mode is suitable for running the drive axle at various speeds without using an external position control circuit. If you want to use an external position controller, we recommend “speed control with external position control”, as in that mode the sampling time of the analog input is shorter and so the control result is better.

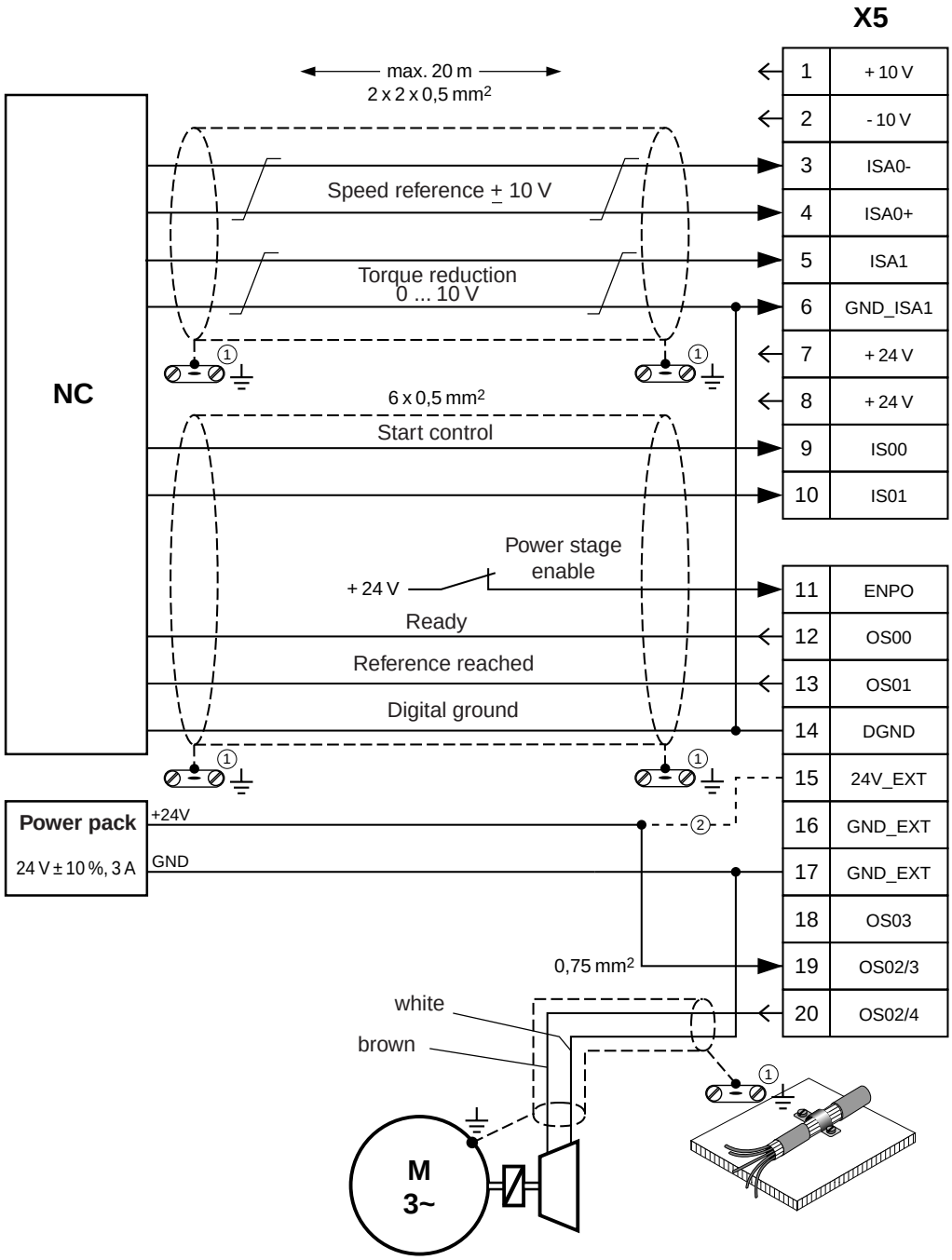
In “speed control with ± 10 V reference generation” mode the MC7000 converts the voltage applied to the ± 10 V input into a motor speed.



The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Linear and sinusoidal speed ramps
- Parameter-controllable encoder simulation
- Brake actuation
- Torque reduction.

Wiring for speed control with ± 10 V reference ge neration

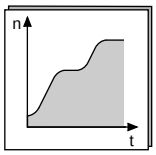


① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

Note: For specification of control terminals see Appendix A.4.

2.2.2 Speed control with fixed speeds



BASIC

In “speed control with fixed speeds” mode up to four fixed speeds can be stored in the MC7000 and selected in operation by way of two binary coded inputs.

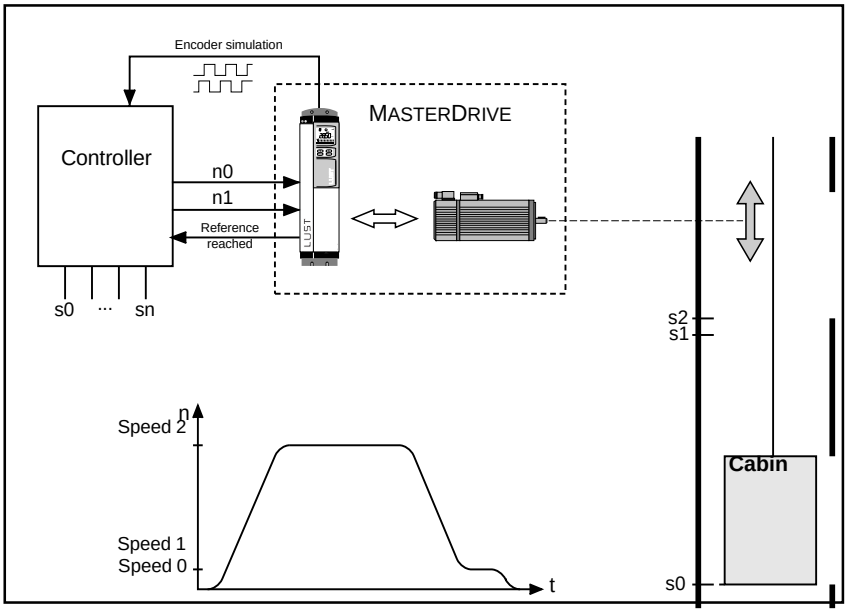
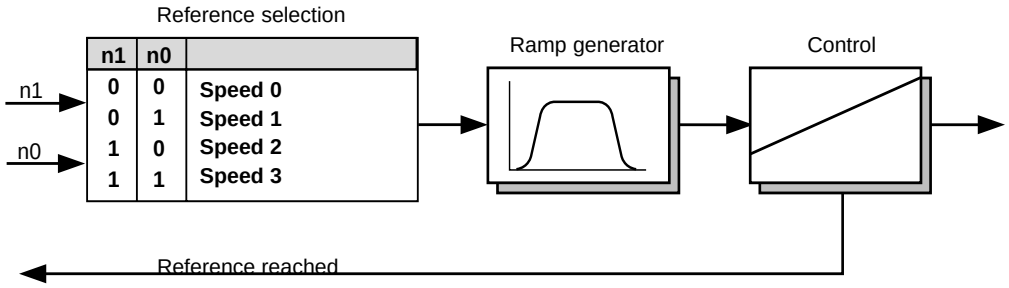


Diagram: Example of a lifting drive with rapid feed/ creep positioning. The controller uses the encoder simulation to determine the position of the cabin.

The reference preparation is shown in more detail in the diagram below:



n1	n0	
0	0	**Speed 0**
0	1	**Speed 1**
1	0	**Speed 2**
1	1	**Speed 3**

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Speed 0	Fixed speed reference 0 ... 3	-max. speed	rpm	Application	742-RFIX1
Speed 1		. . .	rpm	Application	752-RFIX2
Speed 2			rpm	Application	762-RFIX3
Speed 3		+max. speed	rpm	Application	772-RFIX4 (_REF)

The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Linear and sinusoidal speed ramps
- Parameter-controllable encoder simulation
- Brake actuation.

Practical tips:

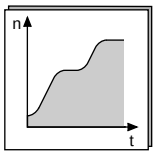
The positional accuracy of a rapid feed/creep positioning operation is determined by the level of the creep speed and the sampling rate of inputs ISA0 and ISA1 (1 kHz).

$$\text{Positional accuracy on motor shaft} = \frac{\text{Creep speed}}{\text{Sampling rate of inputs}} \cdot \frac{\text{rpm}}{60\text{s}} \cdot 360°$$

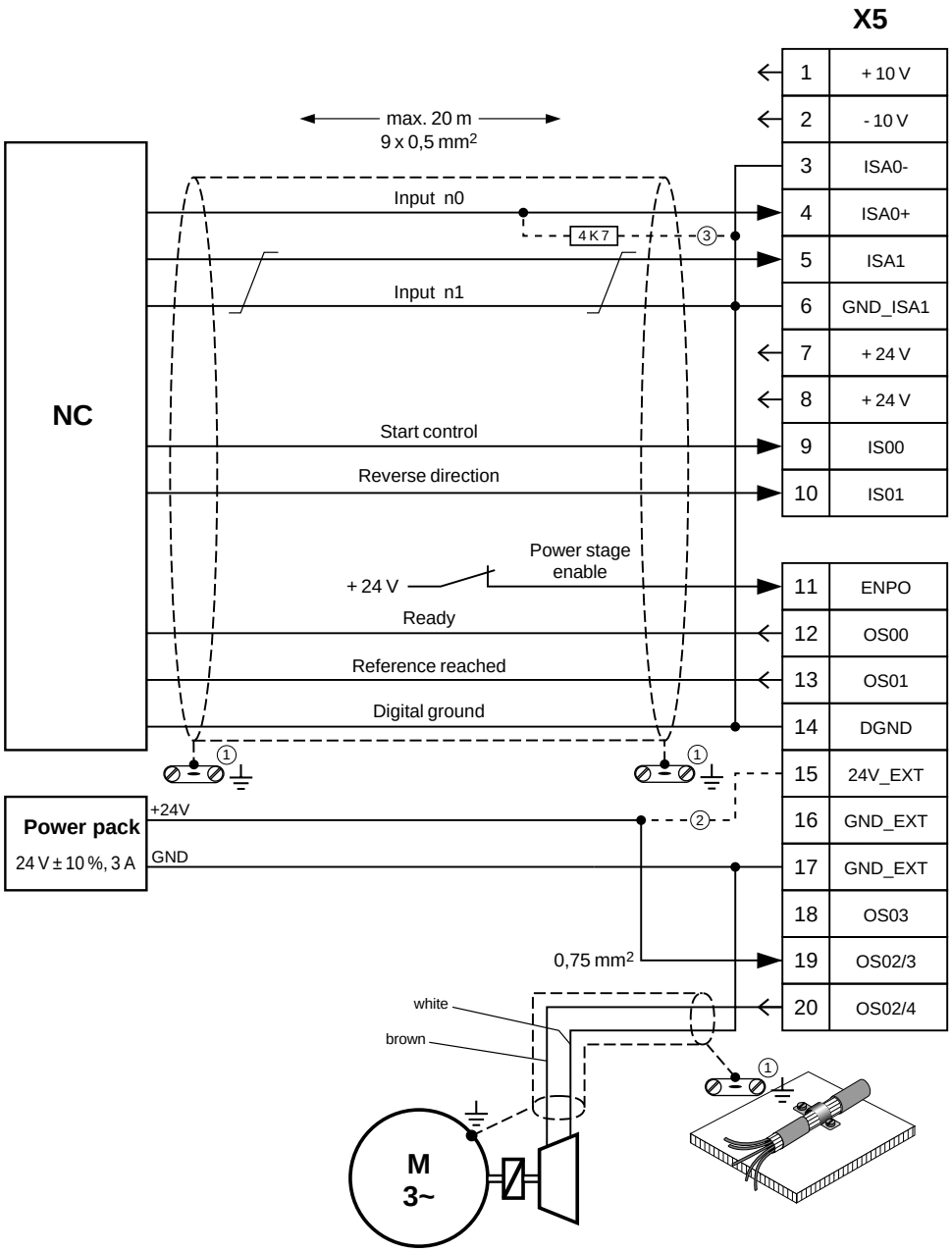
Example: Creep speed = 100 rpm

$$\text{Positional accuracy on motor shaft} = \frac{100}{\text{rpm}} \cdot \frac{\text{s}}{1000} \cdot \frac{\text{rpm}}{60\text{s}} \cdot 360° = 0{,}6°$$

Wiring for speed control with fixed speeds



BASIC



① Ground all cable screens on both sides flat on housing using cable clamps!

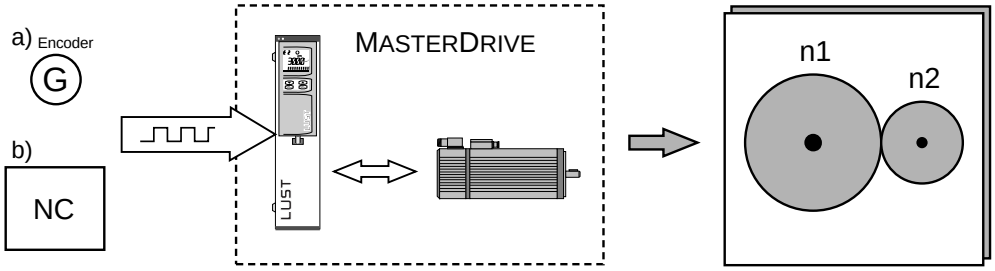
② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

③ When using ISA0+ as a digital input ISA0- and GND_ISA1 must be connected to DGND. Only for actuation via relay instead of NC: for a contact current of 5 mA at this input use a 4.7 kΩ resistor.

Note: For specification of control terminals see Appendix A.4.

2.2.3 Speed control via pulse input

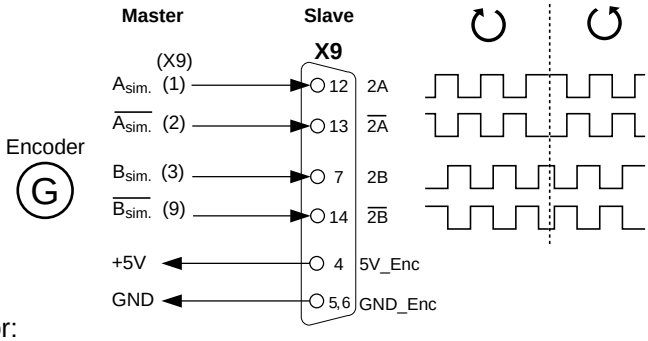
This mode is suitable
- where the MC7000 is to track the rotation speed of a master axle;
- where the MC7000 is to convert the frequency signal of a controller into a rotation speed.



Mode of actuation

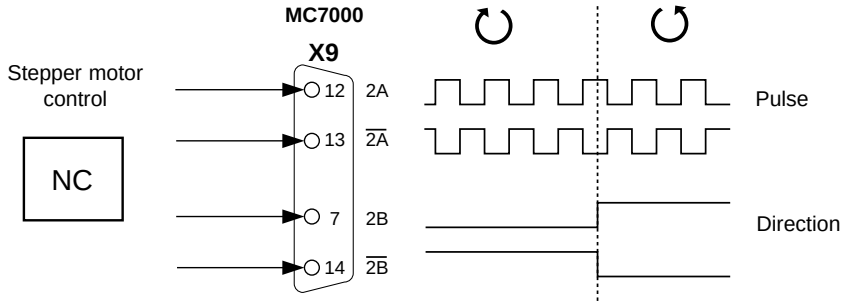
The slave axle can be actuated via differential signals with RS422 level in two different ways. The maximum count frequency is 500 kHz.

a) Incremental encoder signals (e.g. also encoder simulation of a MC6000/ MC7000)

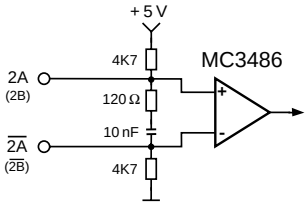


or:

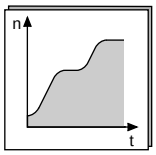
b) Pulse-direction signals



Differential inputs	min.	max.
Input Differential Voltage	–	± 6 V
Input Frequency	0 Hz	500 kHz
Differential input high threshold voltage	–	0.2 V
Differential input low threshold voltage	- 0.2 V	–

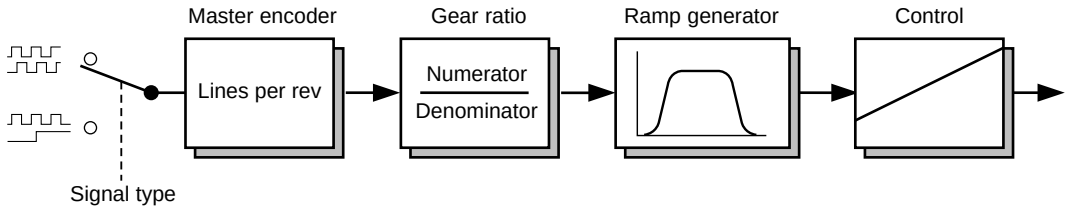


Structure of reference preparation



BASIC

The following diagram shows the structure of reference preparation:



With the parameter **Signal type** (RSTEP) the MC7000 can be adapted to the types of actuation signals used.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Signal type	Type of actuation signals	Incremental encoder, pulse-direction	–	Application 1	125-RSTEP (_REF)

With the parameter **Lines per revolution of master encoder** (EC2LN) the MC7000 can be adapted as a slave axle to the number of lines per revolution of the master axle encoder used.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Master encoder	Number of increments per revolution	512, 1024, 2048, 4096	incre-ments	Application 1 (_ENCD)	335-EC2LN

The transmission ratio of the electronic gearing can be adapted to the application by the following parameters.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Numerator	Numerator of gear ratio	1...65535	–	Application 1	389-RDNOM (_REF)
Denominator	Denominator of gear ratio	1...65535	–	Application 1	390-RDDEN (_REF)
Prefix	Prefix of gearing transmission ratio	POS. NEG	–	Application 1	391-VRSGN (_REF)

The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Linear and sinusoidal speed ramps
- Parameter-controllable encoder simulation
- Brake actuation
- Torque reduction.

The following examples are intended to illustrate setting of the parameters presented here.

Example 1: Speed synchronism

The master axle has an encoder with 10,000 increments and a mechanical gear with a transmission ratio of 15.

The slave axle has a mechanical gear with a transmission ratio of 5.

On the gear output side the slave drive is to run half as fast as the master.

Solution:

- Signal type = incremental encoder
- Lines per revolution of master encoder set at 4096
- Thus for the transmission ratio:

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Selected master encoder line count}}{\text{Master encoder line count}} \cdot \frac{\text{Slave gear ratio}}{\text{Master gear ratio}} \cdot \frac{\text{Slave speed}}{\text{Master speed}}$$

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{4096}{10000} \cdot \frac{5}{15} \cdot \frac{1}{2} = \frac{128}{625} \cdot \frac{1}{15} = \frac{128}{1875}$$

Encoder correction

Mechanical gearing correction

$\frac{\text{Slave}}{\text{Master}}$ speed ratio

Note:

Since no position controller is operative, the angle positions of the master and slave axles drift apart in the same way as the seconds indicators of two quartz watches. During the acceleration and braking phases the drift is dependent on the programmed ramps and torque limits.

If you need angular synchronism, use the “electronic gearing” mode.

Example 2: Speed generation with pulse-direction signals

The MC7000 is connected to a controller which delivers pulse-direction signals. 100 kHz are to correspond to 1000 rpm.

Solution:

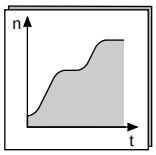
- Signal type = pulse-direction
- Lines per revolution of master encoder set at 4096
- Thus for the transmission ratio:

$$\frac{\text{Numerator}}{\text{Denominator}} = \text{Selected master encoder line count} \cdot \frac{\text{Reference speed}}{\text{Reference frequency}} \cdot \frac{\text{rpm}}{\text{60s}} \cdot 4$$

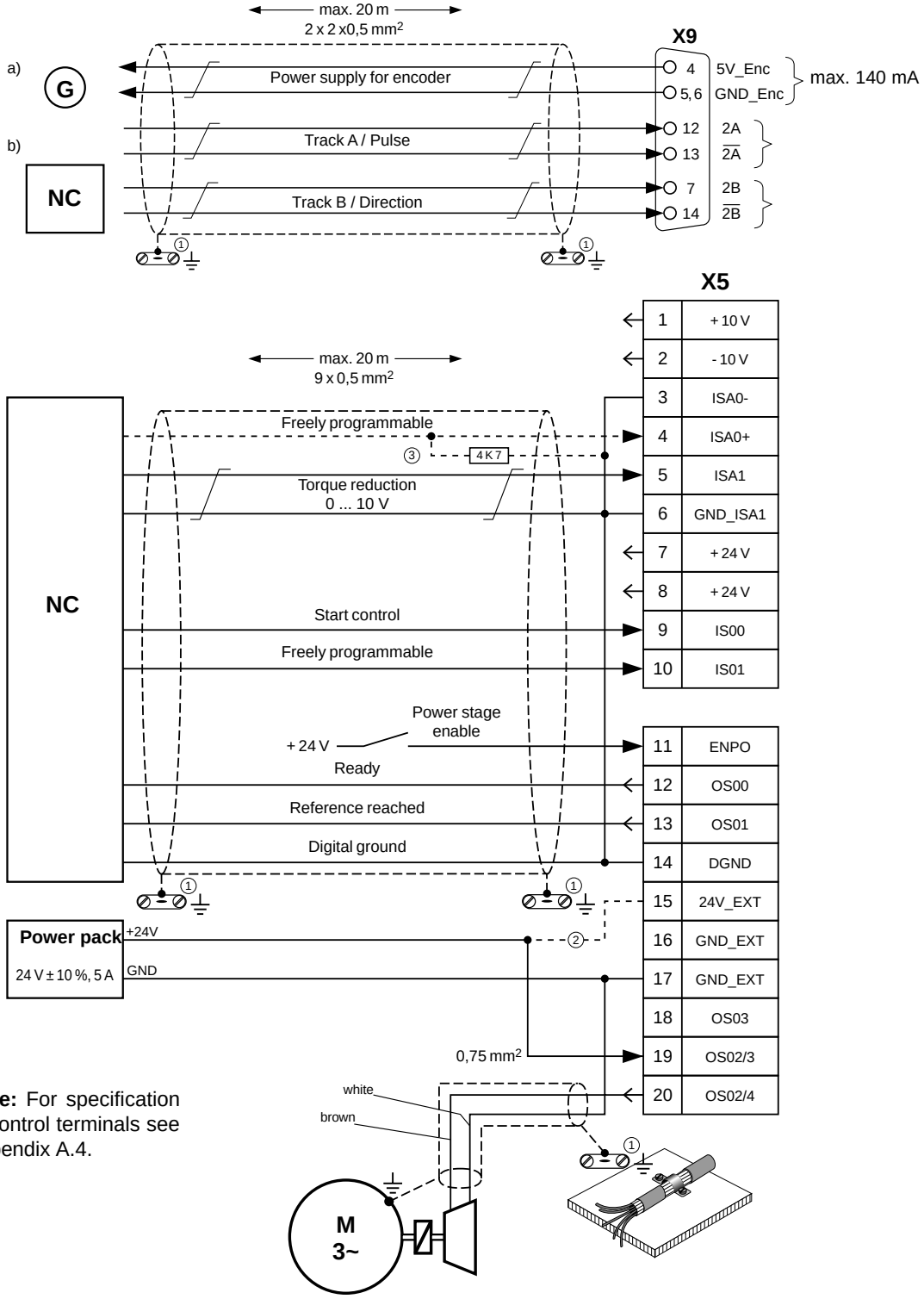
In contrast to the “incremental encoder” signal type, pulse-direction signals do not quadruple pulses; that is, only every rising edge is evaluated. For this reason, the numerator must generally be multiplied by four.

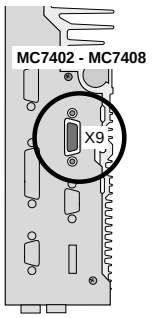
$$\frac{\text{Numerator}}{\text{Denominator}} = 4096 \cdot \frac{1000\text{s}}{100000\text{rpm}} \cdot \frac{\text{rpm}}{\text{60s}} \cdot 4 = \frac{4096}{100 \cdot 15} = \frac{1024}{375}$$

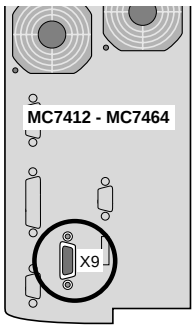
Wiring for speed control via pulse input



BASIC







Note: For specification of control terminals see Appendix A.4.

① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

③ When using ISA0+ as a digital input ISA0- and GND_ISA1 must be connected to DGND. Only for actuation via relay instead of NC: for a contact current of 5 mA at this input use a 4.7 kΩ resistor.

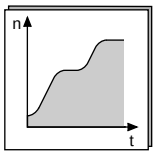
2.3 Torque control

The “torque control” mode is very well suited to use in tractive force control. The internal speed controller remains active and limits the speed to the value set in the **Maximum speed** parameter (SCSMX) plus approx. 20% (safety function). The speed controller operates as a P-controller, the lag time SCTLG is inactive.

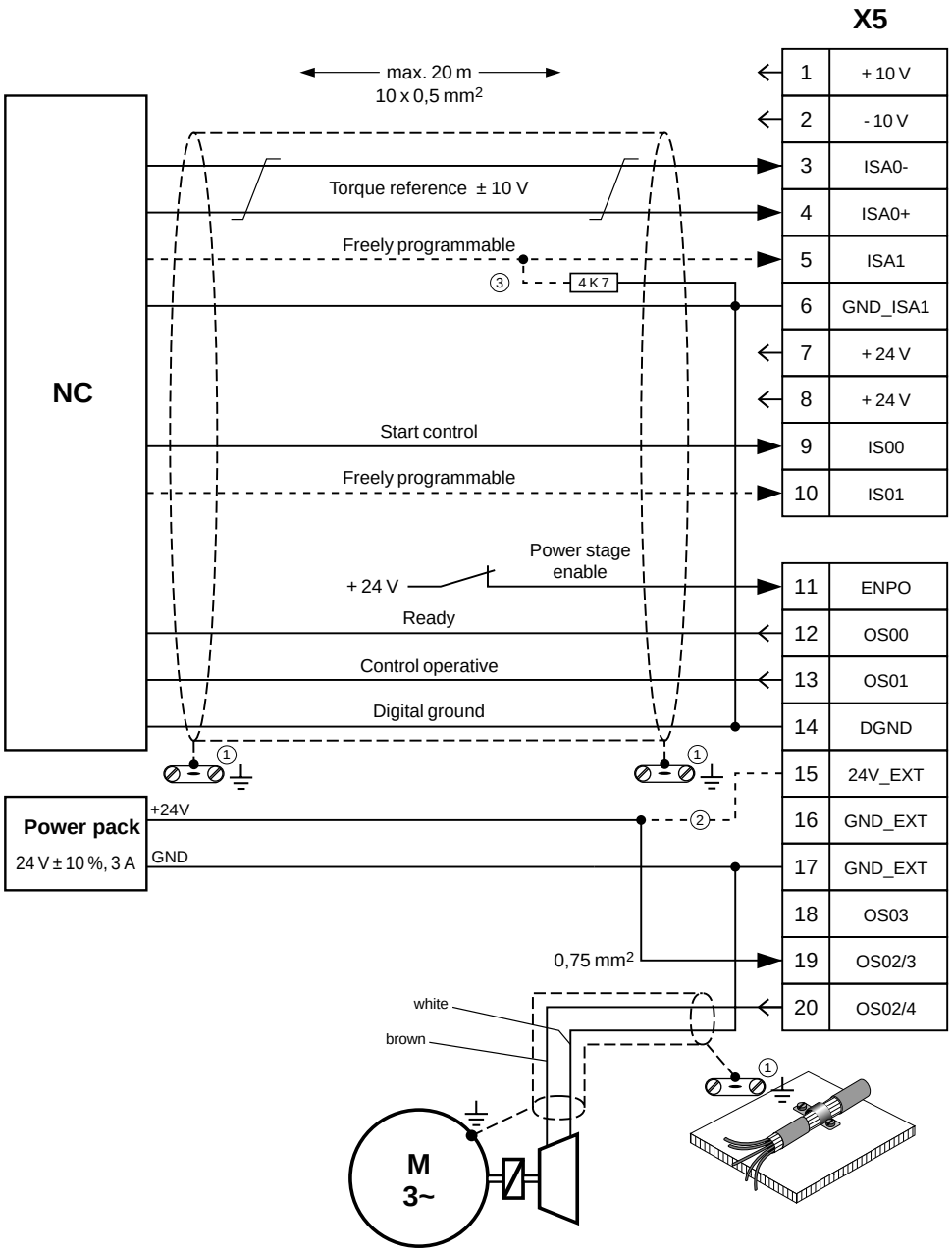
The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Parameter-controllable encoder simulation
- Brake actuation

Wiring for torque control



BASIC



① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

③ When using ISA0+ as a digital input ISA0- and GND_ISA1 must be connected to DGND. Only for actuation via relay instead of NC: for a contact current of 5 mA at this input use a 4.7 kΩ resistor.

Note: For specification of control terminals see Appendix A.4.

2.4 Stepper motor mode

In stepper motor mode the MC7000 can be actuated directly by a stepper motor controller. It converts the incoming signals into a position reference and moves to the position under control.

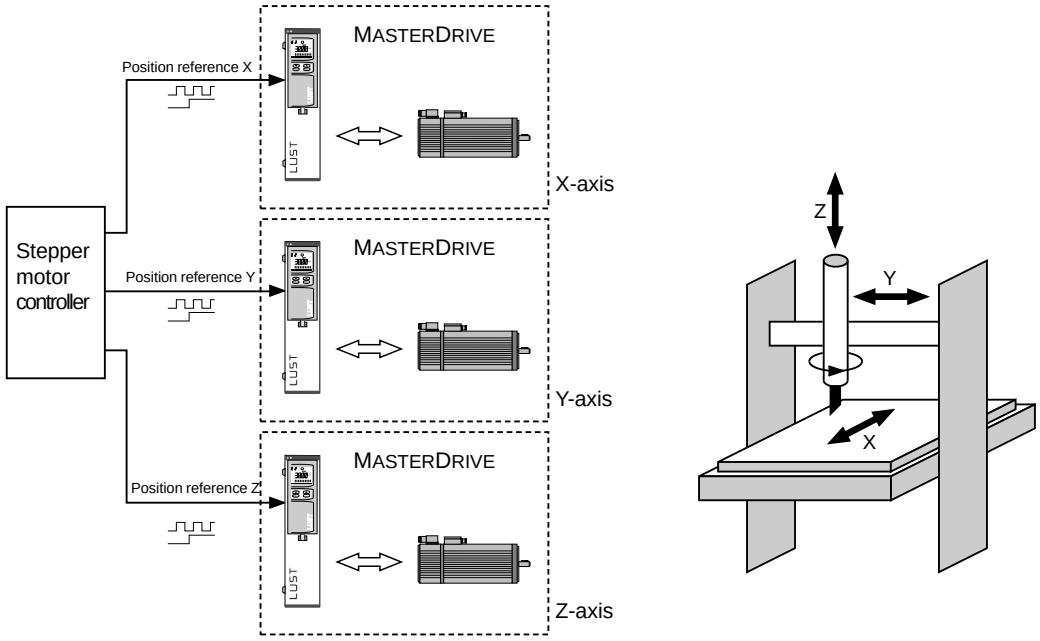


Diagram: Example of a 3-axis path control in stepper motor mode

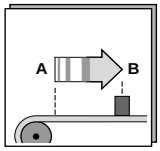
Features:

In stepper motor mode the MASTERCONTROL MC7000 servocontroller provides the following characteristics:

- No loss of steps in event of load surges.
- No “falling out-of-step” at high load torque or high acceleration (meaning the drive does not have to be overdimensioned).
- High torsional rigidity of the axle.
- Smooth running even at low step frequencies.
- Wide manipulating range: at a maximum step frequency of 500 kHz and a positioning step of 1 µm, a maximum velocity of 30 m/min. is attained.
- Low degree of heating at low load torque.
- Low noise.
- Internal position resolution: 65536 increments per motor revolution, irrespective of encoder used.

The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Parameter-controllable encoder simulation
- Brake actuation
- Torque reduction
- Functions for the stepper motor, electronic gearing and point-to-point positioning modes.

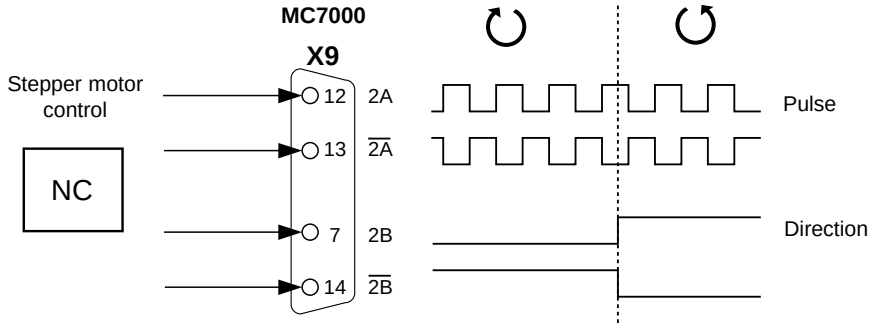


MOTION

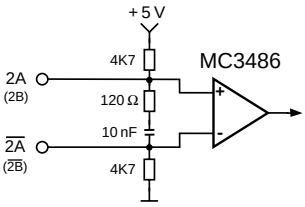
Mode of actuation

Actuation is via differential signals with RS422 level. The maximum count frequency is 500 kHz.

Pulse-direction signals



Differential inputs	min.	max.
Input Differential Voltage	–	± 6 V
Input Frequency	0 Hz	500 kHz
Differential input high threshold voltage	–	0.2 V
Differential input low threshold voltage	- 0.2 V	–



With the following parameters you define how many input pulses are required for a revolution of the motor or for a specific distance to be covered. The examples on the following page indicate useful ways of applying them.

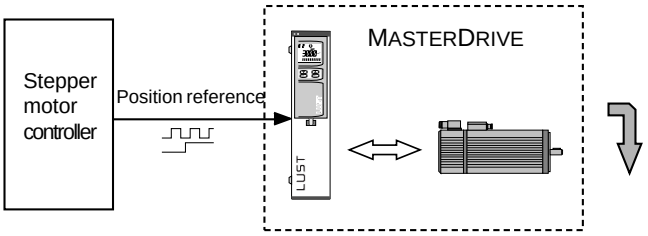
Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Trans. ratio: Numerator	Gear ratio numerator	1...16383	–	Stepper motor	387-VRNOM (_PCON)
Denominator	Gear ratio denominator	1...65535	–	Stepper motor	388-VRDEN (_PCON)
Master encoder	Number of increments per revolution	512, 1024, 2048, 4096	Incre-ments	Stepper motor	335-EC2LN (_REF)

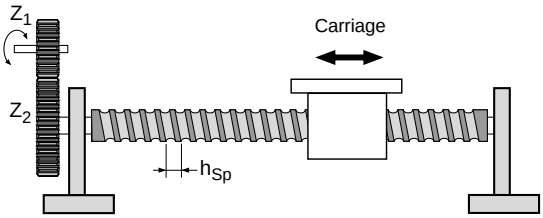
If the drive does not rotate in the desired direction during commissioning, the direction can be reversed with the following parameter:

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Invert direction of rotation	Inversion of direction of rotation OFF: ON:	ON, OFF No change Invert direction of rotation	–	Stepper motor (_REF)	391-RSDIR

Note:
The other parameters offered on the Application tab are described in chapter 3.

Example 1: Linear drive with ball-and-screw spindle





h_{Sp}	Pitch of ball-and-screw spindle:	5 mm
Z_1	Drive pinion teeth:	28
Z_2	Drive pinion teeth:	64

1000 pulses of the controller to correspond to 1 mm (resolution 1 µm)

Maximum positioning speed = 15 m/min

Parameter setting

Lines per revolution of master encoder set at **1024.**

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Selected master encoder line count}}{\text{Pulses per mm}} \cdot \frac{Z_2}{Z_1} \cdot \text{Spindel pitch in mm}$$

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{1024}{1000} \cdot \frac{64}{28} \cdot \frac{1}{5} = \frac{128}{125} \cdot \frac{16}{7} \cdot \frac{1}{5} = \frac{2048}{4375}$$

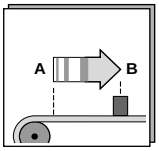
Master encoder correction — Back gear or mech. gearing correction — Spindle pitch

The **Numerator** parameter is set to **2048** and the **Denominator** parameter to **4375**.

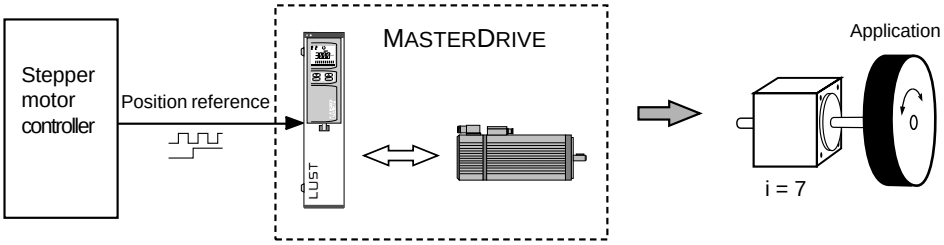
Check of maximum occurring step frequency

$$\text{Maximum step frequency} = 15\frac{\text{m}}{\text{min}} \cdot \frac{\text{min}}{60\,\text{s}} \cdot \frac{1000}{1\text{min}} = 250\,\text{kHz}$$ (OK, because $\leq$ 500 kHz).

Example 2: Rotational drive



MOTION



i Gear transmission ratio = 7

10,000 pulses of the controller to correspond to one revolution on the gear output side

Parameter setting

Lines per revolution of master encoder set at **4096.**

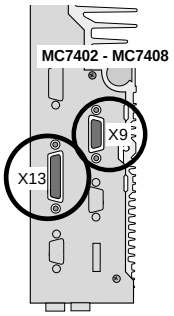
$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Selected master encoder line count}}{\text{Pulses per rev}} \cdot \text{Mech. gearing transmission ratio}$$

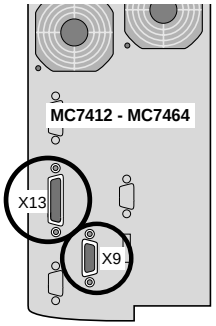
$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{4096}{10000} \cdot \frac{7}{1} = \frac{256}{625} \cdot 7 = \frac{1792}{625}$$

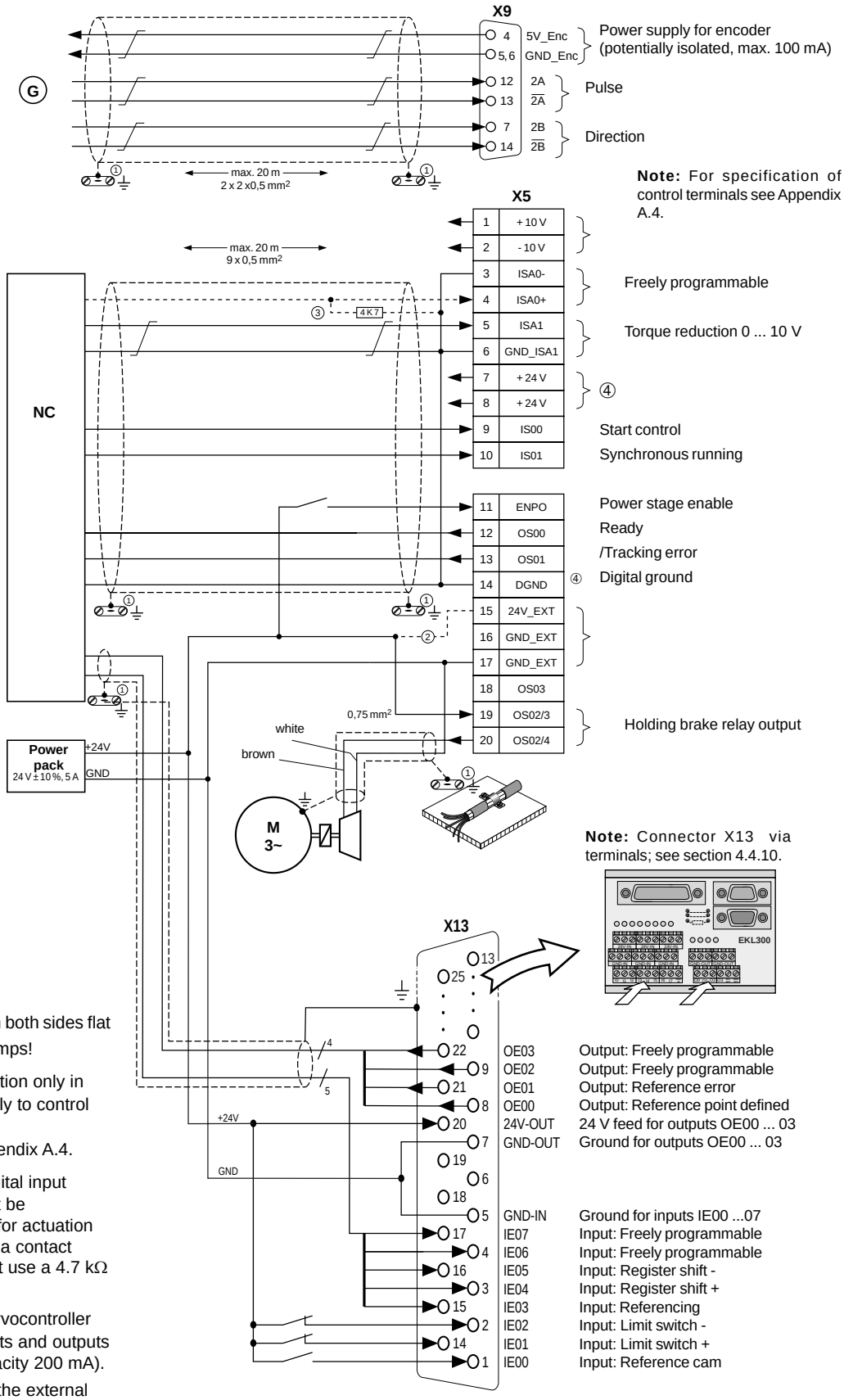
Master encoder correction

Mech. gearing correction

Wiring for stepper motor mode







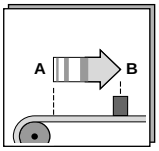
① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

③ When using ISA0+ as a digital input ISA0- and GND_ISA1 must be connected to DGND. Only for actuation via relay instead of NC: for a contact current of 5 mA at this input use a 4.7 kΩ resistor.

④ The internal 24 V of the servocontroller are used to supply the inputs and outputs on X5 (max. total load capacity 200 mA).
When the power supply of the external E/As or the CAN interface is used, its isolation is removed.

2.4.1 Reference run



MOTION

Where a G3 multi-turn absolute value generator is used, the MC7000 servocontroller knows the absolute position of the axle immediately after power-on.

With incremental encoders and resolvers the absolute dimensional reference can be established after power-on by means of a reference run.

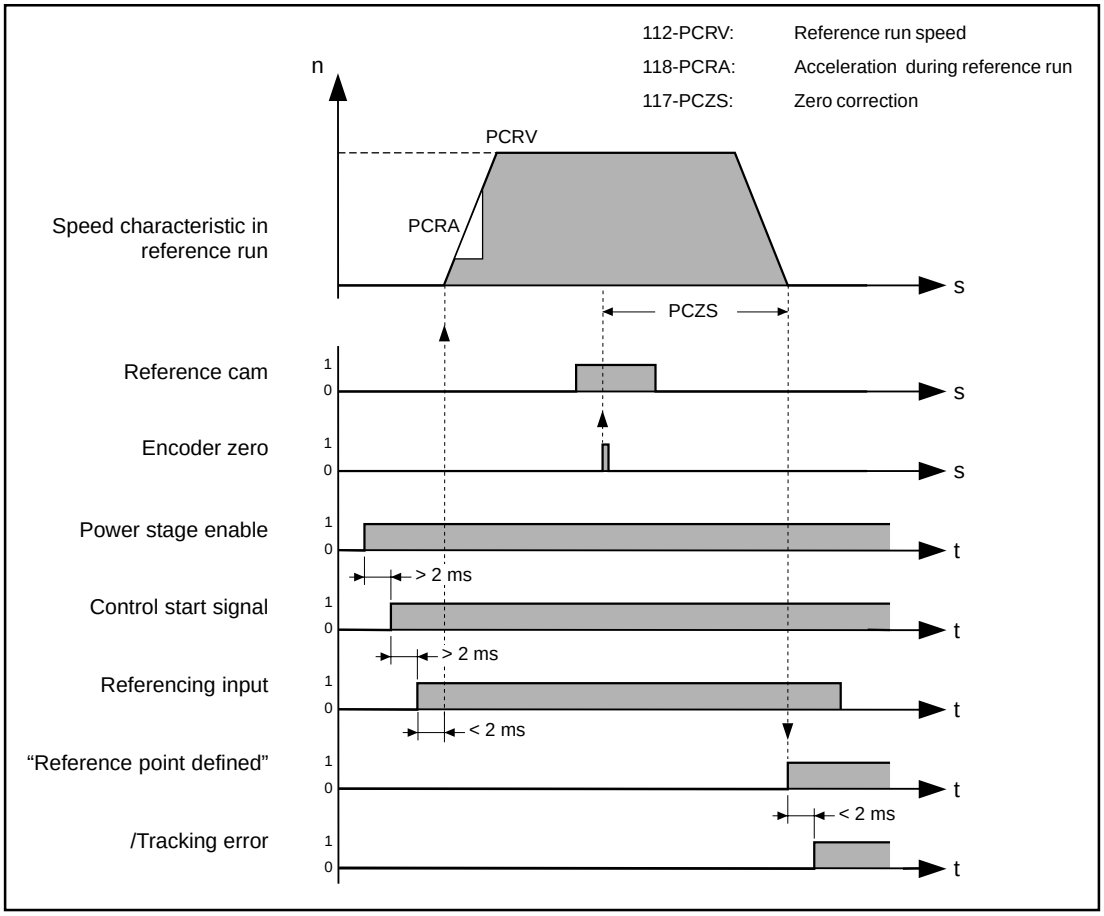


Diagram: Signal characteristics in the reference run

For execution of the reference run:

1. The power stage must be enabled (input ENPO).
2. The control must be started (axle now maintains its position under control).
3. The reference run must be started by a 24 V level at the “Referencing” input.

The reference run speed and acceleration may be selected freely.

If the MC7000 detects the reference cam during the reference run, it continues searching for the encoder zero and, when it has found it, continues positioning by the value specified in the “Zero correction” parameter. The axle is then at the machine zero.

If the MC7000 does not detect a reference cam within the maximum referencing distance during the reference run, the “Reference error” output is set.

If the “Referencing” input is deactivated and the “Synchronous running” input is activated, the drive follows the pulses of the stepper motor controller.

If the drive reaches a limit switch during referencing or synchronous running, it decelerates down to a standstill with the stop ramp.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Reference run: Speed	Speed in reference run	- SCSMX ... + SCSMX	rpm	Stepper motor	112-PCRV (_PCON)
Acceleration	Acceleration in reference run	100 ... 32.000	rpm s^{-1}	Stepper motor	118-PCRA (_PCON)
Reference cam level	Active level of reference cam	24 V, 0 V	V	Stepper motor	120-PCALR (_PCON)
Maximum reference travel	Maximum positioning distance in reference run. If exceeded the “Reference error” output is set.	100 ... 32.000	revs	Stepper motor	113-PCRMD (_PCON)
Zero correction	Distance between reference point and machine zero.	- 32,000 ... + 32.000	incre-ments	Stepper motor	117-PCZS (_PCON)
Tracking error	Amount of permissible lag distance.	0 ... 32.764	incre-ments	Application	308-PDMX (_PCON)

Note:
The other parameters offered on the Application tab are described in chapter 3.

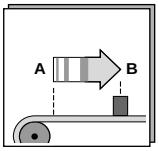
2.4.2 Shift synchronous position

During synchronous running the drive directly follows the position reference formed by the incoming pulse-direction signals.

The “shift synchronous position” function adds a position offset to that reference, so that the position of the axle is shifted in relation to the position reference of the pulse-direction signals.

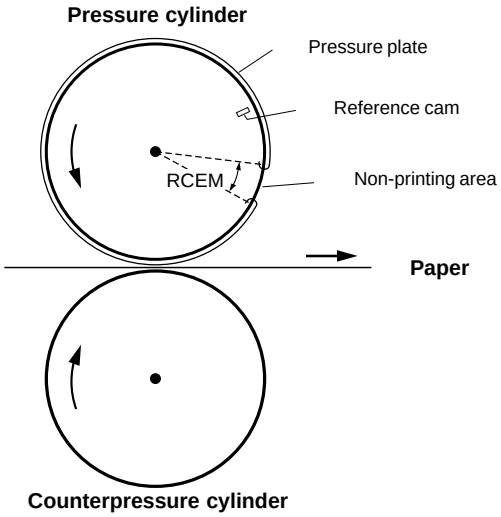
With each edge at one of the “Register shift +” or “Register shift -” inputs the synchronous position of the drive is shifted by the value of the “Offset” parameter. This shift does not take immediate effect, but becomes active after the following sequence:

1. Positive edge at “Register shift +” or “Register shift -” input.
2. Drive detects reference cam.
3. Drive covers “Offset” distance after reference cam.
4. Drive shifts its position by the value of the “Offset” parameter.



MOTION

Example of application: Register control for printing presses



A printing press contains several printing units, with each unit being driven by its own servo drive. In a stepper motor controller there is a virtual axle which supplies all the servo drives with reference values.

In order to implement a register or print mark control - that is, to synchronize the position of the pressure cylinder to the position of the paper - the “Shift synchronous position” function is used.

The position shift can be requested by way of the two inputs “Register shift +” and “Register shift -”. It is only executed, however, when the reference cam has subsequently been passed and the additional “Offset” distance has been covered. In this, the “Offset” parameter is chosen such that the shift occurs when the non-printing area of the pressure cylinder is positioned over the paper. This ensures optimum print results.

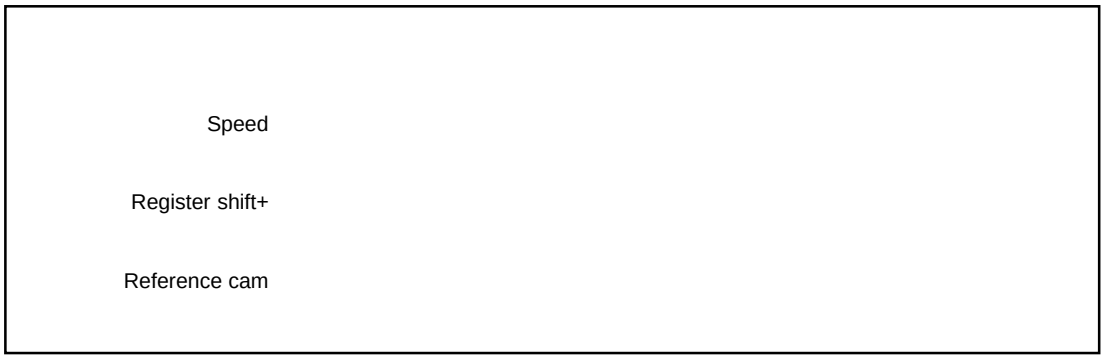


Diagram: Signal courses with register control. (1) shift, parameter 124-RCO.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Register control: Shift	Distance by which the synchronous position of the axle is shifted.	- RCEM ... + RCEM	Incre-ments	Stepper motor	121-RCDE (_PCON)
Max. shift	Maximum adjustment range by which the synchronous position can be shifted.	0 ... 65.536 (0 ... 1 revs)	Incre-ments	Stepper motor	122-RCEM (_PCON)
Offset	Distance between the reference cam and the position at which the synchronous position is shifted.	0 ... 32.764	Incre-ments	Stepper motor	124-RCO (_PCON)

2.5 Electronic gearing

In “electronic gearing” mode the MASTERCONTROL MC7000 servocontroller converts the incoming square pulses of a master encoder directly into a position reference and moves to that reference under control.

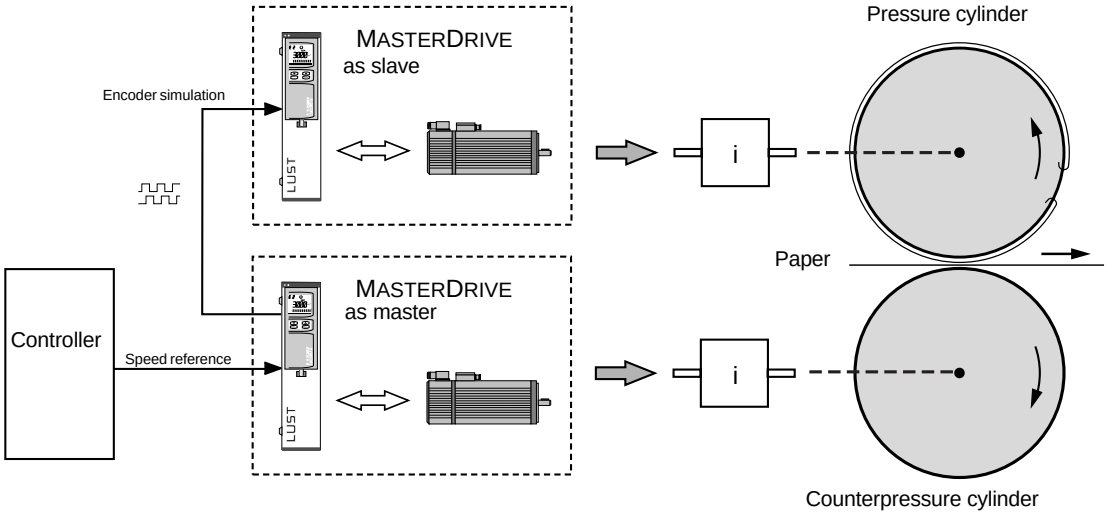


Diagram: Example of a printing press. The MASTERDRIVE driving the counterpressure cylinder operates as the master. Its encoder simulation serves as the position reference for the second MASTERDRIVE which, acting as the slave, follows that reference and drives the pressure cylinder. In this way the movements of the pressure cylinder and the counterpressure cylinder are synchronized.

Features:

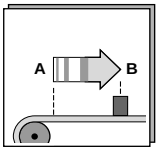
In electronic gearing mode the MC7000 offers the following advantages over mechanical gears and line shafts:

- In most cases less costly with greater accuracy (specially where the master and slave axles are far apart).
- Greater flexibility in machine design.
- Shorter setup times and downtimes on product change.
- The internal position resolution is 65536 increments per motor revolution, irrespective of the encoder used.

The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):

- Standard functions
- Parameter-controllable encoder simulation
- Brake actuation
- Torque reduction.
- Functions for the stepper motor, electronic gearing and point-to-point positioning modes.

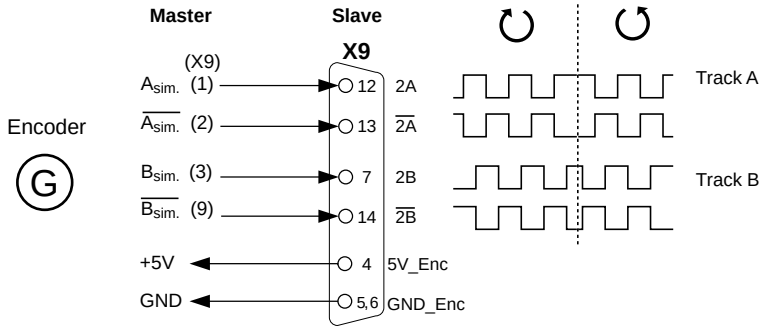
Mode of actuation



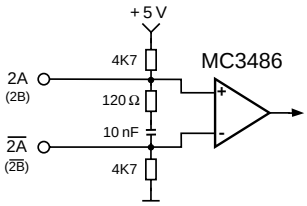
MOTION

Actuation is via incremental encoder signals with RS422 level. The encoder simulation of a MASTERCONTROL MC6000 or MC7000 can also be used to actuate the follow-up axle, for example. The maximum count frequency is 500 kHz.

Incremental encoder signals



Differential inputs	min.	max.
Input Differential Voltage	–	± 6 V
Input Frequency	0 Hz	500 kHz
Differential input high threshold voltage	–	0.2 V
Differential input low threshold voltage	- 0.2 V	–



With the following parameters you define how many pulses are required for a revolution of the motor or for a specific distance to be covered. The example on the following page indicates useful ways of applying them.

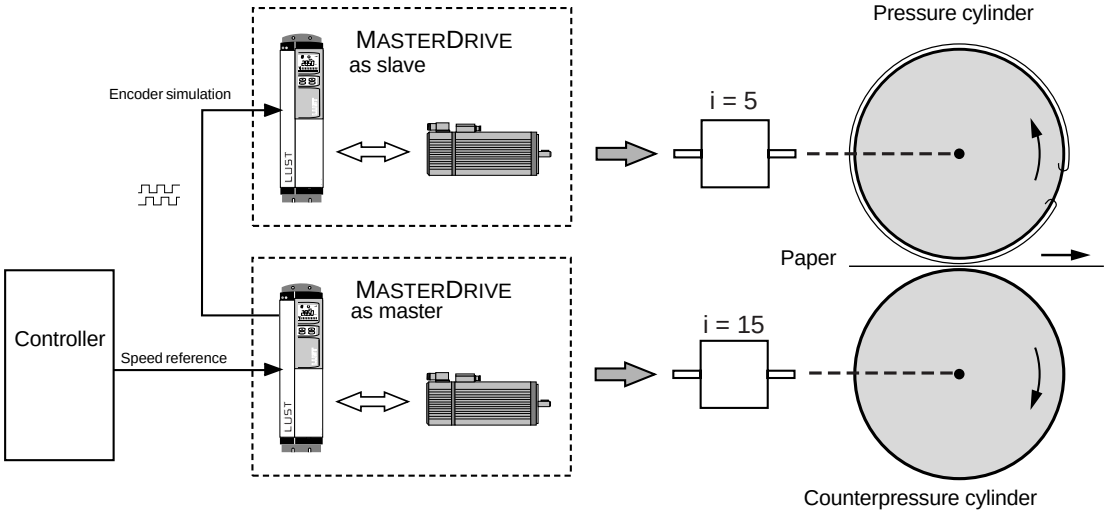
Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Gear ratio: Master encoder	Number of increments per revolution	512, 1024, 2048, 4096	Increments	Gearing	335-EC2LN (_REF)
Numerator	Gear ratio numerator	1...65535	–	Gearing	387-VRNOM (_PCON)
Denominator	Gear ratio denominator	1...65535	–	Gearing	388-VRDEN (_PCON)
Invert direction	Inversion of the motor direction POS: no change NEG: invert direction	POS, NEG	–	Gearing	391-VRSGN (_REF)
Setting off analog numerator [1]	On: Online change of the numerator for the transmission ratio via analog input ISA1 Off: transmission ratio from numerator/denominator parameters	OFF, ON	–	Gearing	394-VRAEN (_PCON)
Upper limit of numerator [1]	Value of the numerator at +10 V on input ISAO	2 ... 65535	–	Gearing	392-VRSMX (_PCON)
Lower limit of numerator [1]	Value of the numerator at -10 V on input ISAO	1 ... 65535	–	Gearing	393-VRSMN (_PCON)

[1] valid as of firmware 4.0

Example: Electronic gearing

A MC7000 as the master axle has an encoder simulation with 3072 increments and a mechanical gear with a transmission ratio of 15. A MC7000 as the slave axle in electronic gearing mode has a mechanical gear with a transmission ratio of 5.

The speeds on the gear output sides of the mechanical gears are to be identical.



Solution:

Lines per revolution of master encoder set at **4096**.

Thus for the **transmission ratio** of the electronic gearing:

$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{Selected master encoder line count}}{\text{Master encoder line count}} \cdot \frac{\text{Slave gear ratio}}{\text{Master gear ratio}}$$

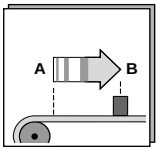
$$\frac{\text{Numerator}}{\text{Denominator}} = \frac{4096}{3072} \cdot \frac{5}{15} = \frac{4}{3} \cdot \frac{1}{3} = \frac{4}{9}$$

Master encoder correction

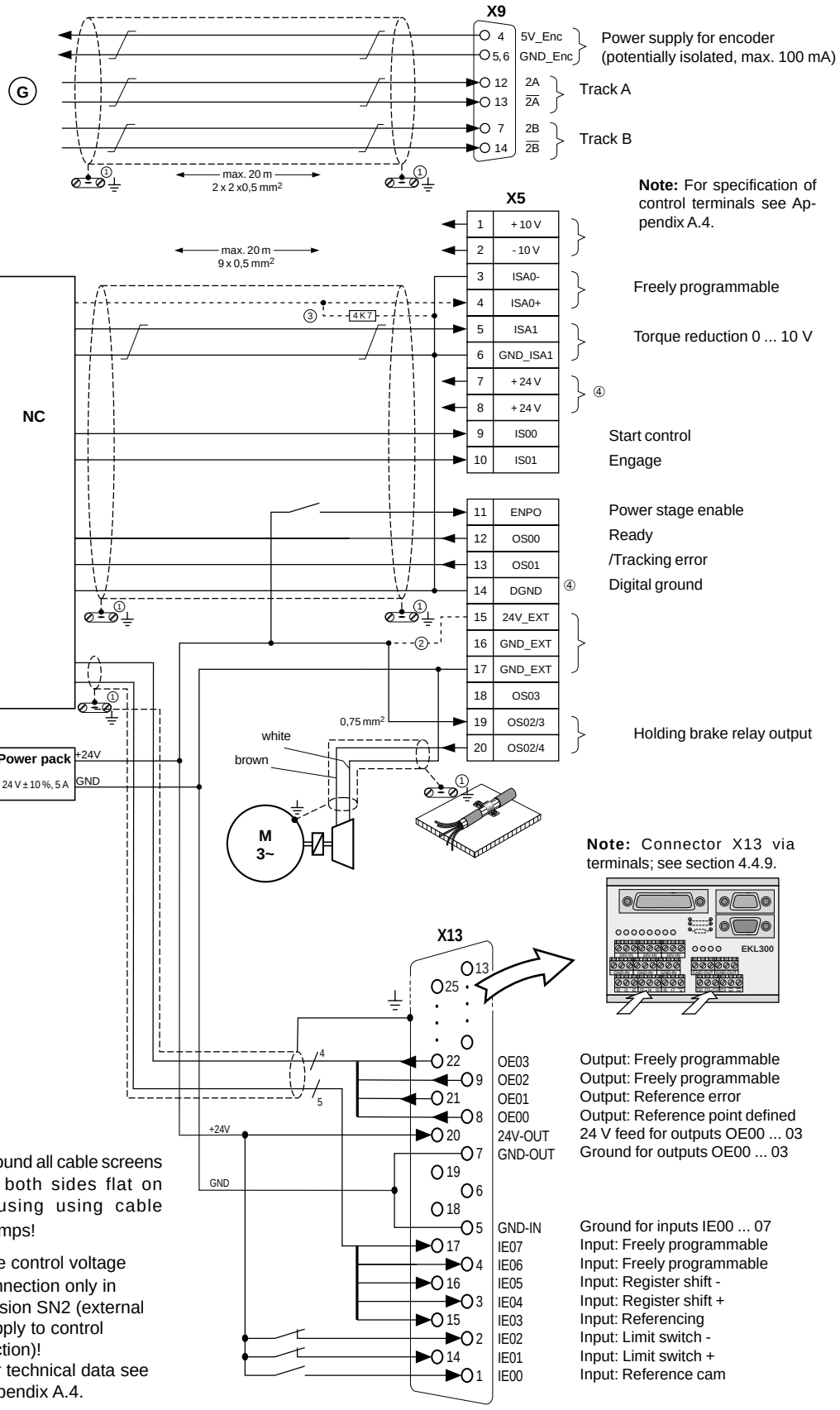
Mechanical gearing correction

The **Numerator** parameter is set to **4** and the **Denominator** parameter to **9**.

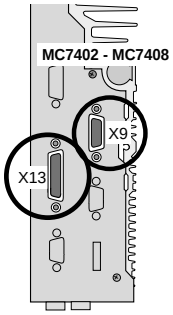
Wiring for electronic gearing

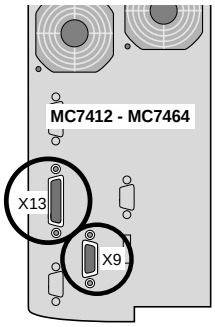


MOTION



Note: For specification of control terminals see Appendix A.4.





Note: Connector X13 via terminals; see section 4.4.9.

① Ground all cable screens on both sides flat on housing using cable clamps!

② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

③ When using ISA0+ as a digital input ISA0- and GND_ISA1 must be connected to DGND. Only for actuation via relay instead of NC: for a contact current of 5 mA at this input use a 4.7 kΩ resistor.

④ The internal 24 V of the servocontroller are used to supply the inputs and outputs on X5 (max. total load capacity 200 mA). When the power supply of the external E/As or the CAN interface is used, its isolation is removed.

2.5.1 Reference run

Where a G3 multi-turn absolute value generator is used, the MC7000 servocontroller knows the absolute position of the axle immediately after power-on.

With incremental encoders and resolvers the absolute dimensional reference can be established after power-on by means of a reference run.

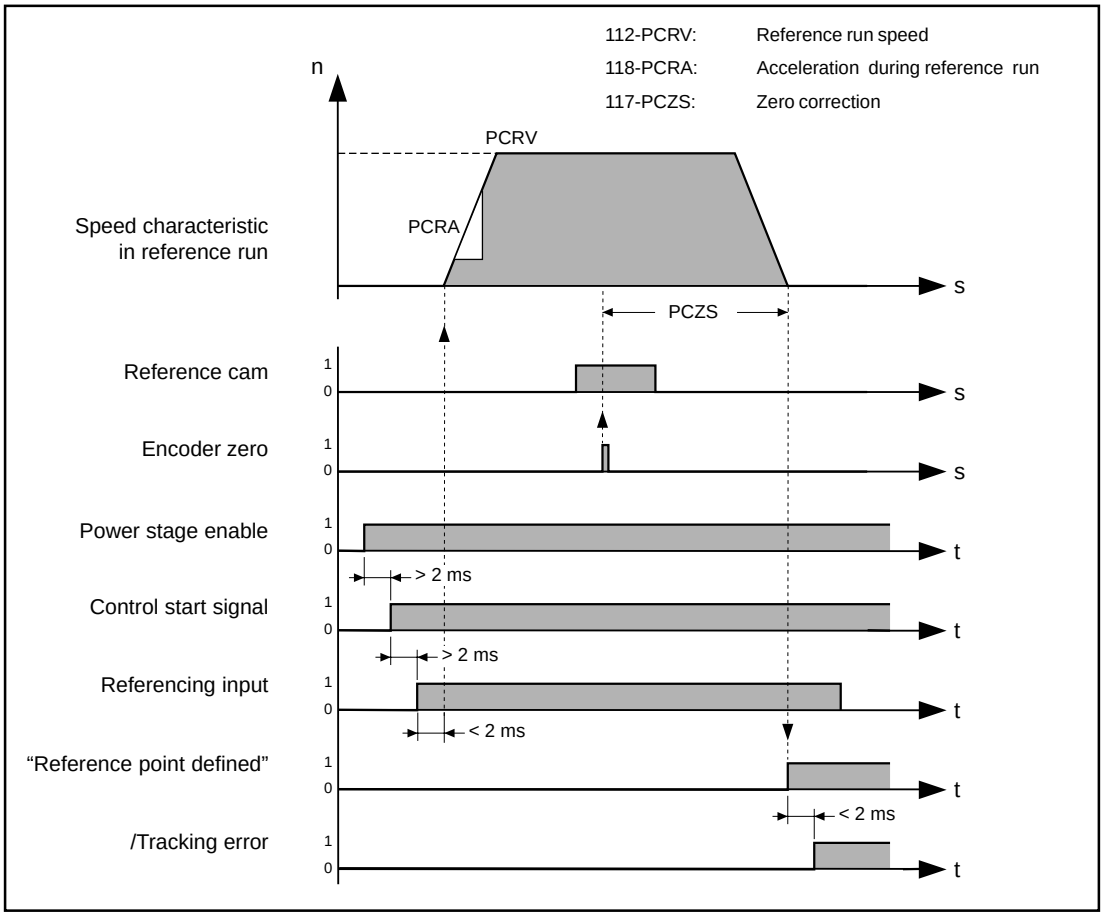


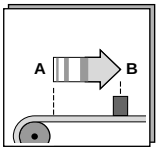
Diagram: Signal characteristics in the reference run

For execution of the reference run:

1. The power stage must be enabled.
2. The control must be started (axle now maintains its position under control).
3. The reference run must be started by a 24 V level at the “Referencing” input.

The reference run speed and acceleration may be selected freely.

If the MC7000 detects the reference cam during the reference run, it continues searching for the encoder zero and, when it has found it, continues positioning by the value specified in the “Zero correction” parameter. The axle is then at the machine zero.



MOTION

If the MC7000 does not detect a reference cam within the maximum referencing distance during the reference run, the “Reference error” output is set.

If the “Referencing” input is deactivated and the “Engage” input is activated, the drive follows the pulses of the master encoder.

If the drive reaches a limit switch during referencing or synchronous running, it decelerates down to a standstill with the stop ramp.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Reference run: Speed	Speed in reference run ... + SCSMX	- SCSMX	rpm	Gearing	112-PCRV (_PCON)
Acceleration	Acceleration in reference run	100 ... 32.000	rpm s^{-1}	Gearing	118-PCRA (_PCON)
Reference cam level	Active level of reference cam	24 V, 0 V	VGearing		120-PCALR (_PCON)
Maximum reference travel	Maximum positioning distance in reference run. If exceeded the “Reference error” output is set.	100 ... 32.000	rpm	Gearing	113-PCRMD (_PCON)
Zero correction	Distance between reference point and machine zero.	- 32,000 ... + 32.000	incre-ments	Gearing	117-PCZS (_PCON)
Evaluate zero pulse	Evaluate zero pulse during the reference run. No: referencing to reference cam only	Yes, No	–	Gearing	592-POZP (_PCON)
Max. tracking error	Amount of permissible lag distance.	0 ... 32.764	incre-ments	Application	308-PDMX (_PCON)

Note:
The other parameters offered on the Application tab are described in chapter 3.

2.5.2 Shift synchronous position

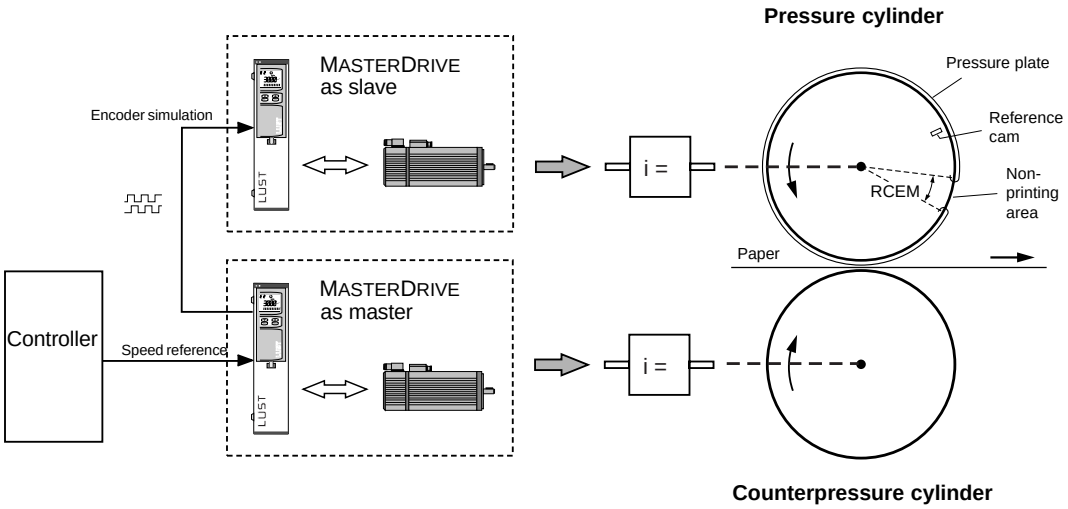
During synchronous running the drive directly follows the position reference formed by the incoming pulse-direction signals.

The “shift synchronous position” function adds a position offset to that reference, so that the position of the axle is shifted in relation to the position reference of the pulse-direction signals.

With each edge at one of the “Register shift +” or “Register shift -” inputs the synchronous position of the drive is shifted by the value of the “Offset” parameter. This shift does not take immediate effect, but becomes active after the following sequence:

1. Positive edge at “Register shift +” or “Register shift -” input.
2. Drive detects reference cam.
3. Drive covers “Offset” distance after reference cam.
4. Drive shifts its position by the value of the “Offset” parameter.

Example of application: Register control for printing presses



A printing press contains several printing units, with each unit being driven by its own servo drive.

In order to implement a register or print mark control - that is, to synchronize the position of the pressure cylinder to the position of the paper - the “Shift synchronous position” function is used.

The position shift can be requested by way of the two inputs “Register shift +” and “Register shift -”. It is only executed, however, when the reference cam has subsequently been passed and the additional “Offset” distance has been covered. In this, the “Offset” parameter is chosen such that the shift occurs when the non-printing area of the pressure cylinder is positioned over the paper. This ensures optimum print results.

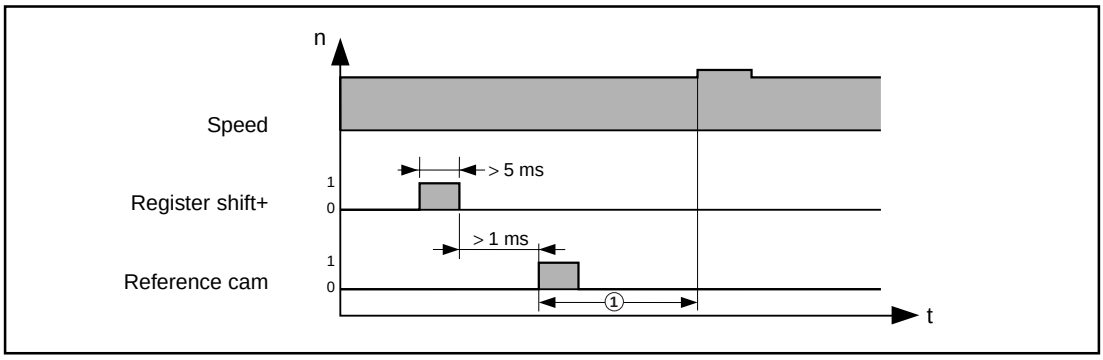
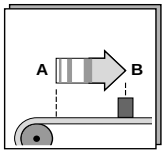


Diagram: Signal courses during register control. (1) shift, parameter 124-RCO.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Shift	Distance by which the synchronous position of the axle is shifted.	- RCEM ... + RCEM	Incre-ments	Gearing	121-RCDE (_PCON)
Max. shift	Maximum adjustment range by which the synchronous position can be shifted.	0 ... 65536 (0 ... 1 revs)	Incre-ments	Gearing	122-RCEM (_PCON)
Offset	Distance between the reference cam and the position at which the synchronous position Is shifted.	0 ... 32.764	Incre-ments	Gearing	124-RCO (_PCON)

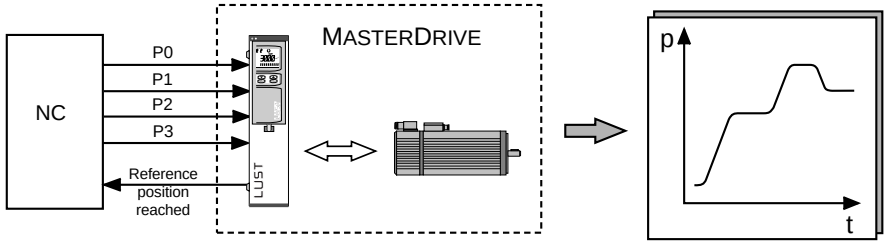
2.6 Point-to-point positioning



MOTION

This mode is suitable
- where the drive has to approach a maximum of 15 positions (e.g. a machine tool);
- where the drive has to position continuously by a set positioning distance (e.g. a conveyor belt).

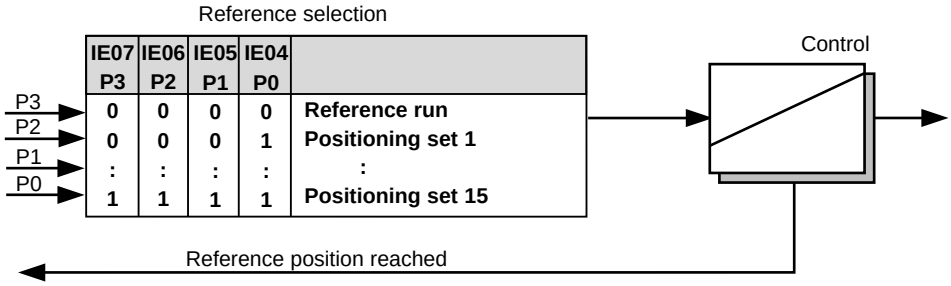
In point-to-point positioning up to 15 positioning sets can be stored in the MC7000 and selected in operation by way of four binary coded inputs.



Features
- Maximum 16 positioning sets, of which one for the reference run.
- Absolute and relative positioning.
- Linear and sinusoidal speed ramps for particularly low-stress movements.
- Position resolution: 65536 increments per motor revolution.

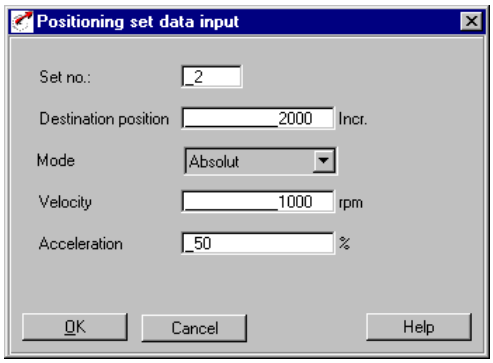
The following functions are available for quick and easy adaptation of the MC7000 to your application (see chapter 3):
- Standard functions
- Linear and sinusoidal speed ramps
- Parameter-controllable encoder simulation
- Brake actuation
- Functions for the stepper motor, electronic gearing and point-to-point positioning modes.

The reference preparation is shown in more detail in the diagram below:



A positioning set consists of:

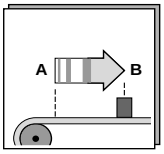
- Destination position
- Mode (absolute/relative)
- Velocity
- Acceleration.



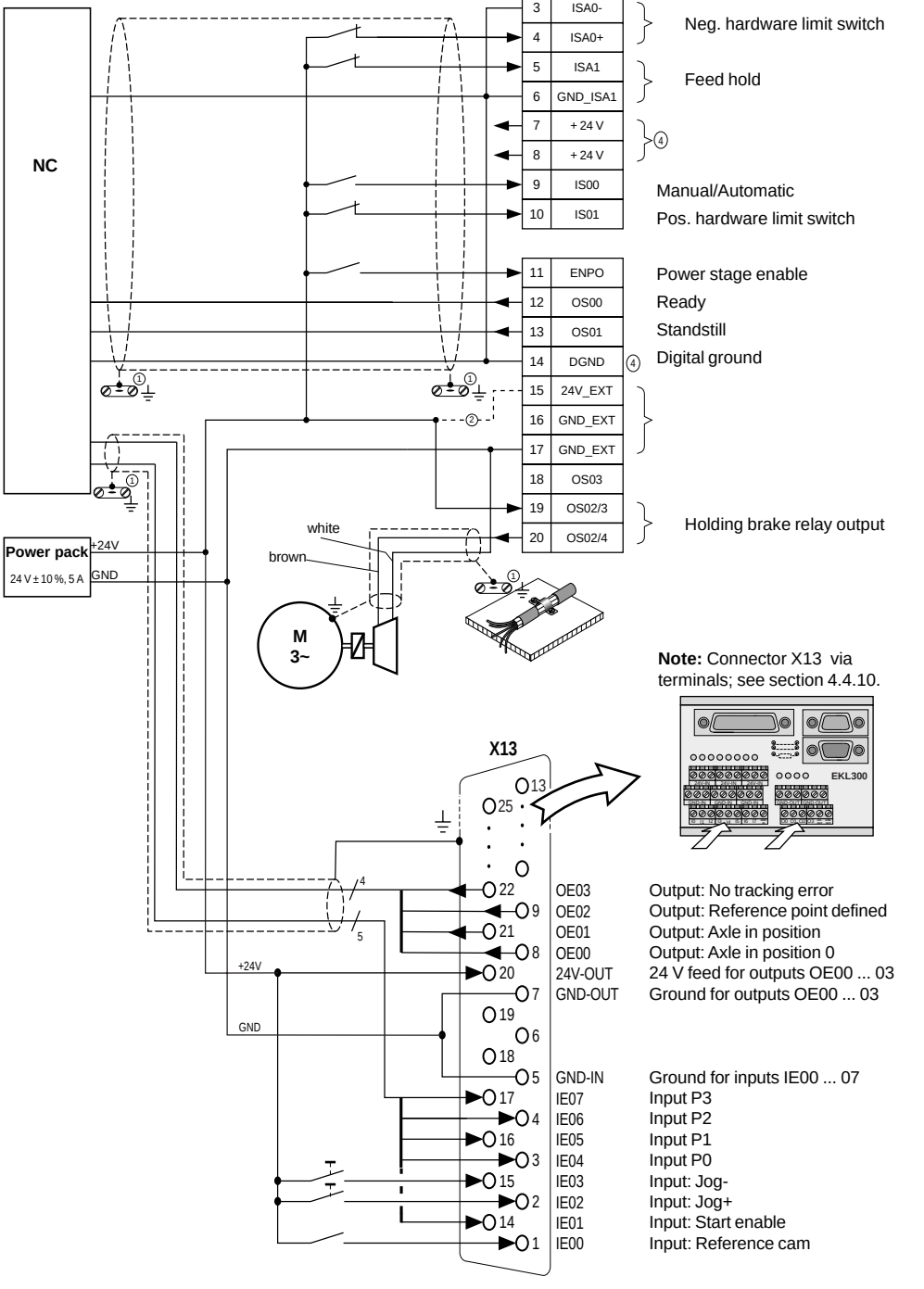
The units are:

- Destination position: Increments
- Velocity: min^{-1}
- Acceleration: $min^{-1}\ s^{-1}$

Wiring for point-to-point positioning



MOTION



Note: For specification of control terminals see Appendix A.4.

Neg. hardware limit switch

Feed hold

④

Manual/Automatic

Pos. hardware limit switch

Power stage enable

Ready

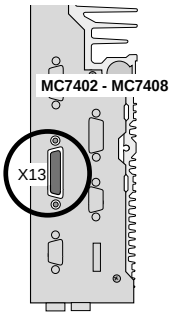
Standstill

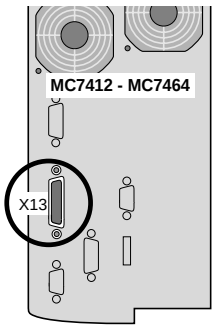
Digital ground

Holding brake relay output

Note: Connector X13 via terminals; see section 4.4.10.

OE03	Output: No tracking error
OE02	Output: Reference point defined
OE01	Output: Axle in position
OE00	Output: Axle in position 0
24V-OUT	24 V feed for outputs OE00 ... 03
GND-OUT	Ground for outputs OE00 ... 03
GND-IN	Ground for inputs IE00 ... 07
IE07	Input P3
IE06	Input P2
IE05	Input P1
IE04	Input P0
IE03	Input: Jog-
IE02	Input: Jog+
IE01	Input: Start enable
IE00	Input: Reference cam





① Ground all cable screens on both sides flat on housing using cable clamps!

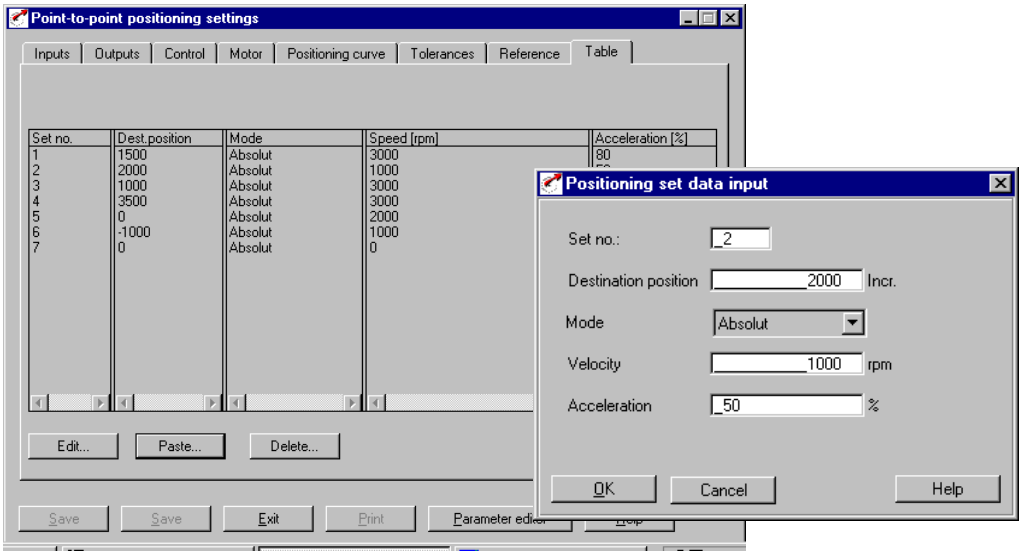
② Use control voltage connection only in version SN2 (external supply to control section)!
For technical data see Appendix A.4.

④ The internal 24 V of the servocontroller are used to supply the inputs and outputs on X5 (max. total load capacity 200 mA). When the power supply of the external E/As or the CAN interface is used, its isolation is removed.

2.6.1 Parameter setting for positioning sets

“Table” tab

By input in the form on the “Table” tab a maximum of 15 positioning sets can be programmed. The number of the positioning set at the same time corresponds to the binary code which must be set up at the control inputs P0 ... P3 to select the set in question. Parameters of data set numbers not used or programmed are set to zero, so no movement occurs.



Functions of the Buttons

- **"Save"** will transfer the data of the positioning sets into the temporary memory (RAM) of the device. These data are lost after power-off.
- **"Store"** will transfer the data of the positioning sets into the permanent memory (Flash-EPROM) of the device. These data are not erased after power-off.
- **"Parameter editor"** will activate the window to edit all parameters respective to the selected user level. Typically this is for advanced use.
  It is important to notice that you will be able to change parameters which do not belong to the current operation mode. A change of other parameters will lead to the abortion of the operation mode (warning message from the DRIVEMANAGER). When having aborted the operation it is only possible to edit parameters with the editor instead of the windows belonging to a particular operation mode.

Storing of positioning sets and general settings

- Data of positioning sets can not be stored on the SMARTCARD. This data have to be stored in the MC7000 or on your PC. In the menu **Active device - Store** (or Load) positioning sets you can transfer and store them on the respective device.
- The general settings for the point-to-point positioning can be stored separately in the same menu with **Store settings to** or **Load settings from**.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Destination position	Destination position of positioning set. In relative positioning this preceding sign determines the direction of rotation (pos.□→□↻, neg.□→□↺).One revolution on the motor shaft corresponds to 65536 increments (16 bits).	-2147.483.648 ... +2147.483.647 (± 32. 768 revs)	Incre-ments	Table	–
Mode*	Mode of positioning	Absolute Relative	–	Table	–
Speed	Positioning speed for this positioning set. In absolute and relative positioning the speed should always be given as a positive number, because the positioning direction is derived internally from comparison of the reference and actual positions.	0 ... motor nominal speed	rpm	Table	–
Acceleration*	Max. acceleration on startup and during braking for this positioning set.	0 ... 100% of the limit values set under the positioning curve.	%	Table	–

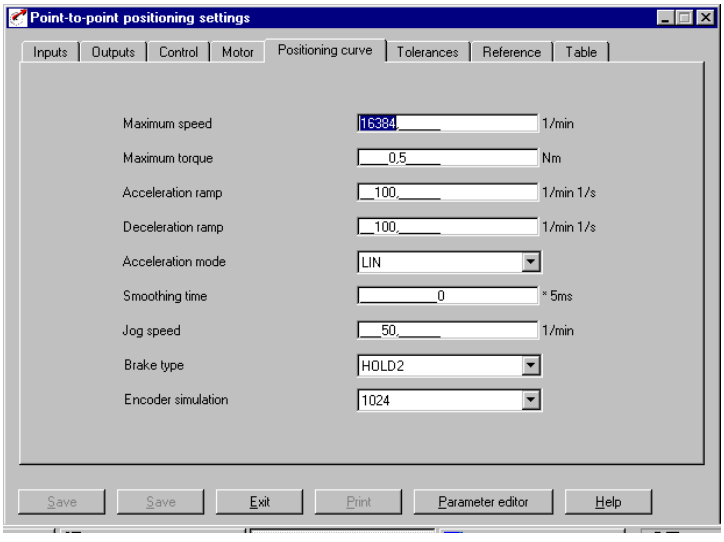
***Note:**
If the **Mode** or **Acceleration** parameters change between positioning sets, the ramp characteristics must be recalculated.
This may lead to additional response times of up to 90 ms.

2.6.2 Parameter setting for process values

"Positioning Curve" tab

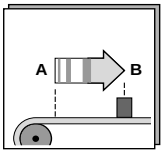
This is the input box in which all settings for the positioning curve are made.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Maximum speed*	Maximum permissible motor speed	1 ... motor nominal speed	rpm	Positioning curve	–
Maximum torque* adequately dimensioned)	Maximum permissible torque on the motor shaft	0 ... 4 x motor nominal torque (only if servo-controller is	Nm	Positioning curve	353-TCMMX (_TCON)
Acceleration ramp*	Maximum permissible acceleration	1 ... 65536	rpm s^{-1}	Positioning curve	–
Deceleration ramp*	Maximum permissible deceleration **Note:** Pay attention to braking chopper dimensioning (see chapter 4)	1 ... 65536	rpm s^{-1}	Positioning curve	–
Acceleration mode	Acceleration mode for Motion	lin - Linear ramps (dynamic) sin - Sinusoidal ramps (smoothed)	–	Positioning curve	–
Smoothing time*	Smoothing time of sinusoidal ramps (the longer the smoothing time the better the bucking limitation). The smoothing time extends the acceleration process, see also section 3.2	0 ... 2000	ms	Positioning curve	–
Jog speed	Speed of motor shaft in jog mode	0 ... 1000	rpm	Positioning curve	–



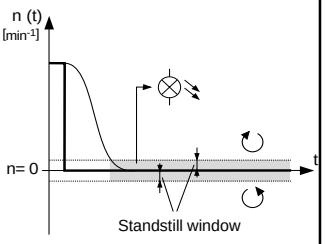
*Parameter also available in other operation modes; see chapter 3.

“Tolerances” tab

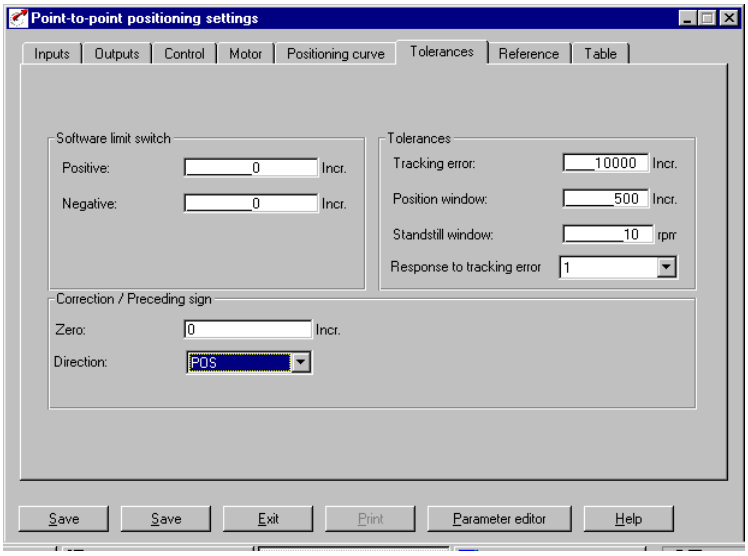


MOTION

This is the input box in which settings for software limit switches, position value hysteresis and count direction are made.

Software limit switch positive/negative	Setting of software switches in addition to the hardware switches. If both values are set to 0, monitoring is deactivated. The input value should be seen as the absolute position in increments from the reference point.	-2.147.483.648 ... +2.147.483.647	Incre-ments	Tolerances	–
Tracking error	Lag distance tolerance (difference between reference position and actual position in positioning). If the set value is exceeded, the controller shuts down with error message E-FLW.	0 ... 65535	Incre-ments	Tolerances	–
Positioning window*	Window for “Position reached” message.	0 ... 37768	Incre-ments	Tolerances	–
Standstill window*	Window for “Speed = 0” message. 	0 ... 20	rpm	Tolerances	401-SPD_0 (_CONF)

Note:
The settings for the positioning curve cannot be stored on SMARTCARD. They can only be created and archived by way of the DRIVEMANAGER PC user interface.



*Parameter also available in other operation modes; see chapter 3.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Response to tracking error	Response of servocontroller to error message "Tracking error"	2...5 (see section 3.6)	–	Tolerances	–
Zero correction	Offset value for actual position after reference run. Actual position is set equal to this value when reference run has been performed (for example see below).	-2 147.483.648 ... +2 147.483.647 (± 32.768 revs)	Increments	Tolerances	–
Direction	Setting of count direction. Default: pos. direction → ↻ motor shaft clockwise rotation. **Note:** If the "Direction" setting is changed the fact must be taken into account in the destination position setting.	Positive, negative	–	Tolerances	–

Example: Zero correction

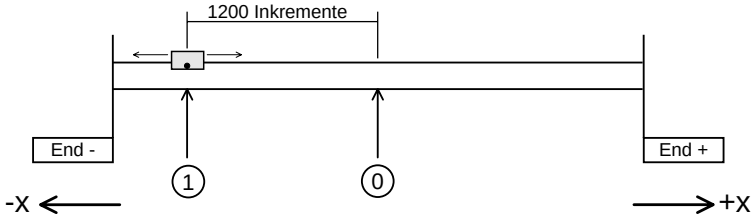
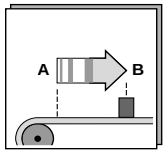
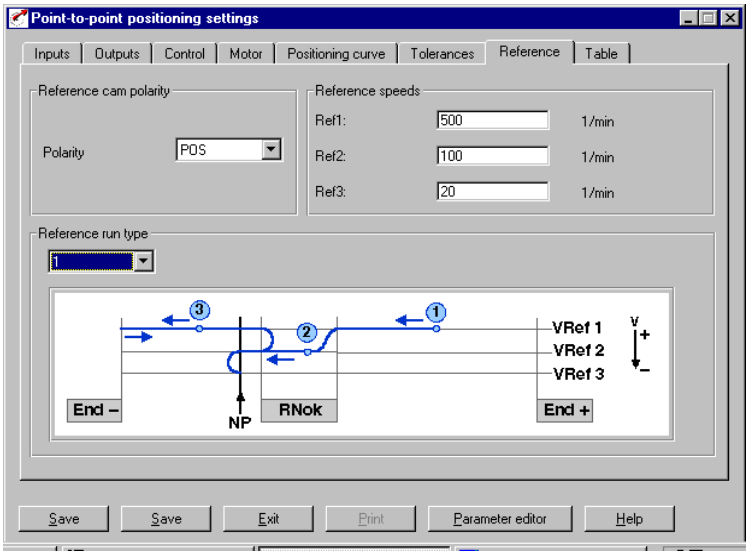


Diagram: Zero correction (0 = machine zero, 1 = reference point, i.e. current position after completed reference run).
*Thus the **zero correction** parameter = 1200 increments.*

"Reference" tab



MOTION



This is the input box in which the background conditions for a reference run are set.

Parameter	Meaning	Value range	Unit	Tabr	KeyPad
Reference cam polarity	Defines whether the reference cam operates as a break or make contact.	Positive = make contact negative = break contact	–	Reference	–
Reference speeds	Sets the positioning speeds during the reference run.	1 ... 1000	rpm	Reference	–
Reference run type	Sets the positioning curve during the reference run.	0 ... 9	–	Reference	–

Example: Reference run type 0

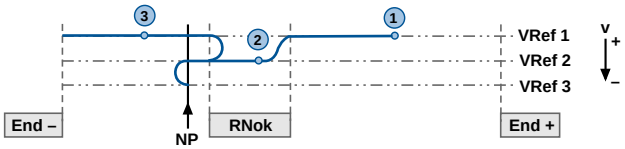


Diagram: *Reference run type 0. The actual position is defined as the reference point. An additional movement does not take place. Example: conveyor.*

Example: Reference run type 1

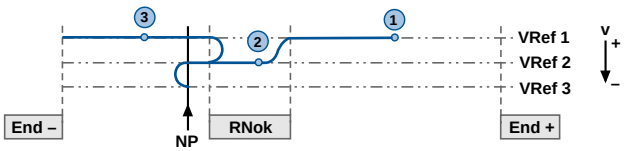


Diagram: *Reference run type 1. The reference cam is located between the two hardware limit switches. The zero pulse to be evaluated is to be the first one after the cam in negative direction.*

2.6.3 Jog mode via terminals

Jog mode via terminals can only be used in manual operation (input IS00 = Low) and when the user interface “Control” window is not open.

The inputs JOG+ (IE02) and JOG- (IE03) are provided for operation.

When one of these inputs is activated the axle moves at the jog speed set under “Process values”.

When the input is deactivated the axle is stopped with the deceleration ramp set under “Process values”.

2.6.4 Referencing

A reference run based on the parameters set under the “Process Values” tab can be requested by way of the **Control** menu in the user interface or in automatic mode (IS00 = High) by setting input IE01 at control inputs P0 - P3 = 0.

In automatic mode the code for positioning set 0 must be present at the “Pos” inputs for this to happen. A reference run can only be aborted by deactivation of the hardware enable (input ENPO).

In the reference run a position is approached, dependent on the switching edge of the reference cam, at which the encoder system used delivers a zero pulse or the position value 0. Optical encoder systems deliver a zero pulse once per motor revolution. Resolvers deliver this value more than once in a motor revolution, dependent on their number of pole pairs (for example, a 3-pair resolver R8 delivers three zero points per revolution).

The reference run can also be made without making note of the zero pulse, to the reference cam only (parameter 592-POZP "Evaluate zero pulse").

Note:

If the encoder zero and the switching edge of the cam are very close together, it may be that the zero is not always correctly detected (adjacent zero points are approached). A remedy is offered by mechanical shifting of the reference cam.

Positioning set 0 is used to request a reference run, its parameters are not set.

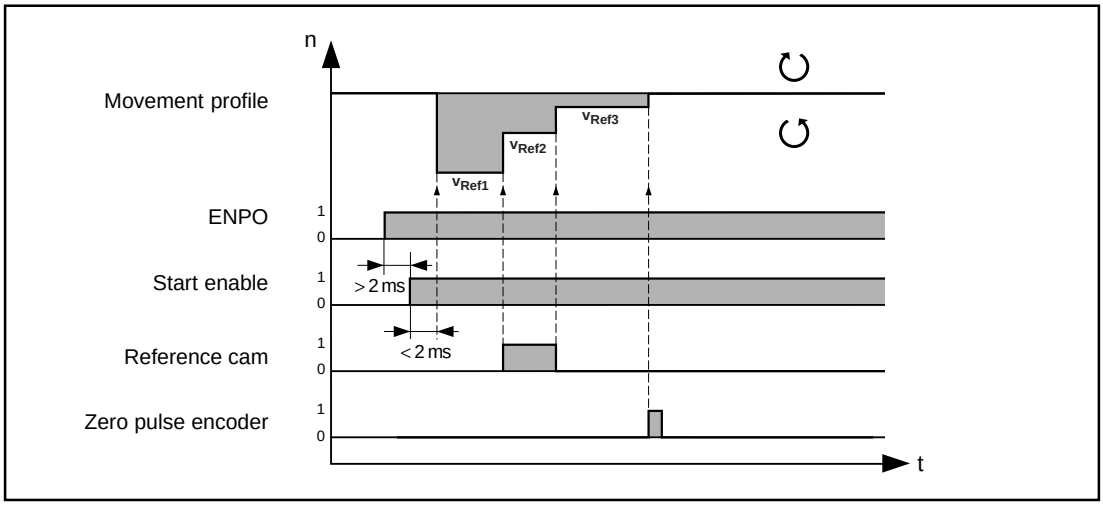
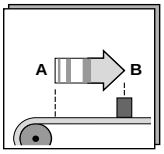


Diagram: Progression of a reference run over time (example for rerference run type 1 with left run)

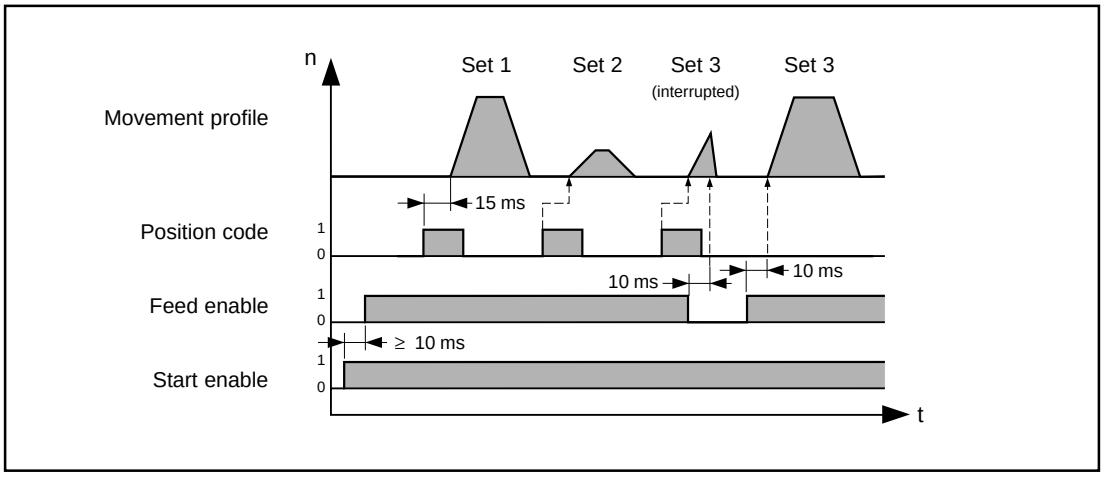
2.6.5 Feed hold



MOTION

The “Feed hold” digital input is a general enable for movements of the axle; that is, the axle can only be moved when this input is activated with 24 V.

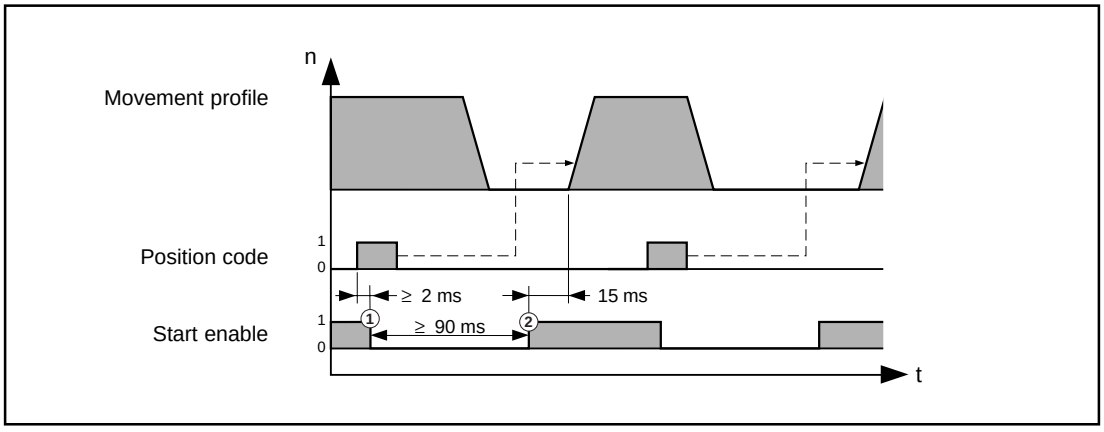
- An ongoing positioning operation is interrupted with the high/low edge and the programmed braking ramp, and is resumed after a low/high edge.
- After a switch from manual to automatic mode the “Feed hold” input must have a low/high edge to start the positioning.



2.6.6 Start enable

Selection of a positioning set: With a high/low edge change at the “Start enable” input the binary code currently applied at the position inputs IE04 to IE07 (P0 to P3) is adopted.

Start of positioning: the subsequent low/high edge change releases the positioning set for positioning.



Note:

When a positioning set has already been selected it must be worked through. It is not possible simply to change the positioning set number.

A selected positioning set can be deleted, however, by selecting “Manual” by means of input IS00. Before returning to “Automatic” afterward, the relevant code must be applied to the position inputs. When the positioning program is in Automatic mode again, the “Feed hold” input must be supplied with a low/high edge (see section 2.6.5).

2.6.7 Control via DriveManager

The axle can be controlled by way of the DriveManager by selecting **Active device - Control - Point-to-point positioning**. The “Control” function can only be used in Manual mode (IS00 = Low) and when the jog inputs are inactive. In this input box the jog, reference run request and direct positioning functions can be used.

Jog mode:

Choose “Jog+” or “Jog-” as appropriate to move the axle at jog speed.

Reference run:

Choose the “Reference” button to request a reference run. The reference run can only be stopped by deactivating the power stage enable ENPO!

Position:

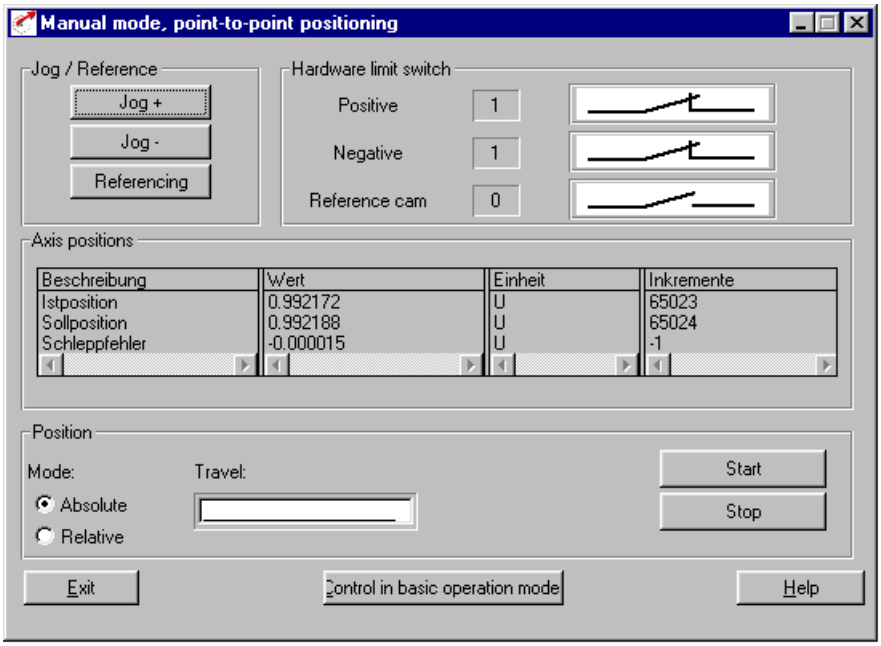
Here a position (absolute/relative) can be set which is approached automatically at jog speed when you choose the “Start” button. The “Stop” button stops an ongoing movement.

Actual value display:

The actual value display delivers the status of the hardware limit switches and of the reference cam. Also, the actual and reference positions as well as the lag distance are displayed cyclically in increments and motor revolutions.

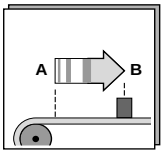
Note:

When the “Control” window is active you cannot switch to Automatic mode or Jog mode via terminals.



The positions and the tracking error are displayed in revolutions and increments.

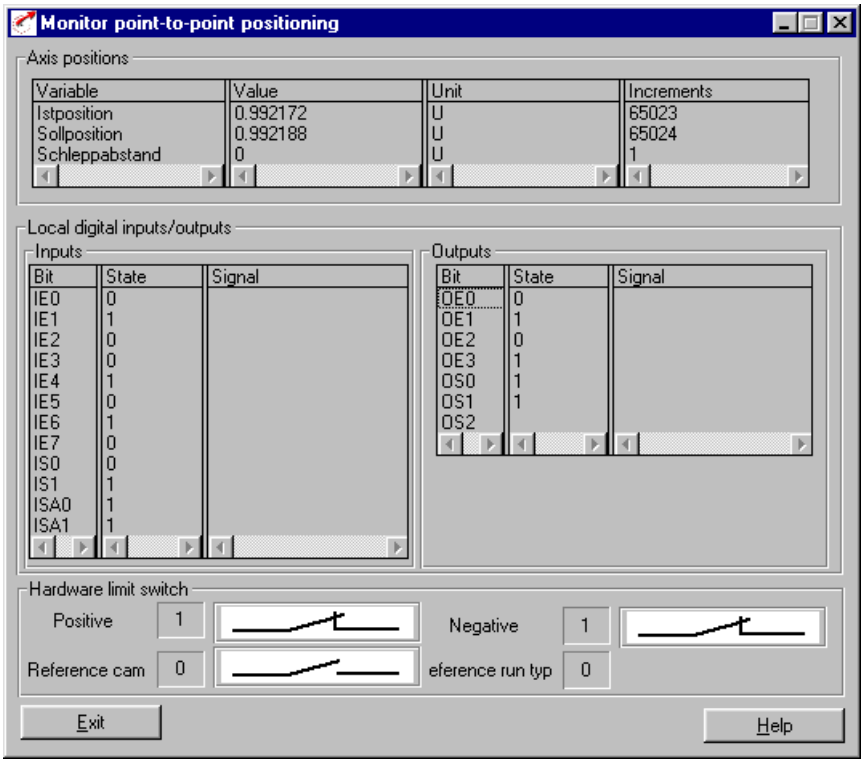
2.6.8 Monitoring via DRIVEMANAGER



MOTION

The status display can be called up at any time. The window cyclically displays status information relating to the actual and reference positions and the lag distance in motor revolutions and increments.

The states of the inputs and outputs are also displayed.



Resetting of errors

In the operation mode point-to-point the error messages are acknowledged with a rising edge on the Manual/Auto input (IS00).

2.6.9 Normal mode

Normal mode means that the axle parameters are all set and the axle is actuated via the digital inputs.

Normal mode is activated by connecting 24 V to input IS00 “Manual/Automatic”, and remains active until that signal is removed.

Actuation

Actuation is possible in Automatic mode only by way of the “Feed hold” and “Start enable” inputs and the four position inputs (see sections 2.6.5 and 2.6.6).

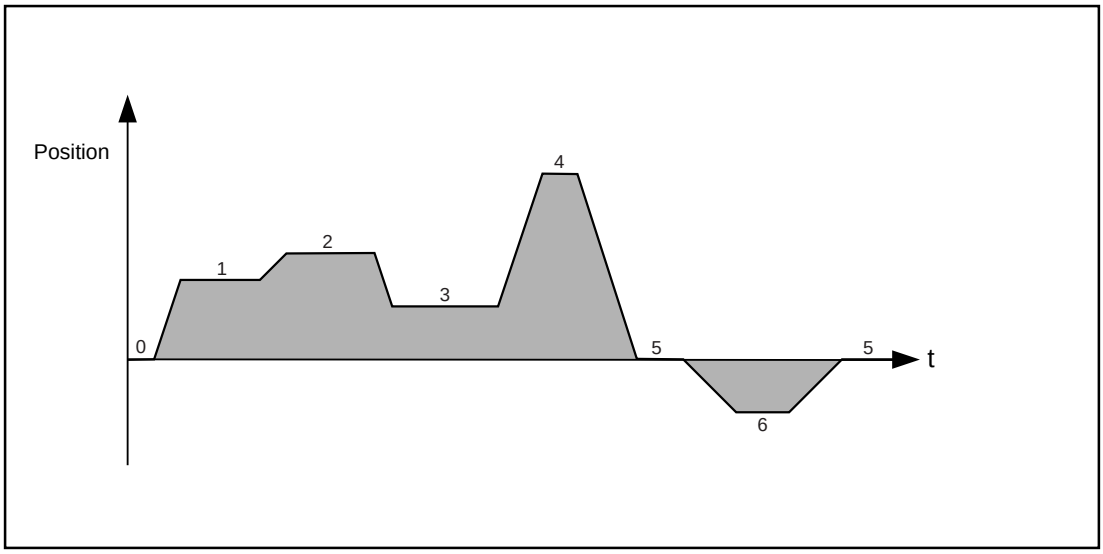
Selection of positioning sets:

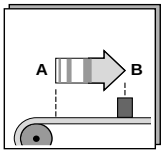
Set no.	P3	P2	P1	P0	
0	0	0	0	0	= Reference run
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	
:	:	:	:	:	
15	1	1	1	1	

A reference run can be requested by setting the “Start enable” input. With reference run type 0 the request causes the current actual position to be adopted as the reference point. When a reference run is requested an ongoing positioning operation is aborted. After a re-initialization (power-on) a reference run must first be requested before a positioning set can be requested.

2.6.10 Examples of point-to-point positioning

Example 1: Point-to-point positioning with absolute values





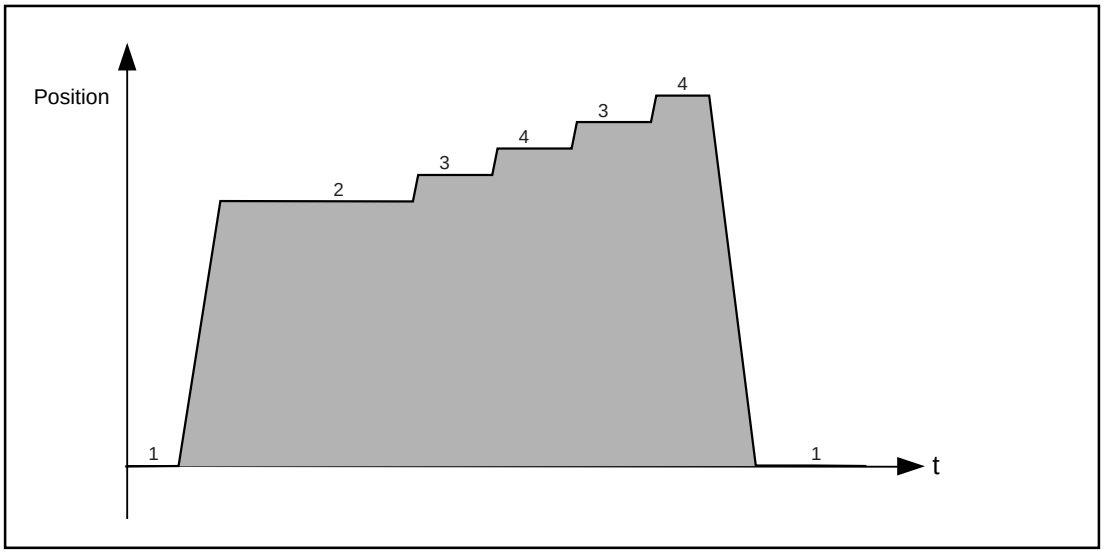
MOTION

Positioning set table:

Set no.	Destination pos.	Mode	Speed	Acceleration
1	1500	Absolute	3000	80%
2	2000	Absolute	1000	50%
3	1000	Absolute	3000	100%
4	3500	Absolute	3000	50%
5	0	Absolute	3000	50%
6	-1000	Absolute	1000	50%
7	0	Absolute	0	0
:	:	:	:	:

Example 2: Point-to-point positioning with relative destination position

Task: Starting from an absolute position, further positioning is to be relative only.



Positioning set table:

Set no.	Destination pos.	Mode	Speed	Acceleration
1	0	Absolute	3000	100%
2	1000	Absolute	3000	100%
3	100	Relative	3000	100%
4	100	Relative	3000	100%
5	0	0	0	0%
:	0	0	0	0%

Example 3: Referencing

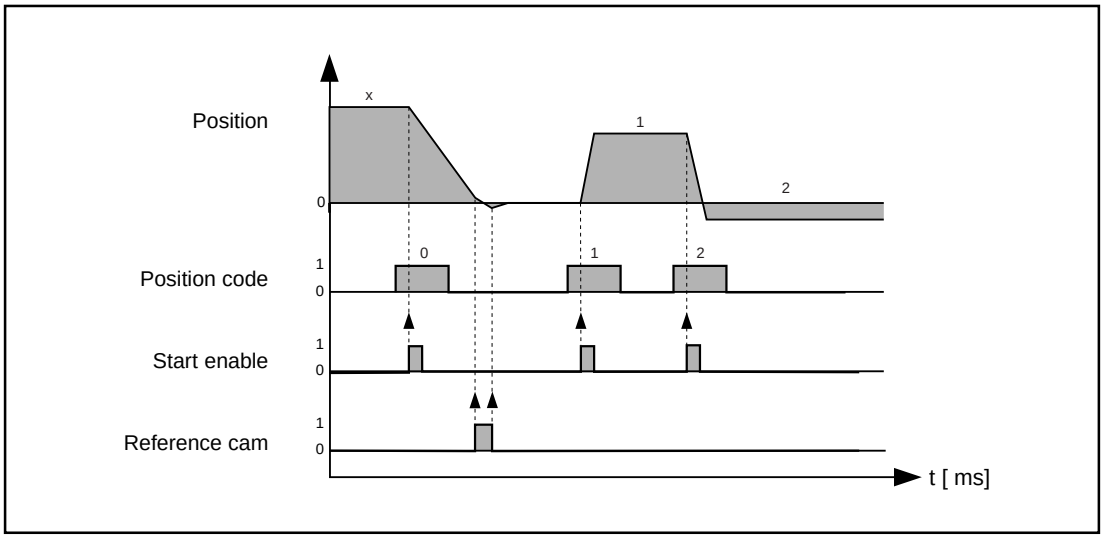


Diagram: Referencing operation with reference run type 1. The reference cam is searched for in negative direction from the current position x.

3 Functions

Overview of functions

1. Standard functions
   - Limitation of maximum speed
   - Limitation of motor torque
   - Output: Standstill
   - Output: Reference reached
   - Autostart
2. Linear and sinusoidal speed ramps
3. Parameter-controllable encoder simulation
4. Brake actuation
5. Torque reduction
6. Functions for the stepper motor, electronic gearing and point-to-point positioning modes
   - Limit switch evaluation
   - Output: Axle in position
   - Response to tracking error

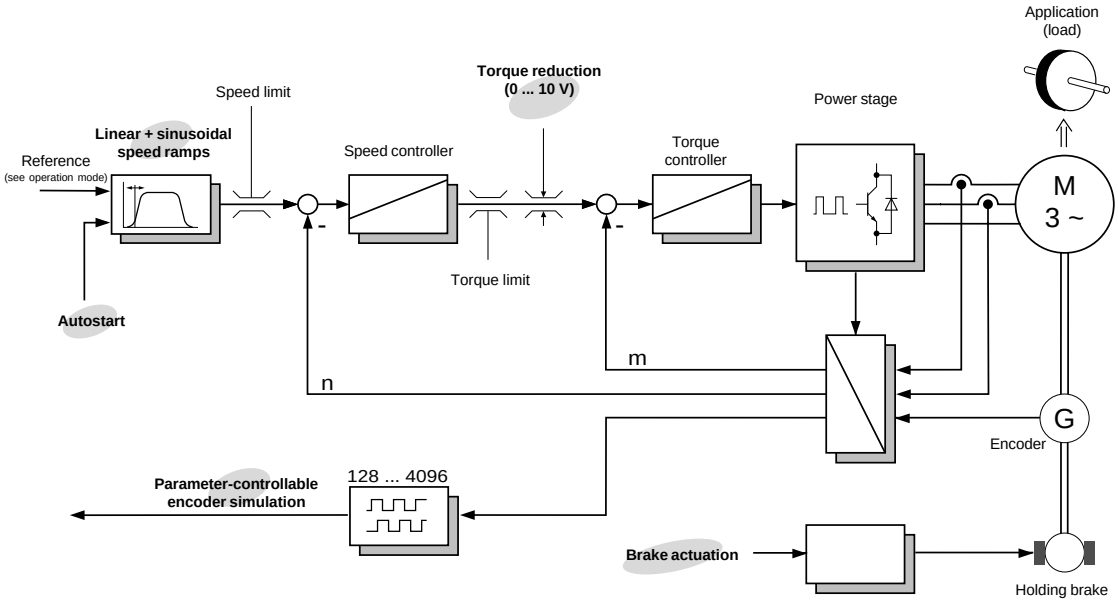


Diagram: Block diagram of interaction of functions

3.1 Standard functions

Limitation of maximum speed

For all operation modes.

To protect the machine, the maximum speed of the drive can be limited by the parameter **Maximum speed** SCSMX. The limitation is in both directions.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Maximum speed	Maximum achievable speed	0 ... maximum motor speed	rpm	Application	384-SCSMX (_SCON)

Limitation of maximum torque

For all operation modes.

The maximum torque of the motor can be limited to a fixed value by the parameter **Maximum torque** TCMMX. The limitation is in both positive and negative directions.

The value range of the **Maximum torque** parameter is dependent on the maximum permissible torque of the motor and on the maximum output current of the servocontroller. If the **Maximum torque** parameter is selected too high, it is automatically limited to the maximum possible value.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Maximum torque	Maximum achievable torque	0 ... maximum motor torque, if permitted by the maximum controller output current.	Nm	Application	353-TCMMX (_TCON)

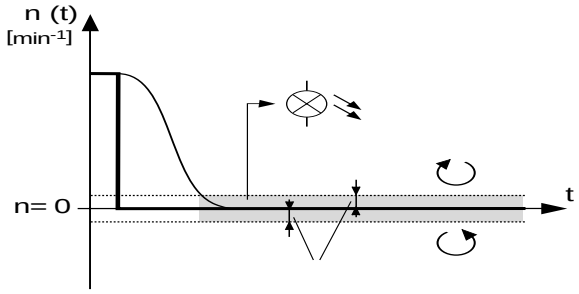
For applications in which the maximum torque is to be dynamically adapted during operation, there is the “Torque reduction” function (see section 3.4).

Output: Standstill

For all operation modes.

When the motor is under current and the actual speed is lower than the **Standstill window** parameter, a 24 V level is applied to the “Standstill” output.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Standstill window	Window for “Speed = 0” message	0.02...20	rpm	Tolerances	401-SPD_0 (_CONF)



Explanation:

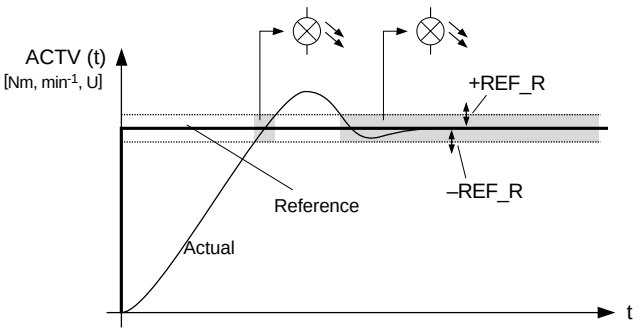
Even the shaft is at standstill the active controller will vary the speed minute. A stable ‘zero speed’ signal will be achieved when the limits are bigger than these speed variations.

Output: Reference reached

For all operation modes in speed and torque control.

If the difference between the actual and reference positions is less than the **Reference window** parameter, a 24 V level is applied to the “Reference reached” output.

Parameter	Meaning	Value range	Unit	Tab	KeyPad
Reference window	Window for “Reference reached” message	0...5 Nm 0...100 rpm	rpm, Nm, depen-dent on the set mode	Application	860-REF_R (_CONF)



Autostart

For all operation modes except point-to-point positioning.

In some applications it may be necessary to activate control automatically when power is connected, without a positive edge at the start input.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Autostart	Control is activated automatically after power-on (also after short-time power failure) if the start signal is additionally present. A positive edge at the start input is not necessary. **Note:** The input ENPO must be set (power stage enable).	ON, OFF	–	Application	7-AUTO (_CONF)

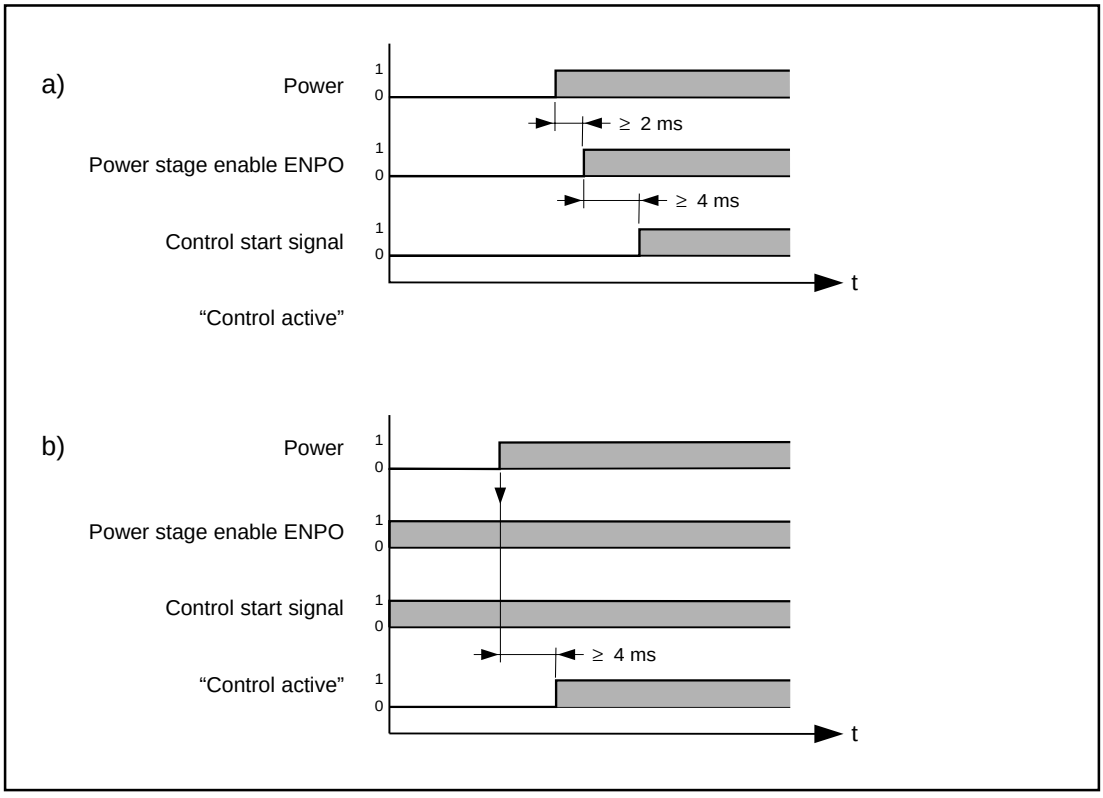


Diagram: Start-up a) without autostart (normal) and b) with autostart

Note:

In point-to-point positioning mode the axle starts automatically when the Manual/Automatic and Feed Hold inputs are set.

3.2 Linear and sinusoidal speed ramps

The MC7000 has a ramp generator which is able to generate linear speed ramps for highly dynamic movements and sinusoidal speed ramps for particularly low-stress movements.

The sinusoidal acceleration ramps are created by limiting the change in time of the acceleration, the buck. This means that no acceleration surges, and thus no force surges, act on the mechanism of the machine, resulting in the following benefits:

- The mechanism vibrates less.
- The material fatigue due to load change is reduced.
- The mechanisms subject to play exhibit less excursion.

As a result of the bucking limitation the acceleration and deceleration times increase by the smoothing time (see diagram). A quick stop (emergency stop) is always effected with the parameter-specific stop ramp STOPR without bucking limitation (linear), in order to keep the braking duration to a minimum.

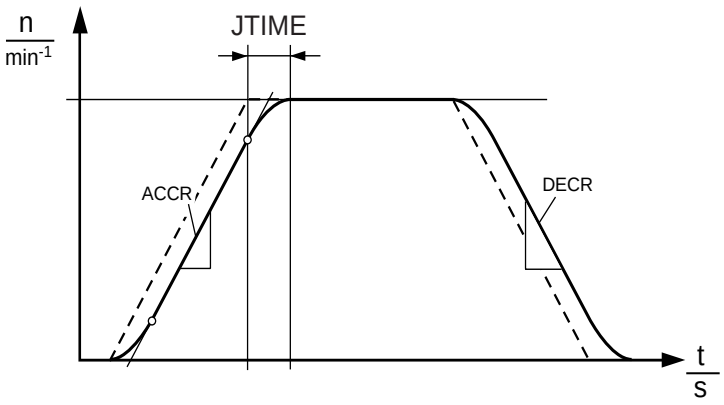


Diagram: Ramp generator with sinusoidal speed ramps

842-ACCR:	Linear acceleration ramp
852-DECR:	Linear deceleration ramp
856-JTIME:	Smoothing time
Dotted line:	Ramps without smoothing time (JTIME = 0)

Note:

- Reaching of the final speed is delayed by precisely the smoothing time.
- In positioning operations the destination is reached precisely the smoothing time later.

A note on operation in field weakening range:

Asynchronous machines can be operated with the MC7000 in any speed-controlled mode, including above the nominal speed in the field weakening range (FWR). One exception is the operation mode with external position control: operation in the FWR is of no benefit in most applications, because the dynamics are reduced in the FWR.

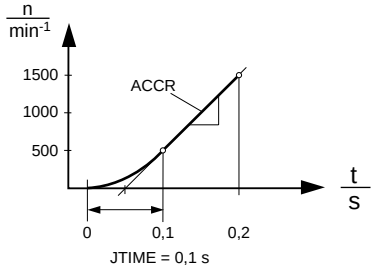
Parameter setting for the speed ramps

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Acceleration ramp	Acceleration ramp of the ramp generator. If the acceleration ramp is set very steep (≥ 5000 rpm s^{-1}), it has practically no effect. The drive then accelerates with maximum torque. The entire ramp generator function can be deactivated by acceleration ramp = 0 or deceleration ramp = 0.	0 ... 65535	rpm s^{-1}	Application	842-ACCR (_REF)

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Deceleration ramp	Deceleration ramp of the ramp generator. If the deceleration ramp is set very steep (≥ 5000 rpm s^{-1}), it has practically no effect. The drive then brakes with maximum torque.	0 ... 65535	rpm s^{-1}	Application	852-DECR (_REF)

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Smoothing time	For the sake of clarity, parameters are set not for the buck itself, but for the smoothing time. This is the time for the rise in acceleration from zero to the value of the acceleration or deceleration ramp. Smoothing time = 0 deactivates the bucking limitation.	0 ... 2000	ms	Application	856-JTIME (_REF)

Example: Acceleration ramp ACCR = 1000 rpm s-1, smoothing time JTIME = 100 ms

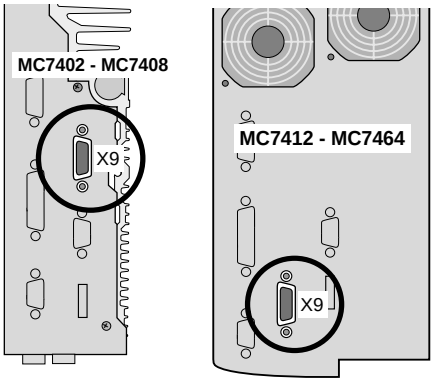


Hinweis: Stop ramp (quick stop) see section 3.4.

3.3 Parameter-controllable encoder simulation

The MC7000 has an encoder simulation (X9) which simulates an incremental encoder with square signals.

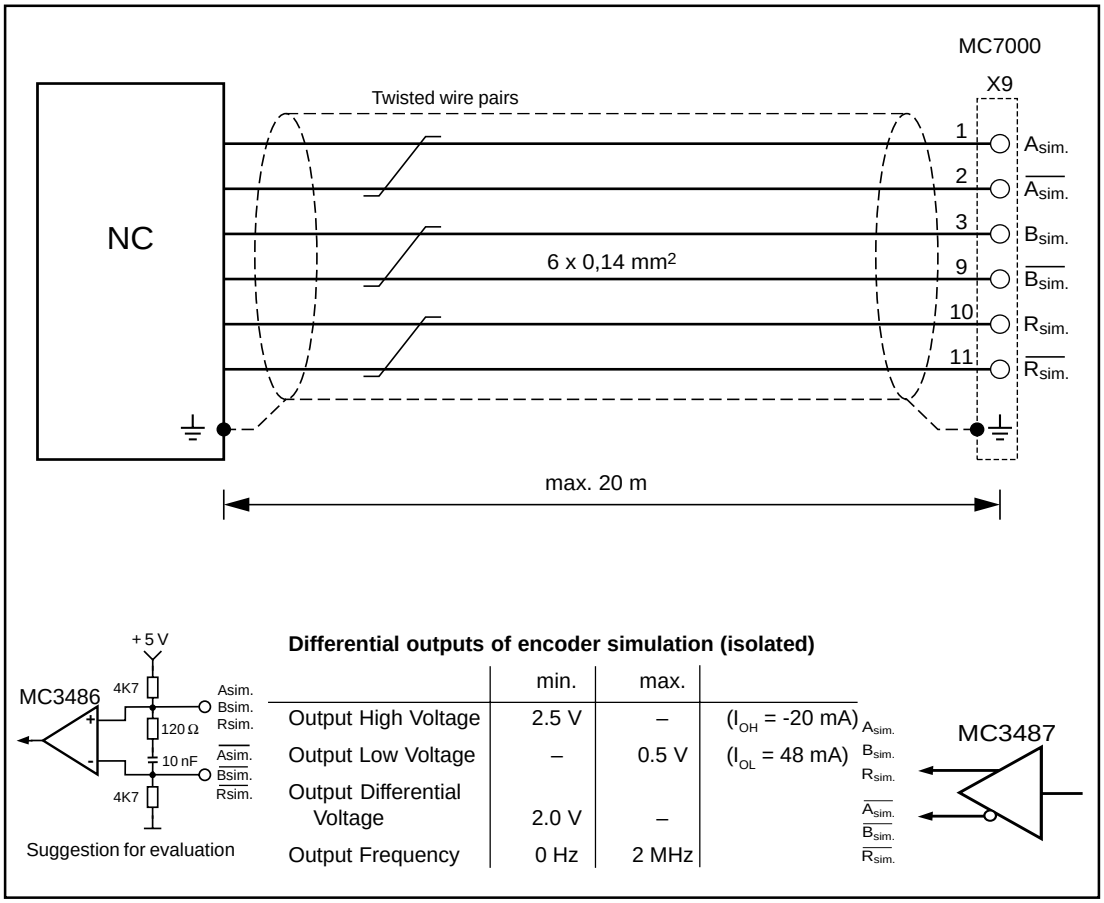
The encoder simulation can be used directly by a controller to register the axle position and for position control. The encoder simulation signals are isolated.



If a motor with a **resolver Rx** is used, the encoder simulation in its default setting delivers 1024 increments per pole pair of the resolver. For a resolver of type R8 with three pole pairs (p = 3), that means 3072 increments per revolution.

Where an **optical encoder G1-G5** is used, the number of lines per revolution of the encoder simulation is the same as that of the encoder (not adjustable).

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Lines per revolution of encoder simulation	Lines per revolution of encoder simulation (adjustable only for resolvers)	p · 128, p · 256, p · 512, p · 1024, p · 2048, p · 4096	1 / rev.	Application	13-ECSLN (_ENCD)



Differential outputs of encoder simulation (isolated)

	min.	max.	
Output High Voltage	2.5 V	–	(I_{OH} = -20 mA)
Output Low Voltage	–	0.5 V	(I_{OL} = 48 mA)
Output Differential Voltage	2.0 V	–	
Output Frequency	0 Hz	2 MHz	

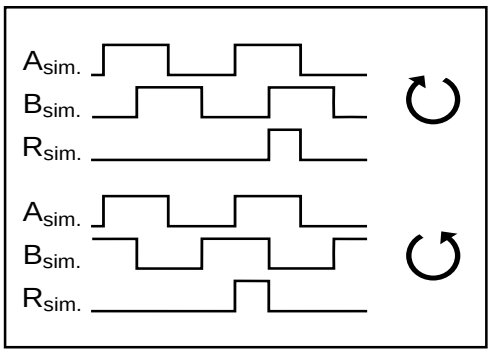


Diagram: *Encoder simulation signals with view onto the motor shaft (at top when motor running clockwise).*
The levels conform to the RS422 standard.

Technical data of resolution

Type of encoder	Resolvers			Optical encoders	
Design code of encoder evaluation	Standard			D2	
Encoder at X10	R1	R2	R8	G1	G2, G3, G5[1)]
Number of pole pairs (for resolvers only)	p = 1	p = 2	p = 3	–	–
Resolution of encoder evaluation [2)]:					
Increments per revolution	2^{14}	2^{15}	3 x 2^{14}	2^{25}	
Degrees	0.022°	0.011°	0.0073°	0.000011°	
Encoder at X9:					
Standard pulses per revolution	1024	2048	3072 (adjustable from p · 128 to p · 4096)	2048	2048
Zero pulses per revolution	1	2	3	1	0 (!)

1) Encoder G5 is the successor to type G2: electrically and mechanically compatible, but different SmartCard required

2) Higher resolutions of encoder evaluation result in higher speed resolutions and so smoother running of the drive.
The resolution of the position controller is 16-bit, irrespective of the encoder used.

Note:

The controller connected to the encoder simulation must be able to process its output frequencies.

Example: $f = \frac{3000\ \text{rpm} \cdot 2048\ \text{pulses}}{60\ \text{rpm}} = 102.4\ \text{kHz}.$

3.4 Brake actuation

A holding brake built into the motor provides protection against unintentional movement of the axle when the controller power is off. In the event of a fault it also offers the possibility of braking to a stop and holding the axle without a controller.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Standstill window	Window for “Standstill” message (speed range around speed 0 rpm)	0.02 ... 20	rpm	Application	401-SPD_0 (_CONF)
Stop ramp	Stop ramp for braking in normal mode and in case of fault. Stop ramp = 0 deactivates the ramp, i.e. the motor is braked at **maximum torque** (TCMMX).	0 ... 65.536	rpm s^{-1}	Application	496-STOPR (_REF)
Brake control overlap time	This is the period of time starting from the “Standstill” message until the controller is shut off. During this time the controller is active and the brake engaged.	100 ... 2000	ms	Application	467-THTDC (_CONF)

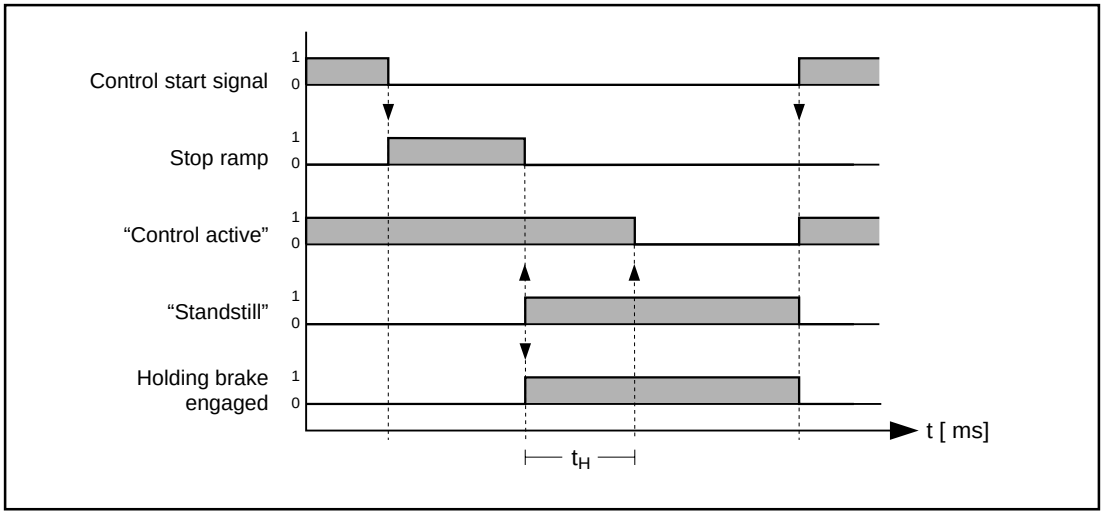


Diagram: Braking in normal mode by cancellation of the start signal

In HOLD1 and HOLD2 modes the holding brake is engaged when the speed enters the standstill window. When the holding time t_H has elapsed the controller is shut off. Setting the controller enable (start) releases the holding brake.

Note:

The holding brake is not designed as a service brake; that is, the brake is always switched on and off when the motor is at a standstill.

If the holding brake is to be used as an emergency brake, observe the permissible lifetime switching capacity of the brake (see MASTERDRIVE data specification). As a rule of thumb, the brake will be worn out after around 20,00 revolutions of the motor with the brake on.

Braking in event of fault

The brake is actuated dependent on the Holding brake mode parameter.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Holding brake mode	See time diagrams	HOLD1, HOLD2	–	Application	465-BRAKE (_CONF)

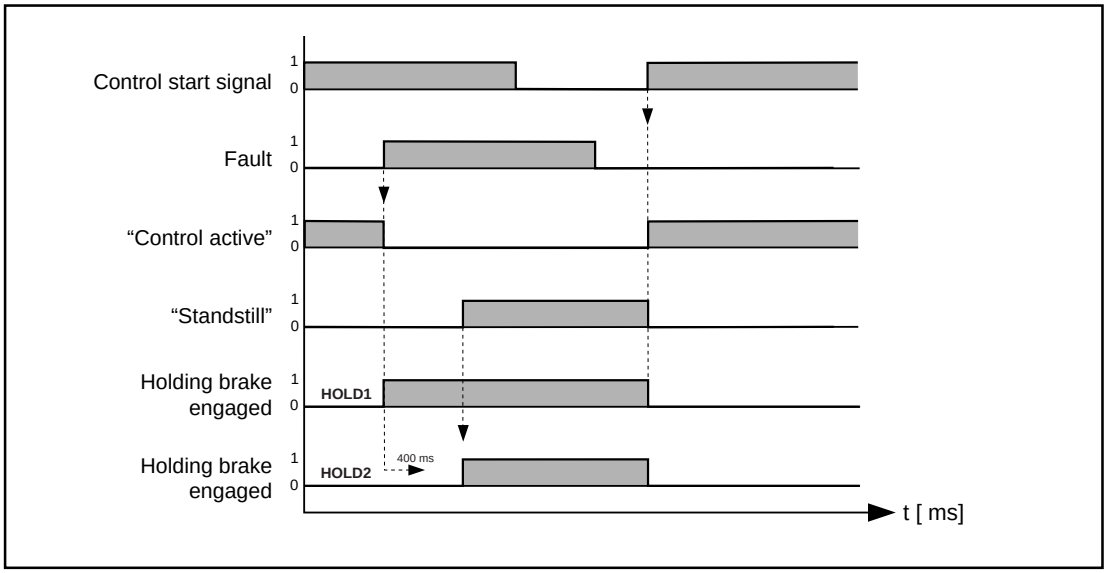


Diagram: Braking in event of a fault leading to deactivation of the power stage (Fault responses 1, 3 and 5; see Appendix C.3)

In **HOLD1 mode** the holding brake is engaged immediately when a fault occurs.

In **HOLD2 mode** the holding brake is engaged in the event of a fault when the speed enters the standstill window. If this has not happened after 400 ms, the brake engages anyway. Setting the controller enable (start) releases the holding brake.

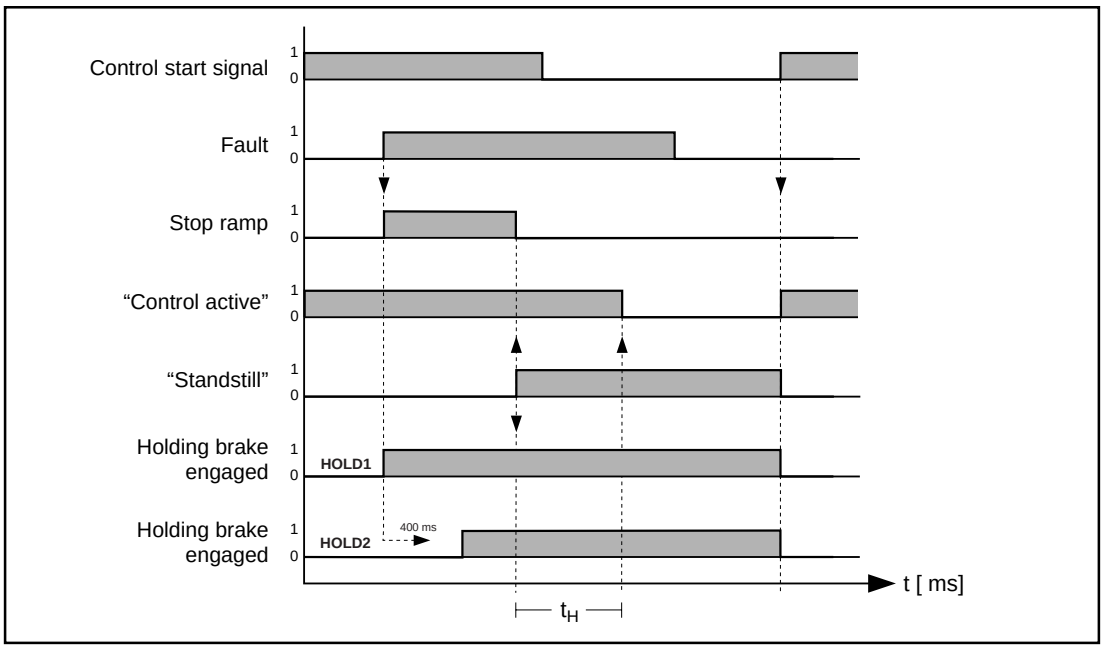
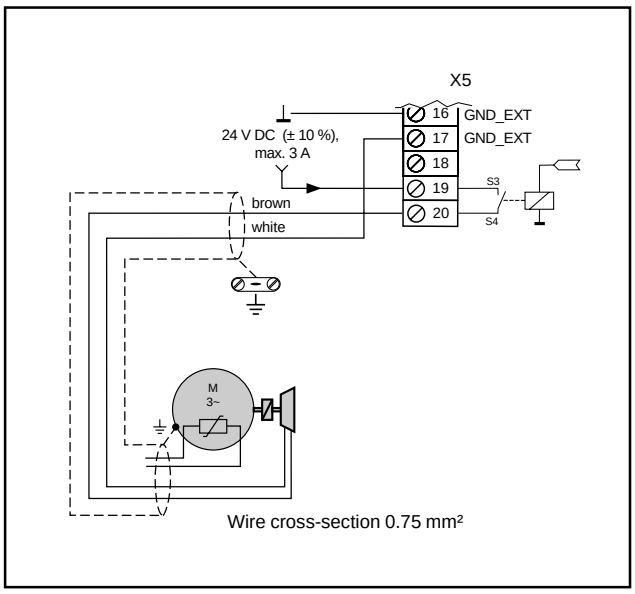


Diagram: Braking in event of a fault triggering a quick-stop (Fault responses 2 and 4; see Appendix C.3)

Connection of the holding brake

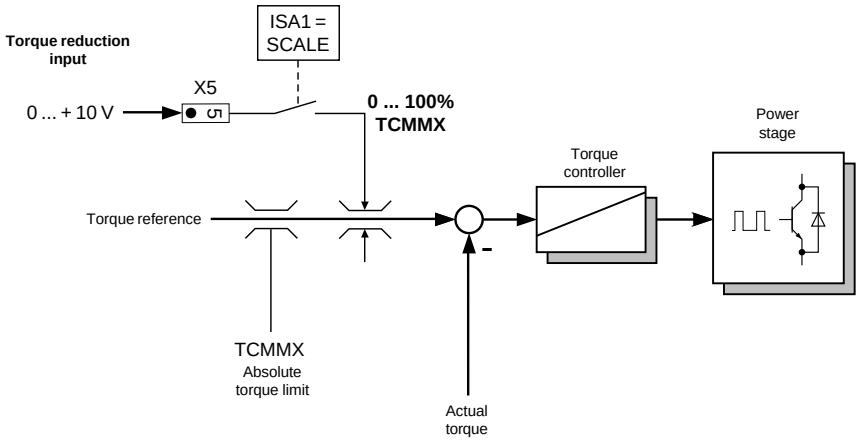


Note:

When the drive is being braked the motor returns energy to the servocontroller. This energy is converted into heat by the internal or external braking resistor. Check that the braking resistor is able to discharge the heat permanently for the braking power arising in a positioning cycle (see section 4.4.4).

3.5 Torque reduction

Some applications require the maximum permissible torque to be adjusted online during operation. With the torque reduction function (“SCALE function”) the maximum torque TCMMX can be adjusted in percentage terms by way of the analog input ISA1.



Parameter	Meaning	Value range	Unit	Tab	KeyPad
Analog input ISA1	In the SCALE setting the **maximum torque** TCMMX can be adjusted online. 0 V = 0 Nm 10 V = max. torque TCMMX	SCALE	–	Inputs/ outputs	442-FISA1 (_CONF)

Note:

- The torque reduction function limits the reference torque; that is to say, the torque generated by the servocontroller. Dynamic forces from the moment of inertia of the load may additionally act on the motor shaft.
- When the torque reduction is active it also takes effect in the event of a quick-stop!
- For operation via field bus: The maximum torque 0 ... 100 % can be typed into parameter 139-SCALE as a numeric value (no analog signal).

3.6 Functions for the stepper motor, electronic gearing and point-to-point positioning modes

Limit switch evaluation

The two inputs ISA0 and ISO1 are intended to be used for evaluation of hardware limit switches. If there are no limit switches in the application, these terminals must be set to 24 V potential. The directional dependency of the inputs must always be observed. When it runs over a limit switch the axle stops with the torque set under the “Process values” tab and delivers an error message.

The axle can be released again in jog mode.

Output: Axle in position

The “Axle in position” output indicates that the axle is at its reference position.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Position window	If the difference between the actual and reference positions is less than the position window, a 24 V level is applied to the “Axle in position” output.	0...32763	Incre-ments	Tolerances	520-POWIN (_PMOD)

Response to tracking error

If the axle is outside the positioning window, the term positional, or tracking, error is also applied. The response to a tracking error (E-FLW) can be set to take account of the individual characteristics of the machine.

Parameter	Meaning	Value range	Unit	Tab	KEYPAD
Tracking error	If the difference between the actual and reference positions is larger than this value, a 0 V level is applied to the “Axle in position” output and the following reaction is released:	0...	Incre-ments	Tolerances	308-PDMX (_PCON)
Reaction on tracking error	0 = signal warning only 1 = signal error and disable power stage 2 = signal error, quick stop and wait for cancellation of start signal	0...2	–	Tolerances	59-R-FLW (_SCTY)

Note:

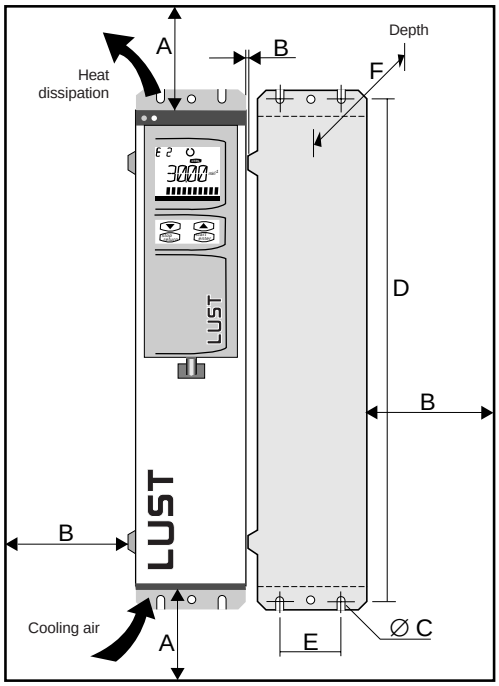
To switch-off the tracking error practically enter a setting of i.e. 327680 (matching 5 revolutions) for the parameter ‘tracking error’.

4 Installation of the drive system

Installation and commissioning must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures!

4.1 Mechanical installation of the servocontroller

- **Mount the servocontroller vertically in a switch cabinet.**



EMC

The servocontroller must be mounted on a **metal mounting plate**. The rear panel of the device must have **good, wide-area contact** with the mounting plate; use scratchy disks where necessary. Use of a HF-screened cabinet with a chrome-plated or galvanized mounting plate offers the best means of EMC installation.

Cooling

The **size of cabinet** required depends, among other factors, on the power loss of the servocontrollers (see Appendix A.3).

The **top and bottom clearances** must always be maintained.

It is permitted to arrange a number of devices **adjacent to each other** without mounting clearances (for exception see table below).

Mounting clearances (for full dimensional drawing see Appendix A.3):

	MC7402	MC7404	MC7408	MC7412	MC7416	MC7432	MC7464
A	≥ 100 mm			≥ 150 mm			
B	0 mm			0 mm / 20 mm [1)]			
C	∅ 4.8			∅ 5.8	∅ 7		
D	315			345	425		
E	40			100	150		240
F	260			260	290		

[1)] Exceptions B = 20 mm: • to other devices or
• to servocontrollers with other power outputs, e.g. 1 x MC7412, 1 x MC7416

Make sure that

- no moisture gets into the device;
- no aggressive or conductive materials are in the immediate vicinity;
- no foreign matter such as metal swarf or screws fall into the device;
- the vent openings on the top are never covered over.

The device may otherwise be destroyed.

4.2 Mechanical installation of the motor

- **Mount the servomotor in your system or machine.**
  - You should, where possible, wait until after commissioning before mounting the output elements (toothed wheels, pulleys, couplings etc.), in order to be able to carry out tests without having to move parts of the system or machine.

Note:

Suitable devices should be used to mount and remove the output elements - the support elements should be installed on the drive end of the shaft.

Observe the permissible axial and lateral forces for the motor shaft according to the "MASTERDRIVE Technical Data" specification.

Caution! The motor contains sensitive mechanical components!

Never strike the motor shaft or the drive-side shaft end with a hammer or any similar implement!

4.3 Preparing electrical installation

Installation and commissioning must only be carried out by qualified electricians!

Caution - Danger to life!

- **Never wire or disconnect electrical connections while they are live!**
- **Before working on the device disconnect the power. Wait for the DC-link capacitors to discharge. Work may only be carried out on the device when the residual voltage (between terminals X1+ and X1-) is below 42 V!**

- **What components do I need from LUST for the installation?**
  (cf. system connection diagram, section 4.4.1)

  ☑ **MC7000** servocontroller, **BASIC or MOTION**

  ☑ Synchronous or asynchronous servomotor

  ☑ Ready made-up **encoder cable** for connection of the rotary encoder built into the motor

  ☑ PPC or notebook with **DRIVEMANAGER** user software

  ☑ **Interface converter cable LBSKK200** to convert the signals of the interference-immune RS485 interface to the PC's RS232 level.

  ☐ The KEYPAD control unit for storing and transferring parameters by chipcard ("SMARTCARD") is useful.

  ☐ Other components depending on requirements, such as external mains filter, line choke and/or external braking resistor.

  Also:
  - Screened cables for motor and power connection (see sections 4.4.3 and 4.4.4)
  - Screened cables for control terminals via terminals or sub-D connector.

- **Matching motor - encoder cable - servocontroller**

  Compare the name plates of the components. Make absolutely sure you are using the right components according to the chosen variant A, B or C!

	Motor (with built-in encoder)	**Encoder cable**	**Servocontroller**
➔**A**	With **resolver** R1, R2, R8, K1, K2 or K8 xxx - xx - xx(Rx)x or - xx(Kx)x	KRX-xxxxx	Encoder interface Standard (no D2)
➔**B**	With **encoder G1** (incremental) xxx - xx - xx(G1)x	KG1-xxxxx	MC7000, D2
➔**C**	With **encoder G3** or **G5** (absolute value) xxx - xx - xx(G3)x or - xx(G5)x	KG2/3-xxxxx	MC7000, D2

4.4 Electrical installation of the drive system

- **Remove the front guard by unscrewing the screw on the front of the unit (bottom right).**

- **Wire up the drive system in accordance with the system connection diagram.**

- **For proper EMC installation and compliance with European EMC interference immunity regulations to EN50082-2 and interference emission regulations to EN50081-2 and EN55011 we recommend:**
  - a matching mains filter (as per specification)
  - screened control and motor cables
  - original encoder cable, and
  - a good, point-to-point grounding.

  Further information on EMC measures is given in the general Operation Manual.

Procedure

1. **Grounding the servocontroller**

   VDE 0160 stipulates a good point-to-point grounding of the unit via a connection between the unit center point (see system connection diagram, section 4.4.1) and the central center point of the cabinet by means of a grounding wire cross-section of at least 10 mm² or by means of two wires with the same thickness as the mains connecting lead cross-section.

2. **Wire up the motor (including thermistor and - where needed -holding brake and external ventilator)**

   Be sure to follow the instructions given in section 4.4.3.

3. **Wire up the mains lead, but do not switch on yet!**

   Be sure to follow the instructions given in section 4.4.4.

4. **Wire up the control terminals according to the selected operation mode.**

   Don’t forget power stage enable ENPO. For control connections see section 2.

5. **Connect the encoder cable to the motor and servocontroller.**

   Be sure to follow the instructions given in section 4.4.6.

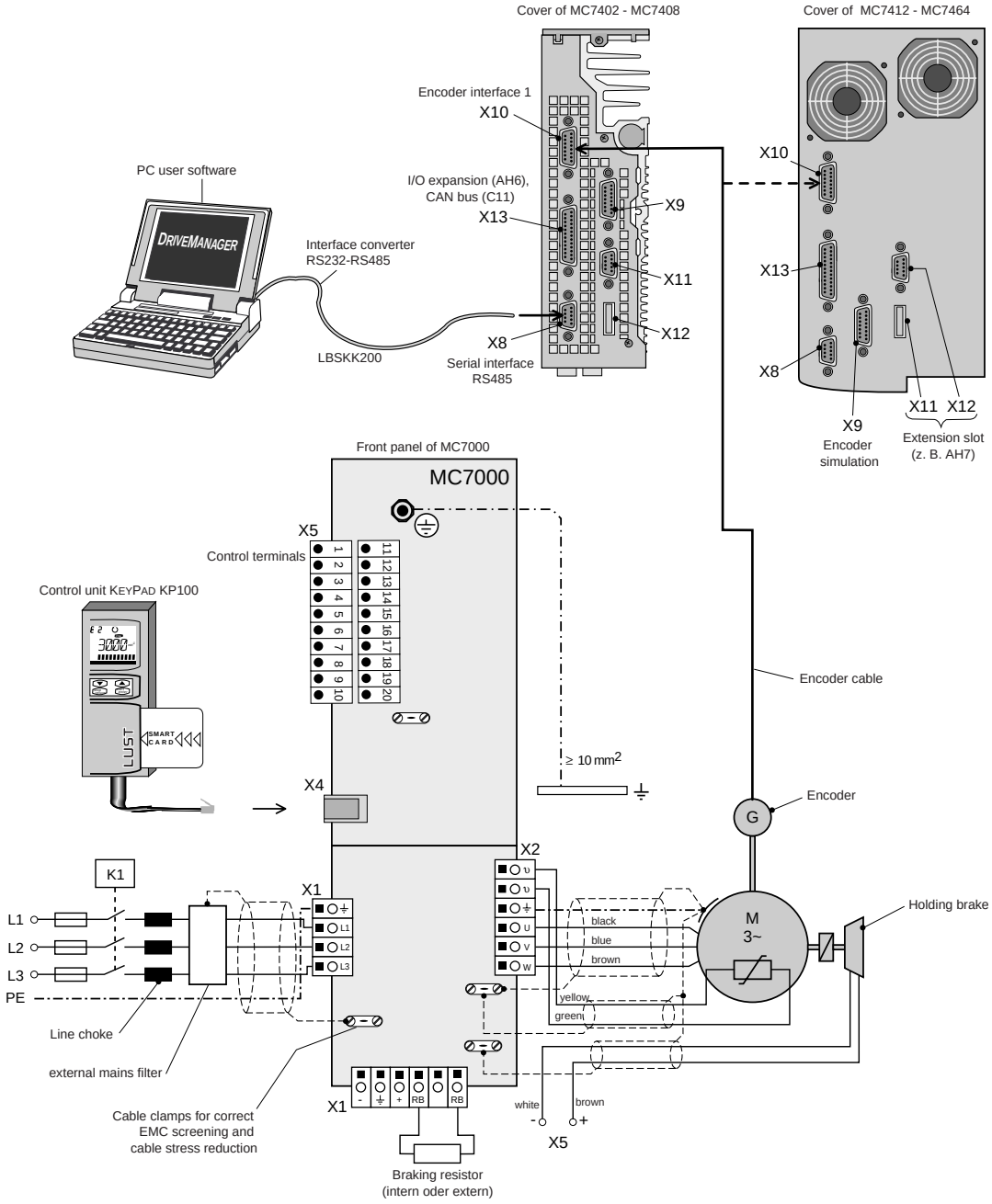
6. **Wire up the encoder simulation where appropriate.**

   Be sure to follow the instructions given in section 3.2.

- **Check the electrical installation. Inspect all connections! Then screw the front guard of the MC7000 back on.**

4.4.1 System connection diagram

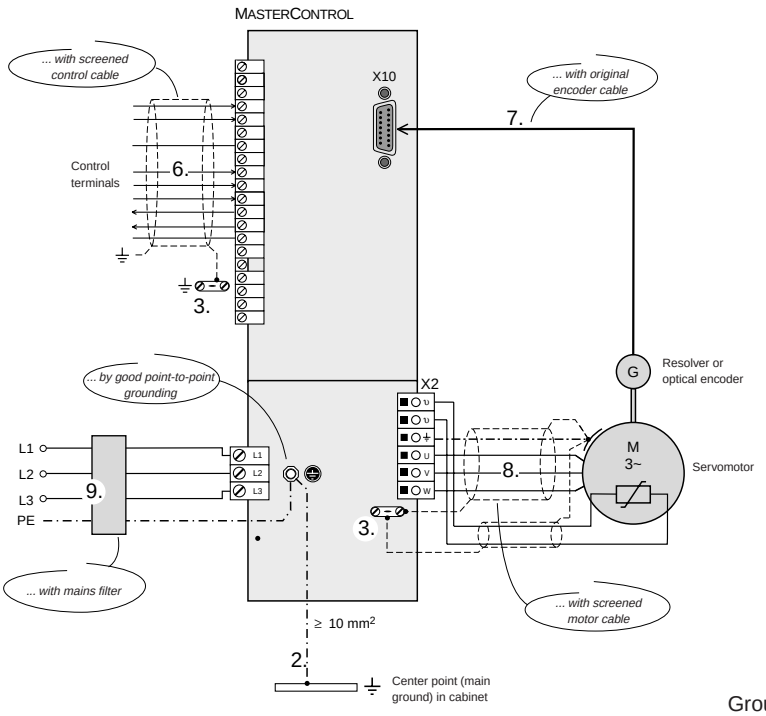
Note:
Schematic layout!



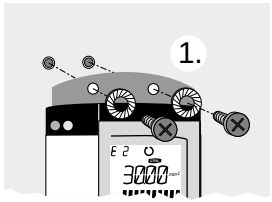
4.4.2 Electromagnetic compatibility (EMC)

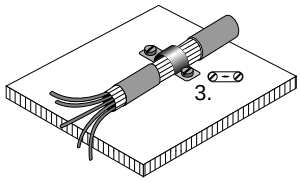
The servocontrollers of the MC7000 series meet the requirements of EMC interference suppression in accordance with EN50082-2 and relating to interference emission in accordance with EN50081-2 and EN55011. The following steps must be taken to comply with the standards.

	Action	Effect/reason
1.	Screw servocontroller onto mounting board using toothed washers.	Highly conductive, full-area contact.
2.	Set up grounding lead connection over at least 10 mm² on PE rail in cabinet.	Good point-to-point grounding due to leakage currents > 3.5 mA.
3.	Ground all cable screens flat over entire area using cable clamps (both sides)!	Screening effect lost if the screen is pigtailed.
4.	Ensure power cable and control cable are laid out completely separate.	Prevent mutual interference.
5.	Ensure mains cable and motor cable are laid out completely separate.	Prevent mutual interference.
6.	Use screened control cable.	Prevent interference on control signals.
7.	Use original encoder cable.	Prevent interference on encoder signals.
8.	Use screened motor cable.	Prevent spread of interference and injected interference via the motor connection.
9.	Screw mains filter onto mounting plate immediately adjacent to servocontroller using toothed washers.	Prevent spread of interference and injected interference via mains connection; highly conductive, full-area contact.



Mounting with toothed washers:





Ground all cable screens flat over both surfaces on housing using cable clamps!

4.4.3 Motor connection

The motor is connected via terminals U, V, W and ⏚ on the servocontroller (X2). Adapt the wire cross-section according to the table under “Mains connection”; see section 4.4.4.

In the interest of interference reduction, the motor connecting cable is **screened**. The screen is mounted over a large surface, and without reduction of cross-section, on **both sides** of the housing ⏚. The screen can be connected optimally to the unit over a large area by way of the cable clamp.

The motor cable should **not** be **separated** (e.g. at terminals in the cabinet), as this would cause the screening effect to be lost!

Caution - Danger to life!

Do not confuse the motor and unit ends of the motor phases U, V and W! If the motor phases are incorrectly connected, the servocontroller will lose control over the motor and the motor may buck or accelerate uncontrollably (“run away”). The entire system may be damaged as a result! There may consequently also be danger to human life.

Explanation:

If working with an open-loop drive (frequency inverter), interchanged motor phases will merely lead to an inversion of the rotary field and thus to a reversal of the direction of rotation of the motor.

If working with a closed-loop drive, the same mistake would cause an error in the control loop of the control circuit!

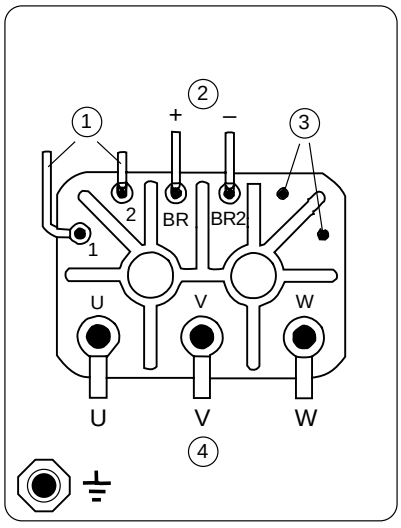
Caution - Danger to life!

Do not touch the motor terminals! There may also be dangerously high induction voltages present on motor terminals U, V and W during coasting!

Motors with terminal boxes

Correct EMC wiring of the motor requires the use of screw glands with a large-area screen contact, e.g. TOP-T-S type made by Lütze. The terminal box can be turned to allow the setting of different outgoing cable directions (square terminal boxes can be turned by 90°, rectangular ones by 180°).

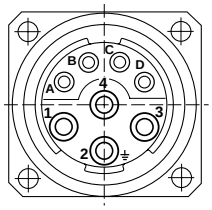
Ensure that the outgoing cables are properly sealed, as otherwise IP65 protection can no longer be guaranteed!



No.	Function
1	PTC thermistor
2	Holding brake (option)
3	not assigned
4	Motor

Motors with plug-in power terminals

Protection class IP65 can only be attained using mating connectors which are wired as authorized and properly tightened.



Suitable mating connector: e.g. Interconnectron, type LPNA 08B NN

Contact no.	Assignment	cores KM1-KSxxx	cores KM2-KSxxx
1	U	black	1
2	⏚	yellow/green	green/yellow
3	W	brown	3
4	V	blue	2
A	Brake +	brown	7
B	Brake –	white	8
C	PTC	green	5
D	PTC	yellow	6

Long motor lines

When working with screened motor cables, in particular, leakage currents are prevalent which cannot be ignored. The level of leakage current depends on the line length, the cable structure, the cable route and the motor type. The rated output currents apply up to a line length of 10 meters.

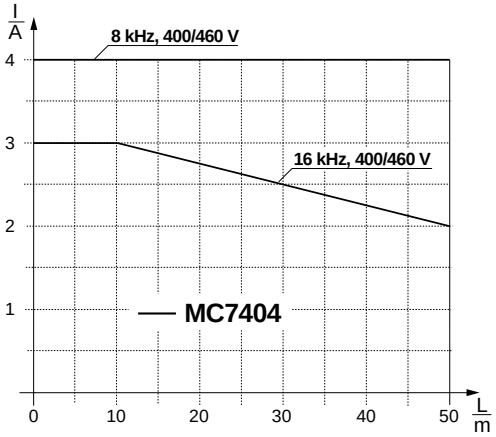


Diagram: Output current as a function of motor cable length; here as an example for the MC7404.

The power reduction for servocontrollers MC7402 to MC7464 is specified in the technical data (see Appendix A.3).

Connection of the thermistor

Temperature monitoring of the motor requires connection to the servocontroller of the thermistor (PTC) integrated in the motor housing. This involves connecting contacts 1 and 2 in the motor terminal box to the two ((Symbol)) terminals (X2) in the MC7000.

The connection of the PTC is **screened**, and executed by a **two-ended interface** to ⏚ via a separate cable (wire cross-section 0.75 mm²).

The resistance of the PTC at the nominal response temperature is > 3 kΩ (cf. DIN 44081 and 44082). When this resistance value is reached, the servocontroller reacts with the error message “Motor overtemperature” (E-OTM).

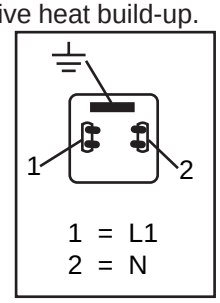
If the thermistor is not connected, the two PTC terminals on the servocontroller must be bridged. This bridge is factory-fitted, and should be removed when the thermistor is connected.

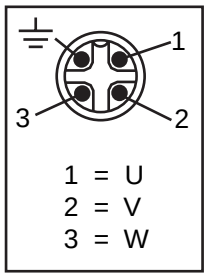
When using motors from other manufacturers, note that the PTC when installed is electrically isolated to DIN VDE 0530 part 1.

Cooling the motors / Motors with external ventilation

The permissible ambient temperature for the motors is between -5 °C and 40 °C. The motors must be installed to guarantee sufficient heat discharge by convection and radiation. Where motors have internal cooling devices, ensure that they are not installed too close together (e.g. in narrow frames or shafts) in order to prevent excessive heat build-up.

If the motor has an **external ventilator unit**, connect it as instructed (wire cross-section 0.75 mm^2) and check that the direction of rotation is correct (note arrow on ventilator housing indicating direction of rotation)! A sufficient quantity of cooling air is required to ensure perfect cooling.



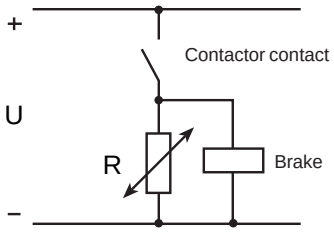


Holding brake (if installed)

The backlash-free, permanent-field single-disc holding brake works on the closed circuit principle, meaning that the brake is operative without power supply. Actuation of the holding brake is described in section 3.3.

Due to the inductance of the holding brakes, a voltage spike which may be over 1000 V will arise when the field current is switched off. To avoid this voltage spike, a protection device with a varistor (recommended type Q69-X3022) should be used.

Motors with a built-in holding brake require a reduction of the maximum speed where appropriate (see MasterDrive data specification).



Suggested switching option for protection of the brake with third-party motors

Motors with shaft seal IP65 (option)

If working with motors with an IP65 built-in shaft seal (option), observe the permissible maximum speed (see MasterDrive data specification). Functional safety can only be guaranteed if sufficient lubrication is applied. Sealing lips may be destroyed by speeds of rotation which are too high.

Refer to the MasterDrive data specification for further important instructions relating to the motors.

Motor maintenance

Maintenance of the motors is limited to cleaning of the motor surfaces. The radial deep groove ball bearings in the motors are lifetime lubricated and designed for 20,000 operating hours. Motors in the ASx and PSx series must not be disassembled!

4.4.4 Mains connection

The mains connection to the MASTERCONTROL is made via terminals L1, L2, L3 and ⏚. Use of a screened mains cable is only necessary as from cable lengths > 20 cm.

The servocontroller MC7000 is developed for TN- and TT-mains. Using IT-mains (with insulated center point) is not allowed! (See Engineering Guide CDA3000, chapter 3.2.1).

In case of mains impedance <0,6 mA and DC-links of several devices use line chokes.

The fuses listed in the following table are to be inserted in series upstream of the servocontroller in accordance with VDE 636, part 1. Adapt the wire cross-section of the connecting cable to the current load.

	Dim.	MC7402 MC7404	MC7408	MC7412 MC7416	MC7432	MC7464
Recommended wire cross-section	mm²	1.5	2.5	4	10	25
Maximum possible wire diameter	mm²	2.5	2.5	4	10	35
Recommended mains fuse (time-lag)	A	6 10	16	25	50	80

Circuit breaker: Trigger characteristic C

Fuse: Utilization catergory GL

Mains filters

The following mains filters are required in order to comply with the EMC directives:

Servo-controllers	Order designation	Motor cable length	Limit curve	Rated Current at 40°C	Leakage Current	Terminal [mm²]
MC7402	NFD10.3	50 m	Class B	10 A	< 116 mA	0.2 ... 4
MC7404	NFD10.3	50 m	Class B	10 A	< 116 mA	0.2 ... 4
MC7408	NFD10.3	50 m	Class A	10 A	< 116 mA	0.2 ... 4
MC7408	NFD10.4	100 m	Class B	10 A	< 24 mA	0.2 ... 4
MC6404	NFD10.3	50 m	Class B	10 A	< 116 mA	0.2 ... 4
MC6408	NFD16.2	100 m	Class A/B*	16 A	< 178 mA	0.2 ... 4
MC6412 a. MC7412	NFD25.1	100 m	Class A/B*	25 A	< 127 mA	0.2 ... 4
MC6416 a. MC7416	NFD25.1	100 m 25 m	Class A Class B	25 A	< 127 mA	0.2 ... 4
MC6432 a. MC7432	NFD50.1	100 m 25 m	Class A Class B	50 A	< 140 mA	0.5 ... 16
MC6464 a. MC7464	NFD80.0	100 m 50 m	Class A Class B	80 A	< 305 mA	10 ... 25

* Achieved by use of an additional line choke of type DNDxx
Nominal voltage: 3 x 480 V AC ±10 %
The information refers to a clock frequency of 8 kHz.

Specifications for other types of mains filter are available on request. For mains filter and line choke dimensions see MASTERDRIVE Technical Specifications.

Use of line chokes

Use of line chokes is necessary:

- When using the drive controller in applications involving interference as per environment class 3 to EN 61000-2-4 and above (hostile industrial environments).
- When several drive controllers are interconnected by DC links.

When several drive controllers are interconnected by DC links:

- Mains voltage fluctuations > $\pm$ 10% U_N
- Short-time outages between 10 ms and 60 s
- Voltage asymmetry > 3%

Environment class 3 typically applies where:

- A major portion of the load is supplied by power converters (DC choppers or soft-start units)
- Welding machines are operated
- Induction or arc furnaces are operated
- Large motors are frequently started up
- Loads fluctuate rapidly.

Benefits:

Using line chokes with 4% U_K ...

- ... reduces the amplitude of the mains charging current by around 50%
- ... reduces the effective value of the mains charging current by around 27%
- ... reduces the harmonic distortion (THD) by around 67%
- ... extends the useful life of the DC-link capacitors by around 300%.

The data demonstrate that the benefits of line chokes are many and varied, and consequently they should not be omitted from any machine or plant system**.**

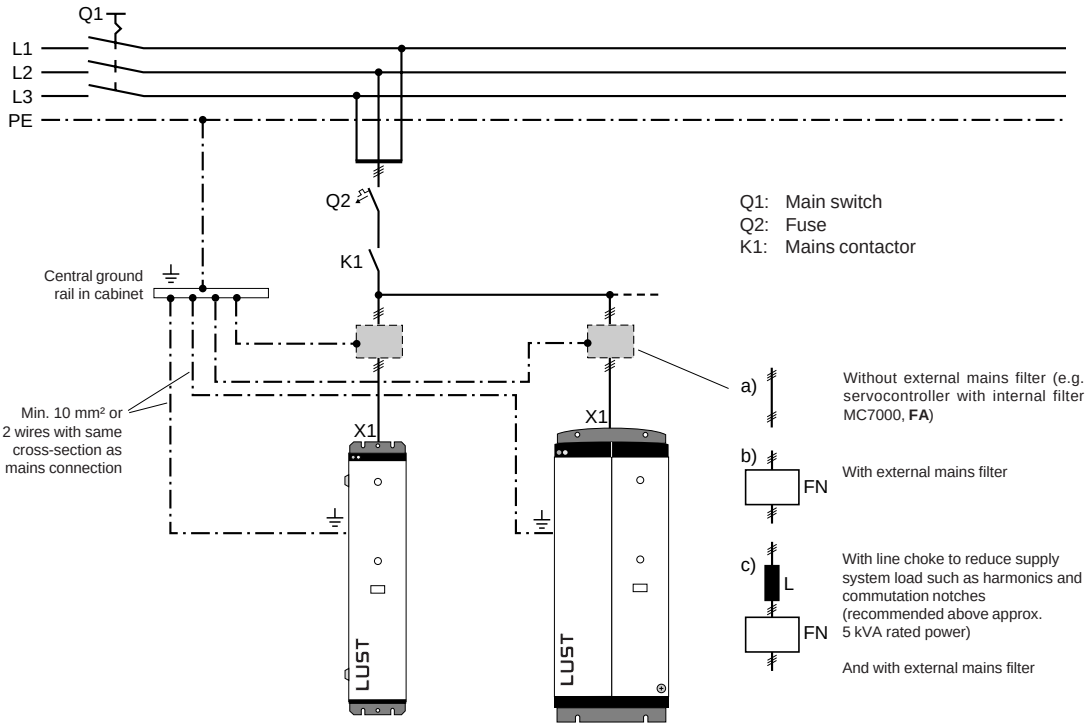


Diagram: Connection of MC7000 servocontrollers to the supply system

Notes:

The servocontroller may only be connected to and disconnected from the mains after an interval higher than 120 seconds. Direct reactivation of the supply voltage is permitted during commissioning or after an emergency shutdown (“Emergency Off”).

The use of fault current breakers alone is prohibited, due to the leakage current (> 3.5 mA). Protective grounding is therefore mandatory (see section 4.4 “Grounding the servocontroller”).

4.4.5 Connection of the control inputs and outputs

Functions can be assigned to the control inputs and outputs by selecting operating modes. The wiring is thus dependent on the mode of operation.

Mode		Connection diagram
Speed control	with external postion control	p. 2-4
	with ±10V reference input	p. 2-6
	with fixed speeds	p. 2-9
	via pulse input	p. 2-13
Torque control		p. 2-15
Stepper motor mode		p. 2-20
Electronic gearing		p. 2-27
Point-to-point positioning		p. 2-33

4.4.6 Connection of the braking resistor

During regenerative operation, e.g. when applying the brake to the drive, the motor returns energy to the servocontroller. This raises the voltage in the DC-link. If the voltage exceeds a value of 745 V DC, the internal braking transistor is switched on and the regenerative energy is converted into heat by an internal or external braking resistor.

If the DC-link voltage exceeds the maximum permissible value of 780 V DC, the servocontroller will register an overvoltage error (E-OV) and disable the power stage. Overvoltage can occur when the brake is applied to large masses and/or short braking durations have been set. Then an external braking resistor or braking chopper should be used.

The servocontroller is not short-circuit-proof or ground-fault-proof at the R_B terminals!

a) **If you want to compile a precise project plan,** the Operation Manual to the MC7000 servocontroller provides useful formulae. The following variables from your application will be needed:

- Moment of inertia of the motor and the load
- Speed before and after braking
- Braking duration.

b) You can get a **rough estimate** using the diagram below and the braking power data (see Appendix A.3). It is essential to check the dimensioning during commissioning!

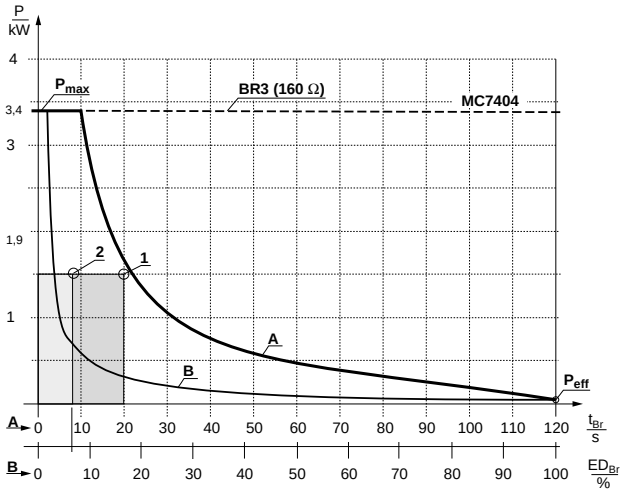


Diagram: *Permissible braking power as a function of continuous duty factor (“ED”; in s or %) as an example for MC7404 servocontrollers*

Standard version:
(with braking resistor in heat sink)

A - Single braking action (waiting period ≥ 15 min.)
B - Cyclic braking (continuous braking power) with continuous duty factor (“ED”).

BR3:
(with braking chopper power electronics for direct connection of an external braking resistor)

The diagram shows the characteristic of the internal electronics; the continuous output power of the external resistor must be rated accordingly!

Operation points (examples):
1 - Permissible operation for single braking action
2 - Impermissible operation for cyclic braking in standard version; use BR3.

Note:

The braking power data table is given in Appendix A.3.

Braking the drive is important to the safety of the machine or system!

Commissioning should include a test for safe functioning of the braking system! Incorrect dimensioning (overload) could lead to destruction of the braking resistor or the braking electronics, and damage to the machine or system. Overload (failure of the braking device) can also lead to serious or fatal physical injury to human beings, for example in lifting applications!

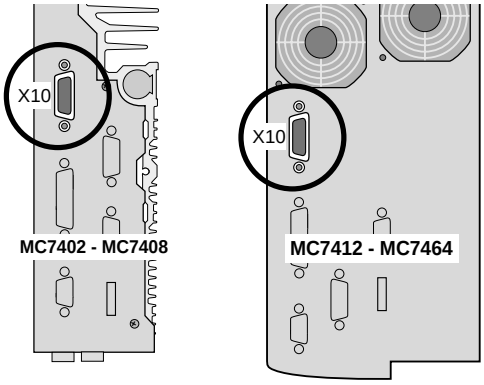
Note:
Electronic devices are fundamentally not fail-safe. Users are themselves responsible for ensuring that the drive is rendered safe if the device fails.

4.4.7 Encoder connection

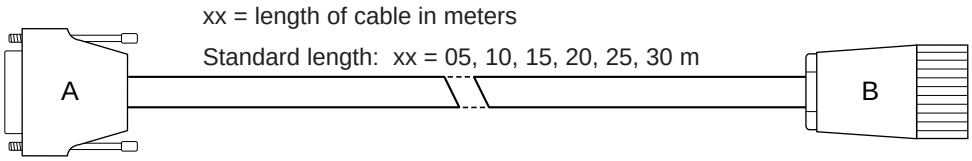
The encoder cable is supplied in ready made-up form. This cable is used to make a direct connection (as in the system connection diagram) between the round connector on the motor housing and the 15-pin sub-D socket (X10) in the device cover.

The encoder cable must **not** be separated, for example to route the signals to the switch cabinet via the terminals. Ensure that the knurled screws on the sub-D connector housing are secured!

The MASTERCONTROL servocontroller detects the connected encoder by reading-in the SMARTCARD belonging to the motor or by reading the motor data set into the servocontroller by means of DRIVEMANAGER.



Resolver cables KRX-Nxx, KRX-KSxx



A	B	Function	Color
1		n. c.	
2		n. c.	
3		n. c.	
4	5	REF+ (R1)	yellow
5	7	REF- (R2)	green
6		n. c.	
7	2	COS+ (S1)	pink
8		n. c.	
9		n. c.	
10		n. c.	
11		n. c.	
12	10	SIN+ (S2)	white
13	1	SIN- (S4)	brown
14	11	COS- (S3)	gray
15		n. c.	
Outer screen + inner screen on housing			

Material

KRX-Nxx Cable not festoon compatible,
Lapp Unitronic CY Pi CY 3x2x0.25

KRX-KSxx Cable festoon compatible,
Lapp Unitronic FD CP TP 3x2x0.25

Connector A Sub-D 15-pin terminals,
metallic housing

Connector B Signal connector, 12-pin socket,
Interconnectron
SPNA12B NNNN 169 (for KRX-Nxx)
PLD121 NV 171187 (for KRX-KSxx)

1) Not for KRX-KSxx.

Caution!

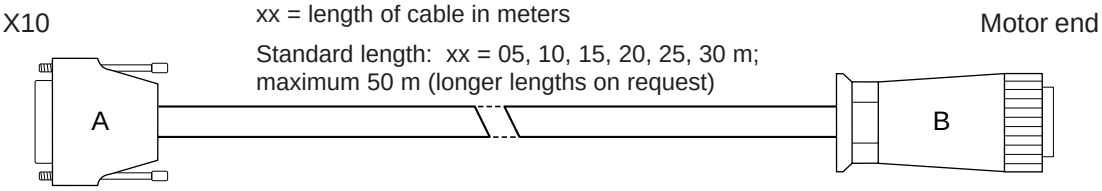
The encoder cable should under no circumstances be detached during operation, as the servocontroller will otherwise lose all control over the motor! The resulting uncontrolled rotation of the drive may lead to damage to the motor and the system, and pose a danger to human beings!

Encoder wire break detection

The encoder signals are continuously monitored before the drive is started up and during operation. If the signals fail, such as due to a wire break, the error E-ENC with error location 1 is triggered (the motor can no longer be controlled and spins out of true).

The monitoring function is operative for all resolvers (R1, R2 and R8) as well as for optical encoders with sin/cos signals (G1, G2, G3 and G5). Incremental encoders with square signals and the absolute position information (DATA and CLK) of encoders G2 to G5 are not monitored.

Encoder cables KG1-KSxx and KG2/3-KSxx



KG1-KSxx

A	B	Function	Color
1		Bridge pin 6	
2		1 K Pin 4	
3		5 V, max. 140 mA	blue
4	C	5 V, 1 K Pin 2	brown/green
5	A	0 V	white/green
6		Bridge pin 1	
7	J	B+	gray
8	H	R-	black
9		n. c.	
10		n. c.	
11		0 V	white
12	E	A+	brown
13	F	A-	green
14	K	B-	pink
15	G	R+	red
Outer screen on housing			

KG2/3-KSxx

A	B	Function	Color
1	T	DATA+	gray
2	U	DATA-	pink
3	D	5 V, max. 140 mA	blue
4	C	5 V	brown/green
5	A	0 V	white/green
6	V	Inner screen	
7	J	B+	blue/black
8		n. c.	
9	S	CLK-	yellow
10	R	CLK+	purple
11	B	0 V	white
12	E	A+	green/black
13	F	A-	yellow/black
14	K	B-	red/black
15		n. c.	
Outer screen on housing			

Material:

KG1-KSxx Cable festoon compatible, Heidenhain 244 957 01

KG2/3-KSxx Cable festoon compatible, Heidenhain 266 306 01

Connector A Sub-D 15-pin terminals, metallic housing

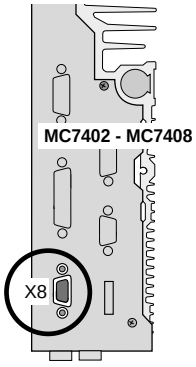
Connector B Connector, 19-pin socket, Schaltbau München MT1

Technical data of the encoder cables

	Dim.	KRX-N0xxx	KRX-KSxxx	KG1-KSxxx	KG2/3-KSxxx
Servocontroller type		All (not version D2)		MC6000, D2 MC7000, D2	
Motors with encoder system		R1, R2, R8, K1, K2, K8		G1	G3, G5
Festoon compatible		no	yes	yes	
Minimum bending radius: in fixed installation in flexible use	 mm mm	 60 not permitted	 60 120	 40 100	
Temperature range: in fixed installation in flexible use	 °C °C	 - 30 ... + 70 not permitted	 - 10 ... + 70 - 10 ... + 70	 - 35 ... + 80 - 10 ... + 80	
Cable diameter approx.	mm	9.9	9.4	8.0	
Material of outer sheath		PVC	PUR	PUR	
Resistance		Flame retardant	Flame retardant resistant to hydrolysis and microbic attack	Resistant to oil, hydrolysis and microbic attack (VDE0472)	

4.4.8 Serial interface RS485

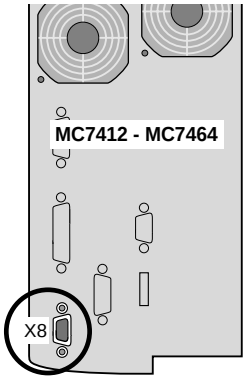
The standard fitted RS485 interface (X8) is the operator control and diagnostic interface for the DRIVEMANAGER Windows-based user interface.



To connect to your PC you will need:

For a single drive:

- Interface converter cable LBSKK200 to convert the signals of the drive's interference-immune RS485 interface to the PC's RS232 level, or
- For an industrial PC with RS485 just a 1:1 interface cable (sub-D 9-pin, male-female).



For several interconnected drives:

- One T-coupler per drive unit, e.g. LUST LB TK101, B&R INT101 and a 1:1 interface cable (sub-D 9-pin, male-female) for the link from the PC to the first T-coupler.

If no interface converter is being used, power must be supplied to the interface. There are two types for using the RS485 interface.

Type 1: Isolated, feed is +24 V.

Type 2: Not isolated, use of internal +5 V.

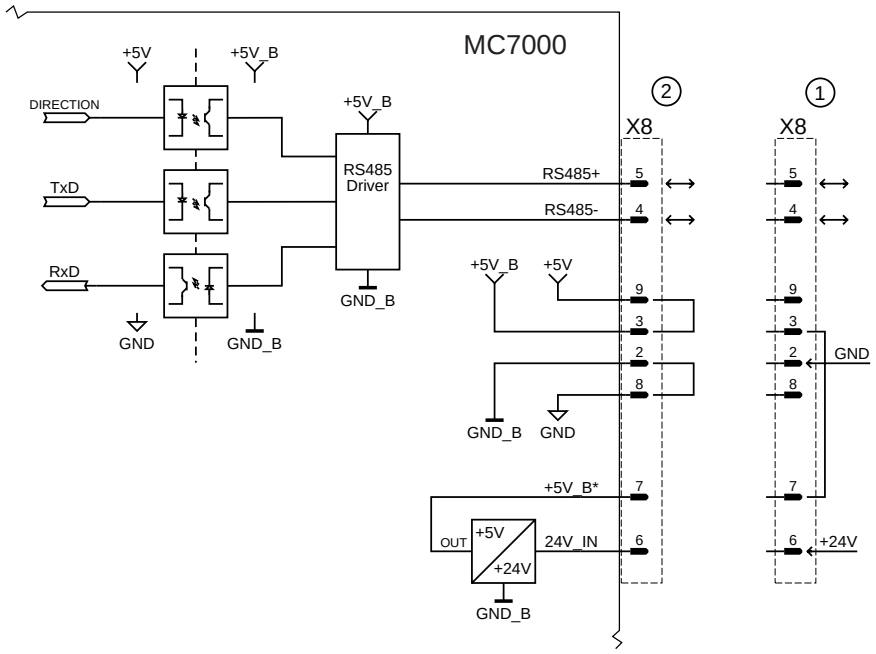


Diagram: Switching types for the RS485 interface

Pin No. X8	Assignment (RS485)	Type 1 (External + 24 V)	Type 2 (Internal + 5 V)
1	n. c.	n. c.	n. c.
2	GND_B	GND	GND, jumper pin 8
3	+5V_B	Jumper pin 7	Jumper pin 9
4	RS485-	RS485-	RS485-
5	RS485+	RS485+	RS485+
6	24V_IN	+ 24 V feed	n. c.
7	+5V_B*	Jumper pin 3	n. c.
8	GND	n. c.	GND, jumper pin 2
9	+5V	n. c.	Jumper pin 3

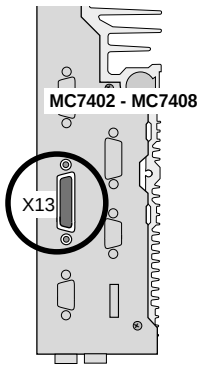
Connection via shielded cable, shield on both sides through plug housing on grounding lead

Note:
If bus operation is to be guaranteed even if the power supply is lost, the +24 V power supply for the control stage must be supplied externally (SB2 design required!)

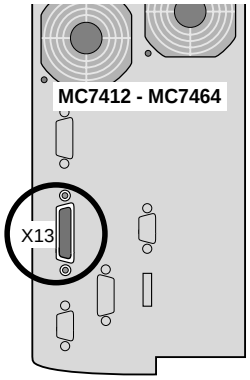
4.4.9 CAN-Bus interface

The bus is connected via X13 (sub-D 25-pin). The EKL300 terminal module is available for conventional connection via 2 x 9-pin sub-D connectors.

The device address is assigned using a parameter (addresses 0 ... 29).



Screening:
The CAN-Bus is to be wired using a screened cable, the screen being mounted on both sides of the connector housing and connected to the grounding lead.



No.	Assignment	Function
10	24V-CAN	Supply to CAN-Bus[1)]
11	GND-CAN	Ground for CAN-Bus[1)]
12	GND-CAN	Ground for CAN-Bus[1)]
13	CAN+	CAN signal+
25	CAN-	CAN signal-

[1)] External +24 V feed required!

Comments: • Housing is at grounding lead potential

Note:
- Uninterrupted duty of the CAN-Bus independent of the mains power supply to the MC7000 requires use of the servocontroller version SN2 with an external +24 V supply voltage.
- More information on installation is given in the description: “Correct EMC installation of bus systems”.

Technical data	
Supply to control section:	24 V DC ± 20 % for MC7000, SN2 max. 3 A, typ. 0.5 A
Supply to CAN-Bus:	24 V DC ± 10 % for CAN-Bus, pin 10 10 (X13) 100 mA per station
Transmission speeds:	Adjustable from 50 Kbit/s (1 km cable length) to 1 Mbit/s (40 m cable length)
Transmission medium:	CAN-Bus to ISO 11898

4.4.10 EKL300

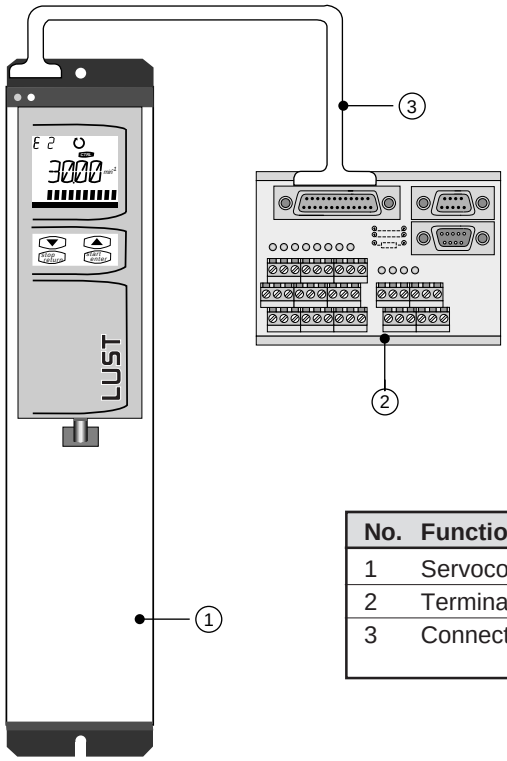
The external terminal module EKL300 facilitates direct wiring of the external inputs and outputs and of the CAN-Bus on the 25-pin sub-D connector X13 in the cabinet. LEDs signal the status of the inputs and outputs.

The EKL300 execution is three-wire. Initiators can be conveniently connected using the three leads for +24 V, signal and ground. The terminal module is simply mounted on a Z-rail.

The connection is made to connector X13 via a 25-pin connecting cable. The KSS252 connecting cable (1.8 meters long) is connected to the X5 connector of the EKL300. Eight inputs can be wired to the X1 terminals and four outputs to X2.

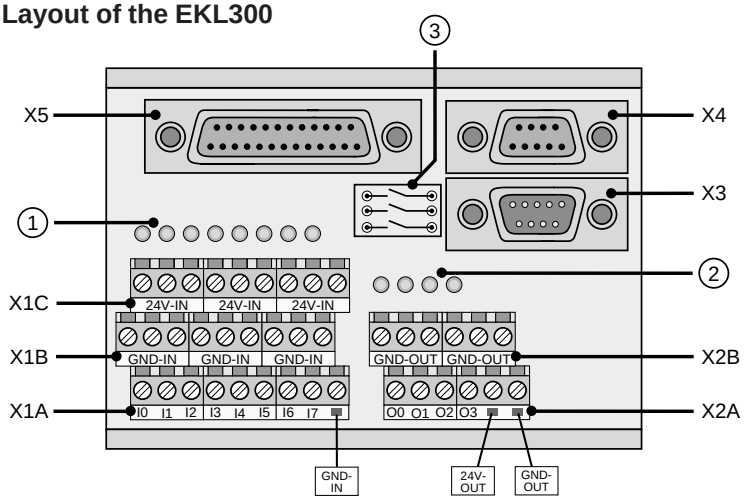
Features of the EKL300 in summary:

- For direct wiring of inputs and outputs in the cabinet
- For CAN-Bus connection via 2 x 9-pin sub-D connectors
- Three-wire execution (signal, +24 V and ground) for convenient connection of initiators
- LEDs as status indicators for inputs and outputs
- Mounting of terminal module on Z-rail
- Dimensions (W x H x D): 113 x 78 x 72 mm
- Max. connecting cable cross-section 2.5 mm²



No.	Function
1	Servocontroller MC7000
2	Terminal module EKL300
3	Connecting cable KSS252 (25-pin, 1.8 m long)

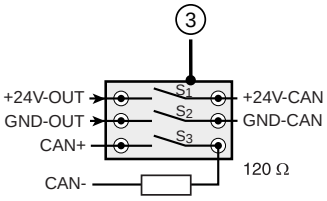
Layout of the EKL300



Terminal labeling in short form

I0 = IE00,

O0 = OE00, etc.



No.	Function	No.	Function
1	LEDs for inputs	X2A	Output terminals
2	LEDs for outputs	X2B	Ground for output terminals (GND-OUT)
3	Jumpers for CAN bus connection: supply via terminals, terminator resistor	X3	CAN-Bus input
X1A	Input terminals	X4	CAN-Bus output
X1B	Ground for input terminals (GND-IN)	X5	Link to I/O module 1)
X1C	+24V for input terminals (+24V-IN)		

1) X5 pin assignment corresponds to X13 on MC7000 (25-pin sub-D connection).

CAN: Connectors X3, X4

If the servocontroller with the EKL300 is at the end of a CAN network, the necessary termination can be provided by closing the switch S3.

No.	Assignment	Function
2	CAN-	CAN signal-
3	GND-CAN	Ground for CAN-Bus[1)]
7	CAN+	CAN signal+
9	24V-CAN	Supply to CAN-Bus [1)]

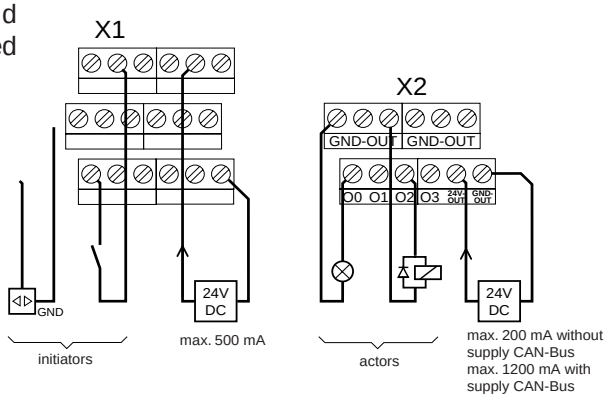
[1)] External +24 V feed required!
It is not allowed to supply more than 10 participants via one incoming supply.

Profibus-Operation

Profibus-Operation with Gateway CP-DP1 by means of the power supply of CAN-busses of the gateway. In that case the switches S1 and S2 must be open.

Block diagram of the circuit

An external +24 V supply is required (floating). Inputs and outputs can be supplied separately.



5 Commissioning of the drive system

Overview

1. Preparing for commissioning: inspect connections and follow safety instructions
2. Switch on power and perform function test
3. Set basic setup of servocontroller
   (operation modes and functions)
4. Test run
5. Adapt drive to machine
6. Optimize drive response

5.1 Preparing commissioning

Commissioning must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures!

The servocontroller must be correctly connected in accordance with section 4.4. Inspect all connections.

Safety note:

Caution - Danger to life!

- **Never wire or disconnect electrical connections while they are live!**
- **Before working on the device disconnect the power. Wait for the DC-link capacitors to discharge. Work may only be carried out on the device when the residual voltage (between terminals X1+ and X1-) is below 42 V! The MC7000, SN2 may take up to 30 minutes to discharge.**

Caution - Danger to life from uncontrolled rotation!

- **The brake (if installed) should be checked for fault-free functioning before installation of the motor.**
- **Before motors with a feather key at the shaft end are commissioned, the feather key should be secured against being ejected, if this cannot be prevented by output elements such as pulleys, couplings etc.**

Additional safety instructions relating to the servomotors

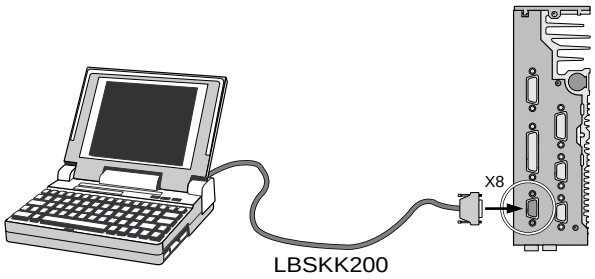
- **The motors are intended for service on the servocontroller. Direct connection to the mains may lead to destruction of the motor.**
- **The motors may be subject to surface temperatures of over 100 °C. Temperature-sensitive items should therefore not be placed on top of or attached to the motors. Protective measures may be needed to prevent touching.**
- **The standstill holding brake (installation optional) is only designed for a limited number of emergency brakings. Use as a working brake is prohibited.**
- **The temperature sensor (PTC) installed in the winding is to be connected to the servocontroller in order to prevent overheating in the motor.**

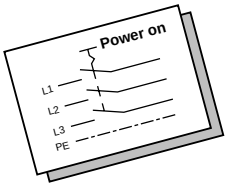
5.2 Startup and function test

You will need:

- Laptop or PC with DriveManager user software. For installation and basic operation of the user interface refer to the description of the DriveManager.
- Interface converter cable LBSKK200 to convert the signals of the drive's interference-immune RS485 interface to the PC's RS232 level.
- KeyPad control unit.
- SmartCard with motor data set or motor data set on floppy disk.

1. Connect the interface converter cable between the PC and the servocontroller.





2. Switch on the power to the servocontroller.

- Input ENPO = Low level at terminal 14 (X5) to prevent unintentional startup of the motor (power stage disabled).
- The MC7000 performs a self-test. If the KeyPad is connected, the display lights up red and shows the "TEST" message.
- Once the self-test has been completed correctly, the display lights up green and the current reference value (REFV parameter in the VAL menu) is displayed in the VAL menu.
- If the unit detects a fault during the self-test, the display lit up red indicates the cause of the error (see Appendix).

3. Check the direction of rotation.

- With KeyPad: The top section of the KeyPad display shows the symbols for the direction of rotation when the motor shaft is turned by hand (↻ for clockwise and ↺ for counter-clockwise).
- With DriveManager: Select the menu View - Device status display. There, too, the direction of rotation is displayed in graphical form.
- Check that the ↻ symbol appears when you rotate the motor shaft clockwise by hand while looking onto the shaft end (flange).
- If the symbol fails to appear, check:

  Is the encoder cable plugged into the motor and the servocontroller ?

  Is the encoder cable in use the correct one for the type of encoder ?

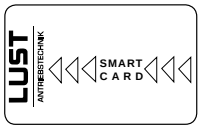
  If using self-made encoder cables: Is the cable correctly wired ?

4. Start the DriveManager.

- Make the connection to the servocontroller, if not already made automatically (see DriveManager description).
- If the DriveManager displays no error message the function test has been performed successfully and the connection to the PC is OK.

5.3 Basic setup of the servocontroller

In closed-loop controlled drive systems it is of fundamental importance for the motor data to be set in the servocontroller. In LUST servocontrollers this is done with the aid of the motor-specific SMARTCARD (up to device version V1.65) or with a floppy disk containing the relevant motor data set (as from device version V3.0).

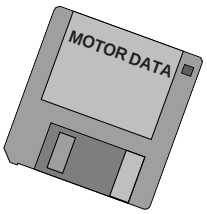


1a Read the SMARTCARD with the motor data into the KEYPAD:

- Exit the **VAL** menu by choosing **Stop/Return**.
- Use the cursor keys to select the **CARD** menu and choose **Start/Enter** to open it.
- Switch to **READ** and confirm with **Start/Enter**.
- Use the cursor keys to select the **DRIVE** area (motor data) on the card and confirm with **Start/Enter**.
- The motor data are read-in. The display indicates “READY”. Exit the CARD menu again by choosing **Stop/Return**.

General use of the KEYPAD is described in Appendix B.

or:



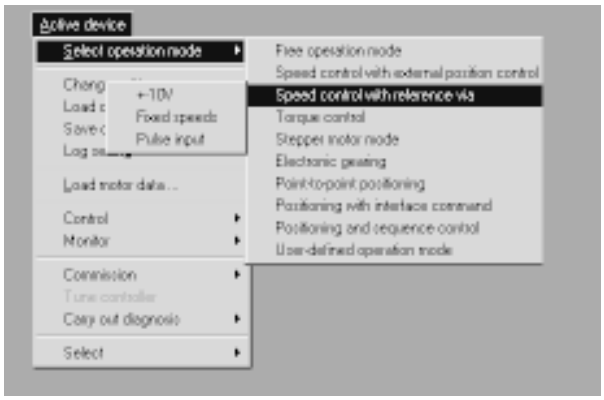
1b Transfer the motor data using the DRIVEMANAGER (as from V3.0):

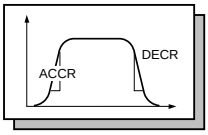
- First install the floppy disks containing the motor data, if they have not already been installed. To do so, open the SETUP.EXE file on the first disk, by double-clicking on its icon under Windows Explorer for example.
- To transfer the data to the servocontroller select the right data set for the motor under the **Active device - Load motor data** menu.

⇒ **The MC7000 servocontroller is now set up for the connected motor.**

2. Select the operation mode

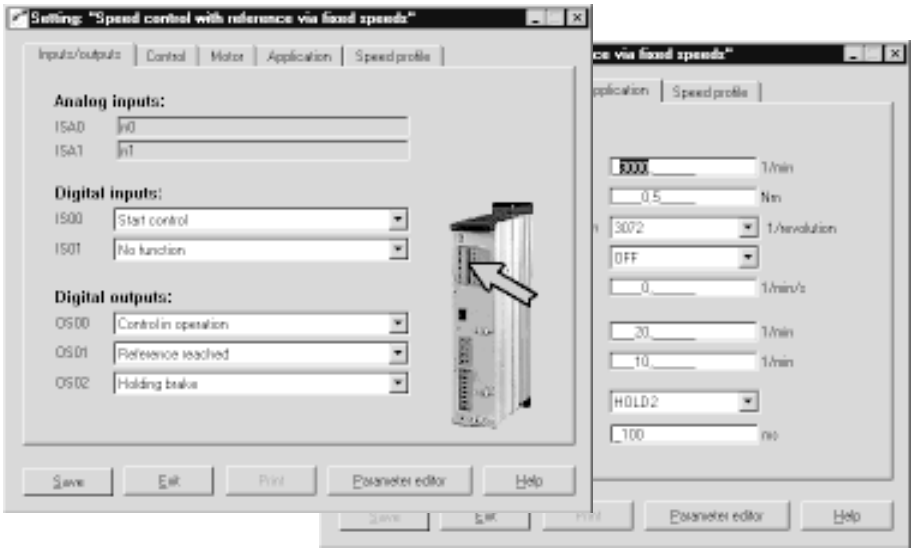
- The **Active device - Select operation mode** menu lists the available modes, depending on the application package. This is where you define the operation mode for the servocontroller, as chosen in chapter 2.
- When you have activated an operation mode the DRIVEMANAGER prompts you to confirm your selection.





3. Program functions

- Program the functions from chapter 3 which you will need - such as speed ramps, torque reduction or actuation of the holding brake - by way of the **Active device - Change settings** menu or by choosing the  icon.



A note on changing parameters:

When the drive is at a standstill (“Start” input not set): Changes to parameters take effect in the servocontroller when you choose the “Save” button in the DRIVEMANAGER.

When the drive is running (“Start” input set): Changes to parameters only take effect in the servocontroller when the start signal has been canceled and then delivered again (controller re-initialization). One exception to this is the speed controller gain parameter SCGFA, which is updated online.

5.4 Test run

It is now possible to test the drive with no mechanical components coupled to it.

Safety note:

If the motor is already connected to the system, you must ensure that the system is not damaged by the test! In particular, pay attention to positioning range limits.

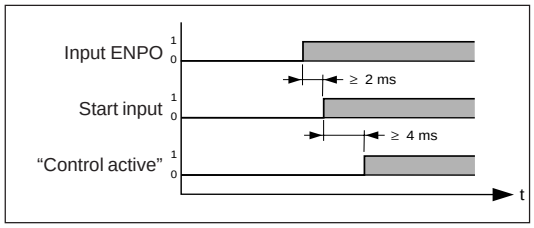
Please note that you yourself are responsible for safe operation. Lust Antriebstechnik GmbH cannot be held responsible for any damage incurred.

Torque control mode:

In this operation mode the drive must not be run without load torque, as otherwise the motor shaft would accelerate unchecked up to the pre-set speed limit.

1. Set power stage enable ENPO

- High level at terminal 11 (X5).



2. Control with DRIVEMANAGER:

- Select **Active device - Control - Basic operation modes** or choose the icon. Select "Speed control" and start the drive, e.g. with reference 0 rpm or 100 rpm.

3. Check the drive response

- Now you can assess the drive response with the aid of step responses, which can be recorded using the DRIVEMANAGER'S digital scope function. Select **Active device - Monitor - Quickly changing digital scope values** or choose the icon.
- The following three values are recorded using the digital scope:
  - Speed reference (n*f)
  - Actual speed (n)
  - Torque reference (m*).
- Start the drive with a reference value of 100 rpm, for example.
  Compare the step response of your drive with the diagram. With resolvers the overshoot of the actual speed should be around 20%; with sin/cos incremental encoders around 30% (referred to the reference value). The scaling of the x-axis may be allowed to deviate significantly (depending on the size of motor).

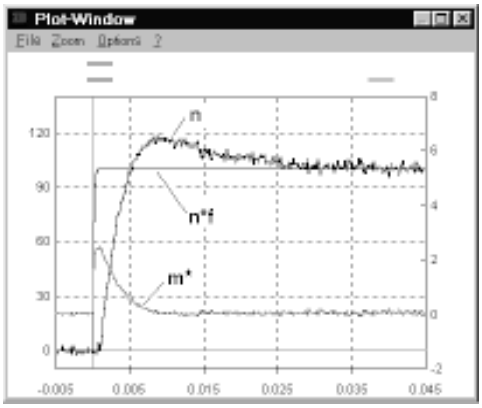


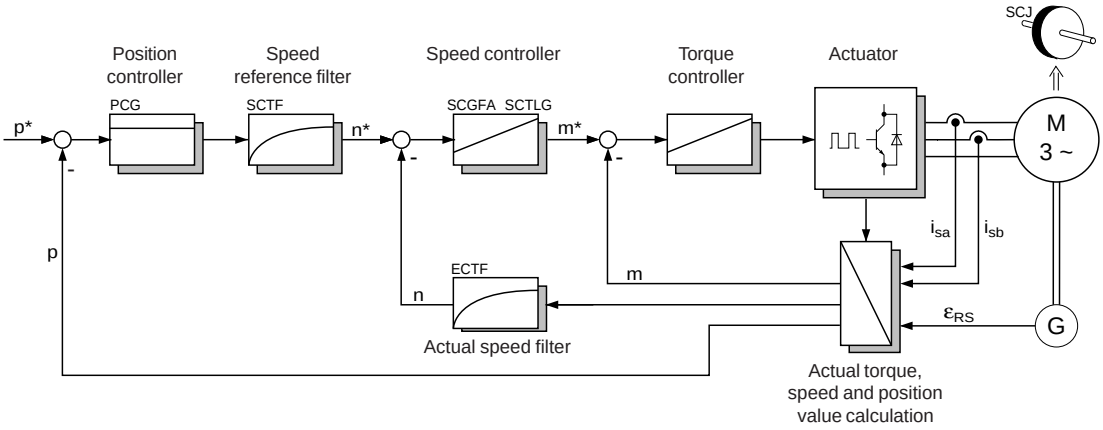
Diagram:
Typical step response recorded with the DRIVEMANAGER

⇒ Result:

- If the step response of your drive more or less matches the diagram, you can be sure that the motor phases are correctly wired, the encoder is correctly connected, and the MC7000 parameters are set to the correct motor.
- If the step response deviates significantly from the diagram, it must be assumed that the motor data are incorrect or the cabling is faulty. Check the individual steps as set out in sections 4.4, 5.2 and 5.3 and then repeat the test run.

5.5 The control structure of the MC7000

The MC7000 has a classic cascade control system with torque, speed and position controllers. The torque controller is always optimized first, then the speed controller, and finally the position controller.



Des.	Meaning
P*	Position reference
p	Actual position
n*	Speed reference
n	Actual speed
m*	Torque reference
m	Actual torque
ε_{RS}	Angle of revolution
i_{sa},i_{sb}	Phase currents

Parameter	Meaning
SCTF	Speed reference filter
SCGFA	Speed controller gain
SCTLG	Speed controller lag time
SCJ	Moment of inertia of mechanism
ECTF	Actual speed filter

Important notes:

The **torque controller** is already optimally attuned to the motor data by the read operation from the SMARTCARD. As a result, torque control mode requires no further adjustment.

The **speed controller** must be adapted to the mechanism coupled to the motor. The following influencing variables are decisive in this:

- The reduced moment of inertia of the mechanism
- The elasticities of the mechanism (toothed belts, plastic couplings, torsion of shafts)
- Play (gear backlash).

The **position controller** is only active in “electronic gearing”, “stepper motor” and “point-to-point positioning” modes. The higher the dynamics of the speed controller, the more dynamically the position controller can be set.

Note:

If the MC7000 BASIC or MOTION is used in conjunction with motor data sets from earlier software versions, the value of the speed reference filter parameter SCTF must be set manually to the value of the lag time SCTLG in order to obtain the same control response.

5.6 Adaptation to the machine and optimization of the speed controller (stage 1)

1. Install the drive into the machine or system.

2. Adapt to the moment of inertia of the mechanism.

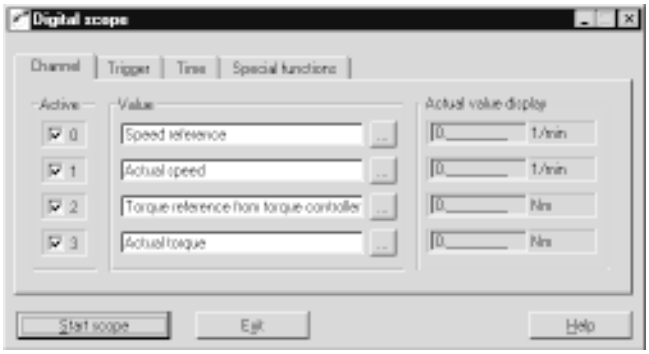
- If you know the exact moment of inertia of the mechanism reduced onto the motor shaft, you can enter it in the relevant box.
- If you do not know the exact moment of inertia, enter = 0 in the box and use steps 3 and 4 to optimize the speed controller.

Rule of thumb:

> **The higher the moment of inertia, the higher the gain.**

3. Check the drive response.

- Now you can optimize the speed controller with the aid of step responses, which can be recorded using the DRIVEMANAGER's digital scope function. Select Active device - Monitor - Quickly changing digital scope values or choose the  icon.
- The following three values are recorded using the digital scope:
  - Speed reference (n*f)
  - Actual speed (n)
  - Torque reference (m*).
- Start the drive again with a reference value of 100 rpm, for example. Compare the step response of your drive with the diagrams on the next page.



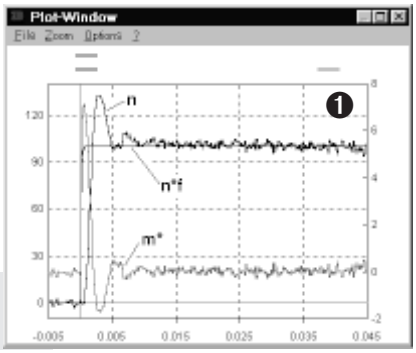
Note:

When recording step responses, make sure the selected step is small enough to ensure the torque reference does not reach the maximum value TCMMX. If it does, start the drive with lower reference values, such as 50 rpm or less.

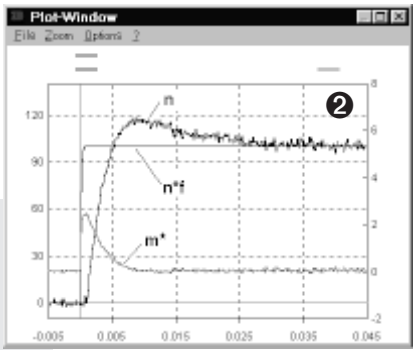
4. Optimization of the speed controller

- Now change the gain SCGFA in increments of 10% (or larger), so that the speed controller is set to its optimum and the drive responds as you want it to.

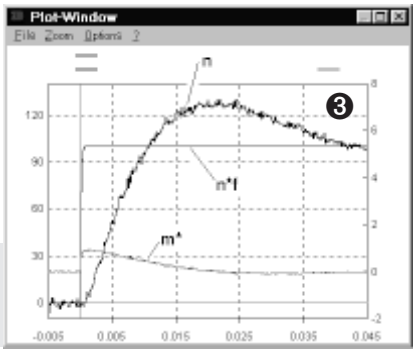
How to change SCGFA correctly:



❶ → **Reduce gain SCGFA**



❷ → **Gain SCGFA OK, overshoot approx. 20%, usually the desired response**



❸ → **Increase gain SCGFA**

5. Adaptation (of the speed controller) to the machine is now completed!

- If the response of the drive is satisfactory, commissioning of the speed control is concluded.
- If you want to optimize the speed control further, you will find information on how to do so in section 5.7.
- We recommend that you log the optimum setup and keep a copy of the step response printout in your records.
- To conclude commissioning you should perform a comprehensive test to check the safe functioning of the machine in all operating states.

5.7 Optimization of the speed controller (stage 2)

These measures will only be necessary

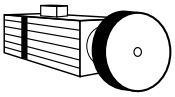
- if the drive cannot be set up adequately by the steps described in section 5.6, or
- if the drive is to be position-controlled in electronic gearing, stepper motor or point-to-point positioning mode.

Controller setup

To set the speed controller's basic settings, the existing mechanism must first be divided roughly into three categories:

Very rigid mechanism

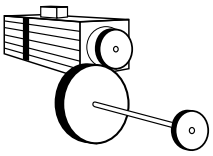
The mechanism has only very low elasticities and no play.



⇒ **Hard controller setup**

Rigid mechanism

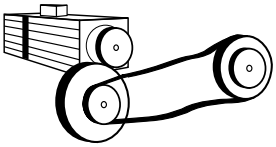
The mechanism has low elasticities and/or play.



⇒ **Medium controller setup**

Less rigid mechanism

The mechanism has higher elasticities and/or play.



⇒ **Soft controller setup**

By selecting the controller setup you can decide on a compromise between control dynamics and smooth running.

A note on dimensioning:

- **Hard controller setup** → **High control dynamics, rough running**
- **Soft controller setup** → **Low control dynamics, smoother running**

Please note:

If the controller setup is too hard, the drive will tend to vibrate.

If the controller setup is too soft, the control dynamics are too low.

Actual speed filter

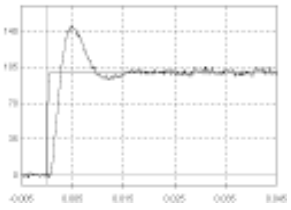
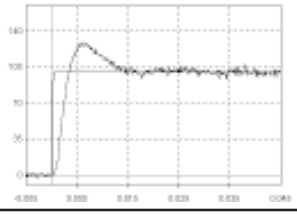
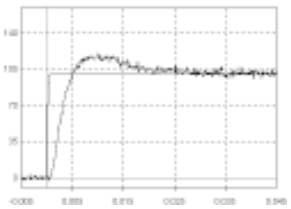
The MC7000 has an actual speed filter which reduces the torque fluctuations and so makes the drive run smoother. The actual speed filter should only be increased in response to high moments of inertia (above 200 kg cm2 with resolvers and 10000 kg cm2 with sin/cos incremental encoders).

Dimensioning pointer:

- **Low actual speed filter** → **High control dynamics, rough running**
- **High actual speed filter** → **Low control dynamics, smoother running**

Control parameter settings (speed controller sampling time ECTS = 8 kHz):

- First select just the controller setup - hard, medium or soft - and then set the gain and lag time according to the table in the DRIVEMANAGER.
- Repeat steps 3 and 4 in section 5.6.

Controller setup	Actual speed filter ECTF [µs]	Gain SCGFA [%]	Lag time SCTLG [ms]
 **Hard**	300	208	3.4
	600	156	4.6
	900	127	5.9
	2000	75	10.3
 **Medium**	[1] → 300	143	4.7
	600	106	8.4
	900	102	10.8
	2000	60	19.1
 **Soft**	300	138	8.6
	[2] → 600	100	12.8
	900	79	17.0
	2000	46	32.4

[1] Factory setting for sin/cos incremental encoders

[2] Factory setting for resolvers

Note:

The moment of inertia of the load SCJ is pre-set to the rotor moment of inertia of the motor MOJNM (inertia adjustment 1:1).

5.8 Optimization of the position controller

The position controller only needs to be set for the “electronic gearing”, “stepper motor” and “point-to-point positioning” modes.

The higher the dynamics of the speed controller, the more dynamic the position controller can be set. Consequently, for optimization of the position controller the speed controller must first have been optimized as detailed in sections 5.6 and 5.7.

A note on point-to-point positioning mode:

If you use linear acceleration and speed ramps in this operation mode, and if you want to avoid overshoot beyond the destination position, the speed controller setup must be soft.

Safety information:

- **The drive can go into operation unintentionally!**
- **Make certain that no one is located in the dangerous area of the machine.**
- **Make certain that the emergency off device functions properly.**

- **Adjust the limit switches in front of the mechanical stopper so that the speed of the axis is at least reduced to the extent that no damage results from the rebound (often the available braking distance is not sufficient for bringing the axis completely to a stand-still). The limit switches must also be activated if the mechanical stopper is reached (and the rubber pad is pushed together)!**
- **Check the proper functionality of the limit switches by activating the limit switches manually. The MC7000 must respond to this in point-to-point positioning with error E-POS with error location number 210 (+) or 211 (-) and with electronic gearing and stepper motor mode with error E-END with error location number 23 (-) or 24 (+).**

- **Bring the axis to the middle position.**
- **Dismount any expensive machine tools.**

Optimization of the position controller

1. Check the drive response.

- Activate the operation mode you want by way of the DRIVEMANAGER. Reset the power stage enable ENPO (low level).
- Select **Active device - Control** or click on the  icon. You can now position the drive in jog mode. Set ENPO.
- Move the axis in jog mode slowly to the positive limit switch. The axis must stop with error E-pos 210. Repeat the procedure in the negative direction.
- Perform a reference run to establish the absolute dimensional reference.
- Set positioning operations at low speed, but with the highest possible acceleration and bucking, without allowing the MC7000 to reach the torque limit TCMMX.
- Record the positioning operation with the DRIVEMANAGER's scope function. Exit the **Control** menu.
- Check the drive behavior while controlling the inputs.

2. Optimize the position controller.

- Now change the position controller gain parameter PCG to set an optimum balance between low overshoot at the destination position and minimized tracking error (see previous page).
- The greater the setting of the **Position controller amplifier** PCG, the more rigid the drive, and the smaller the corresponding lag distances during the positioning process. If too great a setting is selected for the position controller, the result will be over-shooting the target position or even instability of control.

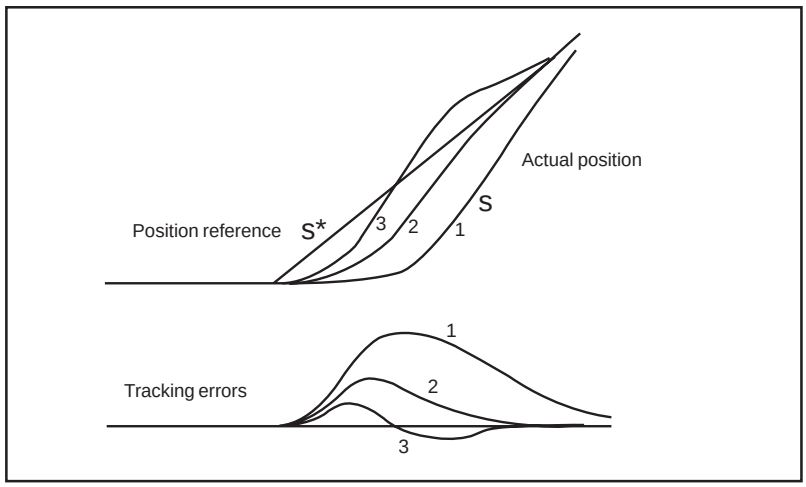


Diagram: Actual position and tracking errors where:
1 position controller gain too low (large tracking error)
2 position controller gain optimum
3 position controller gain too high (overshoot)

3. Test the drive in all possible operating conditions

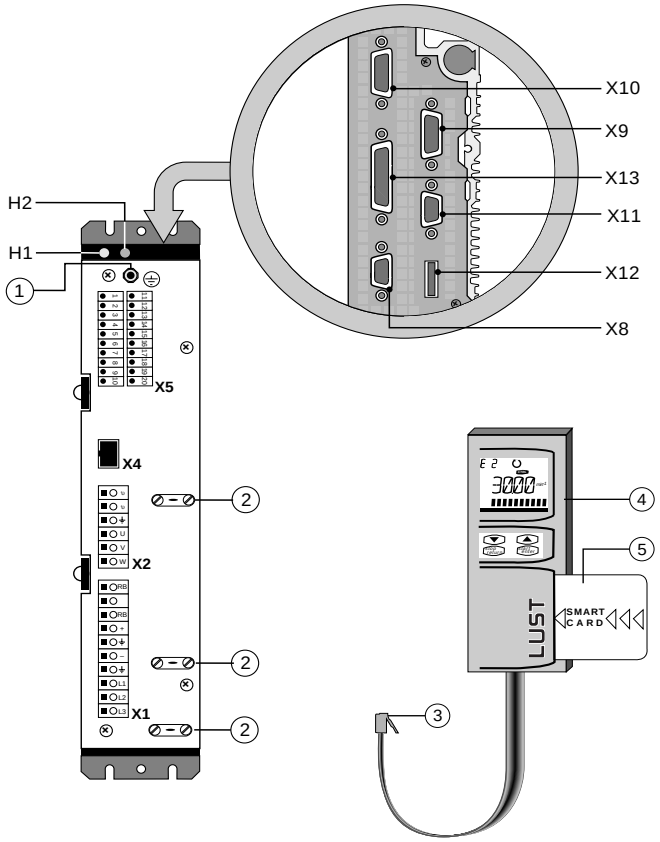
- Test the functionality of the program. Using the "Monitor" window in the **Active device** menu, you can observe the states of the inputs and outputs
- Behavior of power off, malfunctions and heating up during continuous operation
- Check the run behavior, and if necessary make fine adjustments to optimize

Appendix

A Technical data

A.1 Layout, MC7402 - MC7408

Schematic layout!

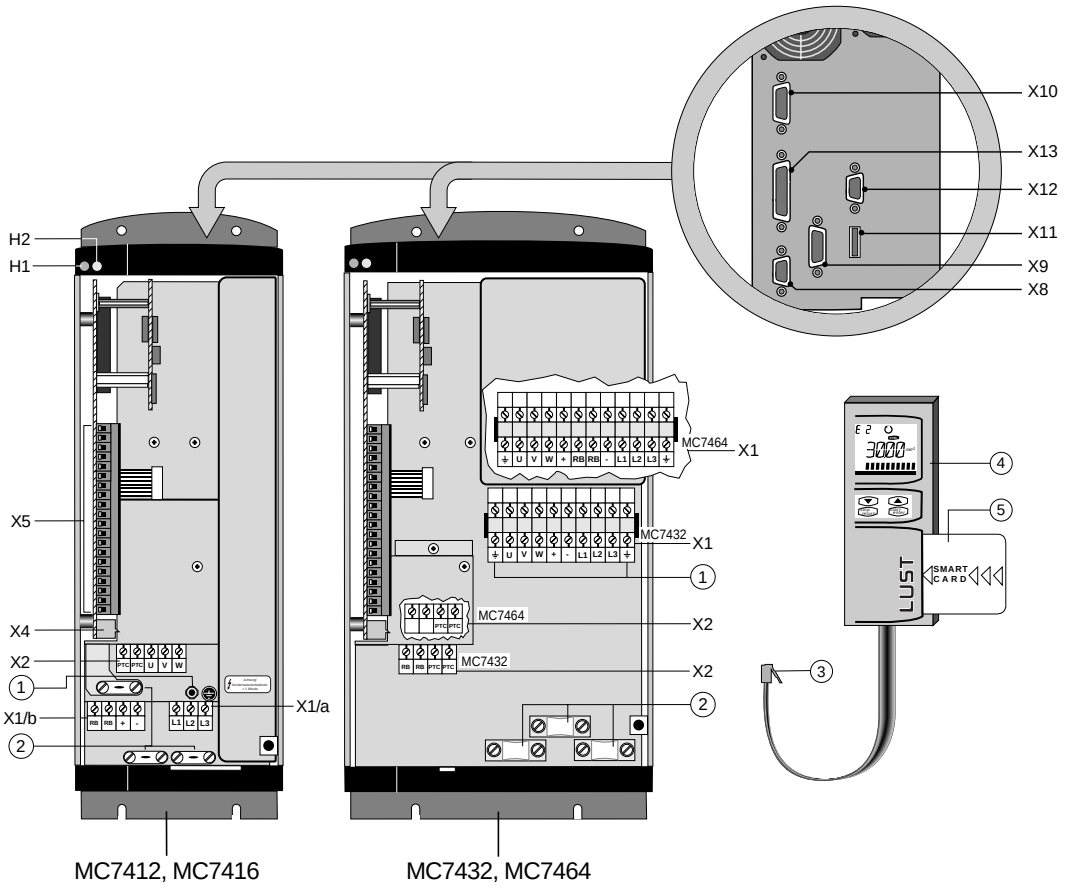


No.	Function	No.	Function
H1	Green LED, ON indicator	X11*	Connection for application hardware 2 (e.g. AH7 with 2 analog outputs) or for bus interface
H2	Yellow LED, fault indicator		
X1	Connection for mains input, DC-link and braking resistor	X12*	Connection for application hardware 2 (e.g. AH7 with 2 analog outputs) or for bus interface
X2	Connection for motor and PTC		
X4	Socket for KeyPad	X13*	Connection for application hardware (e.g. AH6 for I/O expansion) and also for CAN-Bus
X5	Control terminals		
X8	Serial interface RS485	1	Center point for grounding lead connection
X9	Encoder interface 2: encoder simulation and pulse input	2	Cable clamps for correct EMC screening and cable strain relief
X10	Encoder interface 1, for connection of encoder built into motor	3	KeyPad connector
		4	KeyPad KP100 control unit
		5	SmartCard data storage card

* Depending on device version.

A.2 Layout, MC7412 - MC7464

Schematic layout!



No.	Function	No.	Function
H1	Green LED, ON indicator	X11*	Connection for application hardware 2 (e.g. AH7 with 2 analog outputs) or for bus interface
H2	Yellow LED, fault indicator		
X1	Connection for mains input, DC-link and braking resistor	X12*	Connection for application hardware 2 (e.g. AH7 with 2 analog outputs) or for bus interface
X2	Connection for motor and PTC		
X4	Socket for KeyPad	X13*	Connection for application hardware (e.g. AH6 for I/O expansion) and also for CAN-Bus
X5	Control terminals		
X8	Serial interface RS485	1	Center point for grounding lead connection
X9	Encoder interface 2: encoder simulation and pulse input	2	Cable clamps for correct EMC screening a cable strain relief
X10	Encoder interface 1, for connection of encoder built into motor	3	KeyPad connector
		4	KeyPad KP100 control unit
		5	SmartCard data storage card

* Depending on device version.

A.3 Technical data

		Des.	Dim.	MC7402	MC7404	MC7408	MC7412	MC7416	MC7432	MC7464
				Mains filter integrated (limit curve A, industry)						
Output, motor side	Rated power (400 V mains) [1]	S	kVA	1.4	2.8	5.5	8.3	11	22	44
	Rated power (460 V mains) [1]	S	kVA	1.6	3.2	5.2	9.5	11	22	50
	Voltage, effective	U	V	3 x 0 ... 400 (460)						
	Continuous current, eff. (400V/460V) [1]	I_N	A	2 / 2	4 / 4	8 / 6.5	12 / 12	16 / 14	32 / 32	64 / 64
	Continuous current, eff. (400V/460V) [2]	I_N	A	1.5 / 1.5	3 / 3	4 / 3	7.5 / 6	9 / 7	32 / 28	60 / 56
	Pulse current for 10 s	I_{max}	A	$2 \cdot I_N$					[6]	
	Switching frequency of power stage	f_s	kHz	4, 8, 16 (factory setting 8 kHz[3])						
	Motor system			asynchronous or synchronous						
	Protection against short and ground fault			yes, but not at terminals for braking resistor						
Input, mains side	Mains voltage [5]	U	V	3 x 400 ... 460 ± 10%						
	Asymmetry of mains voltage		%	≤ 3						
	Frequency	f	Hz	48 ... 62						
	Power factor of fundamental	$\cos\varphi_1$		> 0,97						
	Efficiency [1] [4]	η	%	> 95						
	Power loss	P_V	W	70	110	200	250	310	600	1000
Braking chopper	Peak braking power with internal braking resistor [max. duration]	P_{SP}	kW	1.9 [17 s]	3.4 [10 s]	6 [3 s]	6 [8 s]	6 [8 s]	– –	
	Continuous braking power (internal)	P_{eff}	W	80	80	40	90	30	–	
	Minimum ohmic resistance of external braking resistors (design code BR3)	R_{min}	Ω	280	160	90	33		13	10
	Peak braking power with external resistor R_{min}	P_{SPex}	kW	1.9	3.4	6.0	16.8		42	55
Encoder simulation	Pulses per revolution with encoder version G1, G3, G5 (sin/cos encoders)	G1 G3 G5		2048						
	Standard pulses per revolution with encoder version R1, R2, R8 (resolvers)	R1		1024 (128, 256, 512, 1024, 2048, 4096)						
		R2		2048 (256, 512, 1024, 2048, 4096, 8192)						
		R8		3072 (384, 768, 1536, 3072, 6144, 12288)						
	Zero pulses per revolution with encoder version G1, G3, G5 (sin/cos encoders)	G1		1						
		G3 G5		0						
	Zero pulses per revolution with encoder version R1, R2, R8 (resolvers)	R1		1						
		R2		2						
		R8		3						

[1] At a factory-set power stage switching frequency of 8 kHz (4 kHz for MC7432 and MC7464). All other data apply irrespective of switching frequency of power stage!

[2] Based on a switching frequency of 16 kHz (8 kHz for MC7432 and MC7464).

[3] Servocontroller MC7432 and MC7464: factory setting 4 kHz.

[4] At rated voltage and rated current.

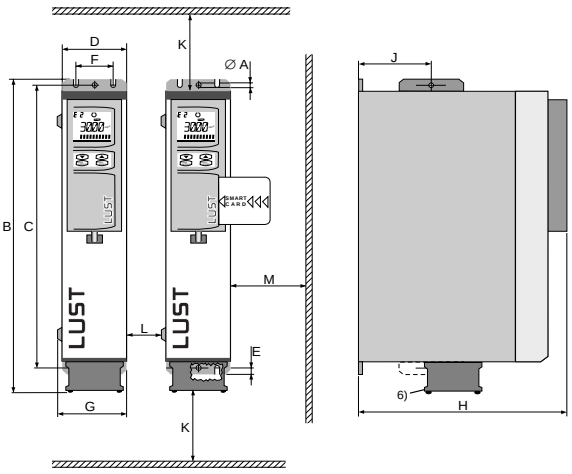
[5] Operation at one mains with non-earthed neutral is not allowed.

[6] Pulse current: MC7432 at 4 kHz: $2.0 \cdot I_N$ (at 8 kHz: $1.3 \cdot I_N$), for MC7464 at 4 kHz: $1.5 \cdot I_N$ (at 8 kHz: $1.0 \cdot I_N$).

Ambient conditions

Mechanism

	Des	Dim.	MC7402	MC7404	MC7408	MC7412	MC7416	MC7432	MC7464
Cooling air temperature (up to 1000 m above sea level)	T_N	°C	0 ... 40						
Type of cooling			Forced cooling						
Relative air humidity	rF	%	15 ... 85, non-condensing (VDE0160)						
Power reduction depending on mounting height	ΔP_H	%	5% per 1000 m above 1000 m above sea level, max. 2000 m above sea level						
Motor line length	L_{ML}	m	0 ... 10 m, with power reduction 10 ... 50 m						
Power reduction depending on motor line length (4 and 8 kHz / 16 kHz)	ΔP_{ML}	mA/m	0 / 25		25 / 65	50 / 70		100 / 150	
Storage temperature	T_L	°C	-25 ... +55 (VDE0160)						
Transport temperature	T_T	°C	-25 ... +70 (VDE0160)						
Vibration			2g (IEC 68-2-6)						
Protection			IP20 , VBG4						
Mounting type			Vertical wall-mounting						
Weight	m	kg	3.7			7.5		10	15
Dimensions	ØA	mm	Ø 4.8			Ø 5.8		Ø 7	
	B	mm	347			360		440	
	C	mm	315			345		425	
	D	mm	65			142.5		190	285
	E	mm	7.5						
	F	mm	40			100		150	240
	G	mm	69			– (G = D)			
	H	mm	260			260		290	
	J	mm	112			–			
Minimum mounting clearances	K	mm	100			150			
	L	mm	0			0 / 20 [7]			
	M	mm	0			0 / 20 [7]			



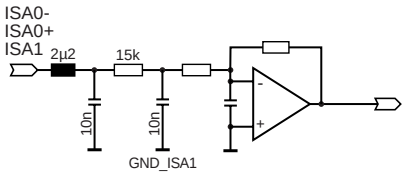
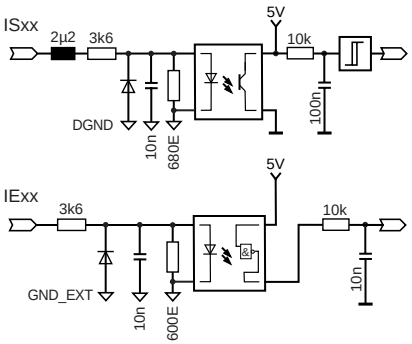
7) Distance 20 mm to other devices or to servocontrollers with other power outputs, e.g. 1 x MC7412, 1 x MC7416.

A.4 Specification of control terminals

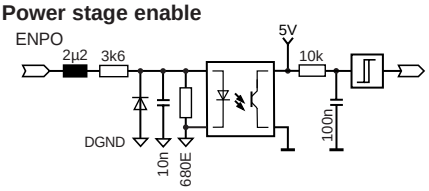
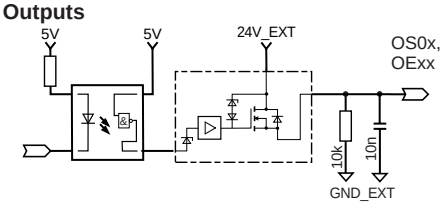
<table>
<tr><th></th><th>No.</th><th>Terminal</th><th>Specification</th></tr>
<tr><td>Auxiliary voltages</td><td>X5-1
X5-2
X5-6</td><td>+10V
-10V
GND_ISA1</td><td>±10,5 V DC ±5%, khort-circuit-proof, load capacity: max. 10 mA

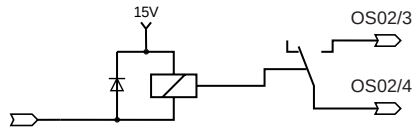
Ground for input ISA1, isolated from DGND</td></tr>
<tr><td></td><td>X5-7
X5-8
X5-14</td><td>+24V
+24V
DGND</td><td>+24V DC ±10%, short-circuit-proof, isolated
Load capacity: max. 200 mA
Digital ground, isolated from GND_ISA1 and GND_EXT</td></tr>
<tr><td></td><td>X5-15

X5-
16, 17</td><td>24V_EXT

GND_EXT</td><td>+24V DC ±20%, external supply
• To supply the control section (SN2):
Power consumption: max. 40 W for MC7402 - MC7408,
max. 50 W for MC7412/7416, max. 70 W for MC7432/7464;
for switching on procedure, 50% more power for 150 ms!
Ground for externally supplied voltage</td></tr>
<tr><td>Reference inputs
 
</td><td>X5-3
X5-4
X5-5</td><td>ISA0-
ISA0+
ISA1</td><td>For generation of reference values with voltage
<table><tr><td></td><td></td><td>ISA0</td><td>ISA1</td></tr><tr><td>Ref. values</td><td>U</td><td>-10 ... +10 V</td><td>0 ... +10 V</td></tr><tr><td>Input impedance</td><td>U</td><td>≥ 100 kΩ</td><td>≥ 100 kΩ</td></tr><tr><td>Resolution</td><td></td><td>12 Bit</td><td>11 Bit</td></tr><tr><td>Accuracy</td><td></td><td colspan="2">1% ± 1 LSB</td></tr><tr><td>Switching level, digital</td><td>Low=
High=</td><td colspan="2">< 4.8 V
> 8 V</td></tr></table>• Offset calibrated at factory
• Also usable as 24 V digital input,
freely programmable
• Sampling time 1 ms, plus < 1 ms operating delay</td></tr>
<tr><td>Digital inputs
 
</td><td>X5-9
X5-10

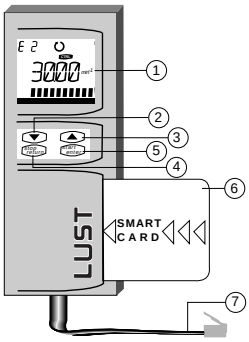
X13-1
...17</td><td>IS00
IS01

IE00...
IE07</td><td>Freely programmable control inputs
• Sampling time 1 ms
• Inputs IS00, IS01: plus < 2 ms operating delay
• Inputs IExx: plus < 10 µs operating delay
• PLC-compatible, +24 V logic isolated from DGND
• Switching level HIGH = 19,2 ... 26,8 V DC
LOW = 0 ... 4,8 V DC
(no other voltage states are permissible)
• Contact current 6.4 mA (24 V), 8 mA (30 V)
• Input impedance 4.3 kΩ</td></tr>
<tr><td>Power stage enable
 
</td><td>X5-11</td><td>ENPO</td><td>Hardware-linked enable of power stage
• Delay time < 2 ms
• PLC-compatible, +24 V logic isolated from DGND
• HIGH level = power stage enabled</td></tr>
<tr><td>Outputs
 
</td><td>X5-12
X5-13</td><td>OS00
OS01</td><td>Digital +24 V outputs, high-active, short-circuit-proof
• Freely programmable
• Sampling time 1 ms, practically no operating delay
• Internal free-running diode
• Max. load capacity per output: 50 mA

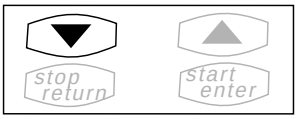
OS00 also usable as a PWM output:
• As a quasi-analog signal for display instruments
• Pulse width modulated output signal (f=200 Hz)
• Minimum load: 1 kΩ</td></tr>
<tr><td> 
</td><td>X5-19
X5-20</td><td>OS02/3
OS02/4</td><td>Relay contacts (make contacts)
• Max. 42 V AC or 63 V DC, max. 3 A
• Freely programmable
• Operating delay of relay 10 ms
• Sampling time 1 ms</td></tr>
</table>

B KeyPad operation

B.1 Layout and control elements

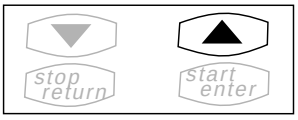


No.	Designation	Function
1	LC display	140 segments, backlit green/red
2	Down key	Scroll back through the menu structure
3	Up key	Scroll forward through the menu structure
4	Stop/Return key	Stop (CTRL menu), cancel or exit selected menu
5	Start/Enter key	Start (CTRL menu), confirm or select menu
6	SmartCard	Chipcard data memory, stores the device settings (accessory)
7	Connecting cable	Maximum length 0.35 m

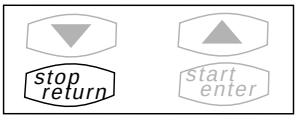


The ▼ and ▲ **keys** are used to select menu branches and the individual parameters and alter them.

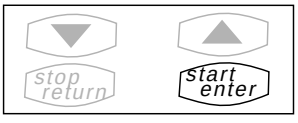
Press once to jump to the next menu branch or parameter or make the smallest possible alteration to a parameter value.



Hold a key down to scroll. Release key to stop scrolling.

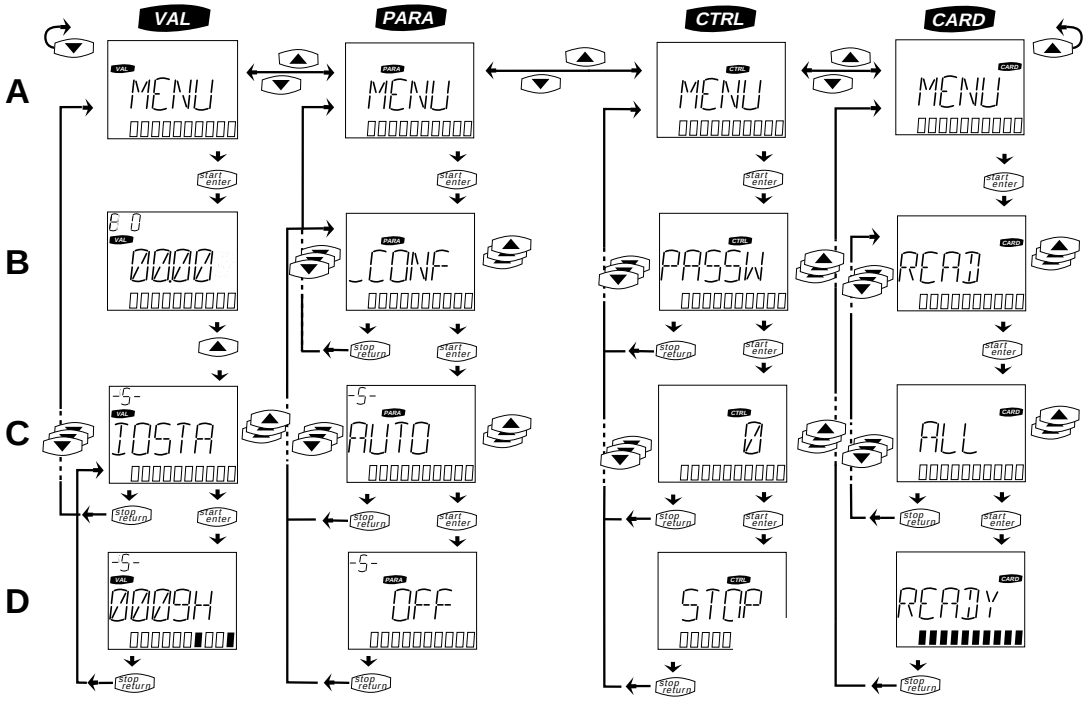


Press the **Stop/Return key** to exit menu branches or to cancel parameter changes (old value is retained).



Press the **Start/Enter key** to call up menu branches or parameters and to store changes.

B.2 KeyPad menu structure



A	VAL menu selected (display actual values)	PARA menu selected (set parameters)	CTRL menu selected (control drive via KeyPad)	CARD menu selected (load/ store with SmartCard)
B	Display parameter value, with cursor key switch to ...	Select subject area	Password prompt, factory setting = no password protection	READ = load “WRITE = store “LOCK= + write protection “UNLCK= - write protection
C	Next parameter	Select parameter	Enter password	Select parameter area, start with Start/Enter key
D	Display parameter value	Display parameter value, change as required	Activate MOP function	Function terminated without error

B.3 The VAL menu

The sole function of the VAL menu is to display actual and fixed values. The parameters cannot be edited. The number of available parameters depends on the user level (MODE parameter).

To display the value of a parameter select the parameter name by scrolling with the ▲ and ▼ **keys** and confirm with the **Start/Enter key**.

When the servocontroller starts up the KEYPAD display shows this menu, indicating the value of the parameter selected as the permanent actual value from the PARA menu. The factory default for this is the control reference, parameter REFV (Reference Value).

Parameters of the VAL menu:

No.	Name	MODE	Unit	Designation	Description
75	CURNT	1	A	Current	Output current (effective phase current)
76	TORQE	1	Nm	Torque	Torque (actual)
77	SPEED	1	rpm	Speed	Speed (actual)
78	POS	1	revs	Position	Position (actual)
86	TSYS	1	min	System Time	System time (time since last power-on)
87	TOP	1	h	Time of Operation	Operating hours meter
90	SREV	1		Standard Revision	For modified software, gives reference to standard software
91	TYPE	1		Type	Device type
92	REV	1		Revision	Software version
94	TERR	1	min	Time Error	System time on occurrence of last error
95	ERR1	1		Error 1	Last error 1)
347	DCV	1	V	DC-(Link-)Voltage	DC-link voltage
400	ACTV	1	Nm, rpm, U	Actual Value	Actual value of control variable
427	TEMP	1	°C	Temperature	Temperature of servocontroller
447	REFV	1	Nm, rpm, U	Reference Value	Control variable reference value
96	ERR2	3		Error 2	Second-last error 1)
97	ERR3	3		Error 3	Third-last error 1)
98	ERR4	3		Error 4	Fourth-last error 1)
483	ISA0	4	V	Voltage on ISA0	Voltage at analog input
484	ISA1	4	V	Voltage on ISA1	Voltage at analog input
115	CSXOR	4	Hex	Checksum XOR	Software checksum (XOR)
116	CSADD	4	Hex	Checksum ADD	Software checksum (AND)

1) The error E-OFF is only stored in the event of short-time power outages. The time since the last power-on (system time) is also displayed

B.4 The PARA menu

Note:

Only the operation modes in speed control can be operated and their parameters set using the KeyPad. To be able to use the full range of functions, you must use the DriveManager PC-based user software.

In the PARA menu the parameters to which the current user level permits access can be changed.

The PARA menu is subdivided in a menu structure. The parameters are arranged in groups according to subject area. This makes the task of working with a large number of parameters considerably easier.

Subject areas in the PARA menu:

Abbreviation	Designation	Description
_CONF	Configuration	System configuration (controller hardware and software)
_ENCD	Encoder	Optical encoders and resolvers
_MOT	Motor	Motor parameters
_TCON	Torque Control	Torque control
_SCON	Speed Control	Speed control
_SIO	Serial Input/Output	Configuration of serial interface
_KPAD	KeyPad	KeyPad settings
_SCTY	Security	Error responses and security rules
_REF	Reference	Parameters for reference value generation

Note:

The parameter list with all key parameters is in Appendix D.

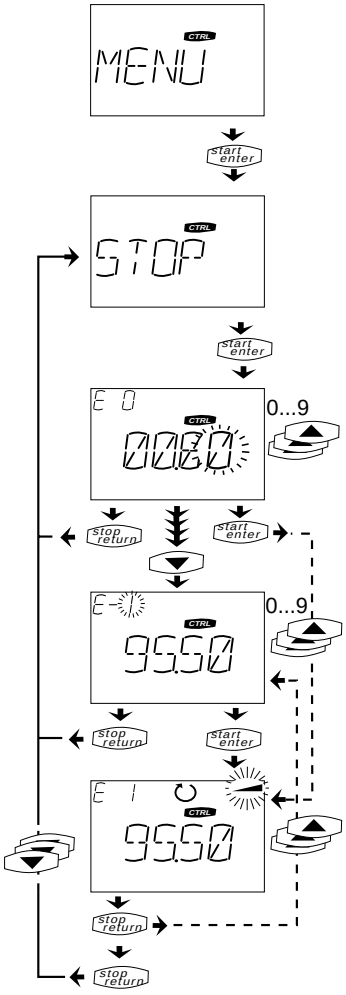
B.5 The CTRL menu

Not available for operation mode point-to-point positioning.

This menu facilitates operation of the drive with any reference value by way of the KEYPAD. According to the current mode, it is possible to select a torque, speed or position reference.

Control of the drive via the CTRL menu:

Preconditions:	Input ENPO	(Power stage enable)	= 24 V.
	Input IS00	(Start control)	= 0 V.



Select CTRL menu.

Press the **Start/Enter key** to initiate reference generation.

The last digit is flashing and can now be changed using the ▲ **key**. Press the ▼ **key** to switch to the next digit. The fifth digit on the extreme left is reserved for specification of the direction of rotation, (—) = counter-clockwise and ( ) = clockwise. The exponent can be entered as the last digit.

Press the **Start/Enter key** to start the controller; the motor is switched to the reference value.

Press the **Stop/Return key** once and the motor will continue running at a constant reference. It is possible to enter a new value. Press the **Start/Enter key** to switch the servocontroller to the new reference.

Press the **Stop/Return key** twice to stop the motor.

B.6 The CARD menu

This menu is used for reading from and writing to SmartCards in order to store device settings and to adapt automatically to the motor in use.

The CARD menu comprises four functions:

- READ Read all or some of the parameters from the SmartCard
- WRITE Store all parameters on the SmartCard
- LOCK Write-protect the SmartCard
- UNLOCK Cancel write protection

Reading and storing (READ and WRITE functions)

The parameters are grouped into areas on the SmartCard according to activity. The areas do not correspond to the subject areas in the PARA menu! In every storage operation all parameters are always saved to the SmartCard.

For read operations, select the desired area after accessing the READ function. It is possible to read just one area from a SmartCard containing the entire parameter set.

Setting	Designation	Store/Read
ALL	All	All parameters
APPLI	Application	Application-specific parameters
SYSTM	System	General system configuration
REFRC	Reference	Parameters of reference generation and function selectors
DRIVE	Drive	Drive parameters

Notes:

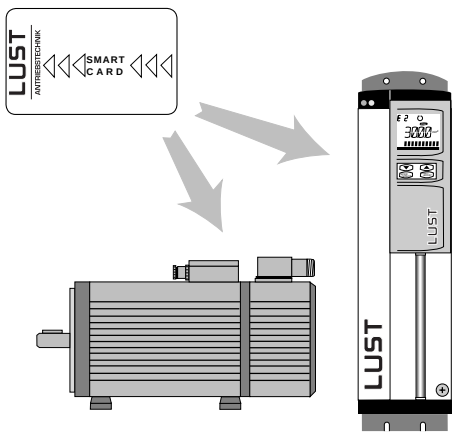
1. The CARD menu can only be selected when the controller is not active!
2. Control cannot be started while you are still in the CARD menu.
3. The system therefore switches automatically to the VAL menu after 10 minutes.
4. In bus system mode: The bus is not active while the SmartCard is being read or written to. The bus watchdog may therefore be triggered if switched on.

SmartCard for servomotors ASx and PSx

The SmartCard is also used for easy adaptation to the servomotors of the ASx and PSx series. All motor parameters and the complete controller dimensioning are stored in the DRIVE area of the SmartCard.

The motor type is printed on the SmartCard.

The maximum motor torque MOMMX (_MOT) set on the SmartCard is twice that of the nominal torque of the motor. For pulse mode (up to 0.2 s) five times the nominal torque is permitted.

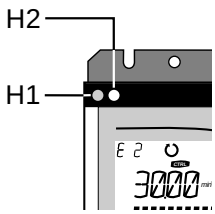


C Diagnosis and fault rectification

C.1 Operation and fault indicators

On the servocontroller

The current status of the servocontroller is indicated by two LEDs on the front panel of the cover.

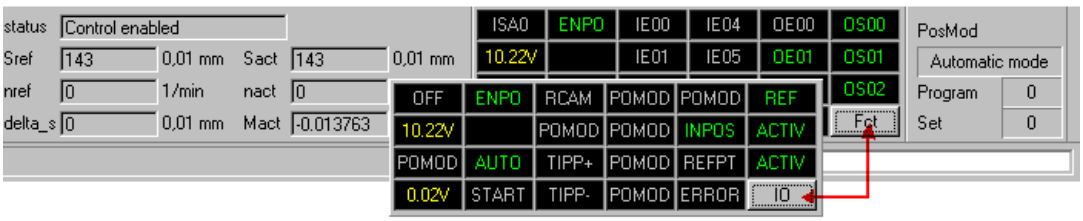


Green LED (H1) Off	Green LED (H1) On	Green LED (H1) Flashing	LED gelb (H2) Off	LED gelb (H2) On	LED gelb (H2) Flashing	Status
X			X			Device is off
	X		X			Servocontroller ready
	X			X		Servocontroller ready and warning
		X	X			Control enabled
		X		X		Control enabled and warning
		X			X	Reference limitation active (RLIM1, RLIM2) 1)
X				X		Fault
X					X	Precharge relay not operated or ENPO open

1) The direction symbol (↻ or ↺) on the KeyPad display also flashes.

In the DriveManager

The operating state is displayed in the footer line (in the **View** menu **from DriveManager version 2.1** on)



Faults are indicated by:

- **Display on device:** LED (H2) lit yellow
- **In DriveManager:** Menu: **Active device - Monitor - Device status**
- **KeyPad:** Display lit red

KeyPad shows:		Section
E-xxx	Servocontroller fault	C.3
ATTx	KeyPad user error	C.4
ERRxx	SmartCard error	C.5

x, xx, xxx - Wildcards for any letters or numbers

C.2 Resetting faults

Resetting faults (after eliminating the cause):

• **Control via terminals:**	With input Ixxx, to which the function Flxxx = RSERR (Reset Error) is assigned
Or:	Rising ramp at **ENPO input** (Please note: control is switched off!)
• **Control via KEYPAD:**	Press **Stop/Return key** on KEYPADS for approx. 3 seconds.
• **Control via DRIVEMANAGER:**	Choose “Reset error” button in **Active device - Control** menu.
• **Control via CAN-Bus:**	Set “Reset fault” bit in CAN-Bus control word.
• **Operation mode point-to-point positioning:**	Rising edge at input "Manual/Automatic"

Starting the drive after an error

- **Cancel start signal and reapply it.**
- **With programmed autostart function:**
  - In fault responses 1, 2 and 5 the drive restarts automatically when the error has been reset.
  - In fault responses 3 and 4 the drive restarts only when the start signal has been canceled and reapplied.

C.3 Fault responses

When a fault occurs the servocontroller responds with one of the responses listed below. The “Response no.” column in the fault table indicates the response of the servocontroller to the respective fault type.

Response No.	Function
0	Signal error only, no further response (warning)
1	Signal error and disable power stage
2	Signal error, quick-stop and wait for cancellation of start signal
3	Signal error, disable power stage and secure against restarting[1)]
4	Signal error, quick-stop, wait for cancellation of start signal and secure against restarting[1)]
5	Signal error, disable power stage, wait for error reset; then software reset.

[1)] Only relevant with programmed autostart function; see section C.2.

C.4 Fault table

In the event of a fault, a plain text message and an error location number (at the top left of the KEYPAD display) appear. The error location number facilitates more detailed definition of the cause.

No.	Error	Error loc. no.	Cause	Response no.	Remedy
0	–	–	No error		
1	E-CPU	–	Processor faulty or wrong software version	5	1)
2	OFF	1	Undervoltage, i.e. DC-link voltage < 425 V (also displayed on normal power-off)	1	- Repair mains failure or - Connect higher mains voltage
3	E-OC	18	Overcurrent due to: - incorrectly set parameters - short-circuit, ground-fault or insulation error - internal device fault	3	- Check parameters of control circuits 1); - Check installation 1)
4	E-OV	1	Overvoltage due to: - overload of the braking chopper (braking too long or too heavy) - mains voltage surge	3	1) - Set DECR ramp parameter slower (_REF), use ext. braking resistor or chopper - Adjust mains voltage
5	E-OLI	1	I x t shutdown to protect the servocontroller (permissible current/ time area exceeded)	3	Reduce load, reduce maximum torque TCMMX (_TCON)
6	E-OTM	18	Overheating in motor (PTC in motor tripped) - PTC not connected - Motor overload	3	Allow motor to cool down - Connect PTC or bridge terminals with 100 Ω - Use a higher-power motor 1)
7	E-OTI	1	Overheating in servocontroller: - ambient temperature too high - load too high (power stage or braking chopper)	3	- Improve ventilation - Use a higher-power servocontroller and ext. braking resistor or chopper 1)
8	E-EEP	3, 12	Error in EEPROM	5	1) EEPROM faulty
		6, 100...116	Error accessing parameters	5	1)
9	E-OLM	1	I^2 x t shutdown to protect the motor	3	Reduce load, use a higher-power motor
10	E-PLS	xxx	Plausibility check detected invalid parameter or impermissible program sequence	5	1)
11	E-PAR	2	Reference generation limits incorrect (RLIM1 > RLIM2)	5	Set RLIM1 < RLIM2 (_REF)
		7	Faulty parameter detected. Before the error message appears the display indicates the number of the faulty parameter.	5	Find faulty parameter based on number from parameter list and correct faulty parameter.
		8	Error in first initialization	5	1)
		13	Function and reference selector settings contradictory	5	Check selectors and change setting (_CONF, _REF)
		16	Parameter for output OS00 incorrectly set	5	Exchange OA0MN and OA0MX (_CONF) values
		58	Invalid operation mode	5	Change operation mode
		101	Impermissible number of pole pairs in resolver (not equal to number of pole pairs of motor and not equal to 1)	5	Set parameter ECNPP (_ENCD) Check resolver
		150	Range limits of D/A module (AH7) incorrectly selected	5	Check DAxMN, DAxMX

Continued →

No.	Error	Error loc. no.	Cause	Response no.	Remedy
12	E-FLT	0	Global error in floating point calculation	5	1)
13	E-PWR	6	Power pack not correctly detected	5	1) Send in device
14	E-EXT	1	Error in an external device	2	Rectify error in other device
15	E-ENC	1	Encoder signals faulty	5	Check cable Check encoder
		6	Encoder interface not correctly detected or cable not connected	5	1) Check cable
16	E-OP1	6	Error on module in slot 1 (X11/X12)	2	1) Check module and ID
17	E-OP2	6	Error on module in slot 2 (X9)	2	1) Check module and ID
18	E-TIM	18	Runtime monitor triggered	5	1)
19	E-FLW		Tracking error, see section C.3	0 (0 ... 2)	Reduce load or acceleration
20	E-WDG	111	Watchdog for RS485 triggered	2	Check bus master or increase SWDGT (_SIO)
21	E-CAN	1	CAN watchdog timeout	2	Check bus master or increase BUTWD (_CONF)
		6	CAN module not detected	2	Module wrong or faulty 1)
22	E-IO1	6	Input module not detected	5	Module wrong or faulty 1)
23	E-IO2	6	Output module not detected	5	Module wrong or faulty 1)
24	E-VEC	19	Error initializing VeCon data RAM	5	1)
		20	Error initializing VeCon program RAM	5	1)
25	E-BRK	1	Error at output OS03: - open circuit	3	Check output OS03 - Brake connected ?
		6	- short - overheating - no protective circuit, or protective circuit inadequate	3	- Check installation - Check protective circuit
26	E-POS	210 211 212 213 214 217 219 220 223 224 225 230 232 236	Pos. hardware limit switch approached Neg. hardware limit switch approached Pos. software limit switch approached Neg. software limit switch approached Reference point not defined Wrong selection of positioning set Position outside positioning range Division by zero Destination position not reached 'Feed enable' signal is missing Illegal selection (Automatic/Ref. run/Jog mode) Max. speed exceeded (SCSMX) ENPO signal missing Hardware limit switches interchanged	2	
27	E-FLH	50...53	Error in Flash memory or delete operation running	5	1)
28	E-END	23 24	Left limit switch approached Right limit switch approached		
29	E-EEX	25	Limit switches interchanged		

1) A hardware or software error has occurred which should not occur in normal operation.
Ascertain a) the error, b) the error location number and c) the software version (parameter REV in the KEYPAD VAL menu or in the DRIVEMANAGER parameter editor) and contact:

Lust Service Center
Gewerbestr. 7
D-35633 Lahnau
Phone: (+49 6441) 966 -136, Fax -211

To acknowledge errors press the **Stop/Return key** for at least 3 seconds!

C.5 KeyPad user errors

The following user errors can occur in operation of the KeyPad KP100:

Error	Cause	Remedy
ATT1	Parameter cannot be changed at current user level or is not editable	Select higher MODE user level 1)
ATT2	Motor must not be controlled online via the CTRL menu	Cancel start signal from a different control location
ATT3	Motor must not be controlled via the CTRL menu because of error state	Reset error
ATT4	New parameter value impermissible	Change value of parameter
ATT5	New parameter value too high	Reduce value of parameter
ATT6	New parameter value too low	Increase value of parameter
ATT7	Card must not be read in current state	Stop control (cancel start signal)
ATT8	Permissible speed limit SCSMX too high for selected control mode or motor	Reduce SCSMX (_SCON) to permissible values
ATT9	CTRL menu cannot be used with POSMOD1	Choose a different menu or remove POSMOD1
ERROR	Invalid password	Enter correct password for user level 1)

1) A higher user level can only be selected by users who are familiar with the device and have the appropriate access permission. They will know the password required for access to the user level.

Reset errors by choosing the **Start/Enter key**.

C.6 Errors in SmartCard operation

Error	Meaning
ERR91	SmartCard write-protected
ERR92	Error in plausibility check
ERR93	SmartCard not readable, wrong servo or inverter type
ERR94	SmartCard not readable, parameter not compatible
ERR96	Connection to SmartCard broken
ERR97	SmartCard data invalid (CS test)
ERR98	Insufficient memory on SmartCard
ERR99	Selected area not present on SmartCard no parameters transferred to SmartCard

These errors occur when impermissible - and usually unintentional - actions are executed such as writing to a backup copy of parameter data or reading a SmartCard for inverters. We therefore recommend using a different SmartCard as a generally applicable remedy.

Reset errors by choosing the **Stop/Return key**.

D Parameter list, BASIC application package

Following you find the parameters listing of the Basic application package. This is to support the usage of the KEYPAD for setting parameters. Due to the complexity the package Motion can only be used in conjunction with the DRIVEMANAGER.

Tab	Parameter	Abbrev. (in KEYPAD)	Subject area (in KEYPAD)	Param.-no.	MODE	Page
Inputs/outputs	Analog input ISA0	FISA0	_CONF	441	1 2	2-x
	Analog input ISA1	FISA1	_CONF	442	1 2	2-x
	Input IS00	FIS00	_CONF	439	1 2	2-x
	Input IS01	FIS01	_CONF	440	1 2	2-x
	Output OS00	FOS00	_CONF	445	1 2	2-x
	Output OS01	FOS01	_CONF	446	1 2	2-x
	Output OS02	FOS02	_CONF	463	1 2	2-x
Control	Speed controller gain	SCGFA	_SCON	375	1 3	5-8
	Speed controller lag time	SCTLG	_SCON	360	1 3	5-10
	Actual speed filter	ECTF	_ENCD	336	1 3	5-10
	System moment of inertia	SCJ	_SCON	363	1 3	5-7
	Speed reference filter	SCTF	_SCON	376	– –	5-6
	Torque controller gain	TCG	_TCON	351	4 –	–
	Torque controller lag time	TCTLG	_TCON	352	4 –	–
Motor	Encoder type	CFENC	_CONF	309	– –	–
	Motor type	CFMOT	_CONF	301	4 –	–
	Rated current	MOCNM	_MOT	317	1 –	–
	Nominal torque	MOMNM	_MOT	318	1 –	–
	Max. torque	MOMMX	_MOT	327	– –	–
	Nominal speed	MOSNM	_MOT	315	1 –	–
	Max. speed	MOSMX	_MOT	316	1 –	–
Application	Max. speed	SCSMX	_SCON	384	1 3	3-2
	Max. torque	TCMMX	_TCON	353	1 3	3-2
	Acceleration ramp	ACCR	_REF	842	1 2	3-6
	Deceleration ramp	DECR	_REF	852	1 2	3-6
	Smoothing time	JTIME	_REF	856	1 2	3-5
	Stop ramp	STOPR	_REF	496	1 2	3-6
	Lines per revolution in encoder simulation	ECSLN	_ENCD	13	4 4	3-8
	Holding brake mode	BRAKE	_CONF	465	1 2	3-7
	Holding time until brake engages	THTDC	_CONF	467	1 2	3-6
	Autostart	AUTO	_CONF	7	1 2	3-4
	Reference window	REF_R	_CONF	862	1 2	3-3
	Standstill window	SPD_0	_CONF	401	1 2	3-3, 3-9
	Speed 0	RFIX1	_REF	742	1 2	2-7
	Speed 1	RFIX2	_REF	752	1 2	2-7
	Speed 2	RFIX3	_REF	762	1 2	2-7
	Speed 3	RFIX4	_REF	772	1 2	2-7
	Signal type	RSTEP	_REF	125	4 4	2-9
	Master encoder (lines per revolution)	EC2LN	_REF	335	4 4	2-9
	Numerator (gear ratio)	RDNOM	_REF	389	1 2	2-9
	Denominator (gear ratio)	RDDEN	_REF	390	1 2	2-9
	Scaling of analog input ISA0	RNA0	_REF	822	1 2	–
	Scaling of analog input ISA1	RNA1	_REF	832	1 2	–

MODE - User level (primarily in KEYPAD operation). The first number indicates the display level, the second the editing level.

– - Parameter not editable, for information only.

Hinweis zur EN 61000-3-2
(rückwirkende Netzbelastung durch Oberwellen)

Unsere Frequenzumrichter und Servoregler sind im Sinne der EN61000 "professionelle Geräte", so dass sie bei einer Nennanschlußleistung ≤1kW in den Geltungsbereich der Norm fallen.
Beim direkten Anschluß von Antriebsgeräten ≤1kW an das öffentliche Niederspannungsnetz sind entweder Maßnahmen zur Einhaltung der Norm zu treffen oder das zuständige Energieversorgungsunternehmen muß eine Anschlußgenehmigung erteilen.
Sollten Sie unsere Antriebsgeräte als eine Komponente in ihrer Maschine/ Anlage einsetzen, dann ist der Geltungsbereich der Norm für die komplette Maschine/ Anlage zu prüfen.

Notes on EN 61000-3-2
(limits for harmonic current emissions)

Our frequency inverters and servocontrollers are "professional devices" in the sense of the European Standard EN 61000, and with a rated power of ≤1kW obtained in the scope of this standard.
Direct connection of drive units ≤1kW to the public low-voltage grid only either by means of measurements for keeping the standard or via an authorization of connection from the responsible public utility.
In case our drive units are used as a component of a machinery/plant, so the appropriate scope of the standard of the machinery/plant must be checked.

Remarque concernant EN 61000-3-2
(valeurs limites pour courants d'harmonique)

Dans l'esprit de EN61000, nos convertisseurs de fréquence et régulateurs automatiques sont des "appareils professionnels". Par conséquent ils tombent sous l'application de la norme lorsque la puissance de raccordement nominale ≤1kW.
Lorsque des appareils d'entraînement sont raccordés directement au réseau public basse tension, il convient de prendre des mesures pour respecter la norme ou l'entreprise de distribution d'électricité compétente doit délivrer une autorisation de branchement.
Si vous deviez utiliser nos appareils de branchement comme composants dans votre machine ou votre installation, il convient dans ce cas de vérifier le domaine d'application de l'ensemble de la machine ou de l'installation.

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