YASKAWA

System SLIO

FM | 054-2BA10 | Manual

HB300 | FM | 054-2BA10 | en | 25-02

Motion Module - Stepper - FM 054 - DC 48V 5A

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054-2BA10_000_FM054 Stepper,3,EN - © 2025

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1 General

1.1 About this manual

Objective and contents

This manual describes the FM 054-2BA10 of the System SLIO.

- It describes the structure, configuration and application.
- The manual is targeted at users with good basic knowledge in automation technology.
- The manual does not replace sufficient basic knowledge of automation technology or sufficient familiarity with the specific product.
- The manual consists of chapters. Each chapter describes a completed topic.
- For guidance, the manual provides:
  - An overall table of contents at the beginning of the manual
  - References with pages numbers

    To be able to return to the previous view from a reference in the PDF, you should activate the page navigation in your PDF viewer.

Validity of the documentation

Product	Order no.	as of version:	
FM 054 Stepper DC 48V 5A	054-2BA10	HW: 01	FW: V1.0.0

Documentation

In the context of the use of the pertinent Yaskawa product, the manual is to be made accessible to the pertinent qualified personnel in:

- Project engineering
- Installation department
- Commissioning
- Operation

Icons and headings

Important passages in the text are highlighted by following icons and headings:

DANGER

- Immediate danger to life and limb of personnel and others.
- Non-compliance will cause death or serious injury.

CAUTION

- Hazardous situation to life and limb of personnel and others. Non-compliance may cause slight injuries.
- This symbol is also used as warning of damages to property.

NOTICE

- Designates a possibly harmful situation.
- Non-compliance can damage the product or something in its environment.

Supplementary information and useful tips.

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Download Center

By entering the product order number in the *'Download Center'* at www.yaskawa.eu.com, the pertinent manuals, data sheets, declarations of conformity, certificates and other helpful information for your product can be found.

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Tel.: +49 6196 569 500 (hotline)
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1.3 Safety instructions

General safety instructions

DANGER

Danger to life due to non-compliance with safety instructions

Non-compliance with the safety instructions in the manual can result in serious injury or death. The manufacturer is not responsible for any injuries or damage to the equipment.

CAUTION

Before commissioning and operating the components described in this manual, it is essential to note the following:

- Modifications to the automation system must only be done in a voltage-free state!
- Connection and modification only by trained electricians
- National regulations and guidelines in the respective country of use must be observed and complied with (installation, protective measures, EMC, etc.)

Intended use

- It is the customer's responsibility to comply with all pertinent standards, codes, or regulations applicable to the use of the product, including those that apply when the Yaskawa product is used in combination with other products.
- The customer must confirm that the Yaskawa product is suitable for the customer's plant, machinery and equipment.
- If the Yaskawa product is used in a manner not specified by this manual, the protection provided by the Yaskawa product may be impaired and the use may result in material or immaterial damage.
- Contact Yaskawa to determine whether use is permitted in the following applications. If the use in the respective application is permissible, the Yaskawa product is to be used by considering additional risk assessments and specifications, and safety measures are to be provided to minimise the dangers in the event of a fault. Special caution is required and protective measures must be taken in the case of:
  - Outdoor use, use with possible chemical contamination or electrical interference, or use under conditions or in environments which are not described in product catalogs or manuals
  - Nuclear control systems, combustion systems, railway systems, aviation systems, automotive systems, medical devices, amusement machines and equipment that is specifically regulated by industry or government
  - Systems, machines and devices that can pose a risk to life or property
  - Systems that require a high degree of reliability, such as gas, water or electricity supply systems or systems that operate 24 hours a day
  - Other systems that require a similarly high level of security
- Never use the Yaskawa product in an application where failure of the product could cause serious danger to life, limb, health or property without first ensuring that the system is designed to provide the required level of safety with risk warnings and redundancy to avoid the realisation of such dangers and that the Yaskawa product is properly designed and installed.
- The connection examples and other application examples described in the product catalogs and manuals of Yaskawa are for reference purposes. Check the functionality and safety of the devices and systems actually to be used before using the Yaskawa product.
- To avoid accidental harm to third parties, read and understand all prohibitions on use and precautions, and operate the Yaskawa product correctly.

Field of application

- The Yaskawa product is not suited for use in life-support machines or systems.
- Please contact your Yaskawa representative or Yaskawa distributor if considering the use of the Yaskawa product for special purposes, such as machines or systems used in passenger cars, in medical, aircraft and aerospace applications, for power supply of networks, for electrical power distribution or for underwater applications.

DANGER

The device is not permitted for use

– in explosive environments (EX zone)

The system is designed and manufactured for proper use and use in accordance with the user manual and is designed for:

- Communication and process control
- general control and automation tasks
- for industrial use
- operation within the environmental conditions specified in the technical data
- installation in a cabinet

DANGER

If this Yaskawa product is used in applications where failure of the device can result in the loss of human life, a serious accident or physical injury, you must install appropriate safety devices.

– Death or serious injury can result if you do not install the safety devices properly.

Disclaimer

(1) The contractual and legal liability of Yaskawa and the legal representatives and vicarious agents of Yaskawa for compensation and reimbursement of expenses in relation to the content of this documentation is excluded or limited as follows:

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(3) A reversal of the burden of proof is not associated with the provisions above.

Disposal

National rules and regulations apply to the disposal of the unit!

2 Basics and mounting

2.1 Safety notes for the user

DANGER

Protection against dangerous voltages

- When using System SLIO modules, the user must be protected from touching hazardous voltage.
- You must therefore create an insulation concept for your system that includes safe separation of the potential areas of extra-low voltage (ELV) and hazardous voltage.
- Here, observe the insulation voltages between the potential areas specified for the System SLIO modules and take suitable measures, such as using PELV/SELV power supplies for System SLIO modules.

Handling of electrostatic sensitive modules

The modules are equipped with highly integrated components in MOS technology. These components are highly sensitive to over-voltages that occur, e.g. with electrostatic discharge. The following symbol is used to identify these hazardous modules:

The symbol is located on modules, module racks or on packaging and thus indicates electrostatic sensitive modules. Electrostatic sensitive modules can be destroyed by energies and voltages that are far below the limits of human perception. If a person who is not electrically discharged handles electrostatic sensitive modules, voltages can occur and damage components and thus impair the functionality of the modules or render the modules unusable. Modules damaged in this way are in most cases not immediately recognized as faulty. The error can only appear after a long period of operation. Components damaged by static discharge can show temporary faults when exposed to temperature changes, vibrations or load changes. Only the consistent use of protective devices and responsible observance of the handling rules can effectively prevent malfunctions and failures on electrostatic sensitive modules.

Shipping of modules

Please always use the original packaging for shipping.

Measurement and modification of electrostatic sensitive modules

For measurements on electrostatic sensitive modules the following must be observed:

- Floating measuring instruments must be discharged before use.
- Measuring instruments used must be grounded.

When modifying electrostatic sensitive modules, ensure that a grounded soldering iron is used.

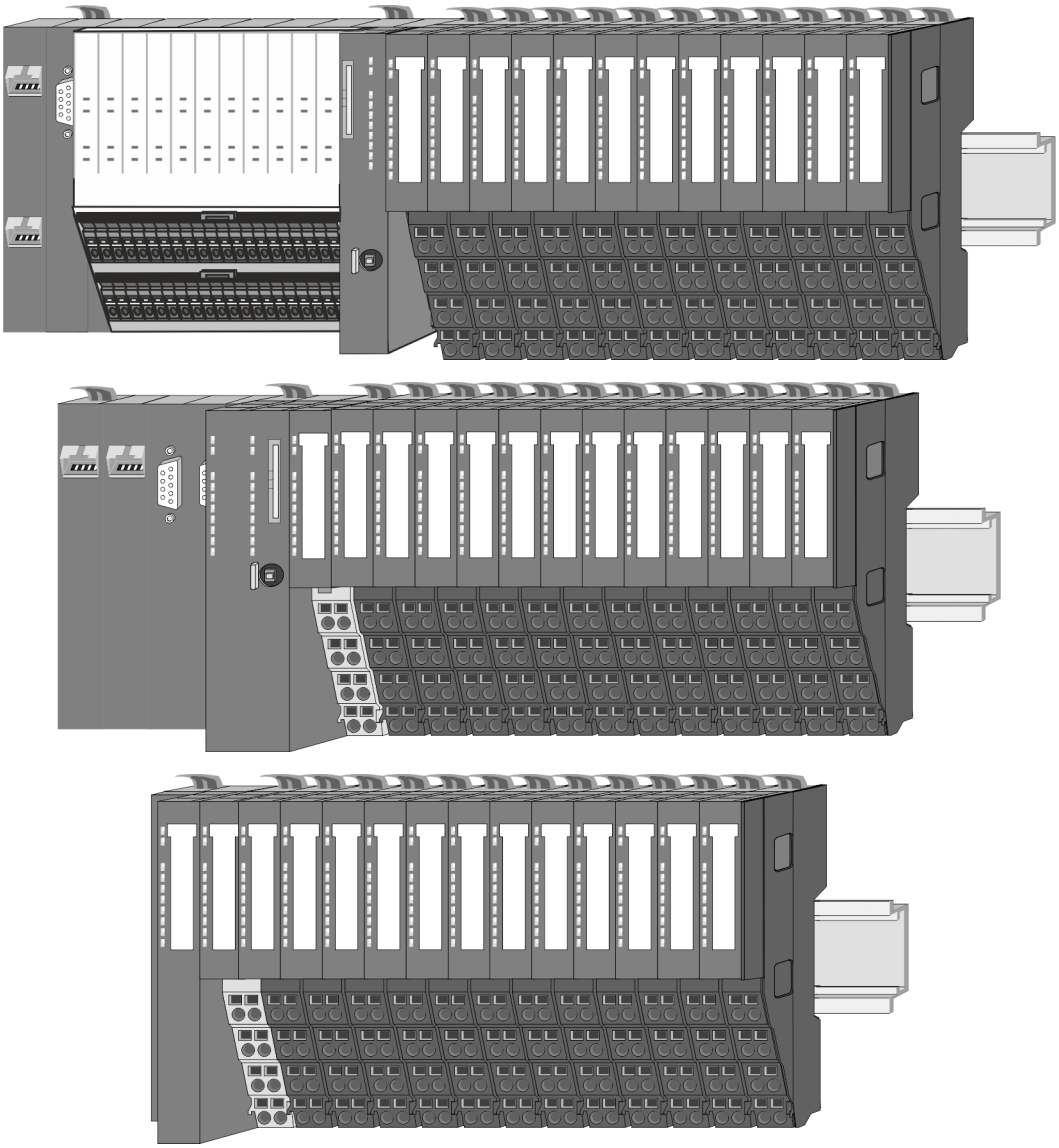
CAUTION

When working with and on electrostatic sensitive modules, make sure that personnel and equipment are adequately grounded.

2.2 System conception

2.2.1 Overview

The System SLIO is a modular automation system for assembly on a 35mm mounting rail. By means of the periphery modules with 2, 4, 8 and 16 channels this system may properly be adapted matching to your automation tasks. The wiring complexity is low, because the supply of the DC 24V power section supply is integrated to the backplane bus and defective modules may be replaced with standing wiring. By deployment of the power modules in contrasting colors within the system, further isolated areas may be defined for the DC 24V power section supply, respectively the electronic power supply may be extended with 2A.



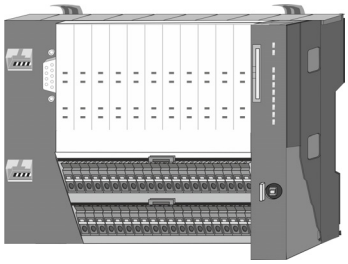
2.2.2 Components

- CPU (head module)
- Bus coupler (head module)
- Line extension
- 8x periphery modules
- 16x periphery modules
- 2-fold wide periphery module - 054-2BA10
- Power modules
- Accessories

CAUTION

Only modules of Yaskawa may be combined. A mixed operation with third-party modules is not allowed!

CPU 01xC



With the CPU 01xC electronic, input/output components and power supply are integrated to one casing. In addition, up to 64 periphery modules of the System SLIO can be connected to the backplane bus. As head module via the integrated power module for power supply CPU electronic and the I/O components are supplied as well as the electronic of the periphery modules, which are connected via backplane bus. To connect the power supply of the I/O components and for DC 24V power section supply of via backplane bus connected periphery modules, the CPU has removable connectors. By installing of up to 64 periphery modules at the backplane bus, these are electrically connected, this means these are assigned to the backplane bus, the electronic modules are power supplied and each periphery module is connected to the DC 24V power section supply.

CPU 01x

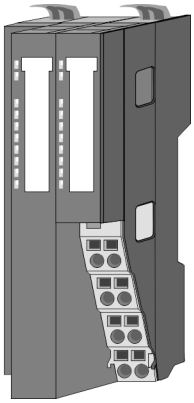
With this CPU 01x, CPU electronic and power supply are integrated to one casing. As head module, via the integrated power module for power supply, CPU electronic and the electronic of the connected periphery modules are supplied. The DC 24V power section supply for the linked periphery modules is established via a further connection of the power module. By installing of up to 64 periphery modules at the backplane bus, these are electrically connected, this means these are assigned to the backplane bus, the electronic modules are power supplied and each periphery module is connected to the DC 24V power section supply.

CAUTION

CPU part and power module may not be separated!

Here you may only exchange the electronic module!

Bus coupler

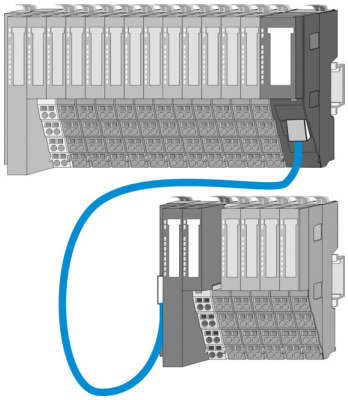


With a bus coupler bus interface and power module is integrated to one casing. With the bus interface you get access to a subordinated bus system. As head module, via the integrated power module for power supply, bus interface and the electronic of the connected periphery modules are supplied. The DC 24V power section supply for the linked periphery modules is established via a further connection of the power module. By installing of up to 64 periphery modules at the bus coupler, these are electrically connected, this means these are assigned to the backplane bus, the electronic modules are power supplied and each periphery module is connected to the DC 24V power section supply.

CAUTION

Bus interface and power module may not be separated! Here you may only exchange the electronic module!

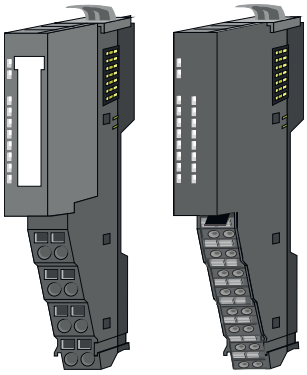
Line extension



In the System SLIO there is the possibility to place up to 64 modules in on line. By means of the line extension you can divide this line into several lines. Here you have to place a line extension MainDevice at each end of a line and the subsequent line has to start with a line extension SubDevice. MainDevice and SubDevice are to be connected via a special connecting cable. In this way, you can divide a line on up to 5 lines. Depending on the line extension, the max. number of pluggable modules at the System SLIO bus is decreased accordingly. To use the line extension no special configuration is required.

Please note that some modules do not support line extensions due to the system. For more information, please refer to the compatibility list. This can be found in the 'Download Center' of www.yaskawa.eu.com under 'System SLIO Compatibility list'.

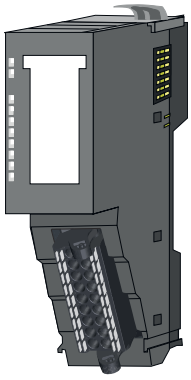
Periphery modules



The periphery modules are available in the following versions, whereby of each the electronic part can be replaced with standing wiring:

- 8x periphery module for a maximum of 8 channels.
- 16x periphery module for a maximum of 16 channels.

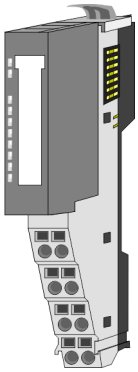
For more details on the use of the 8x/16x periphery modules, please refer to the corresponding manual.



- 2-fold wide periphery module - 054-2BA10

The following chapters only describe the installation and wiring of the 054-2BA10.

Power modules

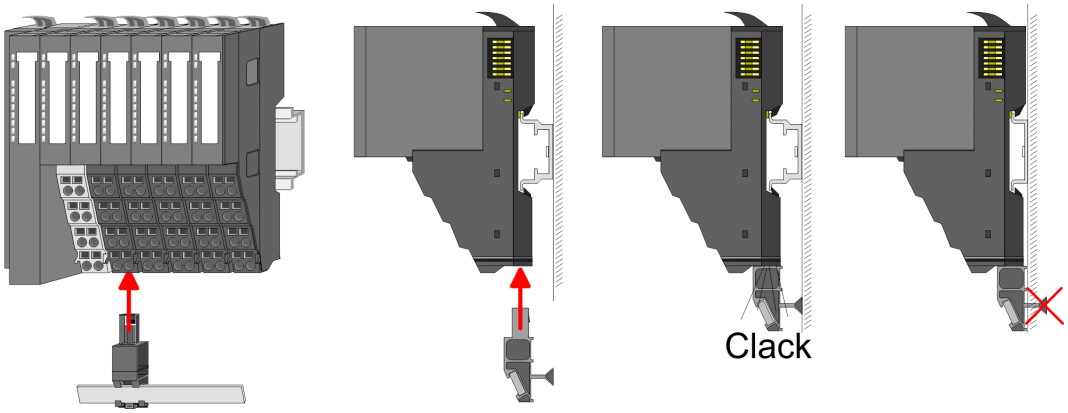


In the System SLIO the power supply is established by power modules. These are either integrated to the head module or may be installed between the periphery modules. Depending on the power module isolated areas of the DC 24V power section supply may be defined respectively the electronic power supply may be extended with 2A. For better recognition the color of the power modules are contrasting to the periphery modules.

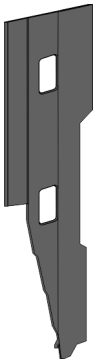
2.2.3 Accessories

Shield bus carrier

The shield bus carrier (order no.: 000-0AB00) serves to carry the shield bus (10mm x 3mm) to connect cable shields. Shield bus carriers, shield bus and shield fixings are not in the scope of delivery. They are only available as accessories. The shield bus carrier is mounted underneath the terminal of the terminal module. With a flat mounting rail for adaptation to a flat mounting rail you may remove the spacer of the shield bus carrier.



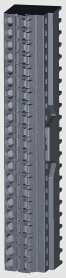
Bus cover



With each head module, to protect the backplane bus connectors, there is a mounted bus cover in the scope of delivery. You have to remove the bus cover of the head module before mounting a System SLIO module. For the protection of the backplane bus connector you always have to mount the bus cover at the last module of your system again. The bus cover has the order no. 000-0AA00.

Spare parts

The following spare parts are available for the System SLIO:

Spare part	Order no.	Description	Packaging unit
	092-9BH00	Terminal block for System SLIO 16x periphery module.	5 pieces
	092-9BK00	Connector for System SLIO CPU 013C.	5 pieces

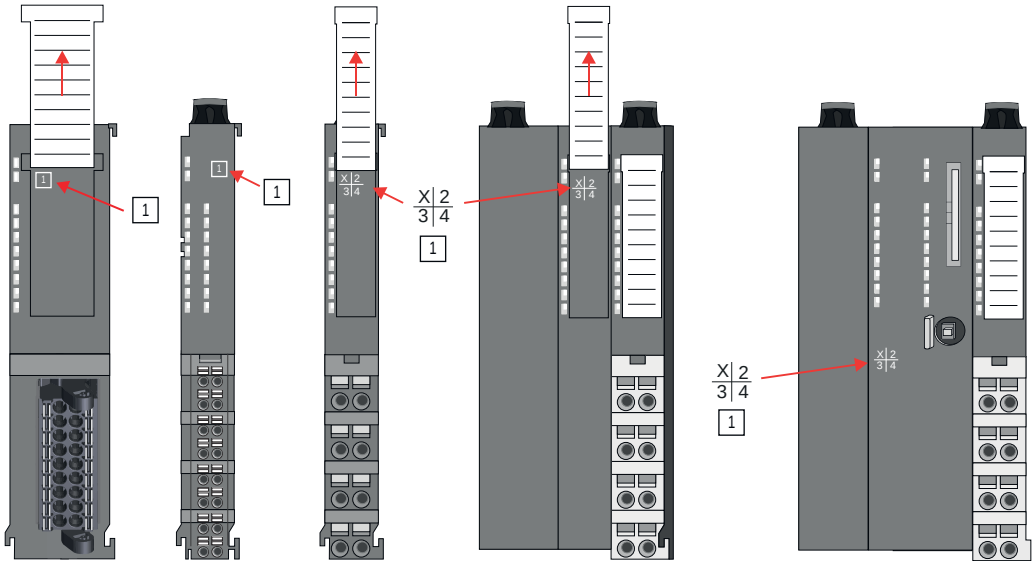
CAUTION

Please note that you may only use the spare parts with Yaskawa modules. Use with third-party modules is not allowed!

2.2.4 Hardware revision

Hardware revision on the front

- The hardware revision version is printed on every System SLIO module.
- Since a System SLIO 8x periphery module consists of a terminal and electronic module, you will find a hardware revision version printed on each of them.
- Authoritative for the hardware revision of a System SLIO module is the hardware revision of the electronic module. This is located under the labeling strip of the corresponding electronic module.
- Depending on the module type, there are the following 2 variants e.g. to indicate hardware revision version 1:
  - Current modules have a [1] on the front.
  - With earlier modules, the 1 is marked with *'X'* on a number grid.



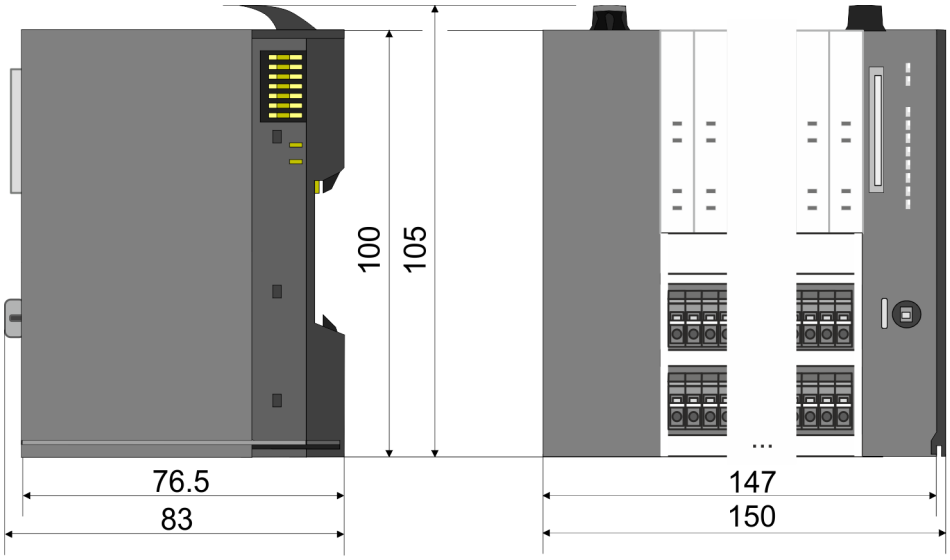
Hardware revision version via web server

On the CPUs and some bus couplers, you can check the hardware revision version *'HW Revision'* via the integrated web server.

2.3 Dimensions

CPU 01xC

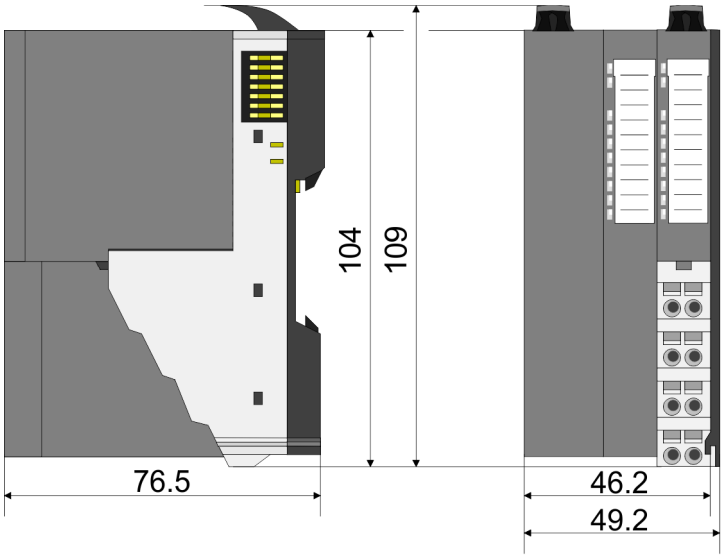
All dimensions are in mm.



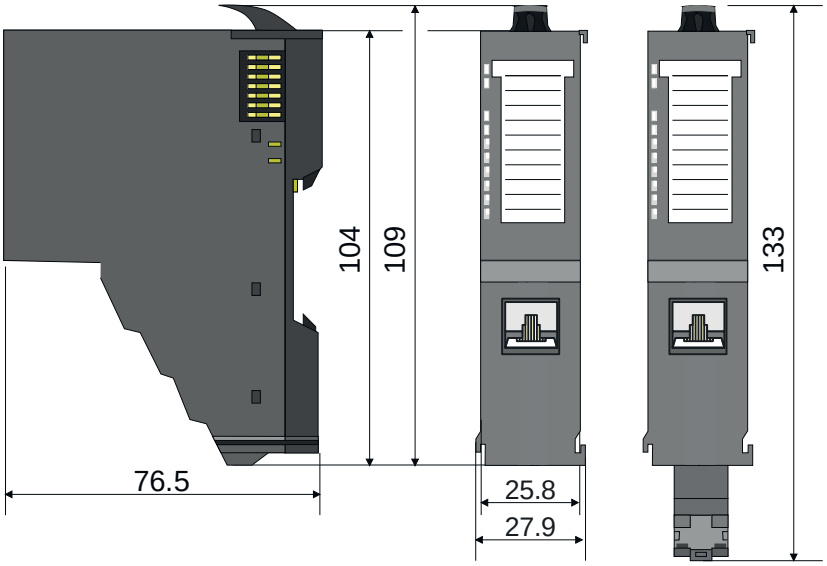
CPU 01x

Dimensions

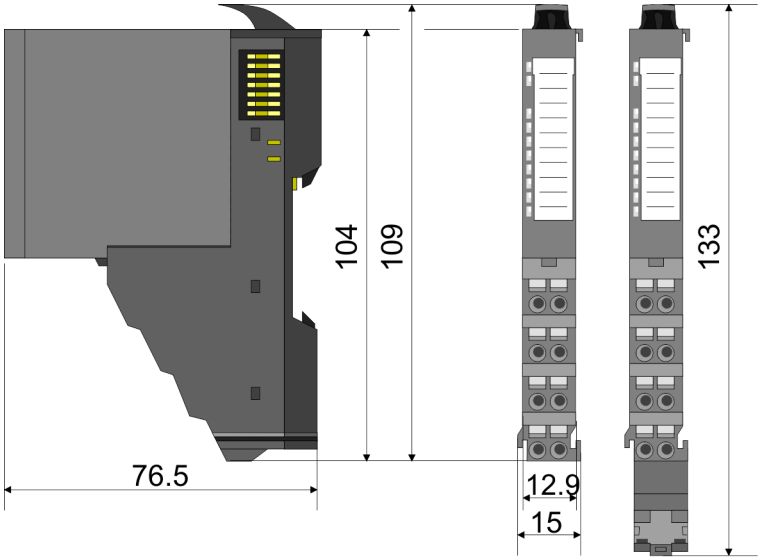
Bus coupler and line extension SubDevice



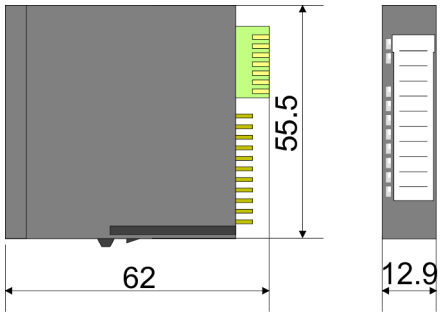
Line extension MainDevice



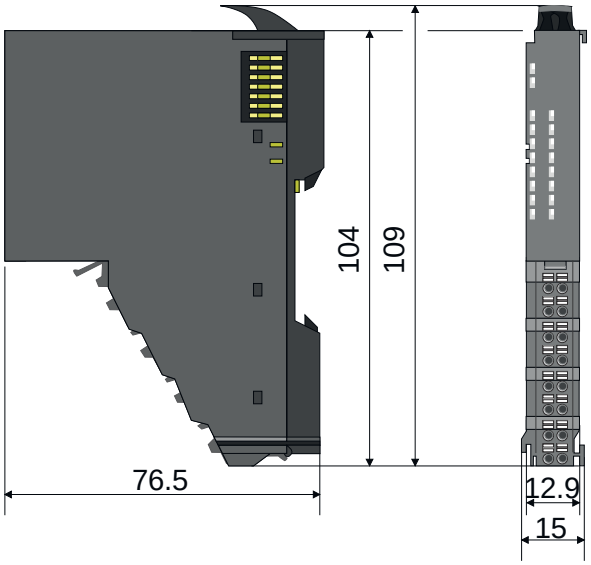
8x periphery module



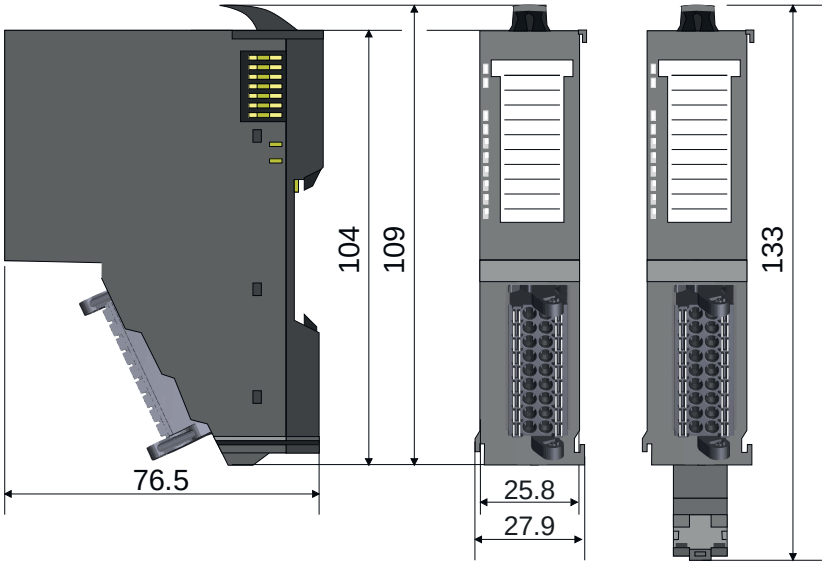
Electronic module



16x periphery module



2-fold wide periphery module. 054-2BA10



2.4 Mounting 2-fold wide periphery module - 054-2BA10

CAUTION

Requirements for UL compliance use

- Use for power supply exclusively SELV/PELV power supplies.
- The System SLIO must be installed and operated in a housing according to IEC 61010-1 9.3.2 c).

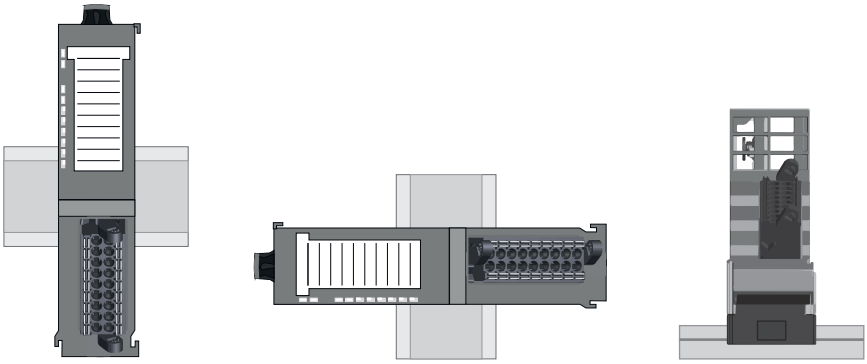
CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

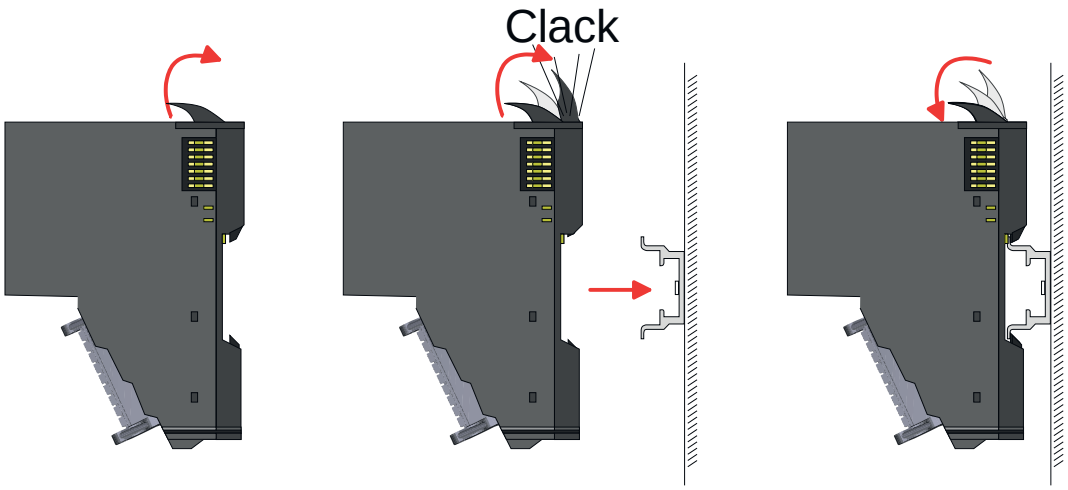
2.4.1 Assembly possibilities

Horizontal hanging, vertical hanging or lying:



2.4.2 Mounting

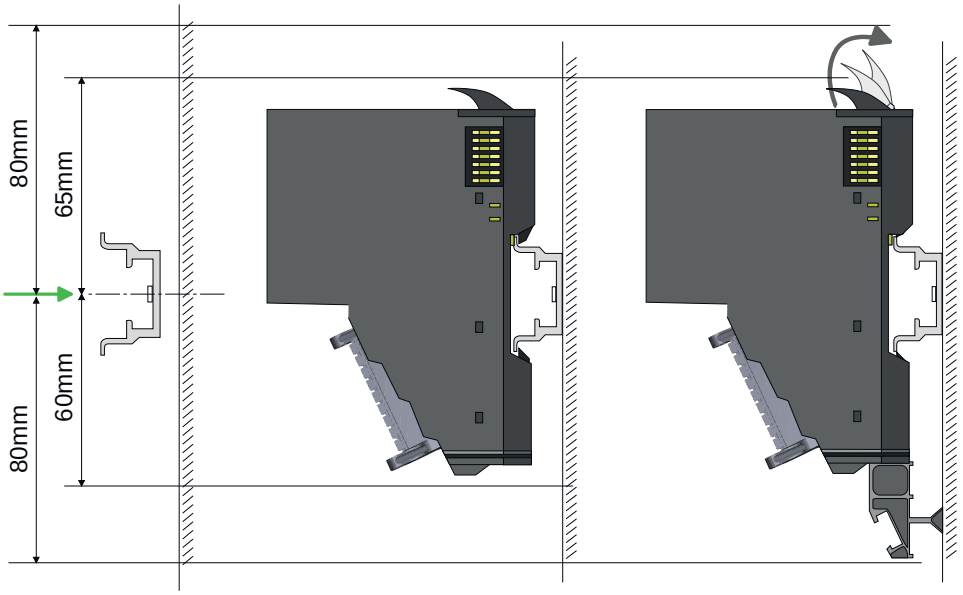
There is a locking lever at the top side of the module. For mounting and demounting this locking lever is to be turned upwards until this engages. For mounting place the module to the module installed before and push the module to the mounting rail guided by the strips at the upper and lower side of the module. The module is fixed to the mounting rail by pushing downward the locking lever. The modules may either separately be mounted to the mounting rail or as block. Here is to be considered that each locking lever is opened. The modules are each installed on a mounting rail. The electronic and power section supply are connected via the backplane bus. Up to 64 modules may be mounted. Please consider here that the sum current of the electronic power supply does not exceed the maximum value of 3A. By means of the power module 007-1AB10 the current of the electronic power supply may be expanded accordingly.



Proceeding

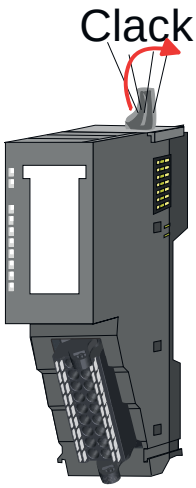
During installation, please note the *'Installation guidelines'...page 35*

To fulfil the EMC specifications, the 054-2BA10 may only be operated in a metal switch cabinet with a metal base plate.

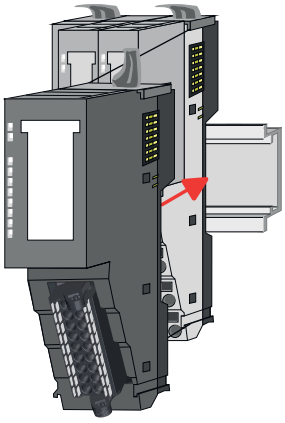


1. Mount the mounting rail! Please consider that a clearance from the middle of the mounting rail of at least 80mm above and 60mm below, respectively 80mm by deployment of shield bus carriers, exist.
2. For a low-impedance connection, screw the mounting rail directly below the module to the base plate and make a screw connection at least every 20cm.
3. Mount your head module such as CPU or field bus coupler.

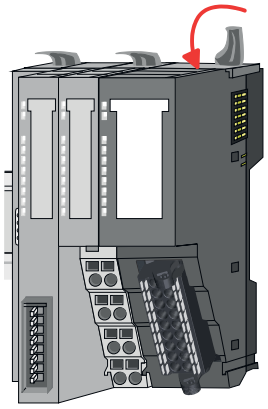
4. Before mounting the periphery modules you have to remove the bus cover at the right side of the head module by pulling it forward. Keep the cover for later mounting.



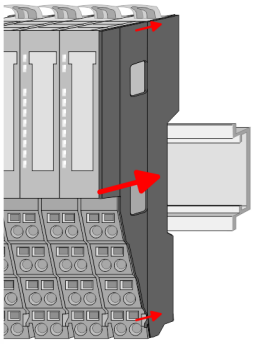
5. For mounting turn the locking lever of the module upwards until it engages.

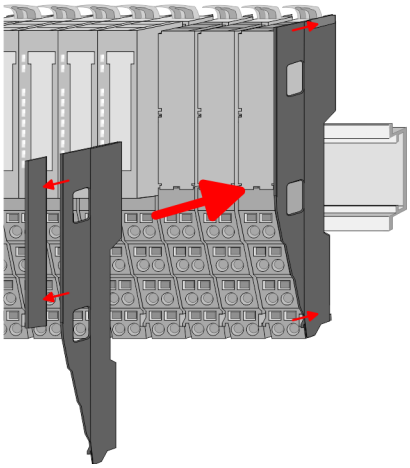


6. For mounting place the module to the module installed before and push the module to the mounting rail guided by the strips at the upper and lower side of the module.



7. Turn the locking lever of the periphery module downward, again.





8. After mounting the whole system, to protect the backplane bus connectors at the last module you have to mount the bus cover, now. If the last module is a clamp module, for adaptation the upper part of the bus cover is to be removed.

2.5 Wiring 2-fold wide periphery module - 054-2BA10

Connectors

CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

CAUTION

Do not connect hazardous voltages!

If this is not explicitly stated in the corresponding module description, hazardous voltages are not allowed to be connected!

CAUTION

Consider temperature for external cables!

Cables may experience temperature increase due to system heat dissipation. Thus the cabling specification must be chosen 25°C above ambient temperature!

The procedure for wiring the 8x periphery modules can be found in the corresponding manual. The wiring of the 054-2BA10 is described below.

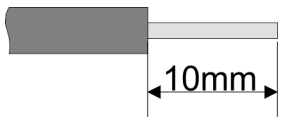
- The 054-2BA10 has a removable connector for wiring.
- With the wiring of the connector a "push-in" spring-clip technique is used. This allows a quick and easy connection of your supply lines without tools.
- Use shielded cables to connect the motor and encoder.
- The wires are disconnected by means of a screwdriver.

Fusing

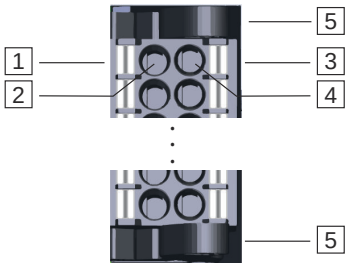
- The DC 20.4 ... 57.6V power supply for the stepper motor must be protected externally with a fuse corresponding to the maximum current, i.e. max. 8A with an 8A fuse (fast) or a line circuit breaker 8A characteristic Z and should be UL approved.

Data

Please use copper wire only!

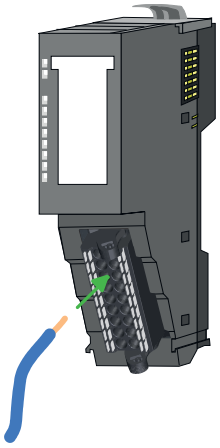


U_{max}	250V
I_{max}	8A
Cross section	0.2 ... 1.5mm² (AWG 24 ... 16)
Stripping length	10mm



1, 3 Locking lever for screwdriver
2, 4 Connection hole for wire
5 Locking lever connector

Insert wire

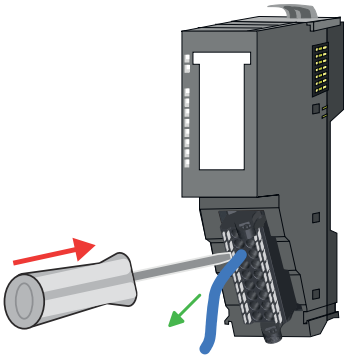


The wiring happens without a tool.

1. Determine the pin position according to the pin assignment.
2. Insert through the round connection hole of the according contact your prepared wire until it stops, so that it is fixed.

   ➥ By pushing the contact spring opens, thus ensuring the necessary contact pressure.

Remove wire

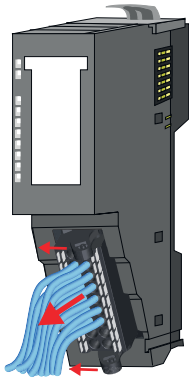


The wire is to be removed by means of a screwdriver with 2.5mm blade width.

1. Press with your screwdriver vertically at the release button.

   ➥ The contact spring releases the wire.
2. Pull the wire from the round hole.

Remove connector



You have the option to remove the connector of the module, e.g. for a module change with fixed wiring. For this the connector has a locking lever. The connector is removed as follows:

1. Remove connector:

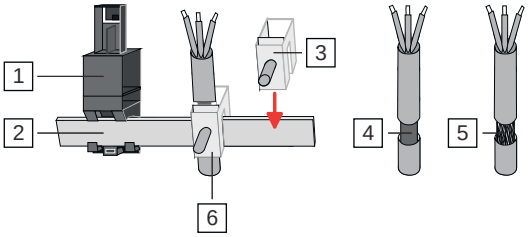
   By pushing the locking levers as shown, the connector is released and can be removed.
2. Plug connector:

   By plugging and engaging the connector directly, the locking levers return to their original position.

2.5.1 Shielding

Overview

Shielding is required for interference-free signal transmission for the 054-2BA10. This weakens electrical, magnetic or electromagnetic interference fields. To attach the shield the mounting of shield bus carriers are necessary. The shield bus carrier (available as accessory) serves to carry the shield bus to connect cable shields.

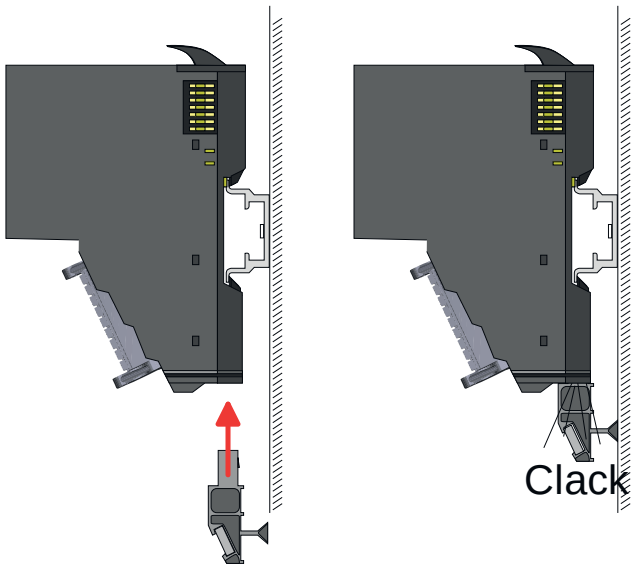


1 Shield bus (10mm x 3mm)
2 Shield clamp
3 Cable shield with metal foil
4 Cable shield with wire mesh (close-meshed)
5 Cable shield mounted with shield clamp

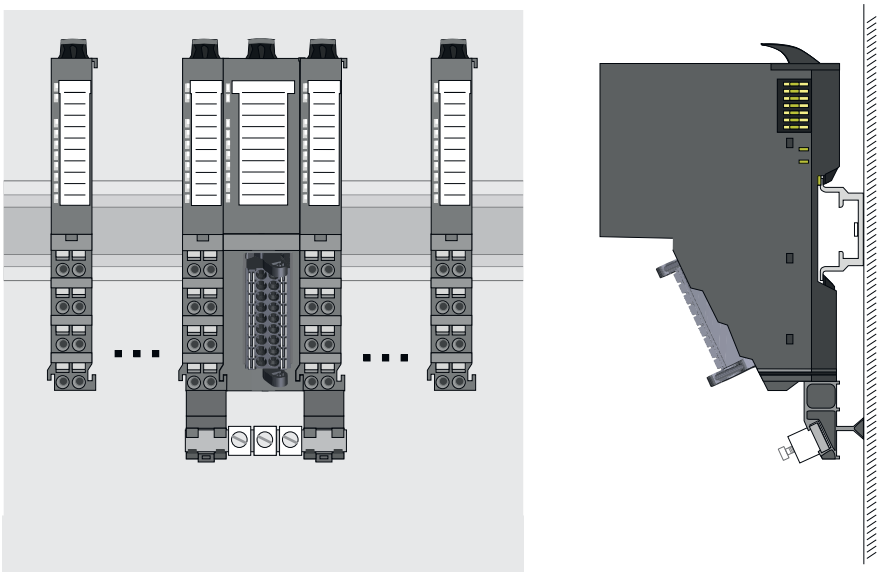
Shield attachment 054-2BA10

Observe the *'Installation guidelines'...page 35* when wiring.

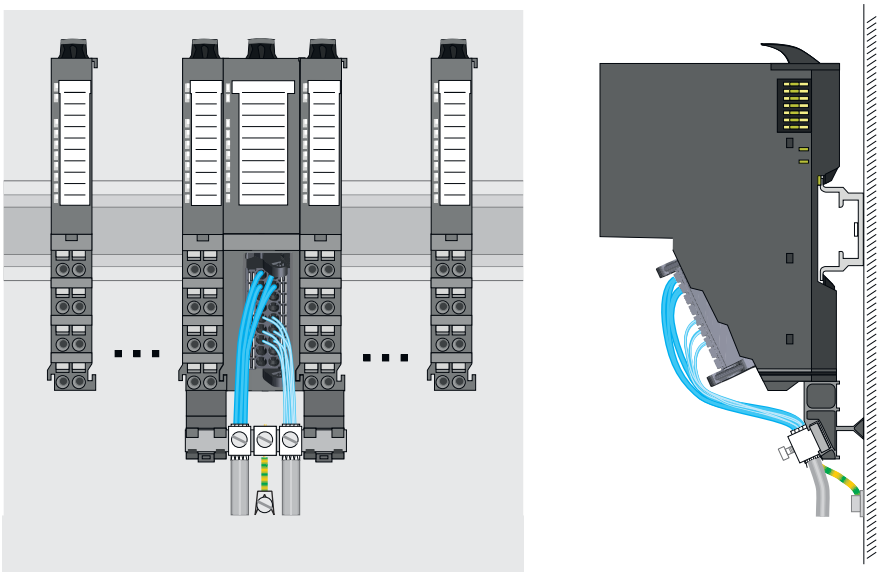
To fulfil the EMC specifications, the 054-2BA10 may only be operated in a metal switch cabinet with a metal base plate.



1. Each System SLIO 8x periphery module has a carrier hole for the shield bus carrier on its lower side. Insert a shield bus carrier to the right and left of the 054-2BA10 until it clicks into place on the module.



2. Insert your shield bus into the shield bus carrier and fit the shield clamps.



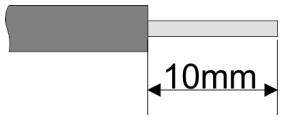
3. Connect your cables with the appropriately stripped cable shield. Connect the cable shield to the shield bus and the shield bus locally, with low impedance, to the base plate. Keep the connecting wires as short as possible.

2.6 Wiring power modules

Terminal module terminals

Power modules are either integrated to the head module or may be installed between the periphery modules. With power modules, terminals with spring clamp technology are used for wiring. The spring clamp technology allows quick and easy connection of your signal and supply lines. In contrast to screw terminal connections this type of connection is vibration proof.

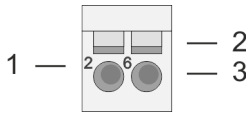
Data



Please use copper wire only!

U_{max}	30V DC
I_{max}	10A
Cross section	0.08 ... 1.5mm² (AWG 28 ... 16)
Stripping length	10mm

Wiring procedure



1 Pin number at the connector
2 Opening for screwdriver
3 Connection hole for wire

CAUTION

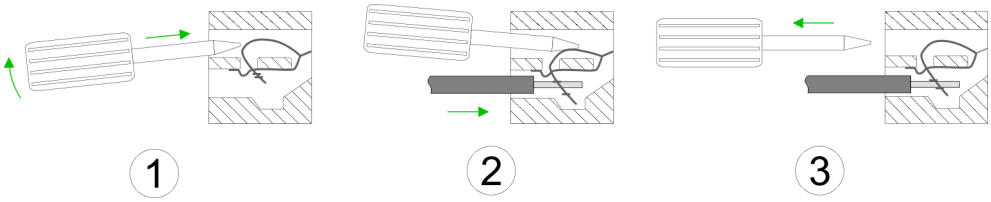
Danger of injury from electrical shock and damage to the unit!

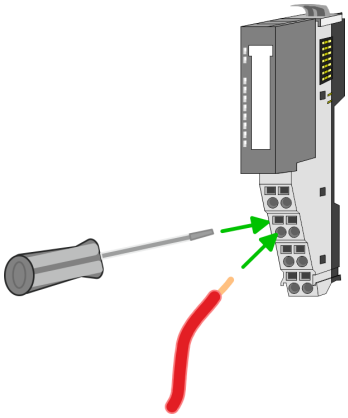
Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

CAUTION

Consider temperature for external cables!

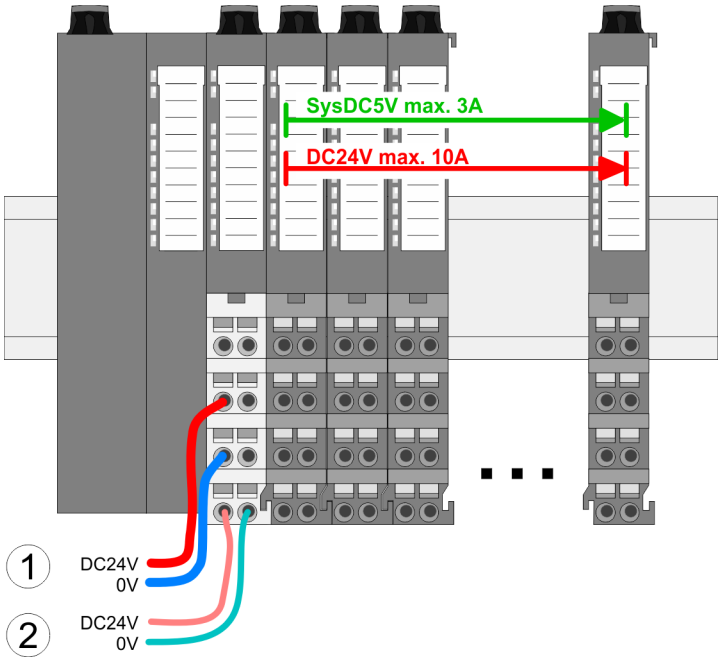
Cables may experience temperature increase due to system heat dissipation. Thus the cabling specification must be chosen 25°C above ambient temperature!





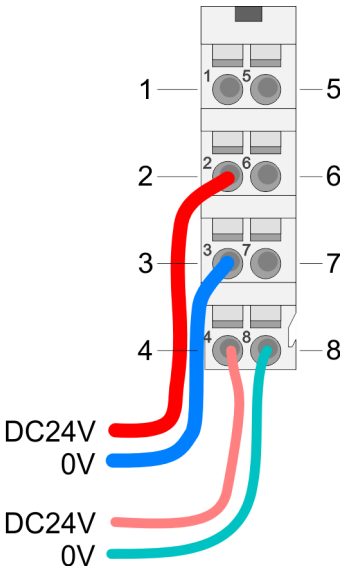
1. Insert a suited screwdriver at an angel into the square opening as shown. Press and hold the screwdriver in the opposite direction to open the contact spring.
2. Insert the stripped end of wire into the round opening. You can use wires with a cross section of 0.08mm² up to 1.5mm²
3. By removing the screwdriver, the wire is securely fixed via the spring contact to the terminal.

Standard wiring



(1) DC 24V for power section supply I/O area (max. 10A)
(2) DC 24V for electronic power supply bus coupler and I/O area

PM - Power module



For wires with a core cross-section of 0.08mm² up to 1.5mm².

Pos.	Function	Type	Description
1	---	---	not connected
2	DC 24V	I	DC 24V for power section supply
3	0V	I	GND for power section supply
4	Sys DC 24V	I	DC 24V for electronic power supply
5	---	---	not connected
6	DC 24V	I	DC 24V for power section supply
7	0V	I	GND for power section supply
8	Sys 0V	I	GND for electronic power supply

I: Input

CAUTION

Since the power section supply is not internally protected, it is to be externally protected with a fuse, which corresponds to the maximum current. This means max. 10A is to be protected by a 10A fuse (fast) respectively by a line circuit breaker 10A characteristics Z and should be UL approved!

The electronic power section supply is internally protected against higher voltage by fuse. The fuse is within the power module. If the fuse releases, its electronic module must be exchanged!

Fusing

- The power section supply is to be externally protected with a fuse, which corresponds to the maximum current. This means max. 10A is to be protected with a 10A fuse (fast) respectively by a line circuit breaker 10A characteristics Z and should be UL approved!
  - For modules with positive logic (PNP), place the fuse on the positive connector.
  - For modules with negative logic (NPN), place the fuse on the negative connector.
  - For mixed logic, one fuse must be placed on the negative and one on the positive connector.
- It is recommended to externally protect the electronic power supply for head modules and I/O area with a 2A fuse (fast) respectively by a line circuit breaker 2A characteristics Z and should be UL approved.
- The electronic power supply for the I/O area of the power module 007-1AB10 should also be externally protected with a 1A fuse (fast) respectively by a line circuit breaker 1A characteristics Z and should be UL approved.

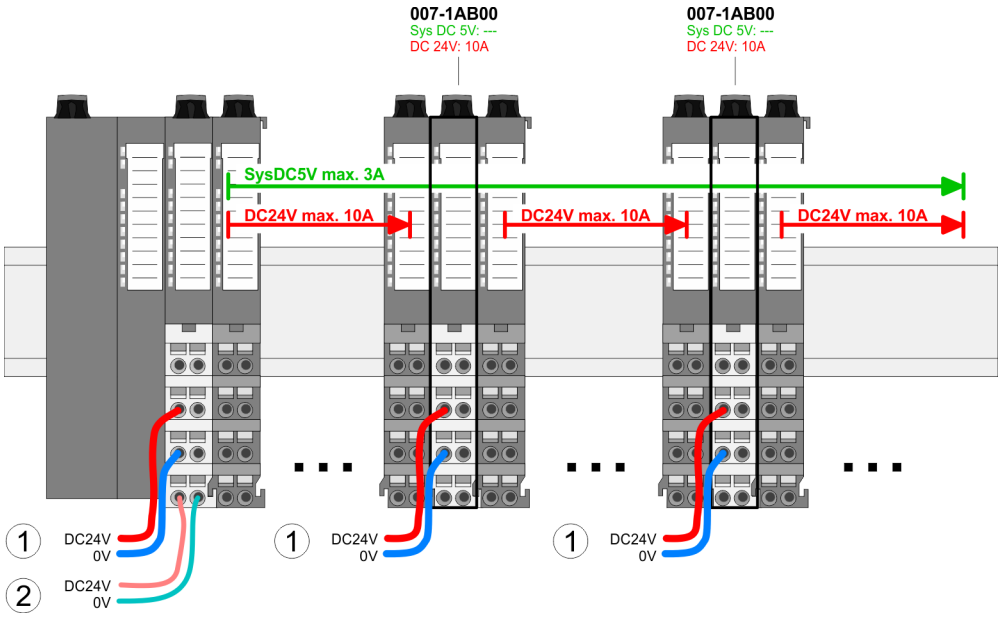
State of the electronic power supply via LEDs

After PowerON of the System SLIO the LEDs RUN respectively MF get on so far as the sum current does not exceed 3A. With a sum current greater than 3A the LEDs may not be activated. Here the power module with the order number 007-1AB10 is to be placed between the peripheral modules.

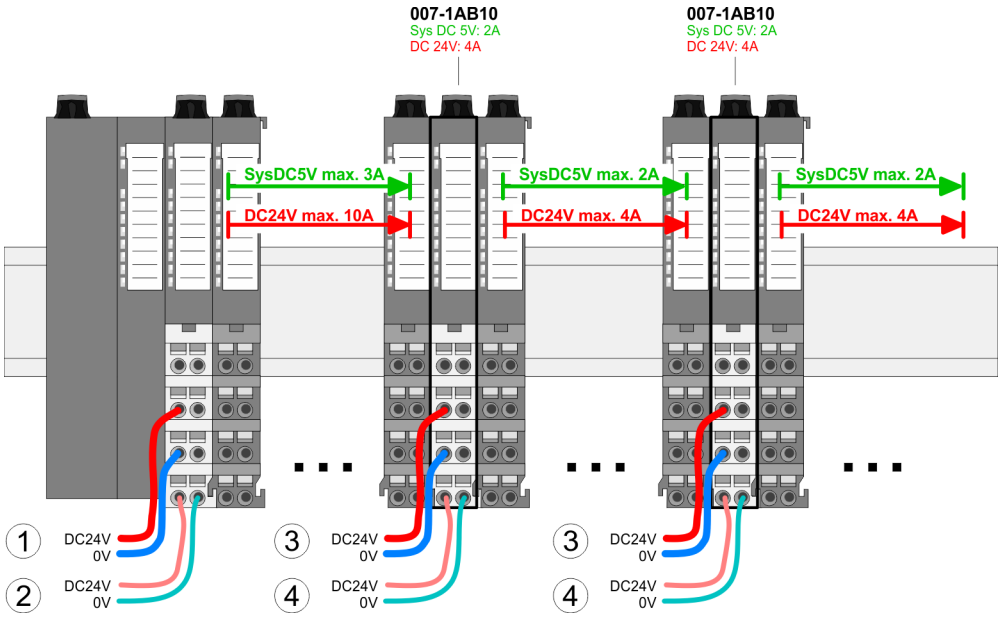
Deployment of the power modules

- If the 10A for the power section supply is no longer sufficient, you may use the power module with the order number 007-1AB00. So you have also the possibility to define isolated groups.
- The power module with the order number 007-1AB10 is to be used if the 3A for the electronic power supply at the backplane bus is no longer sufficient. Additionally you get an isolated group for the DC 24V power section supply with max. 4A.
- By placing the power module 007-1AB10 at the following backplane bus modules may be placed with a sum current of max. 2A. Afterwards a power module is to be placed again. To secure the power supply, the power modules may be mixed used.

Power module 007-1AB00



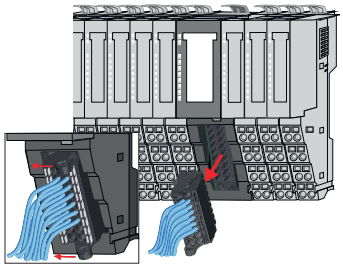
Power module 007-1AB10



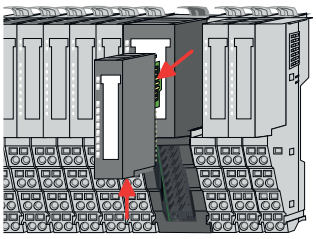
(1) DC 24V for power section supply I/O area (max. 10A)
(2) DC 24V for electronic power supply bus coupler and I/O area
(3) DC 24V for power section supply I/O area (max. 4A)
(4) DC 24V for electronic power supply I/O area

2.7 Demounting 2-fold wide periphery module - 054-2BA10

Proceeding

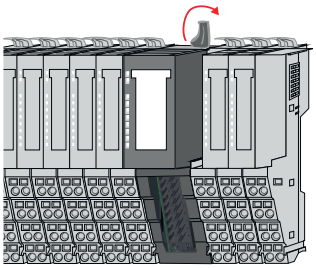


1. Power-off your system.
2. Remove the connector of the module. By pushing the locking levers as shown, the connector is released and can be removed.

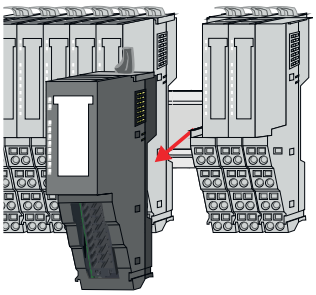


3. *For demounting and exchange of a (head) module or a group of modules, due to mounting reasons you always have to remove the electronic module right beside. After mounting it may be plugged again.*

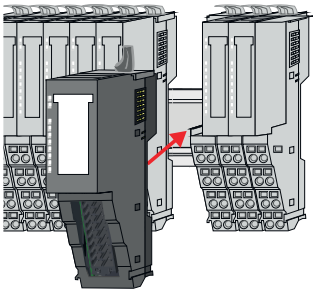
   Press the locking lever at the lower side of the just mounted right module and pull it forward.



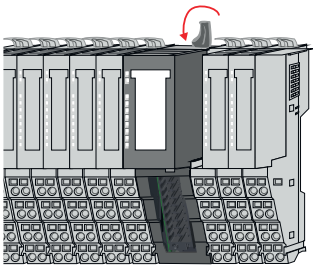
4. Turn the locking lever of the module to be exchanged upwards.



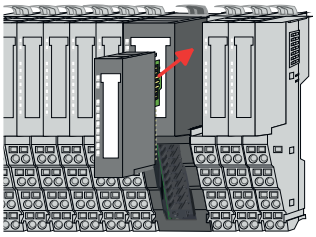
5. Pull the module to be exchanged forward.



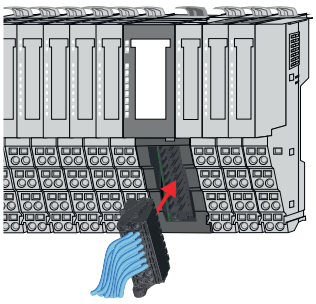
6. For mounting the new module turn the locking lever of the module upwards until it engages.
7. To mount the new module put it to the left periphery module and push it, guided by the stripes, to the mounting rail.



8. Turn the locking lever of the module downward, again.



9. Plug again the electronic module, which you have removed before.



10. Reconnect the connector.

➡ Now you can bring your system back into operation.

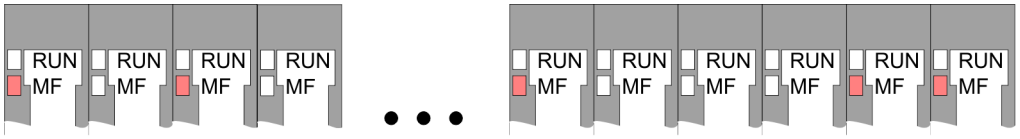
2.8 Trouble shooting - LEDs

General

Each module has the LEDs RUN and MF on its front side. Errors or incorrect modules may be located by means of these LEDs.

In the following illustrations flashing LEDs are marked by ☼.

Sum current of the electronic power supply exceeded

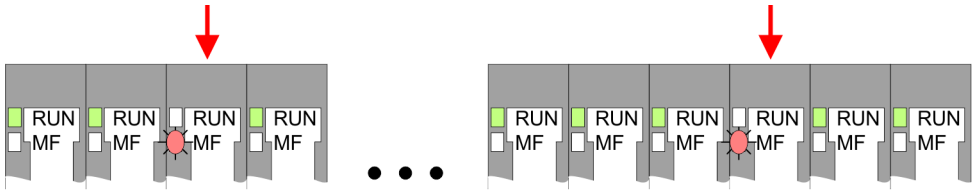


Behavior: After PowerON the RUN LED of each module is off and the MF LED of each module is sporadically on.

Reason: The maximum current for the electronic power supply is exceeded.

Remedy: As soon as the sum current of the electronic power supply is exceeded, always place the power module 007-1AB10. *'Wiring power modules'...page 27*

Error in configuration

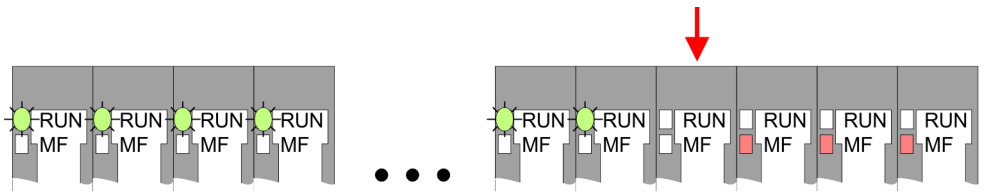


Behavior: After PowerON the MF LED of one module respectively more modules flashes. The RUN LED remains off.

Reason: At this position a module is placed, which does not correspond to the configured module.

Remedy: Match configuration and hardware structure.

Module failure



Behavior: After PowerON all of the RUN LEDs up to the defective module are flashing. With all following modules the MF LED is on and the RUN LED is off.

Reason: The module on the right of the flashing modules is defective.

Remedy: Replace the defective module.

2.9 Industrial security and installation guidelines

2.9.1 Industrial security in information technology

Latest version

This chapter can also be found as a guide *'Industrial IT Security'* in the *'Download Center'* of www.yaskawa.eu.com

Hazards

The topic of data security and access protection has become increasingly important in the industrial environment. The increased networking of entire industrial systems to the network levels within the company together with the functions of remote maintenance have all served to increase vulnerability. Hazards can arise from:

- Internal manipulation such as technical errors, operating and program errors and deliberate program or data manipulation.
- External manipulation such as software viruses, worms and trojans.
- Human carelessness such as password phishing.

Precautions

The most important precautions to prevent manipulation and loss of data security in the industrial environment are:

- Encrypting the data traffic by means of certificates.
- Filtering and inspection of the traffic by means of VPN - "Virtual Private Networks".
- Identification of the user by "Authentication" via save channels.
- Segmenting in protected automation cells, so that only devices in the same group can exchange data.
- Deactivation of unnecessary hardware and software.

Further Information

You can find more information about the measures on the following websites:

- Federal Office for Information Technology ➦ *www.bsi.bund.de*
- Cybersecurity & Infrastructure Security Agency ➦ *us-cert.cisa.gov*
- VDI / VDE Society for Measurement and Automation Technology ➦ *www.vdi.de*

2.9.1.1 Protection of hardware and applications

Precautions

- Do not integrate any components or systems into public networks.
  - Use VPN "Virtual Private Networks" for use in public networks. This allows you to control and filter the data traffic accordingly.
- Always keep your system up-to-date.
  - Always use the latest firmware version for all devices.
  - Update your user software regularly.
- Protect your systems with a firewall.
  - The firewall protects your infrastructure internally and externally.
  - This allows you to segment your network and isolate entire areas.
- Secure access to your plants via user accounts.
  - If possible, use a central user management system.
  - Create a user account for each user for whom authorization is essential.
  - Always keep user accounts up-to-date and deactivate unused user accounts.
- Secure access to your plants via secure passwords.
  - Change the password of a standard login after the first start.
  - Use strong passwords consisting of upper/lower case, numbers and special characters. The use of a password generator or manager is recommended.
  - Change the passwords according to the rules and guidelines that apply to your application.
- Deactivate inactive communication ports respectively protocols.
  - Only the communication ports that are used for communication should be activated.
  - Only the communication protocols that are used for communication should be activated.
- Consider possible defence strategies when planning and securing the system.
  - The isolation of components alone is not sufficient for comprehensive protection. An overall concept is to be drawn up here, which also provides defensive measures in the event of a cyber attack.
  - Periodically carry out threat assessments. Among others, a comparison is made here between the protective measures taken and those required.
- Limit the use of external storage media.
  - Via external storage media such as USB memory sticks or SD memory cards, malware can get directly into a system while bypassing a firewall.
  - External storage media or their slots must be protected against unauthorized physical access, e.g. by using a lockable control cabinet.
  - Make sure that only authorized persons have access.
  - When disposing of storage media, make sure that they are safely destroyed.
- Use secure access paths such as HTTPS or VPN for remote access to your plant.
- Enable security-related event logging in accordance with the applicable security policy and legal requirements for data protection.

2.9.1.2 Protection of PC-based software

Precautions

Since PC-based software is used for programming, configuration and monitoring, it can also be used to manipulate entire systems or individual components. Particular caution is required here!

- Use user accounts on your PC systems.
  - If possible, use a central user management system.
  - Create a user account for each user for whom authorization is essential.
  - Always keep user accounts up-to-date and deactivate unused user accounts.
- Protect your PC systems with secure passwords.
  - Change the password of a standard login after the first start.
  - Use strong passwords consisting of upper/lower case, numbers and special characters. The use of a password generator or manager is recommended.
  - Change the passwords according to the rules and guidelines that apply to your application.
- Enable security-related event logging in accordance with the applicable security policy and legal requirements for data protection.
- Protect your PC systems by security software.
  - Install virus scanners on your PC systems to identify viruses, trojans and other malware.
  - Install software that can detect phishing attacks and actively prevent them.
- Always keep your software up-to-date.
  - Update your operating system regularly.
  - Update your software regularly.
- Make regular backups and store the media at a safe place.
- Regularly restart your PC systems. Only boot from storage media that are protected against manipulation.
- Use encryption systems on your storage media.
- Perform security assessments regularly to reduce the risk of manipulation.
- Use only data and software from approved sources.
- Uninstall software which is not used.
- Disable unused services.
- Activate a password-protected screen lock on your PC systems.
- Always lock your PC systems as soon as you leave your PC workstation.
- Do not click any links that come from unknown sources. If necessary ask, e.g. on e-mails.
- Use secure access paths such as HTTPS or VPN for remote access to your PC system.

2.9.2 Installation guidelines

General

The installation guidelines contain information about the interference free deployment of a PLC system. There is the description of the ways, interference may occur in your PLC, how you can make sure the electromagnetic compatibility (EMC), and how you manage the isolation.

What does EMC mean?

Electromagnetic compatibility (EMC) means the ability of an electrical device, to function error free in an electromagnetic environment without being interfered respectively without interfering the environment.

The components are developed for the deployment in industrial environments and meets high demands on the EMC. Nevertheless you should project an EMC planning before installing the components and take conceivable interference causes into account.

Possible interference causes

Electromagnetic interferences may interfere your control via different ways:

- Electromagnetic fields (RF coupling)
- Magnetic fields with power frequency
- Bus system
- Power supply
- Protected earth conductor

Depending on the spreading medium (lead bound or lead free) and the distance to the interference cause, interferences to your control occur by means of different coupling mechanisms.

There are:

- galvanic coupling
- capacitive coupling
- inductive coupling
- radiant coupling

Basic rules for EMC

In the most times it is enough to take care of some elementary rules to guarantee the EMC. Please regard the following basic rules when installing your PLC.

- Take care of a correct area-wide grounding of the inactive metal parts when installing your components.
  - Install a central connection between the ground and the protected earth conductor system.
  - Connect all inactive metal extensive and impedance-low.
  - Please try not to use aluminium parts. Aluminium is easily oxidizing and is therefore less suitable for grounding.
- When cabling, take care of the correct line routing.
  - Organize your cabling in line groups (high voltage, current supply, signal and data lines).
  - Always lay your high voltage lines and signal respectively data lines in separate channels or bundles.
  - Route the signal and data lines as near as possible beside ground areas (e.g. suspension bars, metal rails, tin cabinet).
- Proof the correct fixing of the lead isolation.
  - Data lines must be shielded.
  - Analog lines must be shielded. When transmitting signals with small amplitudes the one sided laying of the isolation may be favourable.
  - Cables for frequency inverters, servo and stepper motors must be shielded.
  - Lay the line isolation extensively on an isolation/protected earth conductor rail directly after the cabinet entry and fix the isolation with cable clamps.
  - Make sure that the isolation/protected earth conductor rail is connected impedance-low with the cabinet.
  - Use metallic or metallised plug cases for isolated data lines.
- In special use cases you should appoint special EMC actions.
  - Consider to wire all inductivities with erase links.
  - Please consider luminescent lamps can influence signal lines.

- Create a homogeneous reference potential and ground all electrical operating supplies when possible.
  - Please take care for the targeted employment of the grounding actions. The grounding of the PLC serves for protection and functionality activity.
  - Connect installation parts and cabinets with your PLC in star topology with the isolation/protected earth conductor system. So you avoid ground loops.
  - If there are potential differences between installation parts and cabinets, lay sufficiently dimensioned potential compensation lines.

Isolation of conductors

Electrical, magnetically and electromagnetic interference fields are weakened by means of an isolation, one talks of absorption. Via the isolation rail, that is connected conductive with the rack, interference currents are shunt via cable isolation to the ground. Here you have to make sure, that the connection to the protected earth conductor is impedance-low, because otherwise the interference currents may appear as interference cause.

When isolating cables you have to regard the following:

- If possible, use only cables with isolation tangle.
- The hiding power of the isolation should be higher than 80%.
- Normally you should always lay the isolation of cables on both sides. Only by means of the both-sided connection of the isolation you achieve high quality interference suppression in the higher frequency area. Only as exception you may also lay the isolation one-sided. Then you only achieve the absorption of the lower frequencies. A one-sided isolation connection may be convenient, if:
  - the conduction of a potential compensating line is not possible.
  - analog signals (some mV respectively µA) are transferred.
  - foil isolations (static isolations) are used.
- With data lines always use metallic or metallised plugs for serial couplings. Fix the isolation of the data line at the plug rack. Do not lay the isolation on the PIN 1 of the plug bar!
- At stationary operation it is convenient to strip the insulated cable interruption free and lay it on the isolation/protected earth conductor line.
- To fix the isolation tangles use cable clamps out of metal. The clamps must clasp the isolation extensively and have well contact.
- Lay the isolation on an isolation rail directly after the entry of the cable in the cabinet.

CAUTION

Please regard at installation!

At potential differences between the grounding points, there may be a compensation current via the isolation connected at both sides.

Remedy: Potential compensation line

2.10 General data for the System SLIO

Conformity and approval		
Conformity		
CE	2014/35/EU	Low Voltage Directive
	2014/30/EU	EMC Directive
RoHS (EU)	2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment
UKCA	2016 No. 1101	Electrical Equipment (Safety) Regulations
	2016 No. 1091	Electromagnetic Compatibility Regulations
RoHS (UK)	2012 No. 3032	Use of Certain Hazardous Substances
Approval		
Certifications	-	Refer to technical data

Protection of persons and device protection		
Type of protection	-	IP20
Electrical isolation		
to the field bus	-	electrically isolated
to the process level	-	electrically isolated
Insulation resistance	-	-
Insulation voltage to reference earth		
Inputs / outputs	-	AC / DC 50V, test voltage AC 500V
Protective measures	-	against short circuit

Environmental conditions to EN 61131-2		
Operation		
Horizontal installation hanging	EN 61131-2	0…+60°C
Horizontal installation lying	EN 61131-2	0…+55°C
Vertical installation	EN 61131-2	0…+50°C
Air humidity	EN 60068-2-30	RH1 (without condensation, rel. humidity 10…95%)
Pollution	EN 61131-2	Degree of pollution 2
Installation altitude max.	-	2000m
Mechanical		
Oscillation	EN 60068-2-6	1g, 9Hz ... 150Hz
Shock	EN 60068-2-27	15g, 11ms

Mounting conditions		
Mounting place	-	In the control cabinet
Mounting position	-	Horizontal and vertical

EMC	Standard		Comment
Emitted interference	EN 61000-6-4		Class A (Industrial area)
Noise immunity zone B	EN 61000-6-2		Industrial area
		EN 61000-4-2	ESD 8kV at air discharge (degree of severity 3), 4kV at contact discharge (degree of severity 2)
		EN 61000-4-3	HF field immunity (casing) 80MHz … 1000MHz, 10V/m, 80% AM (1kHz) 1.4GHz ... 6GHz, 3V/m, 80% AM (1kHz)
		EN 61000-4-6	HF conducted 150kHz … 80MHz, 10V, 80% AM (1kHz)
		EN 61000-4-4	Burst
		EN 61000-4-5	Surge[1]

1) Due to the high-energetic single pulses with Surge an appropriate external protective circuit with lightning protection elements like conductors for lightning and overvoltage is necessary.

2.10.1 Use in difficult operating conditions

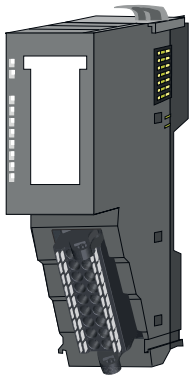
Without additional protective measures, the products must not be used in locations with difficult operating conditions; e.g. due to:

- *dust generation*
- *chemically active substances (corrosive vapors or gases)*
- *strong electric or magnetic fields*

3 Hardware description

3.1 Properties

054-2BA10



The FM 054-2BA10 is a System SLIO module for controlling a 1-axis drive with stepper motor. It can be used for point-to-point positioning and for complex drive profiles with the highest demands on precision, dynamics and speed. Stepper motors are used when maximum torque at low velocity is required and the target position is to be reached and kept without overshooting.

- Stepper motor module for controlling a 1-axis drive.
- 3 digital inputs
- 1 digital output
- Connectors for encoder
- PWM frequency 32kHz
- Step pattern 64-fold micro steps

Compatibility list

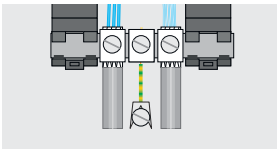
An overview of CPU and bus coupler, which support the 054-2BA10, can be found at ➦ www.yaskawa.eu.com at the download area of the System SLIO manuals.

Ordering data

Type	Order number	Description
FM 054 Stepper DC 48V 5A	054-2BA10	System SLIO 1xstepper module, DC 48V 5A Encoder input, 3xDI, 1xDO

3.2 Structure

Connections



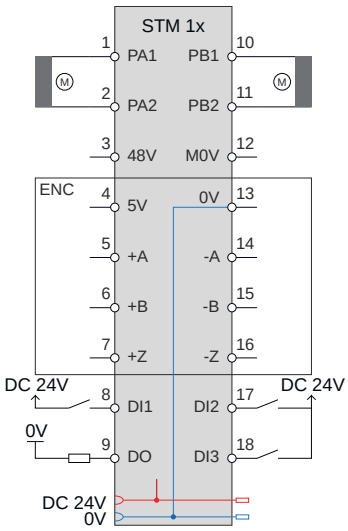
For the connection lines the following requirements apply:

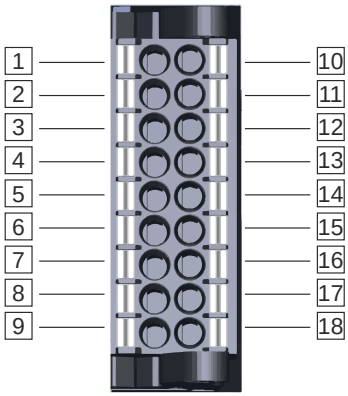
- For the digital I/O connection single lines can be used.
- If the I/O cables are longer than 1m, they must be shielded.
- Motor and encoder must be connected via shielded lines.
- The motor power supply cable must be shielded if the length is more than 1m.
- Shielded cables must be placed directly below the module on the shield bus intended for this purpose. The shield bus must be connected locally to the base plate with low impedance. In addition, the shields of cables coming from outside must be connected to ground/earth at the control cabinet entry.

CAUTION

Improper shielding can lead to increased EMC radiation.

Connections





CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

The stepper motor module has bipolar power stages and can thus control bipolar and unipolar stepper motors. You can use wires with a cross section of 0.08mm² up to 1.5mm². Please ensure that the lines have sufficient current-carrying capacity respectively the voltage drop over long distances.

Pos.	Designation	Type	Description
1	PA1	O	Motor winding A - connection 1
2	PA2	O	Motor winding A - connection 2
3	48V	I	Power supply motor DC 20.4 ... 57.6V
4	ENC5V	O	Encoder power supply 5V
5	ENC+A	I	Encoder input +A (5V/TTL)
6	ENC+B	I	Encoder input +B (5V/TTL)
7	ENC+Z	I	Encoder input +Z (5V/TTL)
8	DI1	I	Digital input 1
9	DO	O	Digital output

Pos.	Designation	Type	Description
10	PB1	O	Motor winding B - connection 1
11	PB2	O	Motor winding B - connection 2
12	M0V	I	Motor power supply GND
13	ENC0V	O	Encoder power supply GND
14	ENC-A	I	Encoder input -A (5V/TTL)
15	ENC-B	I	Encoder input -B (5V/TTL)
16	ENC-Z	I	Encoder input -Z (5V/TTL)
17	DI2	I	Digital input 2
18	DI3	I	Digital input 3
I: Input, O: Output			

Please note when connecting the motor windings!

- *If you connect a motor strand to different output drivers such as PA1 and PB1, this can destroy the output drivers of the stepper motor module.*
- *Overheating of the power stage results in a shutdown.*
- *Connect the windings of a motor strand only at the terminal points of the same output driver of the stepper motor module, for example, one motor strand at PA1 and PA2 and the other motor strand at PB1 and PB2.*

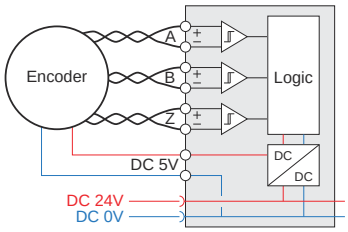
Fusing

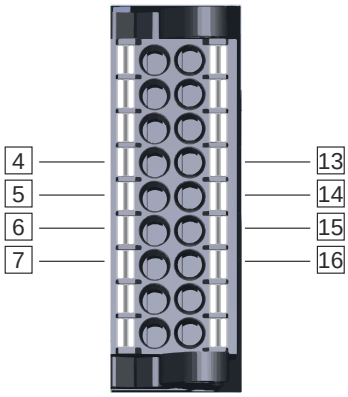
- The DC 20.4 ... 57.6V power supply for the stepper motor must be protected externally with a fuse corresponding to the maximum current, i.e. max. 8A with an 8A fuse (fast) or a line circuit breaker 8A characteristic Z and should be UL approved.

Connecting an encoder

There is the possibility to connect an encoder via the encoder inputs. You can retrieve the encoder value and process it accordingly in your user program. In *Closed Loop* respectively *Pseudo Closed Loop* mode the encoder value is directly included in the control.

Encoder: 5V TTL signal (differentially)
Phase A, B and Z
max. 50kHz
4-fold evaluation



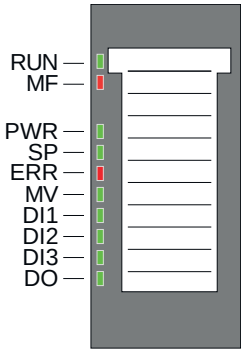


Pos.	Designation	Type	Description
4	ENC5V	O	Encoder power supply 5V
5	ENC+A	I	Encoder input +A (5V/TTL)
6	ENC+B	I	Encoder input +B (5V/TTL)
7	ENC+Z	I	Encoder input +Z (5V/TTL)

Pos.	Designation	Type	Description
13	ENC0V	O	Encoder power supply GND
14	ENC-A	I	Encoder input -A (5V/TTL)
15	ENC-B	I	Encoder input -B (5V/TTL)
16	ENC-Z	I	Encoder input -Z (5V/TTL)
I: Input, O: Output			

You can also connect an encoder with single-ended outputs by connecting the lines of the encoder to +A, +B and +Z. Here the connections -A, -B and -Z remain free.

Status indication



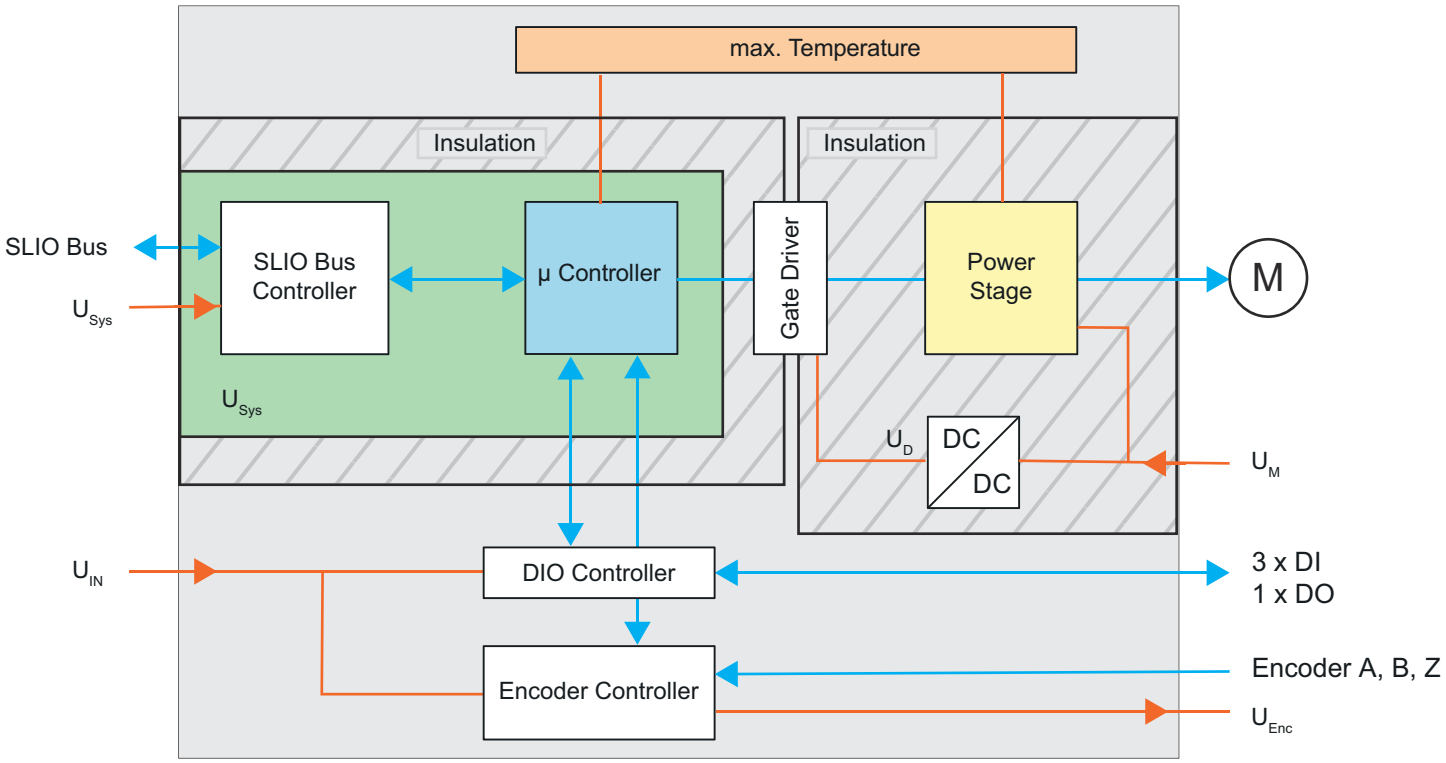
RUN	MF	Description
green	red	
■	■	
■	□	Bus communication is OK, module status is OK
■	■	Bus communication is OK, module status reports error
□	■	Bus communication not possible, module status reports error
□	□	Error at bus power supply
X	◪	Error in configuration *'Trouble shooting - LEDs'...page 32*

LED	Color		Description
PWR	green	□	The state of the module is beyond *'Switched on'* and *'Operation enabled'* *'States'...page 58*
	■	◪	Module is in state *'Switched on'*
		■	Module is in state *'Operation enabled'*
SP	green	□	Velocity target value is 0. In state *'Operation enabled'* there is no reaction of the motor.
	■	■	Velocity target value > 0. In state *'Operation enabled'* there is a reaction of the motor.
ERR	red	□	No error
	■	◪	Warning: 0x80 in *'0x8100-02 - Status word'...page 138*
		■	Error: 0x08 in *'0x8100-02 - Status word'...page 138*
MV	green	□	Power section supply motor - error: *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*
	■	◪	Power section supply motor - warning: *'0x8680-04 - Power section supply voltage min. warning level'...page 164* *'0x8680-05 - Power section supply voltage max. warning level'...page 165*
		■	Power section supply motor - OK
DI1	green	□	Digital input 1 has signal "0"
	■	■	Digital input 1 has signal “1"
DI2	green	□	Digital input 2 has signal "0"
	■	■	Digital input 2 has signal “1"
DI3	green	□	Digital input 3 has signal "0"
	■	■	Digital input 3 has signal “1"
DO	green	□	Digital output has "0" signal
	■	■	Digital output has "1" signal

not relevant: X

3.3 Block diagram

Structure



Voltages

U_{Sys}	DC 5V electronic section supply
	Power supply for electronic and back plane bus communication
U_{IN}	DC 24V power section supply
	Power supply for the I/O area
	Area: DC 20.4 ... 28.8V
U_D	DC 10V driver supply
	The power supply is built via U_M via a DC-DC converter.
U_M	Motor power supply
	Area: DC 20.4 ... 57.6V
U_{Enc}	Encoder power supply
	Voltage: DC 5V, typically 100mA (max. 200mA)

CAUTION

Behavior on failure of the DC 24V power section supply:

- The 5V encoder power supply ENC5V fails.
- Due to signal loss, the encoder count value stops.
- The digital output DO is disabled.
- The digital inputs DI1, DI2 and DI3 permanently show 0 signal in the process data.

Configuration: *'0x8680-08 - 24V monitoring'...page 165*

'0x2017-05 - Hardware property'...page 134

Nominal current I_n

- Full step mode
  - The nominal current I_N of the motor is specified by the manufacturer.
    In full step mode (2 phase), both windings are simultaneously fully powered.
    In full step mode (1 phase), only one winding is fully powered at a time.
  - It is valid: $I_{max\ A} = I_{max\ B} = I_N$
- Micro step mode
  - In the micro step mode, both windings are powered in sine-cosine shape. Thus, both windings are never simultaneously fully powered.
  - To achieve full load the current of a winding can be increased by the factor $\sqrt{2} = 1.41$.
  - It is valid: $I_{max\ A} = I_{max\ B} = \sqrt{2} * I_N$
- Interconnection of the windings
  - Depending on the Interconnection of the windings as unipolar, bipolar series, bipolar parallel, there are different permitted nominal currents of the motor. Details can be found in the data sheet of your motor.

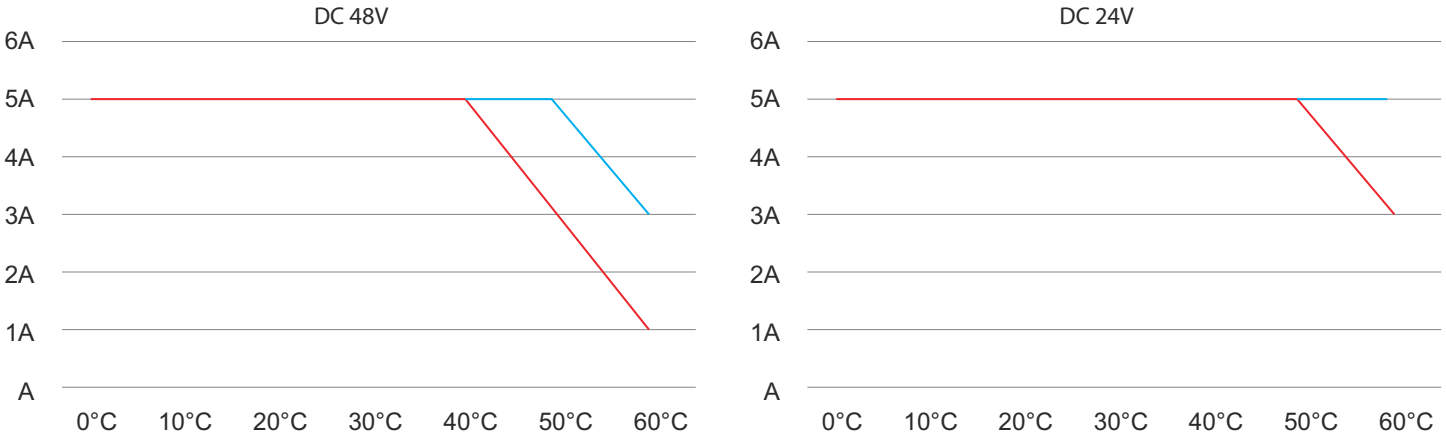
Temperature monitoring

The motion module has an internal temperature monitoring of the µ-controller and the power stage. Via the object dictionary limit temperatures can be defined. If the temperature over or under runs the limit values, there is an error reaction of the motion module, which can be configured.

At an ambient temperature of 60°C and high load on the stepper module and neighbouring modules with high power dissipation, small areas of the housing can reach temperatures higher than 85°C. This is compliant with DIN EN 61010-2-201:2019-04.

Derating

Please note the following derating of the motor current for the corresponding motor supply voltage:



Vertical installation
Horizontal installation
'Assembly possibilities'...page 20

3.4 Technical data

Order no.	054-2BA10
Type	FM 054 - Motion module - Stepper
Module ID	0984 6800
Current consumption/power loss	
Current consumption from backplane bus	100 mA
Power loss	2 W
Technical data digital inputs	
Number of inputs	3
Cable length, shielded	100 m
Cable length, unshielded	1 m
Rated load voltage	DC 20.4...28.8 V
Current consumption from load voltage L+ (without load)	20 mA
Rated value	DC 20.4...28.8 V
Input voltage for signal "0"	DC 0...5 V
Input voltage for signal "1"	DC 11...28.8 V
Input voltage hysteresis	-
Signal logic input	-
Frequency range	-
Input resistance	-
Input current for signal "1"	3 mA
Connection of Two-Wire-BEROs possible	✓
Max. permissible BERO quiescent current	1.5 mA
Input delay of "0" to "1"	-
Input delay of "1" to "0"	-
Input filter delay	internal cycle 1ms, no filter
Number of simultaneously utilizable inputs horizontal configuration	-
Number of simultaneously utilizable inputs vertical configuration	-
Input characteristic curve	IEC 61131-2, type 3
Initial data size	3 Bit
Technical data digital outputs	
Number of outputs	1
Cable length, shielded	100 m
Cable length, unshielded	1 m
Rated load voltage	DC 20.4...28.8 V
Reverse polarity protection of rated load voltage	✓
Current consumption from load voltage L+ (without load)	20 mA

Order no.	054-2BA10
Output voltage signal "1" at min. current	L+ (-0 V)
Output voltage signal "1" at max. current	L+ (-250 mV)
Output current at signal "1", rated value	500 mA (DC general use)
Signal logic output	-
Output current at signal "0" max. (residual current)	5 µA
Output delay of "0" to "1"	internal cycle 1ms
Output delay of "1" to "0"	internal cycle 1ms
Minimum load current	-
Lamp load	10 W (not in scope of UL evaluation)
Parallel switching of outputs for redundant control of a load	not possible
Parallel switching of outputs for increased power	not possible
Actuation of digital input	✓
Switching frequency with resistive load	max. 300 Hz
Switching frequency with inductive load	max. 0.5 Hz
Switching frequency on lamp load	max. 10 Hz
Internal limitation of inductive shut-off voltage	L+ (-45 V)
Short-circuit protection of output	yes, electronic
Trigger level	2.3 A
Number of operating cycle of relay outputs	-
Switching capacity of contacts	-
Output data size	-
Status information, alarms, diagnostics	
Status display	green LED per channel
Interrupts	yes, parameterizable
Process alarm	no
Diagnostic interrupt	yes, parameterizable
Diagnostic functions	yes
Diagnostics information read-out	possible
Supply voltage display	green LED
Group error display	red LED
Channel error display	-
Datasizes	
Input bytes	36
Output bytes	36
Parameter bytes	56
Diagnostic bytes	20
Isolation	
Between channels	-

Order no.	054-2BA10
Between channels of groups to	-
Between channels and backplane bus	✓
Between areas	Backplane bus, 24V DI / DO / encoder, motor output stage, FE (shield)
Max. potential difference between inputs and Mintern (Uiso)	DC 75 V/ AC 50 V
Insulation tested with	AC 500 V
Technical data positioning module	
Number of channels	1
Cable length (motor supply)	20 m shielded, see assembly instructions
Input voltage (rated value)	DC 48 V
Input voltage (permitted range)	DC 20.4...57.6 V
Motor current	5 A
Derating	yes
Cable length (motor)	20 m shielded, see assembly instructions
Power stage	2x Full bridge PWM
Short-circuit protection	✓
Brake chopper	externally, if necessary
PWM frequency	32 kHz
Pulse train frequency	-
Micro steps	64
Steps per rotation	parameterizable
Type of encoder	A/B/Z-track 5V differential
Cable length (encoder)	20 m shielded, see assembly instructions
Encoder frequency	50 kHz
Encoder resolution (internal)	parameterizable
Control type	open loop, closed loop
Temperature sensor controller	✓
Temperature sensor H-bridge	✓
Operating modes position functions	
Homing via homing switch	✓
Positioning via torque	-
Positioning without encoder	✓
Positioning with encoder	✓
Speed control	✓
Torque control	✓
Housing	
Material	PPE / PPE GF10

Order no.	054-2BA10
Mounting	Profile rail 35 mm
Mechanical data	
Dimensions (WxHxD)	25.8 mm x 109 mm x 76.5 mm
Net weight	70 g
Weight including accessories	80 g
Gross weight	95 g
Environmental conditions	
Operating temperature	0 °C to 60 °C
Storage temperature	-25 °C to 70 °C
Certifications	
UL certification	yes
KC certification	yes
UKCA certification	yes
ChinaRoHS certification	yes

4 Deployment

4.1 Basics

General

Open Source license information

- *Open source software is used within the firmware.*
- *You can retrieve the corresponding 'Open Source licence information' via the head module used.*
- *For more details, refer to the 'Open Source Licence Information' in the manual for your head module.*

Addressing

The System SLIO motion module provides its data, such as "Profiling target position" via an object dictionary. In this object dictionary the objects are organized and addressable a unique number consisting of *Index* and *Subindex*. The number is specified as follows:

0x	Index (hexadecimal)	-	Subindex (decimal)
Example: 0x8400-03			

To improve the structure and for expansion at System SLIO Motion Module another object numbering (index-assignment) is used besides the standard CiA 402.

Index area

By separating into *index* and *subindex* a grouping is possible. The individual areas are divided into groups of related objects. With the System SLIO motion module this object directory is structured as follows:

Index area	Content
0x1000 up to 0x6FFF	General data and system data
0x7000 up to 0x7FFF	Data of the digital input and output part
0x8000 up to 0x8FFF	Data of the axis

Each object has a subindex 0. Calling an object with subindex 0, the number of available subindexes of the corresponding object is returned.

Accessing the object dictionary

You have the following options for accessing the objects in the object dictionary:

- Access via *'Acyclic channel'...page 118*
  - Any access to the object dictionary is acknowledged by the motion module.
- Access via I/O area
  - The main objects are mapped in the I/O area.
  - The mapping cannot be changed.
  - *'In-/Output area'...page 115*

Please note if you write via the Acyclic channel to objects, which are mapped in the I/O area, their values will be overwritten again with the next cycle. Therefore, data mapped in the I/O area should not be written via the Acyclic channel!

Input/Output data

The motion module uses 36byte input and 36byte output data.

Head module	Backplane bus	Motion module	
CPU respectively bus coupler	→	Process data	*'Acyclic channel'...page 118*
	←	36byte	

The data exchange with the motion module must be consistent across the 36 bytes! It is therefore only possible to control it via the process image!

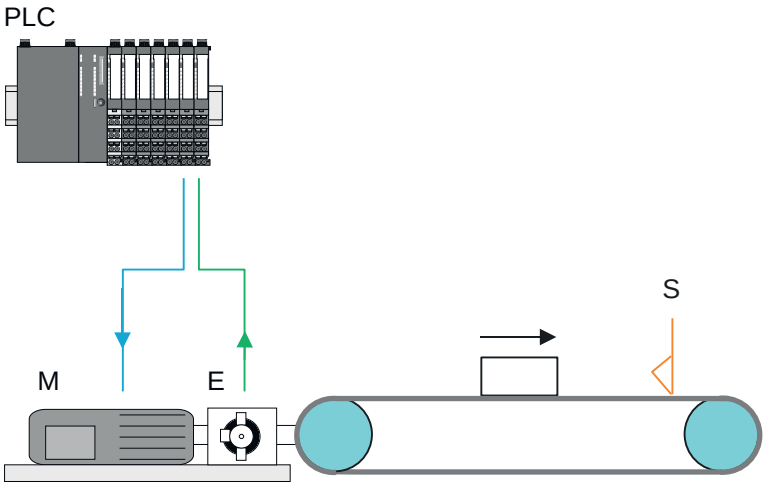
4.1.1 Stepper motor module

The FM 054-2BA10 integrates a compact motion control solution for stepper motors up to 200W in a very compact design. During operation, the module outputs each two controlled currents with sine / cosine character. The controlling of the current happens by means of micro steps with a clock speed of 32kHz. The resolution of the current is 64 steps per full step. This results in a smooth and non-resonant current waveform. With the module, you can control stepper motors with less rotating mass, as well as low-inductance, high-dynamic stepper motors. Due to the micro-stepping and corresponding set-point profiles the stepper motor is always conducted without jerking and there is no oscillation to each step position. This eliminates additional mechanical measures for damping vibrations.

4.1.2 Structure of a positioning control

Structure

The figure below shows the structure of a typical positioning control



PLC Superordinate head module respectively controller.
M Stepper motor
E Encoder
S Software limit switch

Control

The *Control* consists of the PLC with the user program for the processing and the motion module to control the motor. The motion module has an integrated power stage. This generates from the pulses the required currents for the respective motor. You can define a software limit switch in the motion module and react in the user program on the overrun.

CAUTION

Please provide for track limits (general position limit) respectively to avoid damages besides software limit switch hardware limit switches and also consider this in your safety concept.

Stepper motor

A stepper motor is an engine for high-precision positioning. With each pulse, the axis of a motor rotates by a defined angle. With rapid pulse trains, the step movement turns into a steady rotation. When selecting a motor, the following factors must be considered:

- Connection type (4, 6 or 8 wire connection)
- Number of phases (2 phase)
- Torque curve across the speed
- Motor current across the speed
- Winding resistance respectively motor inductance

The general term "motor" will also be used below.

Encoder

- The encoder respectively rotation encoder provides the controller with the position of the drive by means of digital signals. This can accordingly be evaluated by the PLC.
- The encoder respectively rotation encoder supply a certain number of pulses per revolution.
- The value generation is done by counting the pulses.

Mechanical

For the requirements of the load to be moved and the consideration of additional loads such as bearings and gears, you can determine the necessary motor data. Here important parameters are:

- Mass inertia
- Cycle times of positioning
- Start, holding and torque at the maximum required speed
- Acceleration and torque when passing through mechanical resonances e.g. when using mechanical memories as spring elements, vibration buffer or long drive belts.

To avoid step losses, in accordance with the own inertia, the output torque of the Motor should be greater than the determined mechanical torque.

4.2 Commissioning

4.2.1 Mounting

1. Build your System SLIO and connect it. *'Basics and mounting'...page 11*.
2. Connect your motor. *'Connecting a stepper motor'...page 55*

4.2.2 Inspections and tests before the test operation

Preparation

Please check the following items, and take appropriate measures in the event of an error, before you start the test operation.

- Is there an emergency stop mechanism so that you can quickly switch off the drive in the event of danger or a fault?
- Are all wiring and connections correct?
- Are all nuts and bolts at the drive properly tightened?
- For a motor with oil seal: Is the seal not damaged and is the motor lubricated? Please always regard the start-up instructions of your motor!

4.2.3 Commissioning of the System SLIO motion module

Preparation

Please check the following items, and take appropriate measures in the event of an error, before you start the test operation.

- Check the correct setting of the set points for the drive and the I/O signals from the superordinate control.
- Check wiring between the superordinate control and your drive as well as the polarity of the wires.
- Check all operational settings of your drive.

Setting the limits

Please note that the target current is set via the cyclical target value setting and is 0mA at system restart. Thus the motor can operate, you should set the current set value that corresponds to the application and corresponds to the rated motor current.

Set the respective system limits, the system behavior and characteristics in the object dictionary via the *'Acyclic channel'...page 118*. These are e.g.:

- Behaviour at quick stop and on error
- Motor current set value
  '0x8600-03 - Current target value'...page 162
- Motor maximum current
  '0x8C00-04 - Motor max. current'...page 168
- Current limit
  '0x8600-04 - Current limit'...page 162
- Velocity limit values
- Position limitations
- Assignment of the digital inputs and outputs

Optimization of a stepper motor

Proceeding

To optimally optimize a stepping motor, proceed as follows:

1. Decouple the load from the motor (idle mode).
2. Set the motor to *Fullstep mode* by disabling *Microstepping*.
3. Specify the set-point position 0.
   ➡ Only one winding is energized.
4. Show the current of the energized winding on the oscilloscope.
5. Generate a step e.g. by means of a step program with single-step specification
   ➡ You will get step response.
6. Determine the *P* and *I* factors of the controller and adjust them if necessary, until the transient is complete without overshooting after 2 cycles.
7. Activate the *Microstepping* again.

With each system restart of the head module the determined values are to be transmitted to the module. For this e.g. the Acyclic channel can be used.

Steps of commissioning

DANGER

Risk of injury by movement!

- Please note that the stepper application can lead to a dangerous movement!
- Make sure that people and machines are not harmed, particularly during commissioning!
- Provide the corresponding emergency stop mechanism!

Always adapt parameters to the operating mode!

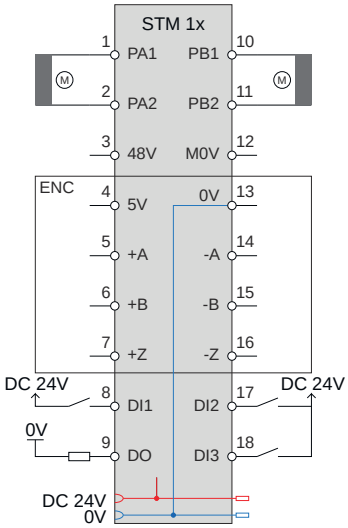
Please ensure that the module always has the correct parameters according to the selected operating mode! Pay special attention to the use of the start parameters and the current values in the output area!
'In-/Output area'...page 115

1. Perform for your System SLIO and your motion module a hardware configuration and create your application program. Transfer both into your CPU.
2. Switch your CPU to RUN state.
3. Switch on the stepper motor.
   ➡ Your system is now ready for communication and you can establish parameter setting via the *Acyclic channel*.
4. Send the command "Shutdown".
   '0x8100-01 - Control word'...page 137 Bit 3...0: x110
   ➡ The motion module shows the state *'Ready to switch on'*.
5. Send the command "Switch on".
   '0x8100-01 - Control word'...page 137 Bit 3...0: 0111
   ➡ The motion module shows the state *'Switched on'*.
6. Send the command "Enable operation".
   '0x8100-01 - Control word'...page 137 Bit 3...0: 1111
   ➡ The motion module shows the state *'Operation enabled'*. The drive is now ready for your move commands.

4.3 Connecting a stepper motor

4.3.1 Connection options

Connections



CAUTION

Danger of injury from electrical shock and damage to the unit!

Put the System SLIO in a safe, powered down state before starting installation, disassembly or wiring of the System SLIO modules!

The stepper motor module has bipolar power stages and can thus control bipolar and unipolar stepper motors. You can use wires with a cross section of 0.08mm² up to 1.5mm². Please ensure that the lines have sufficient current-carrying capacity respectively the voltage drop over long distances. Please observe the installation guidelines for the FM 054-2BA10 *'Connections'...page 40*

Please note when connecting the motor windings!

- *If you connect a motor strand to different output drivers such as PA1 and PB1, this can destroy the output drivers of the stepper motor module.*
- *Overheating of the power stage results in a shutdown.*
- *Connect the windings of a motor strand only at the terminal points of the same output driver of the stepper motor module, for example, one motor strand at PA1 and PA2 and the other motor strand at PB1 and PB2.*

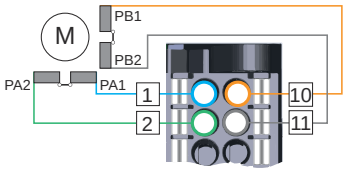
Fusing

- The DC 20.4 ... 57.6V power supply for the stepper motor must be protected externally with a fuse corresponding to the maximum current, i.e. max. 8A with an 8A fuse (fast) or a line circuit breaker 8A characteristic Z and should be UL approved.

4.3.2 Connection types

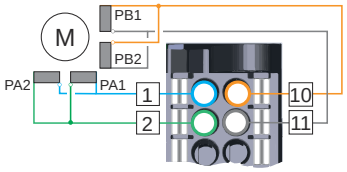
The stepper motor module has bipolar power stages. Here you can control bipolar and unipolar stepper motors.

Bipolar stepper motor serial



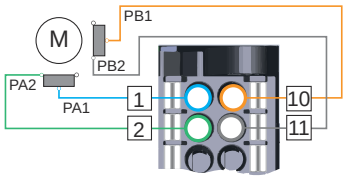
- With the bipolar serial connection of a bipolar stepper motor, both halves of the windings of a bipolar stepper motor are to be serially connected.

Bipolar stepper motor parallel



- With the bipolar parallel connection of a bipolar stepper motor, both halves of the windings of a bipolar stepper motor are to be parallel connected.

Unipolar stepper motor



- With the bipolar connection of a unipolar stepper motor, each one halve of the windings of a unipolar stepper motor is to be connected.

4.4 Drive profile

4.4.1 Overview

Drive profile *CiA 402*

- The System SLIO motion module FM 054-2BA10 is based largely on the drive profile *CiA 402*.
- The drive profile *CiA 402* defines state machine, operating modes and objects (parameters) of components for the drive technology.
- Here significant objects for control and evaluation of the state machine are *Control word*, *Status word* and *Operation mode*.
- Further object serve for configuration and diagnostics of the motion module.
- All the object are summarized in *'Object dictionary'...page 128*.
- The most important objects can be found in *'In-/Output area'...page 115*.
- The access of the objects during runtime happens via *'Acyclic channel'...page 118*.

Term definitions

State machine	The motion module has a state machine implemented. The status of the state machine can be controlled by means of commands.
State change	The relevant command or any errors cause a state change.
State	The state is the current state of the state machine. Via the *Status word* *'0x8100-02 - Status word'...page 138* you can access the state. Here the state is output via appropriate combinations of bits.
Command	For triggering of state transitions, certain combinations of bits must be set in the *Control word* *'0x8100-01 - Control word'...page 137*. Such a combination is called *Command*.

Addressing

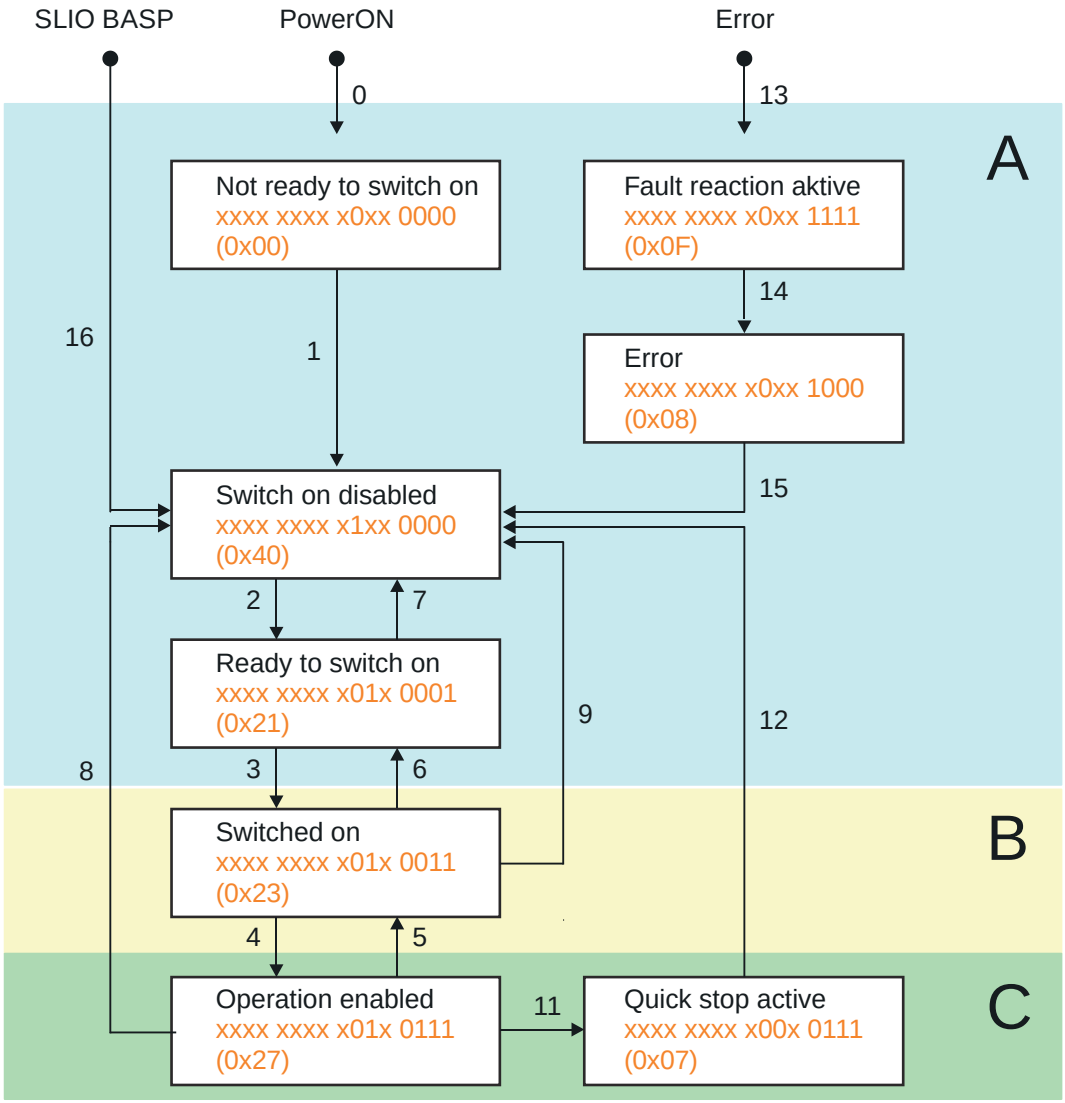
The System SLIO motion module provides its data, such as "Profiling target position" via an object dictionary. In this object dictionary the objects are organized and addressable a unique number consisting of *Index* and *Subindex*. The number is specified as follows:

0x	Index (hexadecimal)	-	Subindex (decimal)
Example: 0x8400-03			

To improve the structure and for expansion at System SLIO Motion Module another object numbering (index-assignment) is used besides the standard CiA 402.

4.4.2 States

State machine according to CiA 402



O	Control power on, drive is not power supplied.
B	Control and main power on, drive is not power supplied.
C	Control and main power on, drive is power supplied.
xxx..	Status of the *Status word*
	Transition by:
0,1	Device start-up and self-test after PowerON
13	Drive or communication error
14	Internal fault reaction
16	Disabling command output disable (BASP)
	'0x8100-01 - Control word'...page 137:
2,6	Bit 3...0: x110: Command "Shutdown"
3	Bit 3...0: 0111: Command "Switch on"
4	Bit 3...0: 1111: Command "Enable operation". According to CiA 402 the automatic transition from *Ready to switch on* to *Operation enabled* is possible.
5	Bit 3...0: 0111: Command "Disable operation"
11	Bit 3...0: x01x: Command "Quick stop"
7,8,9,12	Bit 3...0: xx0x: Command "Disable voltage"
15	Bit 7: Edge 0-1: Command "Fault reset"

Accessing the state machine

At CiA 402 the total control is realized via the following two objects. Both objects are mapped in the cyclic data exchange:

'0x8100-01 - Control word'...page 137	→	State machine	→	*'0x8100-02 - Status word'...page 138*

4.4.3 Operating modes

4.4.3.1 Overview

Communication

- The communication takes place via the I/O area.
- The main data of the object dictionary are mapped into the I/O area.
  'In-/Output area'...page 115
- The objects, which are not mapped, can be accessed by the *Acyclic channel*.
  'Acyclic channel'...page 118

Operating modes

Depending on the set *'0x8F00-01 - Encoder feedback configuration'...page 171*, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed loop control system. Here a distinction is made between the following encoder configurations:

- *'Open loop'...page 110*
- *'Pseudo closed loop'...page 111*
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

The following motion profiles according to the device profile CiA 402 are available:

- *'Homing'...page 61*
- *'Commutation finding'...page 114*
- *'PtP positioning profile'...page 65*
- *'Velocity profile'...page 83*
- *'Torque control'...page 94*
- *'Cyclic synchronous positioning'...page 98*

Combination possibilities

Open loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8)	
'0x8F00-01 - Encoder feedback configuration'...page 171	0: Open loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6 or 8
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8F00-02 - Encoder actual value'...page 172	0 (fix)

Open loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8)	
'0x8F00-01 - Encoder feedback configuration'...page 171	1: Open loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6 or 8
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

Pseudo closed loop | PtP positioning profile (1), Homing (6)	
'0x8F00-01 - Encoder feedback configuration'...page 171	5: Pseudo closed loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1 or 6
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

Closed loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8), Torque control (10), Commutation finding (15)	
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC)
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6, 8, 10 or 15
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

Application data

In addition to the control parameters you have to specify the data from your application, consisting of the nominal drive data and scaling.

'0x8180-02 - Gear factor'...page 147	→	Application data
'0x8C00-04 - Motor max. current'...page 168		
'0x8D00-02 - Stepper full steps per revolution'...page 169		
'0x8D00-03 - Stepper micro steps per full step'...page 170		
'0x8600-04 - Current limit'...page 162		

4.5 Homing

Overview

Here you will find information on how the System SLIO motion module searches the *Reference position*.

- The reference position is also called "basic position", "start position" or "home position".
- *Homing* is an initialisation drive of an axis, where the correct actual position is determined by means of an reference signal. This process is called "referencing", "home drive" or "homing".
- When referencing you can determine velocity, acceleration, deceleration and type of homing.
- The FM 054-2BA10 supports the following homing types:
  - *'Homing by means of a homing switch'...page 62*
  - *'Homing to actual position'...page 64*
- Depending on the set *'0x8F00-01 - Encoder feedback configuration'...page 171*, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed loop control system for positioning. Here a distinction is made between the following encoder configurations:
  - *'Open loop'...page 110*
  - *'Pseudo closed loop'...page 111*
  - *'Closed Loop - Field-oriented control (FOC)'...page 113*

Start - Start parameter homing

Please note:

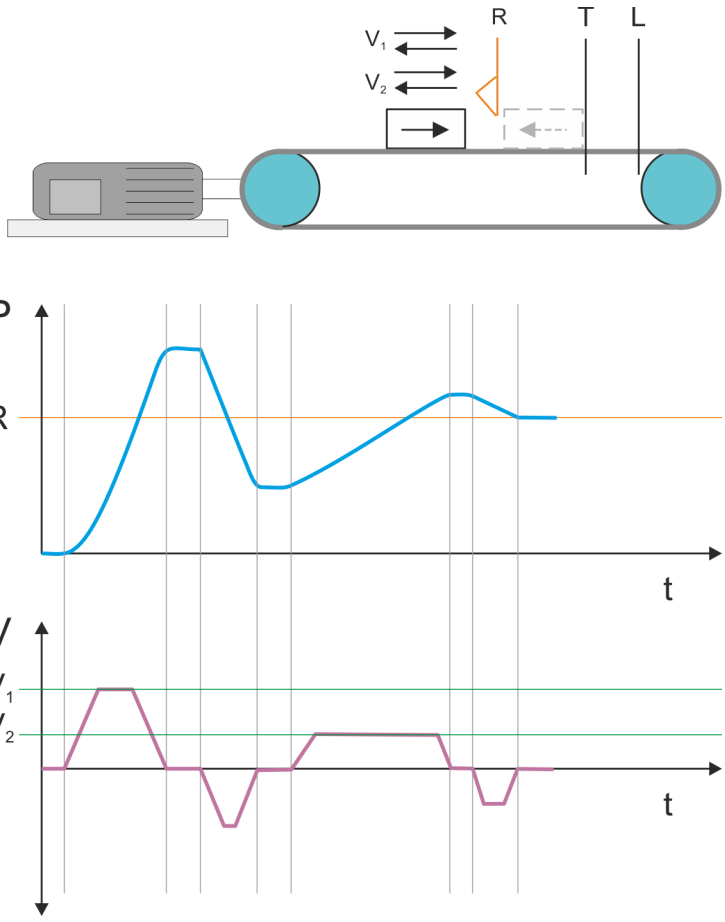
- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 6: Homing mode (*'0x8280-02 - Operating mode actual'...page 150*)	→	Homing	→	*'0x8100-02 - Status word'...page 138* *'0x8280-02 - Operating mode actual'...page 150*
'0x8300-02 - Homing method'...page 151				
'0x8300-03 - Homing digital input DI1…DI3, ENC-Z'...page 151				
'0x8300-04 - Homing digital input active polarity DI1…DI3'...page 152				
'0x8300-05 - Homing target position'...page 152				
'0x8300-06 - Homing velocity V1'...page 152				
'0x8300-07 - Homing velocity V2'...page 153				
'0x8300-08 - Homing acceleration'...page 153				
'0x8300-09 - Homing deceleration'...page 153				
'0x8300-10 - Homing offset value'...page 153				

4.5.1 Homing by means of a homing switch

Overview

- Homing can only be accessed from the *PtP positioning profile* mode.
- The *target position* is the reference position, which is maximally moved to. This is to be specified with sign.
- The homing happens according to the following steps:
  - It is traversed with the high *velocity V1* toward the target position *T* until the homing switch *R* is overrun.
  - Then it is decelerated and traversed in the opposite direction with *velocity V1*.
  - If the homing value *R* is overrun again, it is again decelerated and it is again accelerated in the positive direction with slower *velocity V2*.
  - With the next overrun of the homing switch the reference position *R* is set and moved to with *velocity V2*.
- Use To connect the home switch one of the digital inputs of the motion module and specify the polarity of the switch with the parametrization.



V_1 High velocity
V_2 Low velocity
R Homing switch respectively homing value
T Target position
L General position limit

Proceeding

1. For commissioning *'Commissioning'...page 53*

   Homing objects *'Homing - 0x8300'...page 150*

2. ■ Switch the state machine to state *'Switch on disabled'* *'States'...page 58*
   - Send the command "Disable voltage"
     '0x8100-01 - Control word'...page 137 Bit 3...0: xx0x:

   ➡ The motion module shows the state *'Switch on disabled'*.

3. Set the following parameters:
   - ■ *'0x8300-02 - Homing method'...page 151*
     - Enter the value 17.
   - ■ *'0x8300-03 - Homing digital input DI1…DI3, ENC-Z'...page 151*
     - Select the input to which the homing switch is connected.
   - ■ *'0x8300-04 - Homing digital input active polarity DI1…DI3'...page 152*
     - Define the polarity of the switch
   - ■ *'0x8300-05 - Homing target position'...page 152*
     - Define by specifying a target position the maximum axis movement path, that during movement the homing switch is passed over.
   - ■ *'0x8300-06 - Homing velocity V1'...page 152*
     - Specify the high velocity for the movement to the homing switch.
   - ■ *'0x8300-07 - Homing velocity V2'...page 153*
     - Specify the low velocity for the movement to the homing switch.
   - ■ *'0x8300-08 - Homing acceleration'...page 153*
     - Specify the acceleration for homing.
   - ■ *'0x8300-09 - Homing deceleration'...page 153*
     - Specify the deceleration for homing.
   - ■ *'0x8300-10 - Homing offset value'...page 153*
     - If necessary specify an offset for the homing position.

4. ■ *'0x8400-03 - Positioning profile target velocity'...page 154*
   - Enter the value 0.

5. ■ Switch your motion module to the *Positioning* mode. *'0x8280-01 - Operating mode requested'...page 149*
   - Enter the value 1.

6. Send the command "Shutdown"

   '0x8100-01 - Control word'...page 137 Bit 3...0: x110:

   ➡ The motion module shows the state *'Ready to switch on'*.

7. Send the command "Switch on".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 0111

   ➡ The motion module shows the state *'Switched on'*.

8. Send the command "Enable operation".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 1111

   ➡ The motion module shows the state *'Operation enabled'*. The drive is now ready for your move commands.

9. ■ Switch your motion module to the *Homing* mode. *'0x8280-01 - Operating mode requested'...page 149*
   - Enter the value 6.

   ➡ The drive starts homing. Upon completion of the homing, the position of the reference switch is used as the reference point.

4.5.2 Homing to actual position

Proceeding

1. For commissioning *'Commissioning'...page 53*

   Homing objects *'Homing - 0x8300'...page 150*

2. ■ Switch the state machine to state *'Switch on disabled''States'...page 58*
   - Send the command "Disable voltage"
     '0x8100-01 - Control word'...page 137 Bit 3...0: xx0x:

   ➡ The motion module shows the state *'Switch on disabled'*.

3. Set the following parameters:
   - ■ *'0x8300-02 - Homing method'...page 151*
     - Enter the value 37.
   - ■ *'0x8300-10 - Homing offset value'...page 153*
     - If necessary specify an offset for the homing position.

4. ■ *'0x8400-03 - Positioning profile target velocity'...page 154*
   - Enter the value 0.

5. ■ Switch your motion module to the *Positioning* mode. *'0x8280-01 - Operating mode requested'...page 149*
   - Enter the value 1.

6. Send the command "Shutdown"

   '0x8100-01 - Control word'...page 137 Bit 3...0: x110:

   ➡ The motion module shows the state *'Ready to switch on'*.

7. Send the command "Switch on".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 0111

   ➡ The motion module shows the state *'Switched on'*.

8. Send the command "Enable operation".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 1111

   ➡ The motion module shows the state *'Operation enabled'*. The drive is now ready for your move commands.

9. ■ Switch your motion module to the *Homing* mode.
   '0x8280-01 - Operating mode requested'...page 149
   - Enter the value 6.

   ➡ *'0x8300-10 - Homing offset value'...page 153* is used directly as actual position in *'0x8480-02 - Position actual value'...page 155*.

4.6 PtP positioning profile

Overview

Always adapt parameters to the operating mode!

Please ensure that the module always has the correct parameters according to the selected operating mode! Pay special attention to the use of the start parameters and the current values in the output area!
'In-/Output area'...page 115

With the PTP-position profile, you can move to target positions by specifying profile velocity, profile acceleration and profile deceleration. Here, the limits for velocity and maximum traversing position are always be considered. Due to changes of values are immediately used and activated, "on the fly" changes of the move process are possible.

- Changes in acceleration respectively deceleration are directly used with the profile generation.
- Deceleration and reversing is automatically executed when a new target position requires a change of direction. A separated activation by starting the job in the *Control word* is not necessary.
- If a specified target position is reached or a limit is activated during the traversing, this is indicated in *'0x8100-02 - Status word'...page 138*.
- Current values of position, velocity, acceleration and deceleration are calculated by the System SLIO motion module itself.
- Depending on the set encoder feedback, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed positioning control loop. Here a distinction is made between the following encoder configurations:
  - *'Open loop'...page 65*
  - *'Pseudo closed loop'...page 69*
  - *'Closed loop'...page 72*

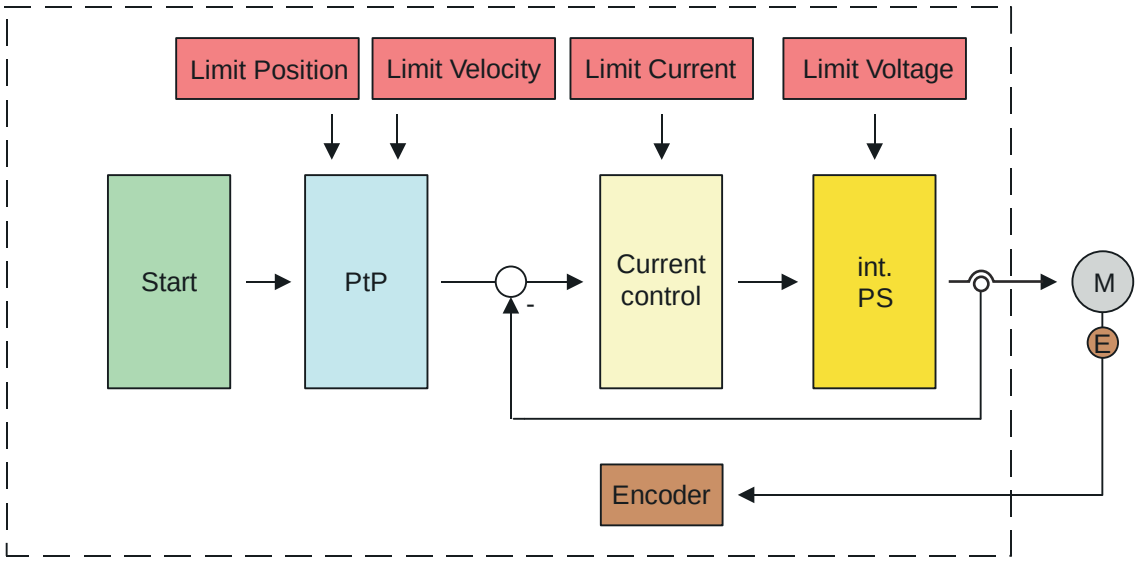
4.6.1 Open loop

Functionality

Open loop | PtP positioning profile	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1: PtP positioning profile
'0x8F00-01 - Encoder feedback configuration'...page 171	Open loop ■ 0: Encoder value is 0 (fix). ■ 1: Encoder value is output in *'0x8F00-02 - Encoder actual value'...page 172*.
'0x8400-02 - Positioning profile target position'...page 154	Specification of the target position
'0x8F00-02 - Encoder actual value'...page 172	The shown value depends on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*

- The System SLIO module operates in controlled mode.
- The encoder signal is not used for the control.
- The setpoint for the current controller is generated by the higher-level profile generator.
- The actual position corresponds to the position value of the profile generator.
- Depending on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*, an encoder value is output.
- *'Open loop'...page 110*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage

PtP: PtP positioning profile
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - Start parameter PtP position profile

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 1: PtP positioning profile (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	PtP Positioning profile generator
'0x8400-02 - Positioning profile target position'...page 154				
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 0: Open Loop (without encoder current value) 1: Open loop (with encoder current value)				

Limit Position - Limitation position

'0x8480-05 - Software position limit positive direction'...page 155 *'0x8480-06 - Software position limit negative direction'...page 156* *'0x8480-07 - Range limit positive direction'...page 156* *'0x8480-08 - Range limit negative direction'...page 156* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Position	→	PtP Positioning profile generator

Limit Velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159 *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Velocity	→	PtP Positioning profile generator

PtP - positioning profile

Limit Position Limitation position Limit Velocity Limitation velocity Start *'0x8400-03 - Positioning profile target velocity'...page 154* *'0x8400-04 - Positioning profile target acceleration'...page 154* *'0x8400-05 - Positioning profile target deceleration'...page 154* *'0x8F00-02 - Encoder actual value'...page 172*	→	PtP	→	Current control Current controller *'0x8480-02 - Position actual value'...page 155* Encoder value *'0x8480-03 - Target position'...page 155* *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current PtP Positioning profile generator *'0x8600-03 - Current target value'...page 162* *'0x8600-06 - Current control P-part'...page 163* *'0x8600-07 - Current control I-part'...page 163* *'0x8600-09 - Current control filter factor '...page 163*	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163*

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage Current control Current controller *'0x8600-02 - Current actual value'...page 162*	→	int. PS	→	Motor Encoder[1] *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*

1) Only if *'0x8F00-01 - Encoder feedback configuration'...page 171* is configured with 1, otherwise 0 is output.

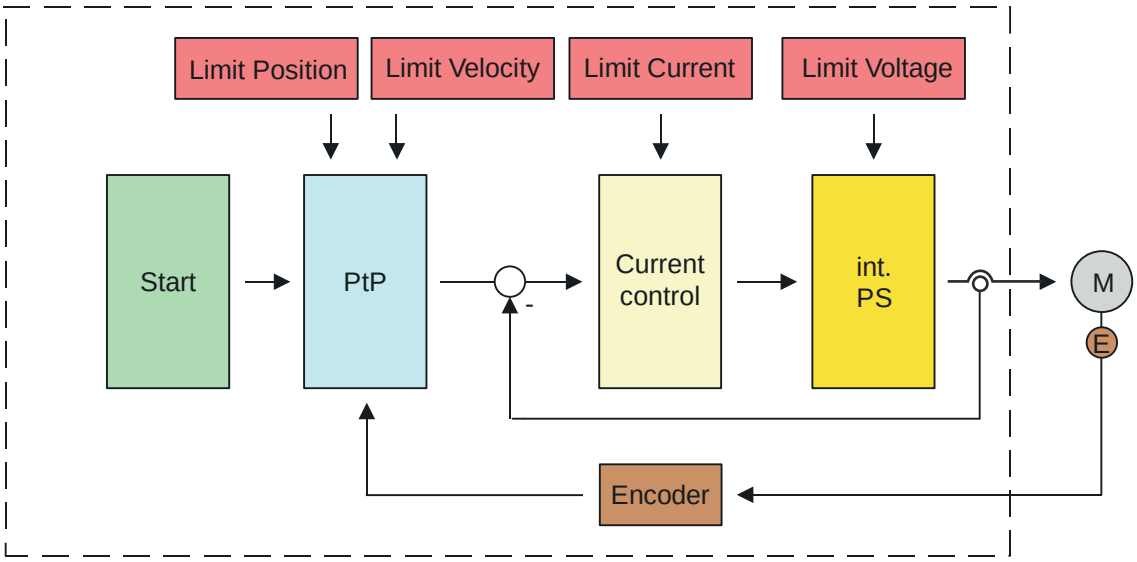
4.6.2 Pseudo closed loop

Functionality

Pseudo closed loop | PtP positioning profile	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1
'0x8F00-01 - Encoder feedback configuration'...page 171	5: Pseudo closed loop
'0x8400-02 - Positioning profile target position'...page 154	Specification of the target position
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalised to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

- The System SLIO module operates in "pseudo" controlled mode.
- The encoder signal is always evaluated at the end of a traverse profile and a position correction is triggered via the profile generator.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level profile generator.
- The actual position corresponds to the value of the encoder normalized to the position.
- An encoder value is output.
- *'Pseudo closed loop'...page 111*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage
PtP: PtP positioning profile
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - Start parameter PtP position profile

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 1: PtP positioning profile (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	PtP Positioning profile generator
'0x8400-02 - Positioning profile target position'...page 154				
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 5: Pseudo closed loop				

Limit Position - Limitation position

'0x8480-05 - Software position limit positive direction'...page 155	→	Limit Position	→	PtP Positioning profile generator
'0x8480-06 - Software position limit negative direction'...page 156				
'0x8480-07 - Range limit positive direction'...page 156				
'0x8480-08 - Range limit negative direction'...page 156				
'0x8580-04 - Acceleration limit'...page 161				
'0x8580-06 - Deceleration limit'...page 161				

Limit Velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159	→	Limit Velocity	→	PtP Positioning profile generator
'0x8500-05 - Velocity control limit negative direction'...page 160				
'0x8580-04 - Acceleration limit'...page 161				
'0x8580-06 - Deceleration limit'...page 161				

PtP - positioning profile

Limit Position Limitation position Limit Velocity Limitation velocity Start *'0x8400-03 - Positioning profile target velocity'...page 154* *'0x8400-04 - Positioning profile target acceleration'...page 154* *'0x8400-05 - Positioning profile target deceleration'...page 154* *'0x8480-02 - Position actual value'...page 155* Encoder value *'0x8F00-02 - Encoder actual value'...page 172*	→	PtP	→	Current control Current controller *'0x8480-03 - Target position'...page 155* *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current PtP Positioning profile generator *'0x8600-03 - Current target value'...page 162* *'0x8600-06 - Current control P-part'...page 163* *'0x8600-07 - Current control I-part'...page 163* *'0x8600-09 - Current control filter factor '...page 163*	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163*

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

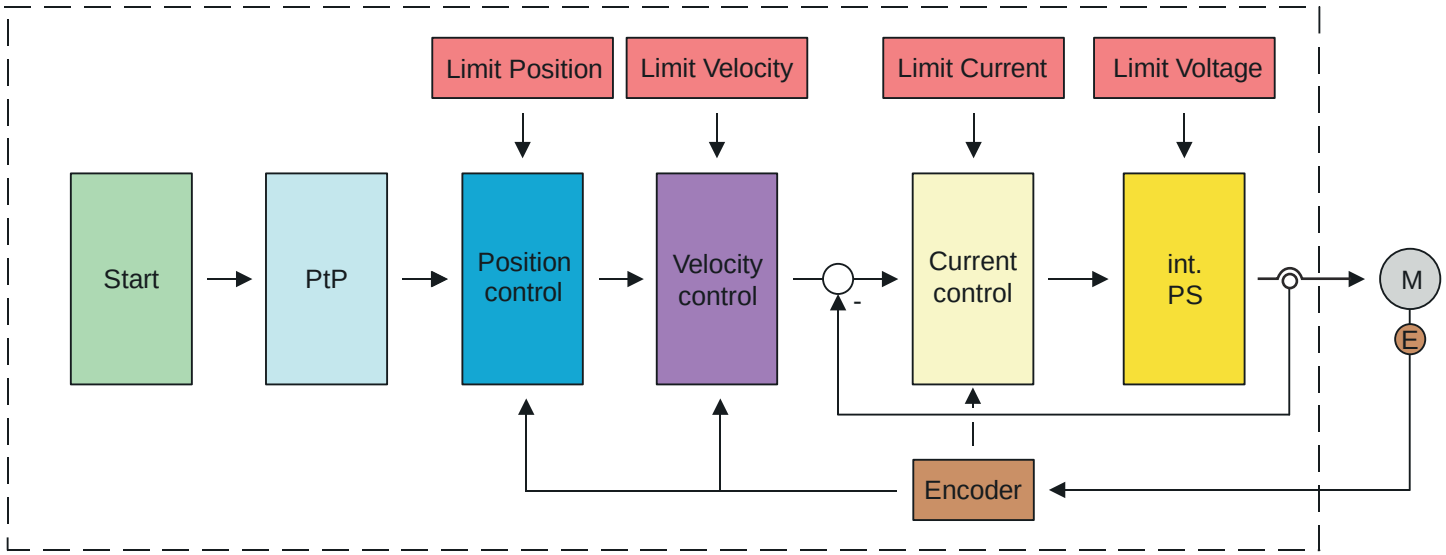
4.6.3 Closed loop

Functionality

Closed loop | PtP positioning profile	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1: PtP positioning profile
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC) *'Closed Loop - Field-oriented control (FOC)'...page 113*
'0x8400-02 - Positioning profile target position'...page 154	Specification of the target position
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalised to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

- The System SLIO module works in controlled mode using a cascaded controller structure.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level control loop.
- The actual position corresponds to the value of the encoder normalized to the position.
- An encoder value is output.
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage
PtP: PtP positioning profile

Position control: Position controller
Velocity control: Speed controller
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - Start parameter PtP position profile

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 1: PtP positioning profile (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	PtP Positioning profile generator
'0x8400-02 - Positioning profile target position'...page 154				
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 3: Closed loop				

PtP - positioning profile

Start *'0x8400-03 - Positioning profile target velocity'...page 154* *'0x8400-04 - Positioning profile target acceleration'...page 154* *'0x8400-05 - Positioning profile target deceleration'...page 154* *'0x8F00-02 - Encoder actual value'...page 172*	→	PtP	→	Position control Position controller *'0x8100-02 - Status word'...page 138*

Limit Position - Limitation position

'0x8480-05 - Software position limit positive direction'...page 155 *'0x8480-06 - Software position limit negative direction'...page 156* *'0x8480-07 - Range limit positive direction'...page 156* *'0x8480-08 - Range limit negative direction'...page 156* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Position	→	Position control Position controller

Position control - Position controller

Limit Position Limitation position *'0x8480-02 - Position actual value'...page 155* Encoder value PtP Positioning profile generator *'0x8480-09 - In-position window'...page 157* *'0x8480-13 - Position control P-part'...page 158* *'0x8480-14 - Position control I-part'...page 158* *'0x8480-15 - Position control D-part'...page 158* *'0x8F00-02 - Encoder actual value'...page 172*	→	Position control	→	Velocity control Speed controller

Limit velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159 *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Velocity	→	Velocity control Speed controller

Velocity control - Speed controller

Limit Velocity Limitation velocity *'0x8480-02 - Position actual value'...page 155* Encoder value Position control Position controller *'0x8500-01 - Velocity control configuration'...page 159* *'0x8500-03 - Velocity control target value'...page 159* *'0x8500-11 - Velocity control P-part'...page 160* *'0x8580-03 - Deceleration quick stop value'...page 161* *'0x8F00-01 - Encoder feedback configuration'...page 171*	→	Velocity control	→	Current control Current controller *'0x8480-03 - Target position'...page 155* *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163* *'0x8600-12 - Current target value winding A'...page 163* *'0x8600-13 - Current target value winding B'...page 164*
'0x8480-02 - Position actual value'...page 155 Encoder value				
Velocity control Speed controller				
'0x8600-03 - Current target value'...page 162				
'0x8600-06 - Current control P-part'...page 163				
'0x8600-07 - Current control I-part'...page 163				
'0x8600-09 - Current control filter factor '...page 163				

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164	→	Limit Voltage	→	int. PS internal power stage
'0x8680-05 - Power section supply voltage max. warning level'...page 165				
'0x8680-06 - Power section supply voltage min. error level'...page 165				
'0x8680-07 - Power section supply voltage max. error level'...page 165				

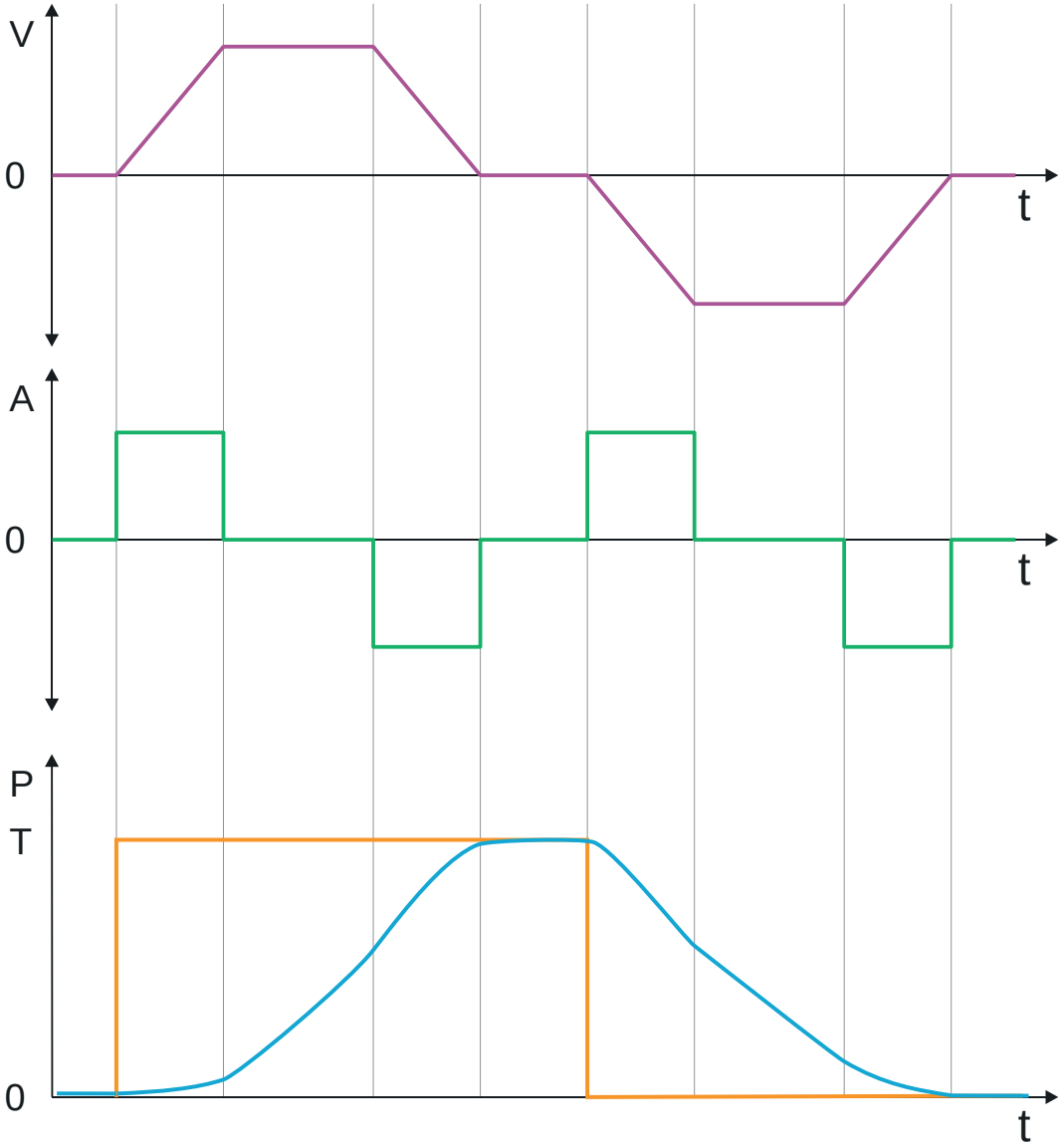
int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

4.6.4 Examples

Symmetrical acceleration and deceleration with reaching the target velocity

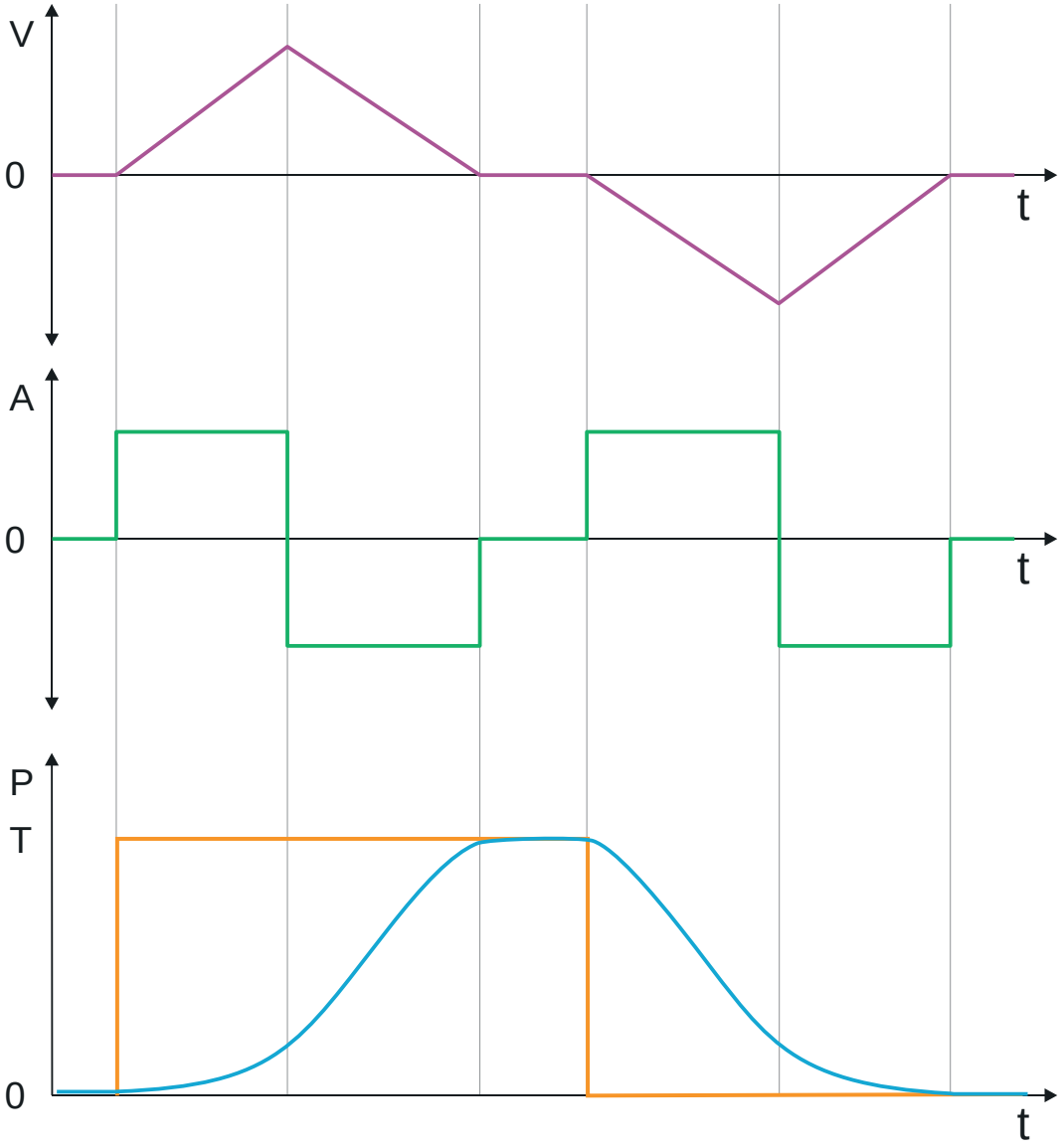
- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.
- Specifying a new target position as starting position.



V Velocity
A Acceleration
P Position
T Target position
t Time line

Symmetrical acceleration and deceleration without reaching the target velocity

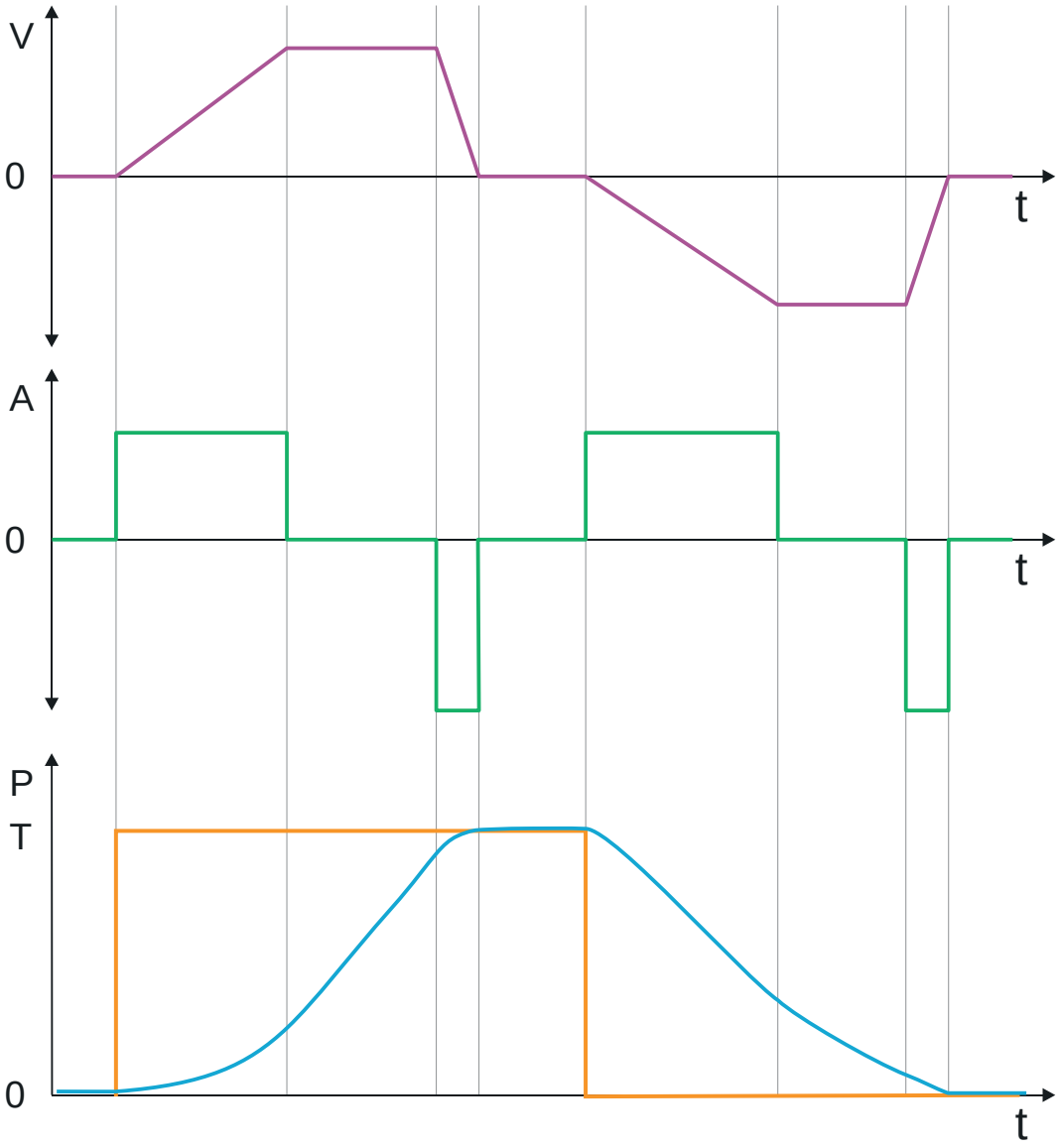
- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is not reached, since before deceleration is initiated to reach the target position.
- Specifying a new target position as starting position.



V Velocity
A Acceleration
P Position
T Target position
t Time line

Asymmetrical acceleration and deceleration with reaching the target velocity

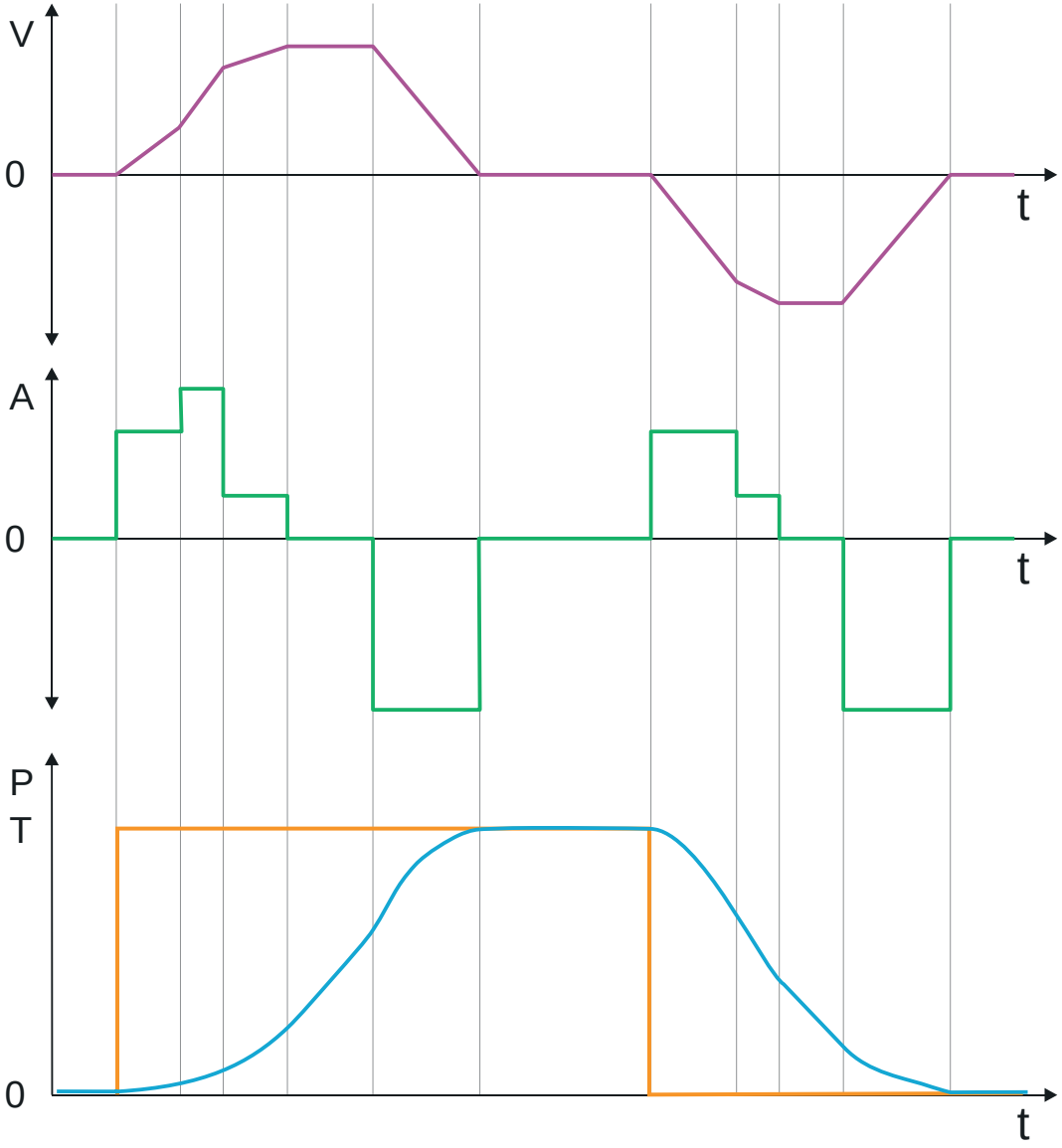
- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.
- Specifying a new target position as starting position.



V Velocity
A Acceleration
P Position
T Target position
t Time line

Asymmetrical acceleration and deceleration with reducing the acceleration during the move

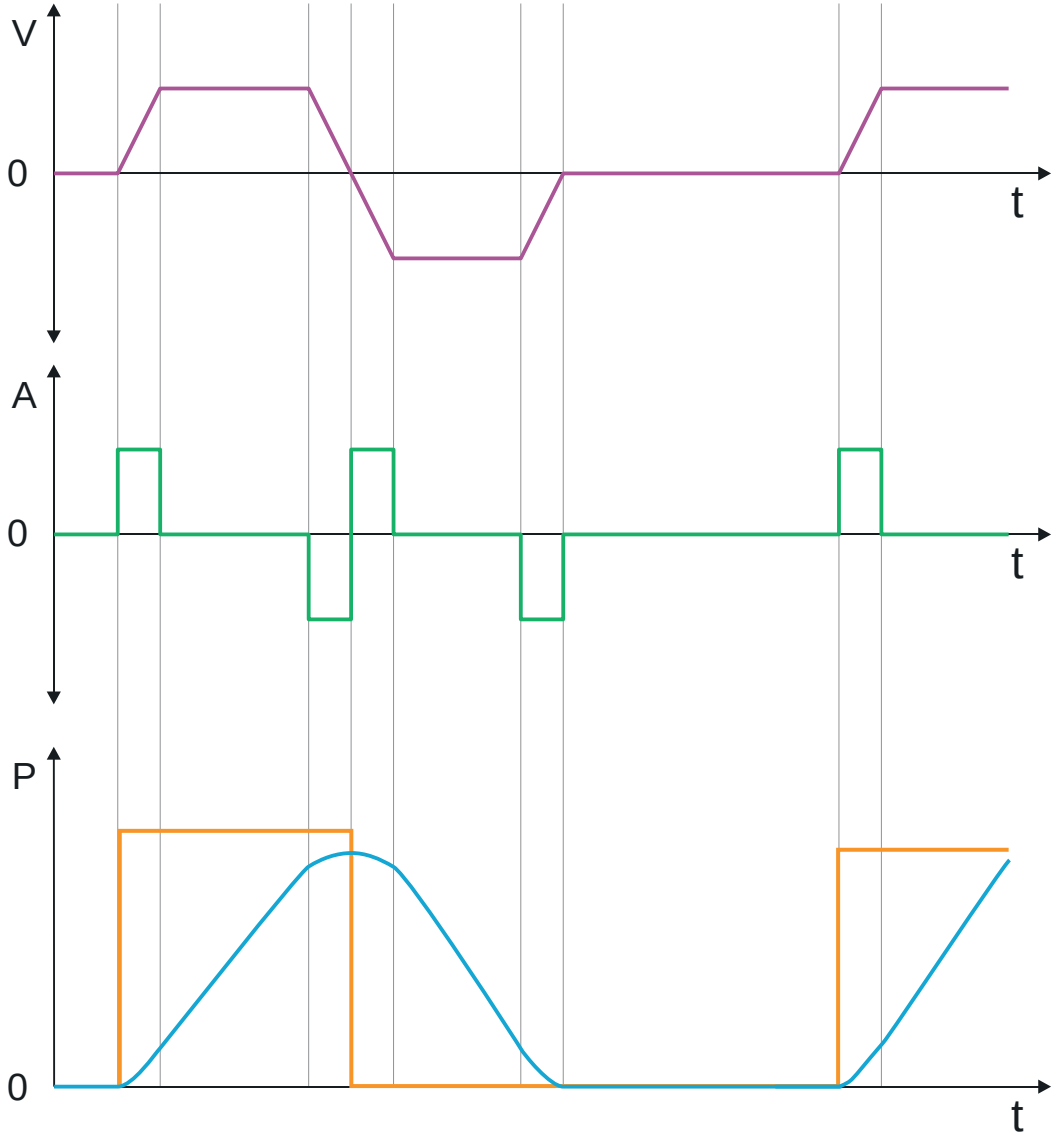
- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.
- Specifying a new target position as starting position.



V Velocity
A Acceleration
P Position
T Target position
t Time line

Symmetrical acceleration and deceleration with reaching the target velocity

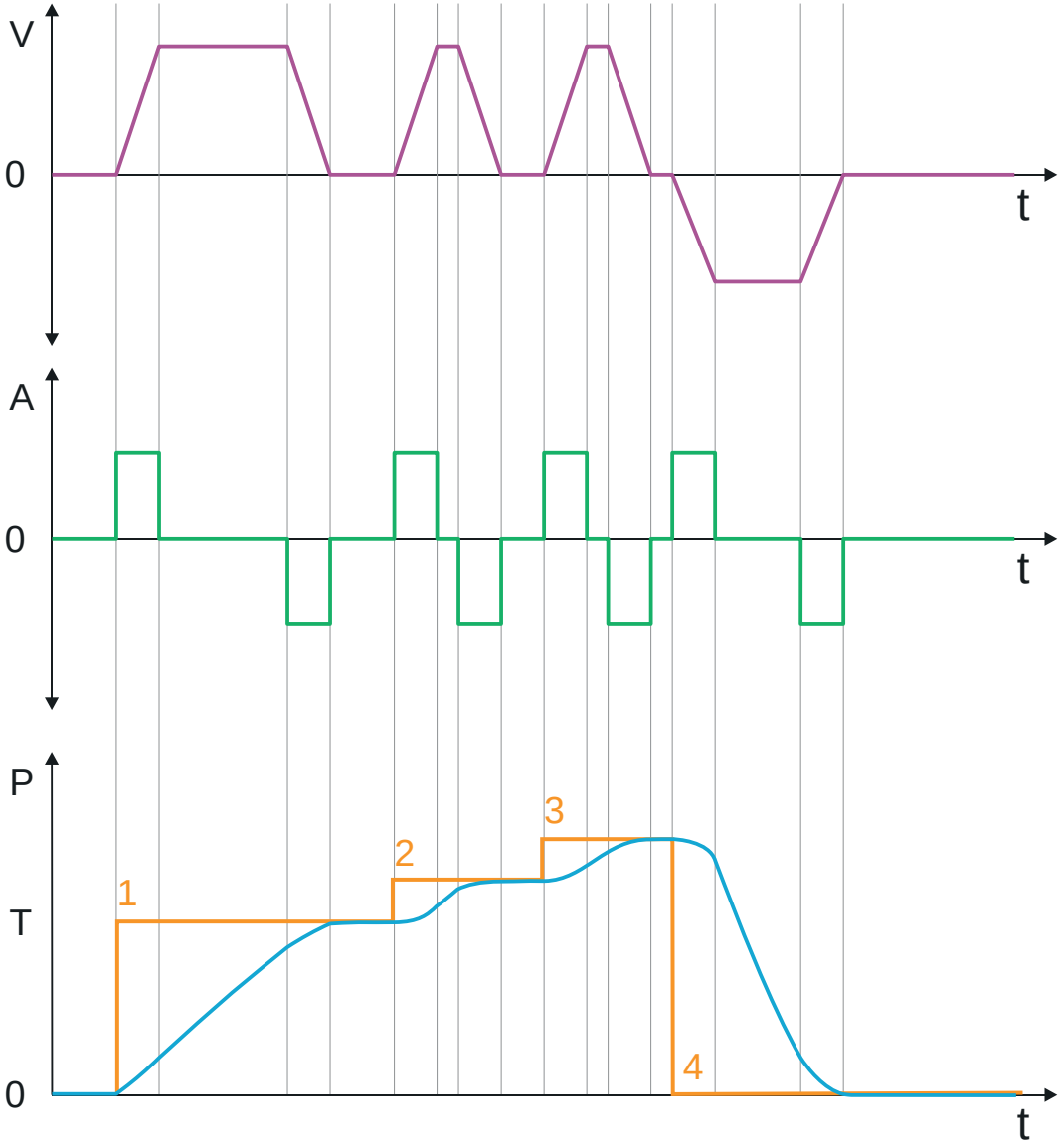
- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.
- Specifying a new target position as starting position during deceleration.



V Velocity
A Acceleration
P Position
T Target position
t Time line

Symmetrical acceleration and deceleration with specifying a target position four times

- Setting
  - Target position
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.
- Four times setting a new target position after the previous target position was reached.



V Velocity
A Acceleration
P Position
T Target position (1 ... 4)
t Time line

4.7 Velocity profile

Overview

Always adapt parameters to the operating mode!

Please ensure that the module always has the correct parameters according to the selected operating mode! Pay special attention to the use of the start parameters and the current values in the output area!
'In-/Output area'...page 115

In the operating mode *Velocity profile* the velocity is output according to profile acceleration and profile deceleration until the target velocity is reached. With this object *'0x8500-01 - Velocity control configuration'...page 159*, you can influence the speed control behavior.

- Changes in acceleration respectively deceleration are directly used with the profile generation.
- Current values of velocity, acceleration and deceleration are calculated by the System SLIO motion module itself.
- Depending on the set encoder feedback, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed loop control system for speed control. Here a distinction is made between the following encoder configurations:
  - *'Open loop'...page 83*
  - *'Closed loop'...page 86*

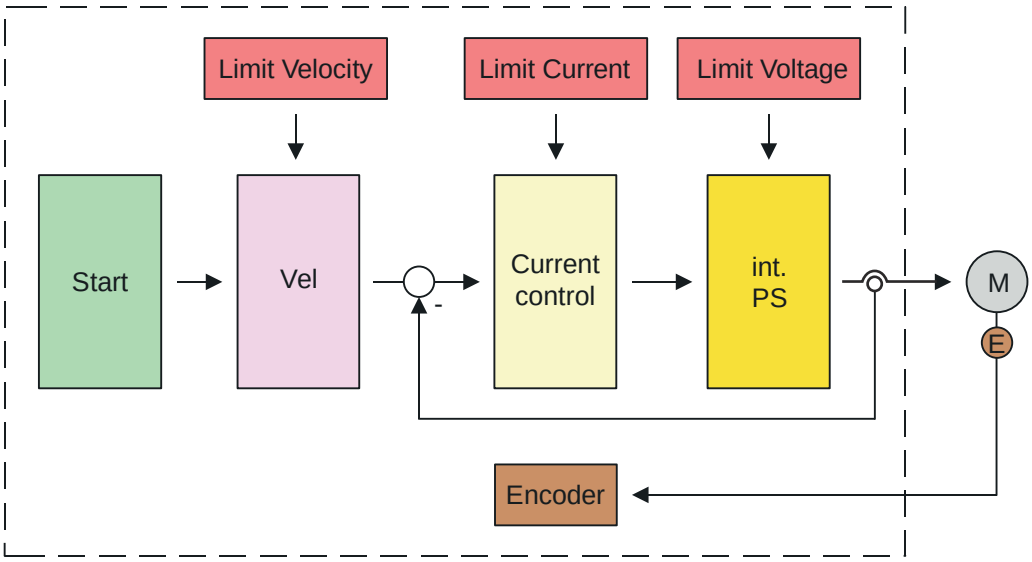
4.7.1 Open loop

Functionality

Open loop | Velocity profile	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 3: Velocity profile
'0x8F00-01 - Encoder feedback configuration'...page 171	Open loop ■ 0: Encoder value is 0 (fix). ■ 1: Encoder value is output in *'0x8F00-02 - Encoder actual value'...page 172*.
'0x8400-03 - Positioning profile target velocity'...page 154	Specification of the target velocity
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8F00-02 - Encoder actual value'...page 172	The shown value depends on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*

- The System SLIO module operates in controlled mode.
- The encoder signal is not used for the control.
- The setpoint for the current controller is generated by the higher-level profile generator.
- The actual position corresponds to the position value of the profile generator.
- Depending on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*, an encoder value is output.
- *'Open loop'...page 110*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Current: Limitation current
Limit Voltage: Limitation voltage
Vel: Velocity profile
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - start parameters velocity profile

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 3: Velocity profile (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	Vel Velocity profile generator
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171				

Limit Velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159 *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Velocity	→	Vel Velocity profile generator

Vel - velocity profile

Limit Velocity Limitation velocity *'0x8500-01 - Velocity control configuration'...page 159* *'0x8500-03 - Velocity control target value'...page 159* *'0x8580-03 - Deceleration quick stop value'...page 161* *'0x8F00-01 - Encoder feedback configuration'...page 171*	→	Vel	→	Current control Current controller *'0x8480-02 - Position actual value'...page 155* Encoder value *'0x8480-03 - Target position'...page 155* *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current Vel Velocity profile generator *'0x8600-03 - Current target value'...page 162* *'0x8600-06 - Current control P-part'...page 163* *'0x8600-07 - Current control I-part'...page 163* *'0x8600-09 - Current control filter factor '...page 163*	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163*

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage PI control PI current controller *'0x8600-02 - Current actual value'...page 162*	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*

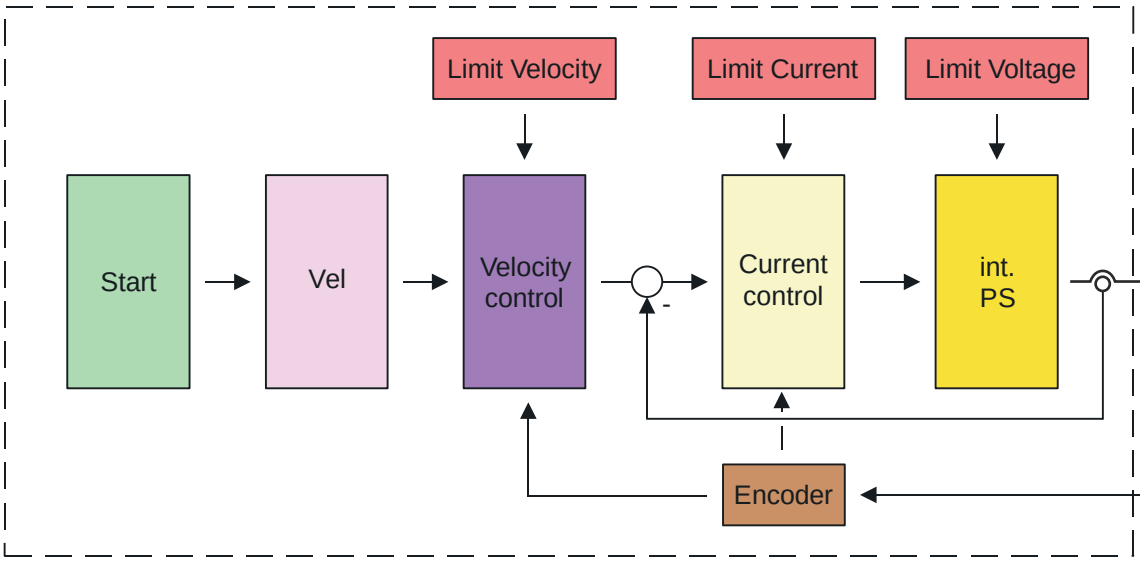
4.7.2 Closed loop

Functionality

Closed loop | Velocity profile	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1: Velocity profile
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC) *'Closed Loop - Field-oriented control (FOC)'...page 113*
'0x8400-03 - Positioning profile target velocity'...page 154	Specification of the target velocity.
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

- The System SLIO module works in controlled mode using a cascaded controller structure.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level control loop.
- An encoder value is output.
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Current: Limitation current
Limit Voltage: Limitation voltage
Vel: Velocity profile
Velocity control: Speed controller
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - Start parameter velocity profile

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 3: Velocity profile (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	Vel Velocity profile generator
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 3: Closed loop				

Vel - velocity profile

Start	→	Vel	→	Velocity control Speed controller

Limit velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159 *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Velocity	→	Velocity control Speed controller

Velocity control - Speed controller

Limit Velocity Limitation velocity *'0x8480-02 - Position actual value'...page 155* Encoder value Vel Velocity profile generator *'0x8500-01 - Velocity control configuration'...page 159* *'0x8500-03 - Velocity control target value'...page 159* *'0x8500-11 - Velocity control P-part'...page 160* *'0x8580-03 - Deceleration quick stop value'...page 161* *'0x8F00-01 - Encoder feedback configuration'...page 171*	→	Velocity control	→	Current control Current controller *'0x8480-03 - Target position'...page 155* *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current	→	Current control	→	int. PS internal power stage
'0x8480-02 - Position actual value'...page 155 Encoder value				*'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163*
Velocity control Speed controller				
'0x8600-03 - Current target value'...page 162				
'0x8600-06 - Current control P-part'...page 163				
'0x8600-07 - Current control I-part'...page 163				
'0x8600-09 - Current control filter factor '...page 163				

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164	→	Limit Voltage	→	int. PS internal power stage
'0x8680-05 - Power section supply voltage max. warning level'...page 165				
'0x8680-06 - Power section supply voltage min. error level'...page 165				
'0x8680-07 - Power section supply voltage max. error level'...page 165				

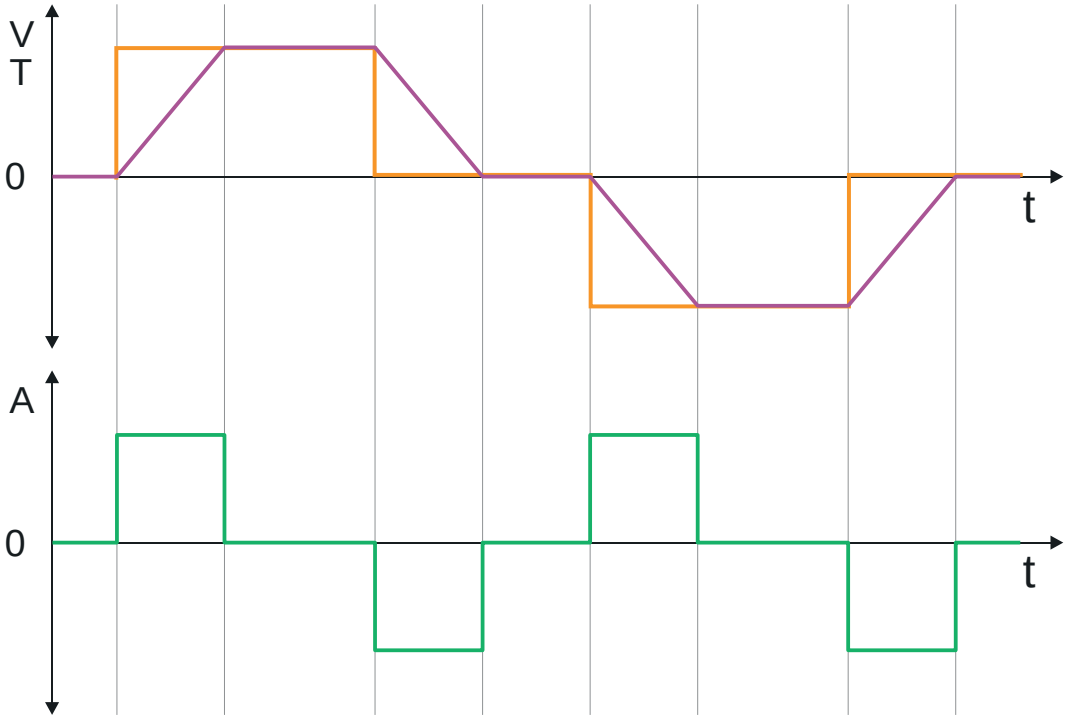
int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

4.7.3 Examples

Symmetrical acceleration and deceleration with reaching the target velocity

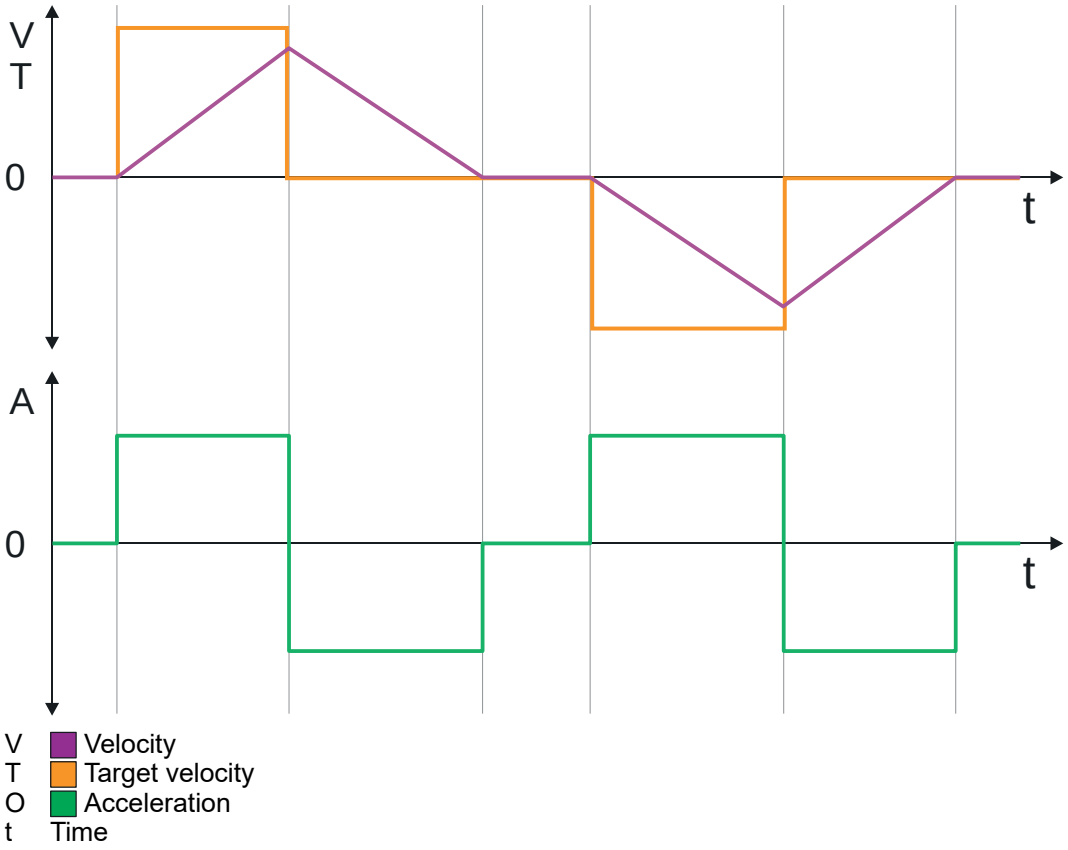
- Setting
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.



V Velocity
T Target velocity
O Acceleration
t Time

Symmetrical acceleration and deceleration without reaching the target velocity

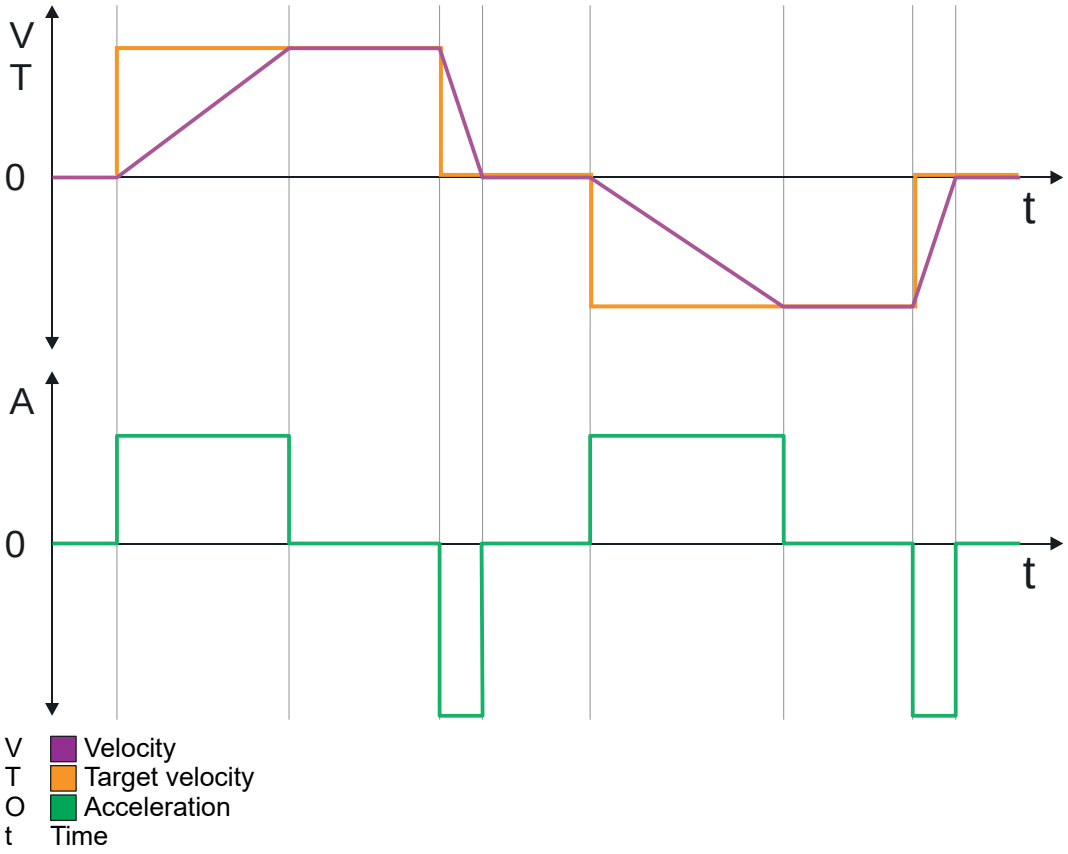
- Setting
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is not reached, since before deceleration is initiated.



V Velocity
T Target velocity
O Acceleration
t Time

Asymmetrical acceleration and deceleration with reaching the target velocity

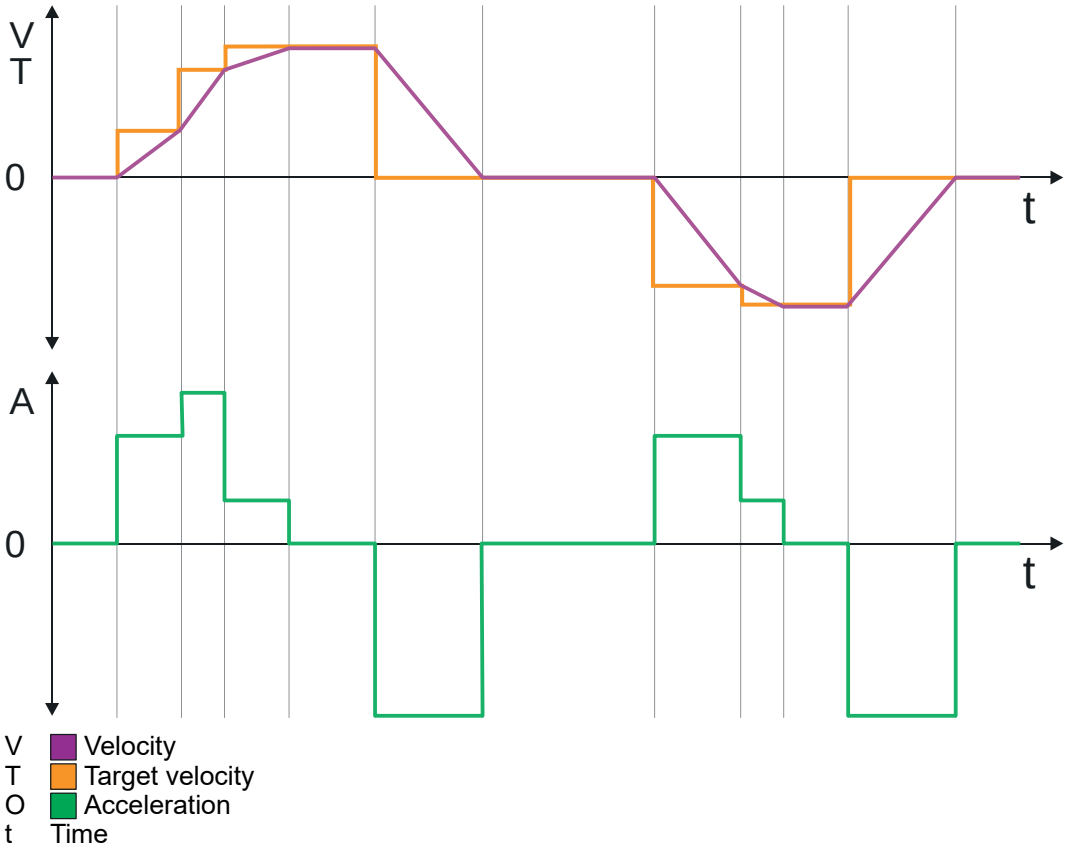
- Setting
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.



V Velocity
T Target velocity
O Acceleration
t Time

Asymmetrical acceleration and deceleration with reducing the acceleration during the move

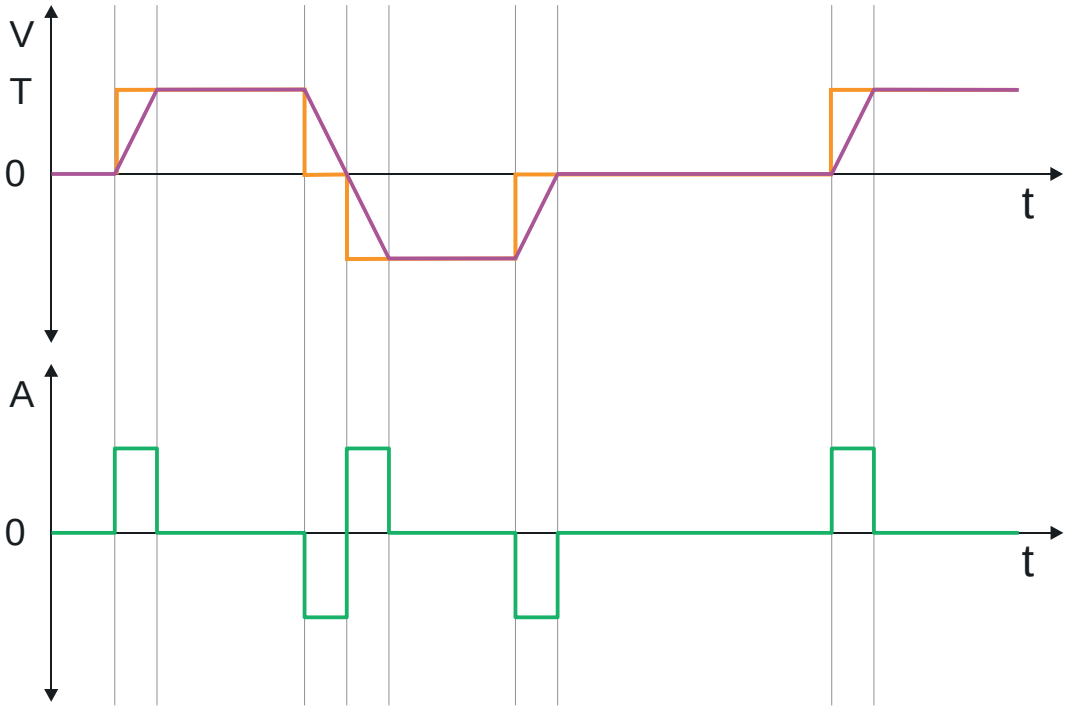
- Setting
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.



V Velocity
T Target velocity
O Acceleration
t Time

Symmetrical acceleration and deceleration with reaching the target velocity

- Setting
  - Profile velocity
  - Profile acceleration
  - Profile deceleration
- Target velocity is reached.



V Velocity
T Target velocity
O Acceleration
t Time

4.8 Torque control

Overview

> ***Always adapt parameters to the operating mode!***
>
> *Please ensure that the module always has the correct parameters according to the selected operating mode! Pay special attention to the use of the start parameters and the current values in the output area!*
> *'In-/Output area'...page 115*

In the operating mode *Torque control* a current set value *'0x8600-03 - Current target value'...page 162* is output to the drive. If the actual current exceeds the permissible motor current, there is an error reaction of the motion module, which can be configured. Also you can set with *'0x8500-07 - Velocity control limit type for torque mode'...page 160* how the motor behaves when reaching the permissible motor current.

- Changes in acceleration respectively deceleration are directly used with the profile generation.
- Current values of velocity, acceleration and deceleration are calculated by the System SLIO motion module itself.
- In torque control mode, the System SLIO motion module operates in controlled operation with closed loop for torque control mode. The following encoder configuration is supported:
  - *'Closed loop'...page 95*

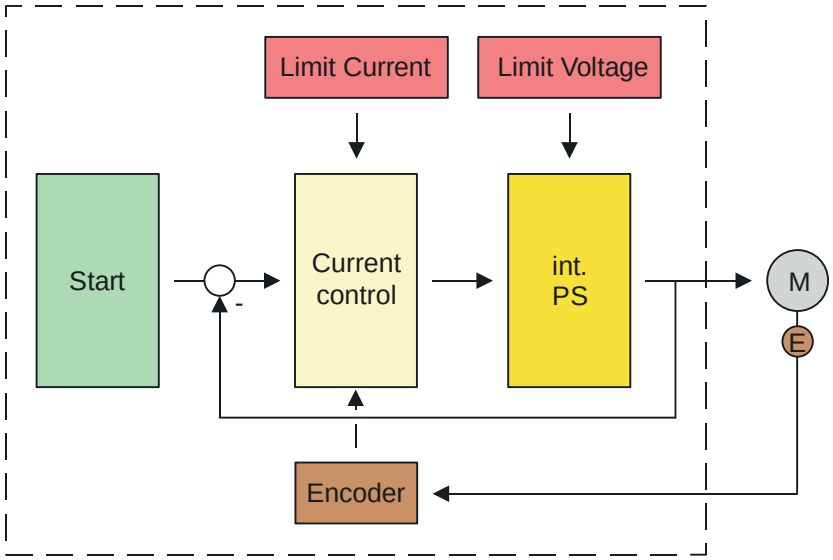
4.8.1 Closed loop

Functionality

Closed loop | Torque control	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 10: Torque control
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC)
'0x8600-03 - Current target value'...page 162	Current target value
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

- The System SLIO module works in controlled mode.
- The encoder signal is used for the control.
- The setpoint for the current controller must be specified. *'0x8600-03 - Current target value'...page 162*
- An encoder value is output.
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

Structure



Start: Start parameters
Limit Current: Limitation current
Limit Voltage: Limitation voltage
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - Start parameter torque control

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 10: Torque control (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	Current control Current controller
'0x8600-03 - Current target value'...page 162				
'0x8500-06 - Velocity control range for torque limit'...page 160				
'0x8500-07 - Velocity control limit type for torque mode'...page 160				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 3: Closed loop				

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168	→	Limit Current	→	Current control Current controller
'0x8600-04 - Current limit'...page 162				

Current control - Current controller

Limit Current Limitation current	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162*
'0x8480-02 - Position actual value'...page 155 Encoder value				
Start				
'0x8600-06 - Current control P-part'...page 163				
'0x8600-07 - Current control I-part'...page 163				
'0x8600-09 - Current control filter factor '...page 163				

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

4.9 Cyclic synchronous positioning

Overview

Always adapt parameters to the operating mode!

Please ensure that the module always has the correct parameters according to the selected operating mode! Pay special attention to the use of the start parameters and the current values in the output area!
'In-/Output area'...page 115

With *Cyclic synchronous positioning*, a target position is specified by the head station in a fixed clock cycle with a minimum period of 1ms via a sync signal. The motion module can be operated cyclic synchronous with periods of 1ms, 2ms, 4ms, 8ms, 16ms and 32ms. If a deviating period duration is detected, the motion module switches to the error state with the error code 0xF044 "SYNC period invalid" *'Error reaction'...page 122*. Since the motion module, for example, performs positioning at a period of 1ms in a 125µs cycle, interpolation results in 8 partial steps for approaching the target position. This smoothes the curve to the target position. The PtP position profile generator is disabled. The limit values for the velocity and maximum drive position are taken into account.

- With cyclic synchronous positioning, you can specify the position directly via *'0x8480-03 - Target position'...page 155* or via the dynamically assigned word 4 in the output area.
- Deceleration and direction reversal is performed automatically when a new target position requires a direction reversal. A separated activation by starting the job in the control word is not necessary.
- If a limitation becomes active during the traversing, this is indicated via the status word. *'0x8100-02 - Status word'...page 138*.
- Depending on the set encoder feedback, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed positioning control loop. Here a distinction is made between the following encoder configurations:
  - *'Open loop'...page 99*
  - *'Closed loop'...page 101*

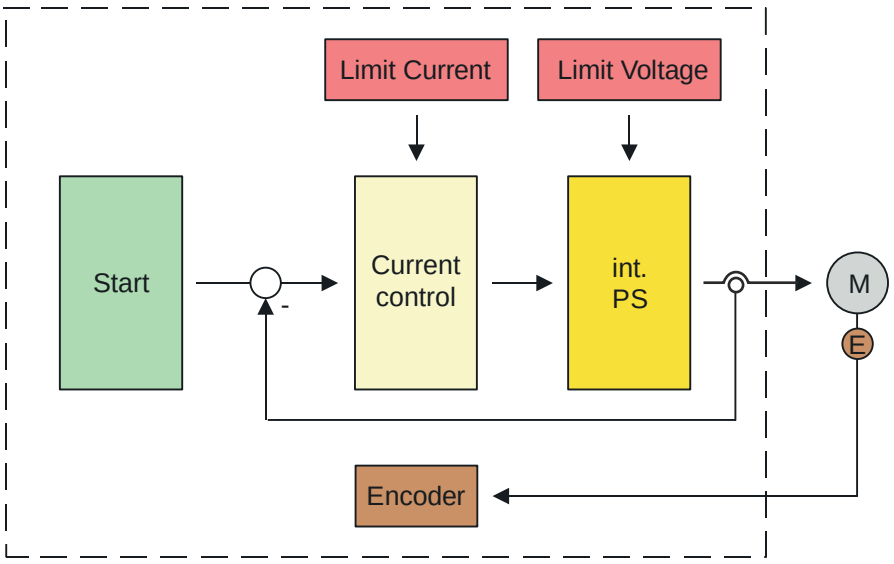
4.9.1 Open loop

Functionality

Open loop | Cycle synchronous positioning	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 8: Cycle synchronous positioning
'0x8F00-01 - Encoder feedback configuration'...page 171	Open loop ■ 0: Encoder value is 0 (fix). ■ 1: Encoder value is output in *'0x8F00-02 - Encoder actual value'...page 172*.
'0x8480-03 - Target position'...page 155	Specification of the target position. The specification can also be made via the dynamically assigned word 4 in the output area. *'In-/Output area'...page 115*
'0x8F00-02 - Encoder actual value'...page 172	The shown value depends on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*

- The System SLIO module operates in controlled mode.
- The encoder signal is not used for the control.
- The setpoint for the current controller is generated by interpolation of the cyclic-synchronously specified target position.
- The actual position corresponds to the interpolated position value.
- Depending on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*, an encoder value is output.
- *'Open loop'...page 110*

Structure



Start: Start parameters
Limit Current: Limitation current
Limit Voltage: Limitation voltage
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - start parameters cycle synchronous positioning

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 8: Cycle synchronous positioning (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	Current control Current controller *'0x8480-02 - Position actual value'...page 155* Encoder value *'0x8480-10 - Lag error'...page 157*
'0x8480-03 - Target position'...page 155				
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 0: Open Loop (without encoder current value) 1: Open loop (with encoder current value)				

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168	→	Limit Current	→	Current control Current controller
'0x8600-04 - Current limit'...page 162				

Current control - Current controller

Limit Current Limitation current	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163*
Start				
'0x8600-03 - Current target value'...page 162				
'0x8600-06 - Current control P-part'...page 163				
'0x8600-07 - Current control I-part'...page 163				
'0x8600-09 - Current control filter factor '...page 163				

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder[1] *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

1) Only if *'0x8F00-01 - Encoder feedback configuration'...page 171* is configured with 1, otherwise 0 is output.

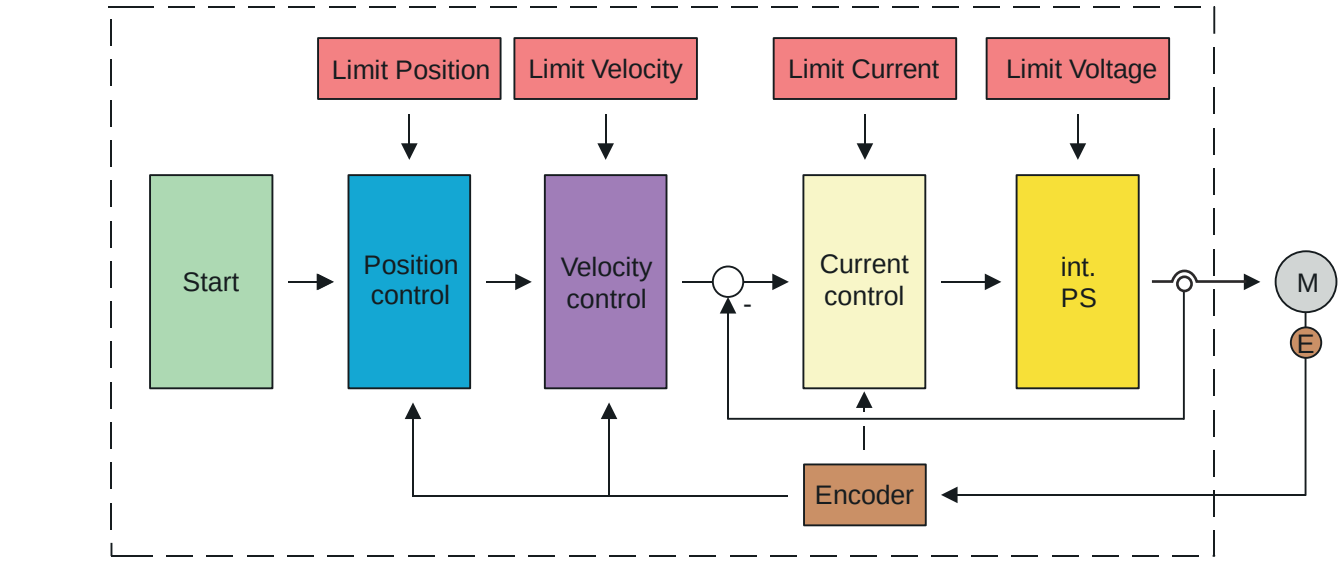
4.9.2 Closed loop

Functionality

Closed loop | Cycle synchronous positioning	
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 8: Cycle synchronous positioning
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC) *'Closed Loop - Field-oriented control (FOC)'...page 113*
'0x8480-03 - Target position'...page 155	Specification of the target position. The specification can also be made via the dynamically assigned word 4 in the output area. *'In-/Output area'...page 115*
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

- The System SLIO module works in controlled mode using a cascaded controller structure.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level control loop.
- The actual position corresponds to the value of the encoder normalized to the position.
- An encoder value is output.
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

Structure



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage
Position control: Position controller
Velocity control: Speed controller
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Start - start parameters cycle synchronous positioning

Please note:

- *'Commissioning'...page 53*
- *'Application data'...page 60*

'0x8280-01 - Operating mode requested'...page 149 8: Cycle synchronous positioning (*'0x8280-02 - Operating mode actual'...page 150*)	→	Start	→	Position control Position controller
'0x8480-03 - Target position'...page 155				
'0x8400-03 - Positioning profile target velocity'...page 154				
'0x8400-04 - Positioning profile target acceleration'...page 154				
'0x8400-05 - Positioning profile target deceleration'...page 154				
'0x8600-04 - Current limit'...page 162				
'0x8C00-04 - Motor max. current'...page 168				
'0x8F00-01 - Encoder feedback configuration'...page 171 3: Closed loop				

Limit Position - Limitation position

'0x8480-05 - Software position limit positive direction'...page 155 *'0x8480-06 - Software position limit negative direction'...page 156* *'0x8480-07 - Range limit positive direction'...page 156* *'0x8480-08 - Range limit negative direction'...page 156* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Position	→	Position control Position controller

Position control - Position controller

Limit Position Limitation position *'0x8480-02 - Position actual value'...page 155* Encoder value Start *'0x8480-09 - In-position window'...page 157* *'0x8480-13 - Position control P-part'...page 158* *'0x8480-14 - Position control I-part'...page 158* *'0x8480-15 - Position control D-part'...page 158* *'0x8F00-02 - Encoder actual value'...page 172*	→	Position control	→	Velocity control Speed controller

Vel - velocity profile

Position control Position controller	→	Vel	→	Velocity control Speed controller

Limit Velocity - Limitation velocity

'0x8500-04 - Velocity control limit positive direction'...page 159 *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8580-04 - Acceleration limit'...page 161* *'0x8580-06 - Deceleration limit'...page 161*	→	Limit Velocity	→	Velocity control Speed controller

Velocity control - Speed controller

Limit Velocity Limitation velocity *'0x8480-02 - Position actual value'...page 155* Encoder value Position control Position controller *'0x8500-01 - Velocity control configuration'...page 159* *'0x8500-03 - Velocity control target value'...page 159* *'0x8500-11 - Velocity control P-part'...page 160* *'0x8580-03 - Deceleration quick stop value'...page 161* *'0x8F00-01 - Encoder feedback configuration'...page 171*	→	Velocity control	→	Current control Current controller *'0x8480-10 - Lag error'...page 157*

Limit Current - Limitation current

'0x8C00-04 - Motor max. current'...page 168 *'0x8600-04 - Current limit'...page 162*	→	Limit Current	→	Current control Current controller

Current control - Current controller

Limit Current Limitation current *'0x8480-02 - Position actual value'...page 155* Encoder value Velocity control Speed controller *'0x8600-03 - Current target value'...page 162* *'0x8600-06 - Current control P-part'...page 163* *'0x8600-07 - Current control I-part'...page 163* *'0x8600-09 - Current control filter factor '...page 163*	→	Current control	→	int. PS internal power stage *'0x8600-02 - Current actual value'...page 162* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163* *'0x8600-12 - Current target value winding A'...page 163* *'0x8600-13 - Current target value winding B'...page 164*

Limit Voltage - Limitation voltage

'0x8680-04 - Power section supply voltage min. warning level'...page 164 *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165*	→	Limit Voltage	→	int. PS internal power stage

int. PS - Internal power stage, motor, encoder

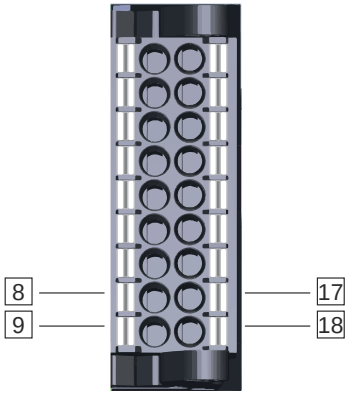
Limit Voltage Limitation voltage	→	int. PS	→	Motor Encoder *'0x8F00-02 - Encoder actual value'...page 172* *'0x8680-02 - Power section supply voltage actual value'...page 164*
Current control Current controller *'0x8600-02 - Current actual value'...page 162*				

4.10 Deployment DIO

Overview

The module has 4 digital connections with the following assignment:

- Digital input
- Digital output

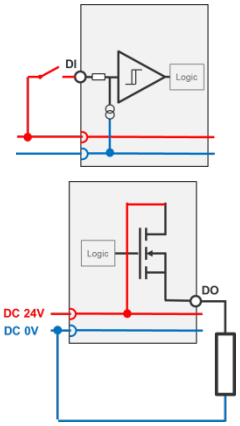


Pos.	Function	Type	Description
8	DI 1	I	Digital input 1
9	DO	O	Digital output

Pos.	Function	Type	Description
17	DI 2	I	Digital input 2
18	DI 3	I	Digital input 3

I: Input, O: Output

Connections



Digital input: DC 24V
IEC 61131-2 type 3
Low-side (sink)

Digital output: DC 24V
500 mA
High-side (source)

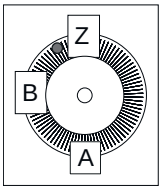
Objects

'0x7100-05 - Status digital input DI1...DI3'...page 136
'0x7200-05 - Digital output state DO actual state'...page 136
'0x7200-06 - Status digital output DO target value'...page 136

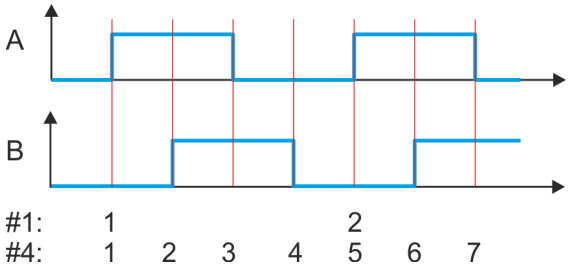
4.11 Deployment Encoder

4.11.1 Encoder - signal evaluation

Evaluation



- Encoder or incremental encoder are sensors for detecting angular or positional changes.
- Depending on the sensor type and the requested resolution, the scanning happens photo electrically or magnetically.
  - With the *optical scanning* a disk, which has a fine raster, is optically scanned.
  - With the magnetic scanning a pole wheel or magnetic band is scanned which has been written with a raster by a magnetization, before.
- The incremental encoder has two sensors *Track A* and *Track B* for scanning and one sensor *Track Z*. The optional *Track Z* emits exactly one pulse per revolution when passing the encoder zero position.
- The sensors are arranged at an angle of 90 degrees from each other on the system to be scanned.
- In a rotational movement of the system, the sensors *Track A* und *Track B* generate a specific number of pulses. These are a measure of the covered angel or way. With the electrical phase shift of the two signals the direction of rotation can be determined.
  - If the axis rotates to the right, then the signal of *Track A* is leading 90° towards the signal of *Track B*.
  - If the axis rotates to the left, then the signal of *Track A* is lagging 90° towards the signal of *Track B*.
- During the sensor evaluation from the difference between two counter values the velocity and direction can be determined.
- With *1-fold* evaluation one signal edge 0-1 of *Track A* corresponds to one counter pulse respectively one division of the system to be scanned corresponds to one counter pulse.
- With *4-fold* evaluation one signal edge of *Track A* and *Track B* corresponds to one counter pulse. The 4-fold evaluation is very often used.

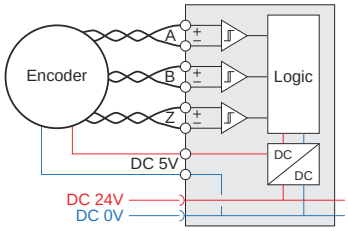


#1 1-fold evaluation
#4 4-fold evaluation

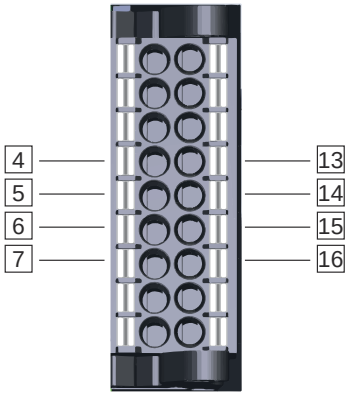
4.11.2 Encoder - connection

Connecting an encoder

There is the possibility to connect an encoder via the encoder inputs. You can retrieve the encoder value and process it accordingly in your user program. In *Closed Loop* respectively *Pseudo Closed Loop* mode the encoder value is directly included in the control.



Encoder: 5V TTL signal (differentially)
Phase A, B and Z
max. 50kHz
4-fold evaluation



Pos.	Designation	Type	Description
4	ENC5V	O	Encoder power supply 5V
5	ENC+A	I	Encoder input +A (5V/TTL)
6	ENC+B	I	Encoder input +B (5V/TTL)
7	ENC+Z	I	Encoder input +Z (5V/TTL)

Pos.	Designation	Type	Description
13	ENC0V	O	Encoder power supply GND
14	ENC-A	I	Encoder input -A (5V/TTL)
15	ENC-B	I	Encoder input -B (5V/TTL)
16	ENC-Z	I	Encoder input -Z (5V/TTL)
I: Input, O: Output			

You can also connect an encoder with single-ended outputs by connecting the lines of the encoder to +A, +B and +Z. Here the connections -A, -B and -Z remain free.

4.11.3 Encoder configurations

Operating modes

Depending on the set *'0x8F00-01 - Encoder feedback configuration'...page 171*, the System SLIO motion module works in controlled respectively closed loop operation with open respectively closed loop control system. Here a distinction is made between the following encoder configurations:

- *'Open loop'...page 110*
- *'Pseudo closed loop'...page 111*
- *'Closed Loop - Field-oriented control (FOC)'...page 113*

The following motion profiles according to the device profile CiA 402 are available:

- *'Homing'...page 61*
- *'Commutation finding'...page 114*
- *'PtP positioning profile'...page 65*
- *'Velocity profile'...page 83*
- *'Torque control'...page 94*
- *'Cyclic synchronous positioning'...page 98*

Combination possibilities

Open loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8)	
'0x8F00-01 - Encoder feedback configuration'...page 171	0: Open loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6 or 8
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8F00-02 - Encoder actual value'...page 172	0 (fix)

Open loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8)	
'0x8F00-01 - Encoder feedback configuration'...page 171	1: Open loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6 or 8
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

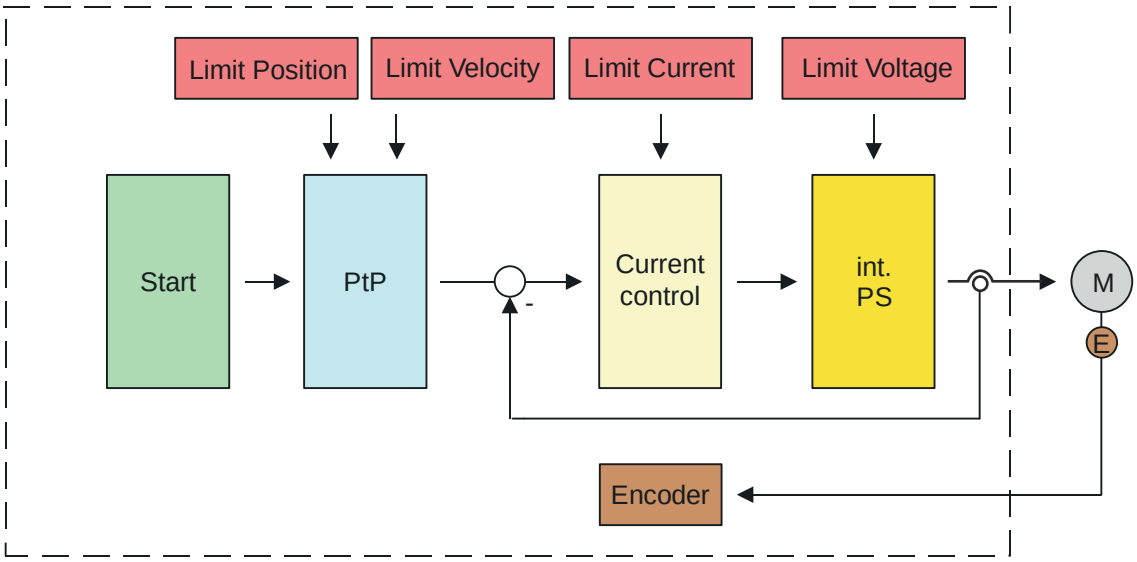
Pseudo closed loop | PtP positioning profile (1), Homing (6)	
'0x8F00-01 - Encoder feedback configuration'...page 171	5: Pseudo closed loop
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1 or 6
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

Closed loop | PtP positioning profile (1), Velocity profile (3), Homing (6), Cycle synchronous positioning (8), Torque control (10), Commutation finding (15)	
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC)
'0x8280-01 - Operating mode requested'...page 149	Operating mode: 1, 3, 6, 8, 10 or 15
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalized to position.
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

4.11.3.1 Open loop

Properties

- The System SLIO module operates in controlled mode.
- The encoder signal is not used for the control.
- The setpoint for the current controller is generated by the higher-level profile generator.
- The actual position corresponds to the position value of the profile generator.
- Depending on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*, an encoder value is output.
  - 0: Encoder value is 0 (fix).
  - 1: Encoder value is output in *'0x8F00-02 - Encoder actual value'...page 172*.



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage

PtP: PtP positioning profile
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Functionality

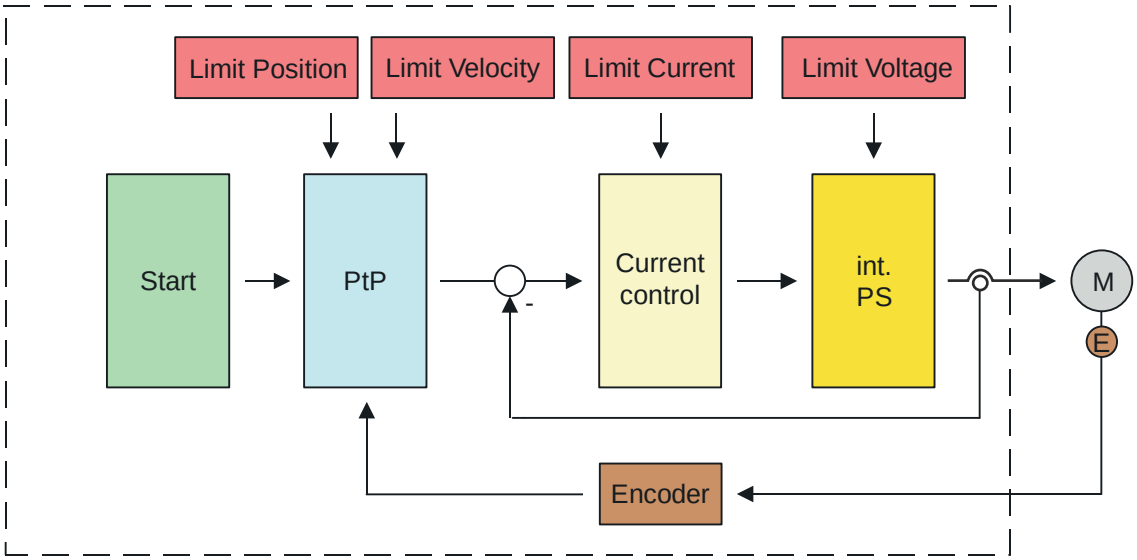
In open loop operating mode, the setpoint for the current controller is generated by the higher-level profile generator. Position and velocity control circuits are not closed and the encoder signal is therefore not evaluated in the control circuits. With open loop, the following objects are used:

Open loop	
'0x8F00-01 - Encoder feedback configuration'...page 171	Open loop ■ 0: Encoder value is 0 (fix). ■ 1: Encoder value is output in *'0x8F00-02 - Encoder actual value'...page 172*.
'0x8480-02 - Position actual value'...page 155	Position value of the profile generator.
'0x8480-03 - Target position'...page 155	Specification of the target position
'0x8F00-02 - Encoder actual value'...page 172	The shown value depends on the setting at *'0x8F00-01 - Encoder feedback configuration'...page 171*

4.11.3.2 Pseudo closed loop

Properties

- The System SLIO module operates in "pseudo" controlled mode.
- The encoder signal is always evaluated at the end of a traverse profile and a position correction is triggered via the profile generator.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level profile generator.
- The actual position corresponds to the value of the encoder normalized to the position.
- An encoder value is output.



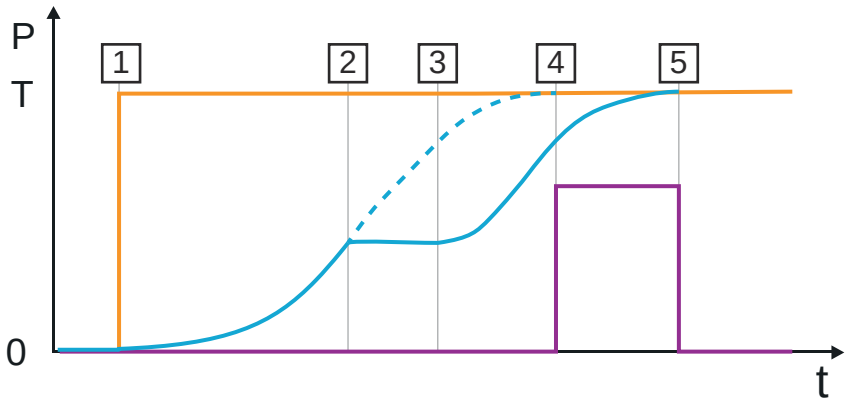
Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage
PtP: PtP positioning profile
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Functionality

In pseudo closed loop operating mode, the setpoint for the current controller is generated by the higher-level profile generator. Position and velocity control circuits are not closed and the encoder signal is therefore not evaluated in the control circuits. In contrast to open loop, in pseudo closed loop the encoder signal is evaluated after the end of a profile process and, if necessary, a position correction is initiated via the profile generator. With pseudo closed loop, the following objects are used:

Pseudo closed loop	
'0x8F00-01 - Encoder feedback configuration'...page 171	5: Setting "Pseudo closed loop"
'0x8100-02 - Status word'...page 138 *'0x8480-09 - In-position window'...page 157*	"Target position reached" bit 10 is set in the status word if the deviation from the setpoint position is less than the configured target window.
'0x8480-10 - Lag error'...page 157	This object can be used to retrieve the deviation between the setpoint and the current value.
'0x8480-11 - Lag error warning'...page 157 *'0x8100-05 - Warnings active bits'...page 142*	You can use this object to specify a limit which, if exceeded, should result in a warning being issued via bit 8.
'0x8480-12 - Lag error error'...page 157 *'0x8100-03 - Error code'...page 139*	You can use this object to specify a limit which, if exceeded, should result in an error to be issued via bit 8. In addition, in the event of an error, the module changes to the error status with positioning error 0x8611.
'0x8100-02 - Status word'...page 138	Bit 12 in status word remains set during the position correction.
'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158	You define the number of correction cycles via this object.

Example



P: Actual position | T: Target position | C: Correction | t: Time line

1: 1. Profile process is started. The drive is free.

2: Profile process continues with stalled drive.

3: Profile process continues. Blockage of the drive is removed again.

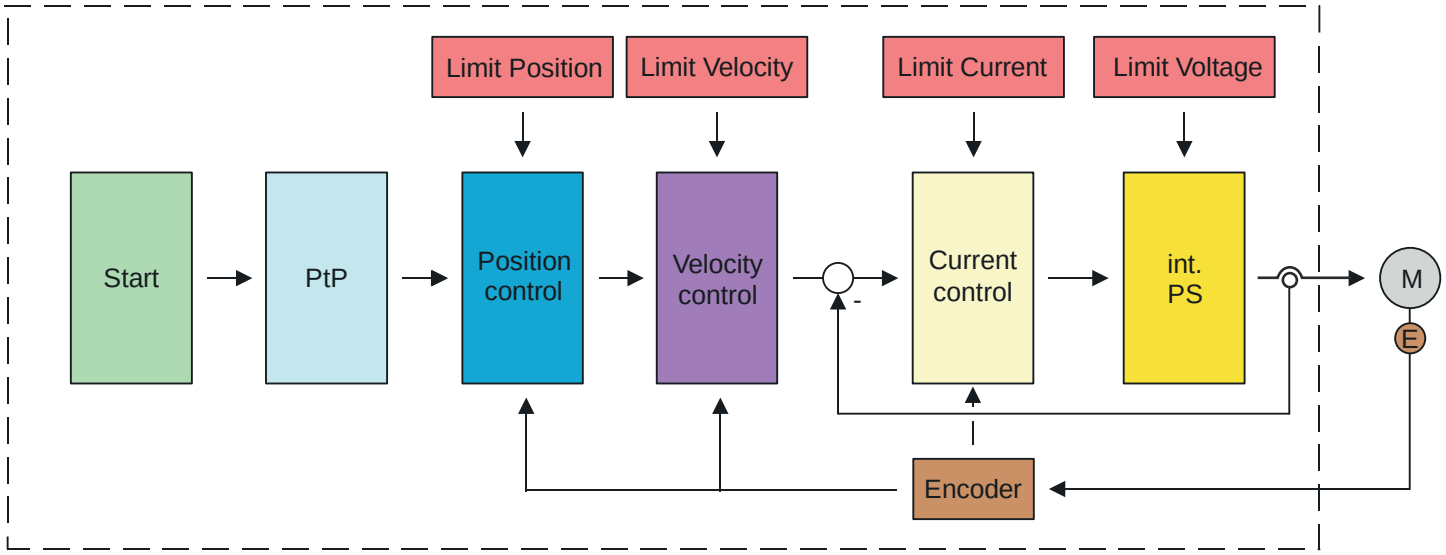
4: Profile process is completed. Due to the high control deviation, the 2nd profile process is started.

5: Actual position corresponds to the target position and profile process is ended.

4.11.3.3 Closed Loop - Field-oriented control (FOC)

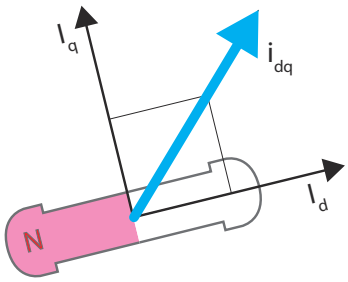
Properties

- The System SLIO module works in controlled mode using a cascaded controller structure.
- The encoder signal is used for the control.
- The setpoint for the current controller is generated by the higher-level control loop.
- The actual position corresponds to the value of the encoder normalized to the position.
- An encoder value is output.



Start: Start parameters
Limit Velocity: Limitation velocity
Limit Position: Limitation position
Limit Current: Limitation current
Limit Voltage: Limitation voltage
PtP: PtP positioning profile
Position control: Position controller
Velocity control: Speed controller
Current control: Current controller
int. PS: Internal power stage
M: Motor
Encoder: Encoder current value

Functionality



The term "closed loop" denotes a closed control circuit. In a closed control circuit, a controlled variable is kept at a set value, despite disruptive factors that influence the system from outside. With a stepper motor, the controller detects the position of the rotor via the signals from the encoder. With field-oriented control, also known as *'vector control'* a drive is controlled via a field-generating and torque-generating component. For the decoupling of both components, a mathematical transformation into a coordinate system takes place, which rotates with the magnetic flux around the rotor axis. With this *'Park transformation'*, the phase currents become two current components, I_d for *'direct'* in field direction and I_q for *'quadrature'* in the torque-forming direction, are calculated from the phase currents. As a result, the alternating variables become stationary direct variables, which means that the motor can be controlled like a DC machine via the torque-forming current variable I_q . The following objects are used with closed loop:

Closed loop	
'0x8F00-01 - Encoder feedback configuration'...page 171	3: Closed loop (FOC)
'0x8480-02 - Position actual value'...page 155	Value of the encoder normalised to position.
'0x8480-03 - Target position'...page 155	Specification of the target position
'0x8F00-02 - Encoder actual value'...page 172	Value of the encoder.

4.11.3.3.1 Commutation finding

Functionality

For field-oriented control, the controller only generates the phase currents in the motor windings that are necessary to compensate for the control deviation. Since the current flow in the stator and rotor is even and an electrical angle of 90° is maintained, you get a maximum controlled torque with reduced ripple. This ensures a smooth-running motor with an even motor power. This can be precisely controlled, even with changing operating conditions. Since an incremental encoder does not provide any absolute values, there is no direct reference to the position of the rotor when the system is started. This reference is to be established when the system is started by means of *Commutation finding*.

Proceeding

- *When using closed loop, a commutation finding must always be done after the system start-up. Otherwise you will get an error message.*
- *During communication finding the motor axis must be able to rotate freely. There must be no counteracting external torque. Activate '0x8D00-04 - Stepper drive free before commutation finding'...page 170 before the commutation finding.*

Under closed loop, an absolute reference between encoder position and pole pitch of the motor is required for control. This reference is established via the *commutation finding*. The *commutation finding* takes place by the following proceeding:

1. For commissioning 'Commissioning'...page 53
2. ■ Switch the state machine to state *'Switch on disabled'* 'States'...page 58
   - Send the command "Disable voltage"
     '0x8100-01 - Control word'...page 137 Bit 3...0: xx0x

   ➡ The motion module shows the state *'Switch on disabled'*.
3. ■ Specify a current setpoint that corresponds to 80% of the nominal motor current. '0x8600-03 - Current target value'...page 162
4. ■ Set the encoder to *closed loop*. '0x8F00-01 - Encoder feedback configuration'...page 171
   - Specify value 3 for *closed loop*.
5. ■ Switch your motion module to the mode *Commutation finding for closed loop*. '0x8280-01 - Operating mode requested'...page 149
   - Specify the value 15.
6. Send the command "Shutdown"

   '0x8100-01 - Control word'...page 137 Bit 3...0: x110

   ➡ The motion module shows the state *'Ready to switch on'*.
7. Send the command "Switch on".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 0111

   ➡ The motion module shows the state *'Switched on'*.
8. Send the command "Enable operation".

   '0x8100-01 - Control word'...page 137 Bit 3...0: 1111

   ➡ The motion module shows the state *'Operation enabled'* and moves 2 full steps and back again. The commutation finding is complete when in '0x8100-02 - Status word'...page 138 bit 10 is set for *'target reached'*. The drive is then ready for position and velocity control. To switch to these operating modes, the state machine must be set to the *'Ready to switch on'* state by means of the *'Shut down'* command. 'States'...page 58

4.12 Brake control

Overview

You can control a brake via the digital output channel. For brake control you have the following possibilities:

- Braking via external brake
- Quick stop via ramping

Braking via external brake

You have the possibility to control a brake via the digital output channel. By integration into your user program, you can control it if necessary.

Quick stop

Quick stop is a ramp function, with which the connected motor can be decelerated and brought to stop. During normal operation it is not necessary to activate this brake functions manually, since normal braking operations are performed by the profile generator. Quick stop is used when the operating conditions require a rapid stopping.

For quick stop there are the following possibilities:

- Direct stop with short-circuit braking and subsequent state change to *'Switch on disabled'*.
- Brake with quick stop deceleration and state change to *'Switch on disabled'*.

Quick stop - objects

'0x8100-01 - Control word'...page 137 *'0x8200-01 - Configuration quick stop'...page 148* *'0x8580-03 - Deceleration quick stop value'...page 161*	→	Quick stop configuration	→	*'0x8100-02 - Status word'...page 138*

4.13 In-/Output area

Input/Output data

The motion module uses 36byte input and 36byte output data.

Head module	Backplane bus	Motion module	
CPU respectively bus coupler	→	Process data	*'Acyclic channel'...page 118*
	←	36byte	

The data exchange with the motion module must be consistent across the 36 bytes! It is therefore only possible to control it via the process image!

Input area

Offset	Size	Area	Description
0	2	Drive	*'0x8100-02 - Status word'...page 138*
2	2	Drive	*'0x8280-02 - Operating mode actual'...page 150*
4	4	Drive	*'0x8480-02 - Position actual value'...page 155*
8	4	Drive	*'0x8500-02 - Velocity control actual value'...page 159*
12	4	Drive	*'0x8580-02 - Acceleration/Deceleration actual value'...page 161*
16	4	Drive	*'0x8480-10 - Lag error'...page 157*
20	2	Drive	*'0x8600-02 - Current actual value'...page 162*
22	2	Encoder	*'0x8F00-02 - Encoder actual value'...page 172*
24	1	DIOs	*'0x7100-05 - Status digital input DI1...DI3'...page 136*
25	1	DIOs	*'0x7200-05 - Digital output state DO actual state'...page 136*
26	1	Acyclic	*'Acyclic channel'...page 118* Status
27	1	Acyclic	*'Acyclic channel'...page 118* Subindex in the object dictionary
28	2	Acyclic	*'Acyclic channel'...page 118* Index in the object dictionary
30	4	Acyclic	*'Acyclic channel'...page 118* Data
34	1	-	reserved
35	1	-	reserved

Output area

Please note if you write via the Acyclic channel to objects, which are mapped in the I/O area, their values will be overwritten again with the next cycle. Therefore, data mapped in the I/O area should not be written via the Acyclic channel!

Offset	Size	Area	Description
0	2	Drive	*'0x8100-01 - Control word'...page 137*
2	2	Drive	*'0x8280-01 - Operating mode requested'...page 149*
4	4	Drive	The assignment depends on the selected *'0x8280-01 - Operating mode requested'...page 149* ■ PtP positioning profile, Velocity profile, Torque control – *'0x8400-02 - Positioning profile target position'...page 154* ■ Cyclic synchronous positioning – *'0x8480-03 - Target position'...page 155*
8	4	Drive	*'0x8400-03 - Positioning profile target velocity'...page 154*
12	4	Drive	*'0x8400-04 - Positioning profile target acceleration'...page 154*
16	4	Drive	*'0x8400-05 - Positioning profile target deceleration'...page 154*
20	2	Drive	The assignment depends on the selected *'0x8F00-01 - Encoder feedback configuration'...page 171*: ■ Encoder functionality: Open loop, pseudo closed loop, closed loop with torque control and closed loop with commutation finding – *'0x8600-03 - Current target value'...page 162*
22	2	-	reserved
24	1	-	reserved
25	1	Drive	*'0x7200-06 - Status digital output DO target value'...page 136*
26	1	Acyclic	*'Acyclic channel'...page 118* Command
27	1	Acyclic	*'Acyclic channel'...page 118* Subindex in the object dictionary
28	2	Acyclic	*'Acyclic channel'...page 118* Index in the object dictionary
30	4	Acyclic	*'Acyclic channel'...page 118* Data
34	1	-	reserved
35	1	-	reserved

4.14 Acyclic channel

Overview

Please note if you write via the Acyclic channel to objects, which are mapped in the I/O area, their values will be overwritten again with the next cycle. Therefore, data mapped in the I/O area should not be written via the Acyclic channel!

Via the *Acyclic channel* you can perform acyclic read and write commands. For this in the input/output area of the motion module a data area for the acyclic communication has been implemented. This area includes 8 bytes output and 8 bytes input data. These have the following assignment:

Request		Response
Output data ■ Byte 0: CMD - Command ■ Byte 1: SUBIDX - Subindex ■ Byte 2: IDX0 - Index (low byte) ■ Byte 3: IDX1 - Index (high byte) ■ Byte 4: DATA0 - Data (low byte) ■ Byte 5: DATA1 - Data ■ Byte 6: DATA2 - Data ■ Byte 7: DATA3 - Data (high byte)	→ ←	Input data ■ Byte 0: STATUS - Status ■ Byte 1: SUBIDX - Subindex ■ Byte 2: IDX0 - Index (low byte) ■ Byte 3: IDX1 - Index (high byte) ■ Byte 4: DATA0 - Data (low byte) ■ Byte 5: DATA1 - Data ■ Byte 6: DATA2 - Data ■ Byte 7: DATA3 - Data (high byte)

CMD:	IDLE →		Command →		IDLE →	
STATUS:		← IDLE		← Command		← IDLE

CMD - Command

Code	Name	Description
0x00	IDLE	Set idle With this command you can request the waiting state for a new command after the command execution was reported by STATUS.
0x11	READ_ONCE	Reading a data object With this command you can request the data once after the command has been recognized.
0x21	WRITE_ONCE	Writing a data object With this command data are written only once after the command has been recognized.

SUBIDX - Subindex Subindex in the object dictionary

IDX0/IDX1 - Index Index in the object dictionary

DATA0 ... DATA3 - Data Data which are to be transmitted.

STATUS - Status

Code	Name	Description
0x00	IDLE	Idle - waiting for commands
0x14	READ_ONCE	Command READ_ONCE has been recognized, data are valid.
0x24	WRITE_ONCE	Command WRITE_ONCE has been recognized, data were accepted.
0x81:	READ_NOT_EXIST	Error - read access - data do not exist Command rejected!
0x91	WRITE_NOT_EXIST	Error - write access - data do not exist Command rejected!
0x92	WRITE_RNG_ERR	Error - write access - data out of range Command rejected!
0x93	WRITE_RDO_ERR	Error - write access - data can only be read Command rejected!
0x94	WRITE_WPR_ERR	Error - write access - data are write protected Command rejected!
0x99	ACYC_COM_ERR	Error during acyclic communication Command rejected!

For the Yaskawa *SPEED7 Studio* and the Siemens SIMATIC Manager there is the block FB 320 ACYC_RW for simplified access available.

More information about the usage of this block may be found in the manual "SPEED7 Operation List".

4.15 Scaling and units

Scaling and units

- Stepper motors rotate in a pulse by a defined angle.
- As a "normalization" for position, velocity and acceleration, you can specify a *Gear factor* *'0x8180-02 - Gear factor'...page 147* in the object dictionary. This gear factor represents *units* in thousands with the rotary axis makes exactly one revolution.

Direction of rotation

Positive direction of rotation is turning to the right (clockwise) with view towards the motor axis.

Current unit

- All currents are normalized to the unit [mA].

4.16 Parameter data

DS Record set for access via CPU, PROFIBUS and PROFINET

IX Index for access via CANopen

SX Subindex for access via EtherCAT with Index 3100h + EtherCAT-Slot

More can be found in the according manual of your bus coupler.

Name	Bytes	Function	Default	DS	IX	SX
DIAG_EN	1	Diagnostic interrupt[1]	00h	00h	3100h	01h
IDX_1	2	Universal parameter 1: Index	00h	80h	3101h ... 3102h	02h
SUBIDX_1	2	Universal parameter 1: Subindex	00h	80h	3103h ... 3104h	03h
DATA_1	4	Universal parameter 1: Value	00h	80h	3105h ... 3108h	04h
IDX_2	2	Universal parameter 2: Index	00h	81h	3109h ... 310Ah	05h
SUBIDX_2	2	Universal parameter 2: Subindex	00h	81h	310Bh ... 310Ch	06h
DATA_2	4	Universal parameter 2: Value	00h	81h	310Dh ... 3110h	07h
IDX_3	2	Universal parameter 3: Index	00h	82h	3111h ... 3112h	08h
SUBIDX_3	2	Universal parameter 3: Subindex	00h	82h	3113h ... 3114h	09h
DATA_3	4	Universal parameter 3: Value	00h	82h	3115h ... 3118h	0Ah
IDX_4	2	Universal parameter 4: Index	00h	83h	3119h ... 311Ah	0Bh
SUBIDX_4	2	Universal parameter 4: Subindex	00h	83h	311Bh ... 311Ch	0Ch
DATA_4	4	Universal parameter 4: Value	00h	83h	311Dh ... 3120h	0Dh
IDX_5	2	Universal parameter 5: Index	00h	84h	3121h ... 3122h	0Eh
SUBIDX_5	2	Universal parameter 5: Subindex	00h	84h	3123h ... 3124h	0Fh
DATA_5	4	Universal parameter 5: Value	00h	84h	3125h ... 3128h	10h
IDX_6	2	Universal parameter 6: Index	00h	85h	3129h ... 312Ah	11h
SUBIDX_6	2	Universal parameter 6: Subindex	00h	85h	312Bh ... 312Ch	12h
DATA_6	4	Universal parameter 6: Value	00h	85h	312Dh ... 3130h	13h
IDX_7	2	Universal parameter 7: Index	00h	86h	3131h ... 3132h	14h
SUBIDX_7	2	Universal parameter 7: Subindex	00h	86h	3133h ... 3134h	15h
DATA_7	4	Universal parameter 7: Value	00h	86h	3135h ... 3138h	16h

1) This record set may only be transferred at STOP state.

For the *SPEED7 Studio* and the Siemens SIMATIC Manager there is the block FB 321 - ACYC_DS for simplified access available.

More information about the usage of this block may be found in the manual "SPEED7 Operation List".

4.17 Monitoring and error reaction

4.17.1 Overview

General

The System SLIO motion module has monitor functions. The monitoring works in 3 steps:

- 1. Limitation
  - Status: *'0x8100-04 - Limit active bits'...page 141*
  - Limitations within the normal operating range, adapted to the respective application.
- 2. Warning
  - Status: *'0x8100-05 - Warnings active bits'...page 142*
  - The permissible operating range is almost exhausted and the system is about to initiate a fault response.
- 3. Error
  - Status: *'0x8100-06 - Error active bits'...page 143*
  - The permissible operating range is exceeded and a configurable fault response is automatically triggered.
  - Error messages are also shown via *'0x8100-02 - Status word'...page 138*.

CAUTION

Please consider that incorrectly set monitoring functions can cause damages to persons and materials!

Voltage monitoring

The DC 48V voltage of the motor supply is monitored. If the voltage over or under runs the limit values, a warning or error is reported by *'0x8100-02 - Status word'...page 138*. On an error, there is an error reaction of the motion module, which can be configured.

Temperature monitoring

The motion module has an internal temperature monitoring of the µ-controller and the power stage. Via the object dictionary limit temperatures can be defined. If the temperature over or under runs the limit values, there is an error reaction of the motion module, which can be configured.

Current monitoring

The by the power stages driven current *'0x8600-03 - Current target value'...page 162* in the windings of the motor is monitored. The target current is limited to a configurable value *'0x8600-04 - Current limit'...page 162* and with active limitation reported via *'0x8100-02 - Status word'...page 138*. If the actual current exceeds the permissible motor current *'0x8C00-04 - Motor max. current'...page 168*, there is an error reaction of the motion module, which can be configured.

Position monitoring

The motion module monitors the traversing of a positioning. When specifying a target position, with exceeding a configurable limit in positive or negative direction of movement, the target position changed to a limit value. You will get a feedback on an active limitation via *'0x8100-02 - Status word'...page 138*.

Velocity monitoring

The motion module monitors the velocity. The set velocity is limited to a configurable value and with active limitation reported via *'0x8100-02 - Status word'...page 138*.

Error reaction

On error, the motion module starts an error reaction. The error reaction can be configured *'0x8200-05 - Configuration fault reaction'...page 148*. Here you have the following possibilities:

- Immediate state change to *'Switch on disabled'*.
- Break with quick stop deceleration *'0x8580-03 - Deceleration quick stop value'...page 161* and subsequent state change to *'Switch on disabled'*.

With edge 0-1 of '0x8100-01 - Control word'...page 137 bit 7 you can reset the error bits.

Below are all the errors that can trigger an error reaction:

Error code	Description
0x2310	Winding overcurrent *'0x8600-10 - Current actual value winding A'...page 163* or *'0x8600-11 - Current actual value winding B'...page 163* is greater than *'0x8C00-04 - Motor max. current'...page 168* *'0x8100-06 - Error active bits'...page 143* Bit: 0
0x2340	Short-circuit in motor *'Connections'...page 41* *'0x8100-06 - Error active bits'...page 143* Bit: 1
0x3210	Power section supply overvoltage *'0x8680-07 - Power section supply voltage max. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 17
0x3220	Power section supply undervoltage *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 16
0x3240	24V monitoring configuration error *'0x2017-05 - Hardware property'...page 134* *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 14
0x3250	24V monitoring undervoltage *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 15
0x4310	Temperature µ-controller exceeded *'0x8780-04 - Temperature µ-Controller error level'...page 166* *'0x8100-06 - Error active bits'...page 143* Bit: 12
0x4311	Temperature power stage exceeded *'0x8780-09 -Temperature power stage error level'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 13
0x8400	Error in velocity control - please check you parameters. *'Velocity profile'...page 83* *'0x8100-06 - Error active bits'...page 143* Bit: 4

Error code	Description
0x8611	Error in position control - please check you parameters. *'PtP positioning profile'...page 65* *'0x8100-06 - Error active bits'...page 143* Bit: 8
0x8612	Error in position control with pseudo closed loop - number of correction cycles reached with existing position deviation. *'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158* *'0x8100-06 - Error active bits'...page 143* Bit: 9
0xF001	Encoder feedback not configured under closed loop - configure the encoder feedback *'0x8F00-01 - Encoder feedback configuration'...page 171* *'0x8100-06 - Error active bits'...page 143* Bit: 20
0xF002	No commutation finding under closed loop after restart - perform a commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 25
0xF003	No movement possible during commutation finding. Activate *'0x8D00-04 - Stepper drive free before commutation finding'...page 170* before the commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 26
0xF010	System communication timeout *'0x6100-10 - System message timeout maximum'...page 135* *'0x8100-06 - Error active bits'...page 143* Bit: 22
0xF011	Command output disable (BASP) is active. *'0x8100-06 - Error active bits'...page 143* Bit: 23
0xF020	Error operation mode is not supported. *'0x8280-01 - Operating mode requested'...page 149* *'0x8100-06 - Error active bits'...page 143* Bit: 24
0xF040	Max. error level missing SYNC signals reached. *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 27
0xF044	SYNC period invalid The cyclic synchronous period set in the head module is not supported by the motion module. The motion module supports the following SYNC periods: 1ms, 2ms, 4ms, 8ms, 16ms and 32ms. *'0x8100-06 - Error active bits'...page 143* Bit: 21
0xF070	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 2
0xF071	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 3
0xF080	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 28
0xF0FF	More than 8 errors occurred. If there are more than 8 errors, 0x8100-15 returns the value 0xF0FF for identification.

4.17.2 Monitoring

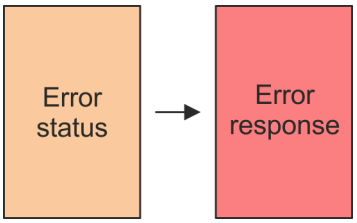
Monitoring limitation

'0x8400-02 - Positioning profile target position'...page 154 *'0x8480-02 - Position actual value'...page 155* *'0x8480-05 - Software position limit positive direction'...page 155* *'0x8480-06 - Software position limit negative direction'...page 156* *'0x8400-03 - Positioning profile target velocity'...page 154* *'0x8500-04 - Velocity control limit positive direction'...page 159* *'0x8500-05 - Velocity control limit negative direction'...page 160* *'0x8600-03 - Current target value'...page 162* *'0x8600-04 - Current limit'...page 162*	→	Monitoring Limitation	→	*'0x8100-04 - Limit active bits'...page 141* *'0x8100-02 - Status word'...page 138*

Monitoring warning

'0x8680-02 - Power section supply voltage actual value'...page 164 *'0x8680-04 - Power section supply voltage min. warning level'...page 164* *'0x8680-05 - Power section supply voltage max. warning level'...page 165* *'0x8780-03 - Temperature µ-Controller warning level'...page 166* *'0x8780-07 - Temperature power stage actual value'...page 166* *'0x8780-08 - Temperature power stage warning level'...page 167* *'0x8480-10 - Lag error'...page 157*	→	Monitoring Warning	→	*'0x8100-05 - Warnings active bits'...page 142* *'0x8100-02 - Status word'...page 138*

Monitoring errors



Error status - Monitoring errors

'0x8680-02 - Power section supply voltage actual value'...page 164 *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8680-07 - Power section supply voltage max. error level'...page 165* *'0x8780-02 - Temperature µ-Controller actual value'...page 166* *'0x8780-04 - Temperature µ-Controller error level'...page 166* *'0x8780-07 - Temperature power stage actual value'...page 166* *'0x8780-09 -Temperature power stage error level'...page 167* *'0x8480-10 - Lag error'...page 157* *'0x8480-12 - Lag error error'...page 157* *'0x8500-02 - Velocity control actual value'...page 159* *'0x8600-10 - Current actual value winding A'...page 163* *'0x8600-11 - Current actual value winding B'...page 163* *'0x8C00-04 - Motor max. current'...page 168*	→	Error status Monitoring errors	→	Error response Error reaction *'0x8100-06 - Error active bits'...page 143* *'0x8100-03 - Error code'...page 139* *'0x8100-07 - number of error entries'...page 144* *'0x8100-08 ... 15 - Error code - Error entry 1 ... 8'...page 144* *'0x8100-02 - Status word'...page 138*

Error response - error reaction

Error status Monitoring errors *'0x8200-05 - Configuration fault reaction'...page 148* *'0x8580-03 - Deceleration quick stop value'...page 161*	→	Error response Configuration reaction	→	*'0x8100-02 - Status word'...page 138*

4.18 Diagnostics and interrupt

Diagnostics data

Via the parametrization you may activate a diagnostic interrupt for the module. With a diagnostics interrupt the module serves for diagnostics data for diagnostic interrupt$_{incoming}$. As soon as the reason for releasing a diagnostic interrupt is no longer present, the diagnostic interrupt$_{going}$ automatically takes place. Within this time window (1. diagnostic interrupt$_{incoming}$ until last diagnostic interrupt$_{going}$) the MF-LED of the module is on.

DS Record set for access via CPU, PROFIBUS and PROFINET. The access happens by DS 01h. Additionally the first 4 bytes may be accessed by DS 00h.

IX Index for access via CANopen. The access happens by IX 2F01h. Additionally the first 4 bytes may be accessed by IX 2F00h.

SX Subindex for access via EtherCAT with Index 5005h.

More can be found in the according manual of your bus coupler.

Name	Bytes	Function	Default	DS	IX	SX
ERR_A	1	Diagnostic	00h	01h	2F01h	02h
MODTYP	1	Module information	18h			03h
ERR_C	1	reserved	00h			04h
ERR_D	1	reserved	00h			05h
CHTYP	1	Channel type	74h			06h
NUMBIT	1	Number diagnostics bits per channel	01h			07h
NUMCH	1	Number channels of the module	01h			08h
CHERR	1	Channel error	00h			09h
CH0ERR	1	Channel-specific error	00h			0Ah
CH1ERR… CH7ERR	7	reserved	00h			0Bh ... 11h
DIAG_US	4	µs ticker (32bit)	00h			13h

ERR_A Diagnostic

Byte	Bit 7 ... 0
0	■ Bit 0: set at module failure ■ Bit 1: set at internal error ■ Bit 2: set at external error ■ Bit 3: set at channel error ■ Bit 6 ... 4: reserved ■ Bit 7: set at error in parametrization

MODTYP Module information

Byte	Bit 7 ... 0
0	■ Bit 3 ... 0: Module class – 1000b: Function module ■ Bit 4: set at channel information present ■ Bit 7 ... 5: reserved

CHTYP Channel type

Byte	Bit 7 ... 0
0	■ Bit 6 ... 0: Channel type – 74h: Analog in-/output ■ Bit 7: 0 (fix)

NUMBIT Diagnostic bits

Byte	Bit 7 ... 0
0	Number of diagnostic bits per channel (here 01h)

NUMCH Channels

Byte	Bit 7 ... 0
0	Number of channels of a module (here 01h)

CHERR - Channel error

Byte	Bit 7 ... 0
0	■ Bit 0: set with error output DO ■ Bit 1 ... 4: reserved

CH0ERR channel specific

Byte	Bit 7 ... 0
0	Diagnostics interrupt due to ... ■ Bit 2 ... 0: reserved ■ Bit 3: Short circuit ■ Bit 7 ... 4: reserved

DIAG_US µs ticker

Byte	Bit 7 ... 0
0 ... 3	Value µs ticker at the moment of the diagnostic

ERR_C/D, CH1ERR ... CH7ERR reserved

Byte	Bit 7 ... 0
0	reserved

5 Object dictionary

5.1 Use

Addressing

The System SLIO motion module provides its data, such as "Profiling target position" via an object dictionary. In this object dictionary the objects are organized and addressable a unique number consisting of *Index* and *Subindex*. The number is specified as follows:

0x	Index (hexadecimal)	-	Subindex (decimal)
Example: 0x8400-03			

To improve the structure and for expansion at System SLIO Motion Module another object numbering (index-assignment) is used besides the standard CiA 402.

Index area

By separating into *index* and *subindex* a grouping is possible. The individual areas are divided into groups of related objects. With the System SLIO motion module this object directory is structured as follows:

Index area	Content
0x1000 up to 0x6FFF	General data and system data
0x7000 up to 0x7FFF	Data of the digital input and output part
0x8000 up to 0x8FFF	Data of the axis

Each object has a subindex 0. Calling an object with subindex 0, the number of available subindexes of the corresponding object is returned.

Accessing the object dictionary

The communication takes place via the I/O area. The main data of the object dictionary are mapped into the I/O area. *'In-/Output area'...page 115*

Included in the mapping is also the area *'Acyclic channel'...page 118* through which you can acyclically access the objects of the motion module. With the acyclic access, any access to the object dictionary is acknowledged by the motion module.

The mapping cannot be changed.

Please note if you write via the Acyclic channel to objects, which are mapped in the I/O area, their values will be overwritten again with the next cycle. Therefore, data mapped in the I/O area should not be written via the Acyclic channel!

5.2 Objects

5.2.1 Overview

Explanation of the elements

Explanation of the elements

Index-Sub	Index and subindex
Sx	Data type SIGNEDx
Ux	Data type UNSIGNEDx
STG	Data type STRING
RW	Read- write access
[degC]	Temperature in degree celsius (°C)
[inc]	Increment - pulse of an encoder *'Encoder - signal evaluation'...page 107*
[User]	The unit [User] is a user defined unit, which can be set via *'0x8180-02 - Gear factor'...page 147*.
*	Object, which is mapped in the *'In-/Output area'...page 115*. If you write via the *Acyclic channel* to this object, the value is overwritten with the next cycle. *'Acyclic channel'...page 118*
**	Object, which can be written in all states of the state machine. Otherwise objects can only be written in the state *'Switch on disabled'*. *'Accessing the state machine'...page 59* *'Passwords and security - 0x1100'...page 135*

Available objects

'0x1000-00 - Device type'...page 132
'0x1008-00 - Manufacturer device name'...page 133
'0x100A-00 - Manufacturer software version'...page 133
'0x1018-00 - Product - number of entries'...page 133
'0x1018-02 - Product ID'...page 133
'0x1018-03 - Revision number'...page 134
'0x1018-05 - Module category'...page 134
'0x2017-05 - Hardware property'...page 134
'0x2018-01 - Serial number'...page 134
'0x1100-00 - Passwords and security - number of entries'...page 135
'0x1100-01 - Password'...page 135
'0x6100-00 - System command - number of entries'...page 135
'0x6100-10 - System message timeout maximum'...page 135
'0x7100-00 - Digital inputs - number of entries'...page 135
'0x7100-05 - Status digital input DI1...DI3'...page 136
'0x7200-00 - Digital output - number of entries'...page 136
'0x7200-05 - Digital output state DO actual state'...page 136
'0x7200-06 - Status digital output DO target value'...page 136
'0x8100-00 - Control drive - number of entries'...page 137
'0x8100-01 - Control word'...page 137
'0x8100-02 - Status word'...page 138

'0x8100-03 - Error code'...page 139
'0x8100-04 - Limit active bits'...page 141
'0x8100-05 - Warnings active bits'...page 142
'0x8100-06 - Error active bits'...page 143
'0x8100-07 - number of error entries'...page 144
'0x8100-08 ... 15 - Error code - Error entry 1 ... 8'...page 144
'0x8180-00 - Configure drive - number of entries'...page 146
'0x8180-02 - Gear factor'...page 147
'0x8200-00 - Options - number of entries'...page 147
'0x8200-01 - Configuration quick stop'...page 148
'0x8200-05 - Configuration fault reaction'...page 148
'0x8280-00 - Operating mode - number of entries'...page 148
'0x8280-01 - Operating mode requested'...page 149
'0x8280-02 - Operating mode actual'...page 150
'0x8300-00 - Homing - number of entries'...page 150
'0x8300-02 - Homing method'...page 151
'0x8300-03 - Homing digital input DI1…DI3, ENC-Z'...page 151
'0x8300-04 - Homing digital input active polarity DI1…DI3'...page 152
'0x8300-05 - Homing target position'...page 152
'0x8300-06 - Homing velocity V1'...page 152
'0x8300-07 - Homing velocity V2'...page 153
'0x8300-08 - Homing acceleration'...page 153
'0x8300-09 - Homing deceleration'...page 153
'0x8300-10 - Homing offset value'...page 153
'0x8400-00 - Positioning profile - number of entries'...page 153
'0x8400-02 - Positioning profile target position'...page 154
'0x8400-03 - Positioning profile target velocity'...page 154
'0x8400-04 - Positioning profile target acceleration'...page 154
'0x8400-05 - Positioning profile target deceleration'...page 154
'0x8480-00 - Positions and limits - number of entries'...page 155
'0x8480-02 - Position actual value'...page 155
'0x8480-03 - Target position'...page 155
'0x8480-05 - Software position limit positive direction'...page 155
'0x8480-06 - Software position limit negative direction'...page 156
'0x8480-07 - Range limit positive direction'...page 156
'0x8480-08 - Range limit negative direction'...page 156
'0x8480-09 - In-position window'...page 157
'0x8480-10 - Lag error'...page 157
'0x8480-11 - Lag error warning'...page 157
'0x8480-12 - Lag error error'...page 157
'0x8480-13 - Position control P-part'...page 158

'0x8480-14 - Position control I-part'...page 158
'0x8480-15 - Position control D-part'...page 158
'0x8480-16 - Position control shift factor'...page 158
'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158
'0x8500-00 - Velocity - number of entries'...page 159
'0x8500-01 - Velocity control configuration'...page 159
'0x8500-02 - Velocity control actual value'...page 159
'0x8500-03 - Velocity control target value'...page 159
'0x8500-04 - Velocity control limit positive direction'...page 159
'0x8500-05 - Velocity control limit negative direction'...page 160
'0x8500-06 - Velocity control range for torque limit'...page 160
'0x8500-07 - Velocity control limit type for torque mode'...page 160
'0x8500-11 - Velocity control P-part'...page 160
'0x8580-00 - Acceleration and deceleration - number entries'...page 161
'0x8580-02 - Acceleration/Deceleration actual value'...page 161
'0x8580-03 - Deceleration quick stop value'...page 161
'0x8580-04 - Acceleration limit'...page 161
'0x8580-06 - Deceleration limit'...page 161
'0x8600-00 - CUR current number of entries '...page 162
'0x8600-02 - Current actual value'...page 162
'0x8600-03 - Current target value'...page 162
'0x8600-04 - Current limit'...page 162
'0x8600-06 - Current control P-part'...page 163
'0x8600-07 - Current control I-part'...page 163
'0x8600-09 - Current control filter factor '...page 163
'0x8600-10 - Current actual value winding A'...page 163
'0x8600-11 - Current actual value winding B'...page 163
'0x8600-12 - Current target value winding A'...page 163
'0x8600-13 - Current target value winding B'...page 164
'0x8680-00 - Voltages - number of entries'...page 164
'0x8680-01 - Blanking time'...page 164
'0x8680-02 - Power section supply voltage actual value'...page 164
'0x8680-04 - Power section supply voltage min. warning level'...page 164
'0x8680-05 - Power section supply voltage max. warning level'...page 165
'0x8680-06 - Power section supply voltage min. error level'...page 165
'0x8680-07 - Power section supply voltage max. error level'...page 165
'0x8680-08 - 24V monitoring'...page 165
'0x8780-00 - Temperatures - number of entries'...page 166
'0x8780-02 - Temperature µ-Controller actual value'...page 166
'0x8780-03 - Temperature µ-Controller warning level'...page 166
'0x8780-04 - Temperature µ-Controller error level'...page 166

'0x8780-07 - Temperature power stage actual value'...page 166
'0x8780-08 - Temperature power stage warning level'...page 167
'0x8780-09 -Temperature power stage error level'...page 167
'0x8B00-00 - SYNC parameter - number of entries'...page 167
'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167
'0x8B00-02 - SYNC parameter - Error reaction'...page 168
'0x8C00-00 - Motor data - number of entries'...page 168
'0x8C00-04 - Motor max. current'...page 168
'0x8C00-07 - Motor max. velocity'...page 169
'0x8D00-00 - Stepper number of entries'...page 169
'0x8D00-02 - Stepper full steps per revolution'...page 169
'0x8D00-03 - Stepper micro steps per full step'...page 170
'0x8D00-04 - Stepper drive free before commutation finding'...page 170
'0x8D00-05 - Stepper duration per full step at commutation finding'...page 171
'0x8F00-00 - Encoder - number of entries'...page 171
'0x8F00-01 - Encoder feedback configuration'...page 171
'0x8F00-02 - Encoder actual value'...page 172
'0x8F00-03 - Encoder resolution'...page 172

5.2.2 Information about the product - 0x1000...0x2018

0x1000-00 - Device type

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1000-00	U32	R	0x00200192	0 … 0xFFFFFFFF		Device type

'Explanation of the elements'...page 129

Here you are shown the unit type according to CiA 402.

MSB		LSB
31 … 24	23 … 16	15 … 0
Additional information		Device profile number
Mode bit = 0x00	Type = 0x20	0x0192

0x1008-00 - Manufacturer device name

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1008-00	STG	R	0x3035342D3242413130			Vendor device name
'Explanation of the elements'...page 129						

Here you can find the name of the motion module ASCII coded:
0x3035342D3242413130: *'054-2BA10'*.

Please note that when accessing via the Acyclic channel, the value 0 is always output!

0x100A-00 - Manufacturer software version

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x100A-00	U32	R	current version			Manufacturer software version
'Explanation of the elements'...page 129						

Here you can find the software version of the motion module as a hexadecimal value e.g. 0x01050300: V1.5.3.0

Please note that when accessing via the Acyclic channel, only the first 4 bytes (0x01050300: "0105030") can be read!

0x1018-00 - Product - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1018-00	U08	R	5	5		Product - number of entries
'Explanation of the elements'...page 129						

0x1018-02 - Product ID

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1018-02	U32	R	0x534C494F	0 … 0xFFFFFFFF		Product ID
'Explanation of the elements'...page 129						

Here according to CiA 402 the product ID of the motion module can be found:
0x534C494F

0x1018-03 - Revision number

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1018-03	U32	R	0	0 … 0xFFFFFFFF		Revision number
'Explanation of the elements'...page 129						

Here according to CiA 402 the revision number of the module can be found. Currently this object is not used and returns 0.

0x1018-05 - Module category

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1018-05	U32	R	0x21	0 … 200		Module category
'Explanation of the elements'...page 129						

Here according to CiA 402 you can find the module category of the motion module: 0x21: STM

0x2017-05 - Hardware property

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x2017-05	U08	R	1	0 ... 255		Hardware property
'Explanation of the elements'...page 129						

Bit 0

- 1: The module supports 24V monitoring.
- 0: The 24V monitoring is not supported.

Bit 7 ... 1

- reserved

0x2018-01 - Serial number

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x2018-01	STG	R	0	0 … 0xFFFFFFFF		Serial number
'Explanation of the elements'...page 129						

Here according to CiA 402 the serial number of the module can be found.

Please note that when accessing via the Acyclic channel, the value 0 is always output!

5.2.3 Passwords and security - 0x1100

0x1100-00 - Passwords and security - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1100-00	U08	R	2	2		Passwords and security - number of entries
'Explanation of the elements'...page 129						

0x1100-01 - Password

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x1100-01	U32	R/W**	0	0 … 0xFFFFFFFF		Password
'Explanation of the elements'...page 129						

With this object you can enable the password, which allows to write objects in all states of the state machine. Otherwise objects can only be written in the state *'Switch on disabled'*. The password is: 0xABCDABCD and cannot be changed. *'Accessing the state machine'...page 59*

5.2.4 System command - 0x6100

0x6100-00 - System command - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x6100-00	U08	R	17	17		System command - number of entries
'Explanation of the elements'...page 129						

0x6100-10 - System message timeout maximum

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x6100-10	U32	R/W	0	0 … 0xFFFFFFFF	[mS]	System message timeout maximum
'Explanation of the elements'...page 129						

With this object, you can enable the monitoring of the cyclic communication to the System SLIO bus and thus to the fieldbus. If there is no communication within the specified time in ms, the motion module enters the error state. Should the application require a cyclic communication with the motion module but the monitoring of the cycle can not be ensured on the side of the fieldbus coupler or CPU, by means of this object a monitoring time should be entered. By default, no monitoring is active.

5.2.5 Digital inputs DI1...DI3 - 0x7100

0x7100-00 - Digital inputs - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x7100-00	U08	R	5	5		Digital inputs - number of entries
'Explanation of the elements'...page 129 *'Deployment DIO'...page 106*						

0x7100-05 - Status digital input DI1...DI3

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x7100-05*	U08	R	0	0 … 0xFF		Status digital input DI1…DI3
'Explanation of the elements'...page 129						

This object contains the current values of the digital inputs DI1...DI3. They also can be found in the input area.

Bit 2 ... 0

3	2	1	0	Description
x	x	x	0	Input DI1 has signal "0"
x	x	x	1	Input DI1 has signal "1"
x	x	0	x	Input DI2 has signal "0"
x	x	1	x	Input DI2 has signal "1"
x	0	x	x	Input DI3 has signal "0"
x	1	x	x	Input DI3 has signal "1"

5.2.6 Digital output DO - 0x7200

0x7200-00 - Digital output - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x7200-00	U08	R	6	6		Digital output - number of entries
'Explanation of the elements'...page 129						
'Deployment DIO'...page 106						

0x7200-05 - Digital output state DO actual state

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x7200-05*	U08	R	0	0 … 0xFF		Status digital output DO actual state
'Explanation of the elements'...page 129						

This object contains the actual value of the digital output. You will also find this in the output area.

0x7200-06 - Status digital output DO target value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x7200-06*	U08	R/W**	0	0 … 0xFF		Status digital output DO target value
'Explanation of the elements'...page 129						

This object contains the target value of the digital output. You will also find this in the output area.

Please note if you write via the Acyclic channel to objects, which are mapped in the I/O area, their values will be overwritten again with the next cycle. Therefore, data mapped in the I/O area should not be written via the Acyclic channel!

5.2.7 Control drive - 0x8100

0x8100-00 - Control drive - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-00	U08	R	15	15		Control drive - number of entries

'Explanation of the elements'...page 129

0x8100-01 - Control word

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-01*	U16	R/W**	0	0 … 65535		Control word

With the *Control word* you can change the current state of the motor controller respectively reset all the error bits:

- Bit 0: Switch on
- Bit 1: Disable voltage
- Bit 2: Quick stop
- Bit 3: Switch on
- Bit 6 ... 4: reserved
- Bit 7: Command "Fault reset"
- Bit 15 ... 8: reserved

'Explanation of the elements'...page 129

'States'...page 58

Bit combinations

3	2	1	0	Bit 3 ... 0 - Control drive state
x	1	1	0	Shutdown
0	1	1	1	Switch on
1	1	1	1	Switch on and enable operation
x	x	0	x	Disable voltage
0	1	1	1	Disable operation
1	1	1	1	Enable operation
x	0	1	x	Quick stop

15...8	7	6	Bit 15 ... 4 - Reset error bits
reserved	0→1	reserved	Edge 0-1 resets all error bits in *'0x8100-06 - Error active bits'...page 143*.

0x8100-02 - Status word

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-02*	U16	R	0	0 … 65535		Status word

- Bit 0: Ready to switch on
- Bit 1: Switched on
- Bit 2: Operation enabled
- Bit 3: Error
- Bit 4: Voltage disabled
- Bit 5: Quick stop active
- Bit 6: Switch on disabled
- Bit 7: Warning
- Bit 8: *'Cyclic synchronous positioning'...page 98*
  - 0: Motion module not in-SYNC. Failure of at least one SYNC signal (warning active).
  - 1: Motion Module in-Sync - no SYNC signal failure.
- Bit 9: reserved
- Bit 10: Target position reached
- Bit 11: Internal limitation active
- Bit 12: The assignment depends on the selected *'0x8280-01 - Operating mode requested'...page 149*
  - *'Homing'...page 61*
    As soon as homing is completed, bit 12 is set.
  - *'Pseudo closed loop'...page 111*
    Bit 12 is set during position correction.
- Bit 15 ... 13: reserved

'Explanation of the elements'...page 129

'States'...page 58

Please consider that the data bits are not latched and may need to be temporarily stored for further processing!

Bit combinations

7	6	5	4	3	2	1	0	hex	Bit 7 ... 0 - Drive state state machine
x	0	x	x	0	0	0	0	0x00	State *'Not ready to switch on'*
x	1	x	x	0	0	0	0	0x40	State *'Switch on disabled'*
x	0	1	x	0	0	0	1	0x21	State *'Ready to switch on'*
x	0	1	x	0	0	1	1	0x23	State *'Switched on'*
x	0	1	x	0	1	1	1	0x27	State *'Operation enabled'*
x	0	0	x	0	1	1	1	0x07	State *'Quick stop active'*
x	0	x	x	1	1	1	1	0x0F	State *'Fault reaction active'*
x	0	x	x	1	0	0	0	0x08	State *'Error'* *'0x8100-03 - Error code'...page 139*
1	x	x	x	x	x	x	x	0x80	A warning has occurred *'0x8100-05 - Warnings active bits'...page 142*

0x8100-03 - Error code

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-03	U16	R	0	0 … 65535		Last error code

'Explanation of the elements'...page 129

'Monitoring and error reaction'...page 121

With edge 0-1 of '0x8100-01 - Control word'...page 137 bit 7 you can reset the error bits.

This object shows the most recent error code, which has occurred in the System SLIO motion module. A group message can be obtained from bit 3 in the *'0x8100-02 - Status word'...page 138*. If multiple errors have occurred, you can use *'0x8100-07 - number of error entries'...page 144* to get the number of errors and *'0x8100-08 ... 15 - Error code - Error entry 1 ... 8'...page 144* to retrieve the error codes. There are the following error messages:

Error code	Description
0x2310	Winding overcurrent *'0x8600-10 - Current actual value winding A'...page 163* or *'0x8600-11 - Current actual value winding B'...page 163* is greater than *'0x8C00-04 - Motor max. current'...page 168* *'0x8100-06 - Error active bits'...page 143* Bit: 0
0x2340	Short-circuit in motor *'Connections'...page 41* *'0x8100-06 - Error active bits'...page 143* Bit: 1
0x3210	Power section supply overvoltage *'0x8680-07 - Power section supply voltage max. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 17
0x3220	Power section supply undervoltage *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 16
0x3240	24V monitoring configuration error *'0x2017-05 - Hardware property'...page 134* *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 14
0x3250	24V monitoring undervoltage *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 15
0x4310	Temperature µ-controller exceeded *'0x8780-04 - Temperature µ-Controller error level'...page 166* *'0x8100-06 - Error active bits'...page 143* Bit: 12
0x4311	Temperature power stage exceeded *'0x8780-09 -Temperature power stage error level'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 13

Error code	Description
0x8400	Error in velocity control - please check you parameters. *'Velocity profile'...page 83* *'0x8100-06 - Error active bits'...page 143* Bit: 4
0x8611	Error in position control - please check you parameters. *'PtP positioning profile'...page 65* *'0x8100-06 - Error active bits'...page 143* Bit: 8
0x8612	Error in position control with pseudo closed loop - number of correction cycles reached with existing position deviation. *'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158* *'0x8100-06 - Error active bits'...page 143* Bit: 9
0xF001	Encoder feedback not configured under closed loop - configure the encoder feedback *'0x8F00-01 - Encoder feedback configuration'...page 171* *'0x8100-06 - Error active bits'...page 143* Bit: 20
0xF002	No commutation finding under closed loop after restart - perform a commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 25
0xF003	No movement possible during commutation finding. Activate *'0x8D00-04 - Stepper drive free before commutation finding'...page 170* before the commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 26
0xF010	System communication timeout *'0x6100-10 - System message timeout maximum'...page 135* *'0x8100-06 - Error active bits'...page 143* Bit: 22
0xF011	Command output disable (BASP) is active. *'0x8100-06 - Error active bits'...page 143* Bit: 23
0xF020	Error operation mode is not supported. *'0x8280-01 - Operating mode requested'...page 149* *'0x8100-06 - Error active bits'...page 143* Bit: 24
0xF040	Max. error level missing SYNC signals reached. *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 27
0xF044	SYNC period invalid The cyclic synchronous period set in the head module is not supported by the motion module. The motion module supports the following SYNC periods: 1ms, 2ms, 4ms, 8ms, 16ms and 32ms. *'0x8100-06 - Error active bits'...page 143* Bit: 21
0xF070	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 2
0xF071	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 3

Error code	Description
0xF080	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 28
0xF0FF	More than 8 errors occurred. If there are more than 8 errors, 0x8100-15 returns the value 0xF0FF for identification.

0x8100-04 - Limit active bits

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-04	U32	R	0	0 … 0xFFFFFFFF		Limit active bits

Limit active bits

0: de-activated, 1: activated

- Bit 0: Limit current
  - *'0x8600-03 - Current target value'...page 162* > positive *'0x8600-04 - Current limit'...page 162*
  - *'0x8600-03 - Current target value'...page 162* < negative *'0x8600-04 - Current limit'...page 162*
  - *'0x8600-12 - Current target value winding A'...page 163* > positive *'0x8600-04 - Current limit'...page 162*
  - *'0x8600-12 - Current target value winding A'...page 163* < negative *'0x8600-04 - Current limit'...page 162*
  - *'0x8600-13 - Current target value winding B'...page 164* > positive *'0x8600-04 - Current limit'...page 162*
  - *'0x8600-13 - Current target value winding B'...page 164* < negative *'0x8600-04 - Current limit'...page 162*
- Bit 3 ... 1: reserved
- Bit 4: Limit velocity
  - *'0x8500-03 - Velocity control target value'...page 159* > *'0x8500-04 - Velocity control limit positive direction'...page 159*
  - *'0x8500-03 - Velocity control target value'...page 159* < *'0x8500-05 - Velocity control limit negative direction'...page 160*
- Bit 7 ... 5: reserved
- Bit 8: Location of the target position
  - 0: Position is out of the permissible limits
  - 1: Position is within the permissible limits
  - *'0x8400-02 - Positioning profile target position'...page 154* > *'0x8480-05 - Software position limit positive direction'...page 155*
  - *'0x8400-02 - Positioning profile target position'...page 154* < *'0x8480-06 - Software position limit negative direction'...page 156*
  - *'0x8480-03 - Target position'...page 155* > *'0x8480-05 - Software position limit positive direction'...page 155*
  - *'0x8480-03 - Target position'...page 155* < *'0x8480-06 - Software position limit negative direction'...page 156*
- Bit 9: Location of the actual position to the positive limit value
  - 0: Position is below the positive limit value.
  - 1: Position is above the positive limit value.
- Bit 31 ... 10: reserved

'Explanation of the elements'...page 129

'Monitoring and error reaction'...page 121

0x8100-05 - Warnings active bits

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-05	U32	R	0	0 … 0xFFFFFFFF		Warnings active bits

Warnings active bits

0: de-activated, 1: activated

- Bit 7...0: reserved
- Bit 8: Warning lag error
  - *'0x8480-10 - Lag error'...page 157* > *'0x8480-11 - Lag error warning'...page 157*
- Bit 11...9: reserved
- Bit 12: Temperature warning µ-Controller
  - *'0x8780-02 - Temperature µ-Controller actual value'...page 166* > *'0x8780-03 - Temperature µ-Controller warning level'...page 166*
- Bit 13: Temperature warning power stage motion module
  - *'0x8780-07 - Temperature power stage actual value'...page 166* > *'0x8780-08 - Temperature power stage warning level'...page 167*
- Bit 14: Warning disabled 24V monitoring
  - *'0x8680-08 - 24V monitoring'...page 165*
- Bit 15: reserved
- Bit 16: Warning undervoltage U_{IN} $48V_{DC}$
  - *'0x8680-02 - Power section supply voltage actual value'...page 164* < *'0x8680-04 - Power section supply voltage min. warning level'...page 164*
- Bit 17: Warning overvoltage U_{IN} $48V_{DC}$
  - *'0x8680-02 - Power section supply voltage actual value'...page 164* > *'0x8680-05 - Power section supply voltage max. warning level'...page 165*
- Bit 26 ... 18: reserved
- Bit 27: Warning Out of SYNC - 1. Loss of SYNC signal
  - *'Cyclic synchronous positioning'...page 98*
- Bit 31 ... 28: reserved

'Explanation of the elements'...page 129

'Monitoring and error reaction'...page 121

0x8100-06 - Error active bits

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-06	U32	R	0	0 … 0xFFFFFFFF		Error active bits

Error active bits

0: de-activated, 1: activated

- Bit 0: Limit current error
  - *'0x8600-10 - Current actual value winding A'...page 163* > *'0x8C00-04 - Motor max. current'...page 168*
  - *'0x8600-11 - Current actual value winding B'...page 163* > *'0x8C00-04 - Motor max. current'...page 168*
- Bit 1: Error - short circuit on the motor (phase current > 4A)
- Bit 3, 2: System error
  - There is an internal error - please contact our Yaskawa support!
- Bit 4: Error - velocity control - please check you parameters. [1]
  - *'Velocity profile'...page 83*
- Bit 7...5: reserved
- Bit 8: Error - velocity control - please check you parameters. [1]
  - *'PtP positioning profile'...page 65*
- Bit 9: Error - position control with pseudo closed loop - number of correction cycles reached with existing position deviation. [1]
  - *'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158*
- Bit 11, 10: reserved
- Bit 12: Error - temperature µ-controller [1]
  - *'0x8780-02 - Temperature µ-Controller actual value'...page 166* > *'0x8780-04 - Temperature µ-Controller error level'...page 166*
- Bit 13: Error - temperature power stage motion module [1]
  - *'0x8780-07 - Temperature power stage actual value'...page 166* > *'0x8780-09 -Temperature power stage error level'...page 167*
- Bit 14: Error - 24V monitoring is not supported - disable the 24V monitoring.
  - *'0x8680-08 - 24V monitoring'...page 165*
- Bit 15: Error - 24V monitoring undervoltage - check the DC 24V power section supply.
- Bit 16: Error - undervoltage U_{IN} 48V_{DC}
  - *'0x8680-02 - Power section supply voltage actual value'...page 164* < *'0x8680-06 - Power section supply voltage min. error level'...page 165*
- Bit 17: Error - overvoltage U_{IN} 48V_{DC}
  - *'0x8680-02 - Power section supply voltage actual value'...page 164* > *'0x8680-07 - Power section supply voltage max. error level'...page 165*
- Bit 19, 18: reserved
- Bit 20: Error - encoder feedback not configured under closed loop - configure the encoder feedback.[1]
  - *'0x8F00-01 - Encoder feedback configuration'...page 171*
- Bit 21: Error - SYNC period invalid. The cyclic synchronous period set in the head module is not supported by the motion module. The following SYNC periods are supported: 1ms, 2ms, 4ms, 8ms, 16ms and 32ms. [1]
- Bit 22: Error - system communication timeout [1]
  - *'0x6100-10 - System message timeout maximum'...page 135*
- Bit 23: Error - command output disable (BASP) active [1]
- Bit 24: Error - operating mode is not supported
  - *'0x8280-01 - Operating mode requested'...page 149*
- Bit 25: Error - no commutation finding under closed loop after restart. [1]
  - *'Commutation finding'...page 114*

Error active bits
■ Bit 26: Error - no movement possible during commutation finding. [1] – *'Commutation finding'...page 114* ■ Bit 27: Error - Max. error level missing SYNC signals reached. [1] – *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167* ■ Bit 28: System error – There is an internal error - please contact the Yaskawa support! ■ Bit 31 ... 29: reserved
'Explanation of the elements'...page 129
1) Triggers an error reaction *'Monitoring and error reaction'...page 121*

0x8100-07 - number of error entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-07	U08	R	8	8		Control drive - number of error entries
'Explanation of the elements'...page 129						

0x8100-08 ... 15 - Error code - Error entry 1 ... 8

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8100-08 ... 0x8100-15	U16	R	0	0 … 65535		Error code - Error entry 1 ... Error code - Error entry 8
'Explanation of the elements'...page 129 *'Monitoring and error reaction'...page 121*						

With edge 0-1 of '0x8100-01 - Control word'...page 137 bit 7 you can reset the error bits.

With the objects 0x8100-08 to 0x8100-15 the 1st to 8th error code can be accessed in the event of an error in the System SLIO motion module. If there are more than 8 errors, 0x8100-15 returns the value 0xF0FF for identification. A group message can be obtained from bit 3 in the *'0x8100-02 - Status word'...page 138*. There are the following error messages:

Error code	Description
0x2310	Winding overcurrent *'0x8600-10 - Current actual value winding A'...page 163* or *'0x8600-11 - Current actual value winding B'...page 163* is greater than *'0x8C00-04 - Motor max. current'...page 168* *'0x8100-06 - Error active bits'...page 143* Bit: 0
0x2340	Short-circuit in motor *'Connections'...page 41* *'0x8100-06 - Error active bits'...page 143* Bit: 1

Error code	Description
0x3210	Power section supply overvoltage *'0x8680-07 - Power section supply voltage max. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 17
0x3220	Power section supply undervoltage *'0x8680-06 - Power section supply voltage min. error level'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 16
0x3240	24V monitoring configuration error *'0x2017-05 - Hardware property'...page 134* *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 14
0x3250	24V monitoring undervoltage *'0x8680-08 - 24V monitoring'...page 165* *'0x8100-06 - Error active bits'...page 143* Bit: 15
0x4310	Temperature µ-controller exceeded *'0x8780-04 - Temperature µ-Controller error level'...page 166* *'0x8100-06 - Error active bits'...page 143* Bit: 12
0x4311	Temperature power stage exceeded *'0x8780-09 -Temperature power stage error level'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 13
0x8400	Error in velocity control - please check you parameters. *'Velocity profile'...page 83* *'0x8100-06 - Error active bits'...page 143* Bit: 4
0x8611	Error in position control - please check you parameters. *'PtP positioning profile'...page 65* *'0x8100-06 - Error active bits'...page 143* Bit: 8
0x8612	Error in position control with pseudo closed loop - number of correction cycles reached with existing position deviation. *'0x8480-17 - Pseudo closed loop: Number of correction cycles'...page 158* *'0x8100-06 - Error active bits'...page 143* Bit: 9
0xF001	Encoder feedback not configured under closed loop - configure the encoder feedback *'0x8F00-01 - Encoder feedback configuration'...page 171* *'0x8100-06 - Error active bits'...page 143* Bit: 20
0xF002	No commutation finding under closed loop after restart - perform a commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 25
0xF003	No movement possible during commutation finding. Activate *'0x8D00-04 - Stepper drive free before commutation finding'...page 170* before the commutation finding. *'Commutation finding'...page 114* *'0x8100-06 - Error active bits'...page 143* Bit: 26

Error code	Description
0xF010	System communication timeout *'0x6100-10 - System message timeout maximum'...page 135* *'0x8100-06 - Error active bits'...page 143* Bit: 22
0xF011	Command output disable (BASP) is active. *'0x8100-06 - Error active bits'...page 143* Bit: 23
0xF020	Error operation mode is not supported. *'0x8280-01 - Operating mode requested'...page 149* *'0x8100-06 - Error active bits'...page 143* Bit: 24
0xF040	Max. error level missing SYNC signals reached. *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167* *'0x8100-06 - Error active bits'...page 143* Bit: 27
0xF044	SYNC period invalid The cyclic synchronous period set in the head module is not supported by the motion module. The motion module supports the following SYNC periods: 1ms, 2ms, 4ms, 8ms, 16ms and 32ms. *'0x8100-06 - Error active bits'...page 143* Bit: 21
0xF070	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 2
0xF071	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 3
0xF080	There is an internal error - please contact our support! *'0x8100-06 - Error active bits'...page 143* Bit: 28
0xF0FF	More than 8 errors occurred. If there are more than 8 errors, 0x8100-15 returns the value 0xF0FF for identification.

5.2.8 Configure drive - 0x8180

0x8180-00 - Configure drive - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8180-00	U08	R	3	3		Configure drive - number of entries
'Explanation of the elements'...page 129						

0x8180-02 - Gear factor

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8180-02	U32	R/W	10000000	800000 … 16000000		Gear factor

'Explanation of the elements'...page 129

Gear factor for normalization of position, velocity and acceleration values. The value represents "units" in thousands with the rotary axis makes exactly one revolution. "Units" may thus be regarded as user units such as µm, mm, inch, degree angle and revolutions.

- Position
  - A to be traversed position thus results directly from the specified number of units.
- Velocity
  - The velocity is normalized to unit/s
- Acceleration and deceleration
  - Acceleration and deceleration are normalized to unit/s²

Example 1:

A motor directly drives a toothed disk. Via a toothed belt, a drilling machine is 1:1 coupled. It is to be used with a resolution of 0.0001 U (= 1 unit). In order to drive a speed of 900 U/min, therefore, a value of 150000 must be reported.

$$Units = \frac{1U/U}{0.0001U} = 10000\ 1/U$$

Gear factor = 10000 · 1000 = 10000000

Example 2:

A motor directly drives a spindle with a pitch of 20 mm/U. It is to be used with a resolution of 10µm (= 1 unit). In order to traverse a difference in position of 7000µm, 7000 can directly be specified (relative to the previous value).

$$Units = \frac{20mm/U}{10\mu m} = 20000\ 1/U$$

Gear factor = 20000 · 1000 = 20000000

5.2.9 Options - 0x8200

0x8200-00 - Options - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8200-00	U08	R	5	5		Options - number of entries

'Explanation of the elements'...page 129

0x8200-01 - Configuration quick stop

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8200-01	S16	R/W**	2	0 ... 2		Configuration quick stop
'Explanation of the elements'...page 129 *'Brake control'...page 115*						

The object contains the action to be used at a *Quick stop*.

Mode	Description
0	Instant state change to *'Switch on disabled'*
1	reserved
2	Break with quick stop deceleration 0x8580-03 and subsequent state change to *'Switch on disabled'*

0x8200-05 - Configuration fault reaction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8200-05	S16	R/W**	2	0 … 2		Configuration fault reaction
'Explanation of the elements'...page 129						

The object contains the action to be used on an error of the System SLIO motion module.

Mode	Description
0	Instant state change to *'Switch on disabled'*
1	reserved
2	Break with 0x8580-03 and subsequent state change to *'Switch on disabled'*

5.2.10 Operating modes - 0x8280

0x8280-00 - Operating mode - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8280-00	U08	R	2	2		Operating mode - number of entries
'Explanation of the elements'...page 129						

0x8280-01 - Operating mode requested

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8280-01*	S16	R/W	0	-128 … 127		Operating mode requested

'Explanation of the elements'...page 129

'Operating modes'...page 59

With the object 0x8280-01 the mode of the motor controller can be set. The following operating modes are supported:

Value	Description
0	No operating mode
1	*'PtP positioning profile'...page 65* ■ The *Homing mode* can be called during the operation, if you have previously set a homing method via *'0x8300-02 - Homing method'...page 151*. ■ A change to the *Velocity profile* is only possible if the state machine is in state *'Switch on disabled'*.
3	*'Velocity profile'...page 83*
4	reserved
6	*'Homing'...page 61*
8	*'Cyclic synchronous positioning'...page 98*
10	*'Torque control'...page 94*
15	Commutation finding for closed loop *'Commutation finding'...page 114*

0x8280-02 - Operating mode actual

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8280-02*	S16	R	0	-128 … 127		Operating mode actual

'Explanation of the elements'...page 129

'Operating modes'...page 59

In object 0x8280-02 the current operating mode of the motor controller can be read. The following values are supported:

Value	Description
0	No operating mode
1	*'PtP positioning profile'...page 65* ■ The *Homing mode* can be called during the operation, if you have previously set a homing method via *'0x8300-02 - Homing method'...page 151*. ■ A change to the *Velocity profile* is only possible if the state machine is in state *'Switch on disabled'*.
3	*'Velocity profile'...page 83*
4	reserved
6	*'Homing'...page 61*
8	*'Cyclic synchronous positioning'...page 98*
10	*'Torque control'...page 94*
15	Commutation finding for closed loop *'Commutation finding'...page 114*

5.2.11 Homing - 0x8300

0x8300-00 - Homing - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-00	U08	R	10	10		Homing - number of entries

'Explanation of the elements'...page 129

'Homing'...page 61

0x8300-02 - Homing method

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-02	S08	R/W**	0	-128 … 127		Homing method

'Explanation of the elements'...page 129

'Homing'...page 61

This object is used to select the homing method. Homing is an initialization drive of an axis, where the correct position is determined by means of an reference signal. For complete configuration of a homing run, all index 0x8300 associated objects are required.

Supported homing method

Mode	Description
17	It is referenced to a switch at the end of the position area (= homing switch). For the evaluation of the reference switch, a digital input of the motion module is used. A signal edge is expected. Please note in this case, the correct electrical connection! But you can also reference to track Z.
37	The current position is used as reference position and the position value is reset to zero.

Please note that neither homing nor other operation modes of System SLIO motion module are monitored by limit switches, which cause a shut-down or stopping when reached. If you wish a surveillance and response, you have to ensure this through separate measures.

0x8300-03 - Homing digital input DI1…DI3, ENC-Z

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-03	U08	R/W**	0	0 … 3		Homing digital input DI1…DI3

'Explanation of the elements'...page 129

This object sets for homing *Mode 17* the digital input to which the homing switch is connected.

Enter here a number:

- 0: inactive
- 1: Input DI1
- 2: Input DI2
- 3: Input DI3
- 4: Input encoder track Z ENC-Z

0x8300-04 - Homing digital input active polarity DI1…DI3

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-04	U08	R/W**	1	0 … 1		Homing digital input polarity DI1…DI3
'Explanation of the elements'...page 129						

This object sets for homing *Mode 17* the polarity of the digital input DI1…DI3 of the System SLIO motion module. The internal logic of the System SLIO motion module evaluates a pulse signal from the reference switch. Please note in this case, the correct electrical connection!

At *'0x7100-05 - Status digital input DI1...DI3'...page 136* the corresponding bit is set per DI if the input has the signal "1". You can use *polarity* to determine the state for the reference run that triggers the "Limit switch reached" event.

- 0: With *polarity* = 0, the "0" signal of the corresponding DI triggers the "Limit switch reached" event.
- 1: With *polarity* = 1, the "1" signal of the corresponding DI triggers the "Limit switch reached" event.

0x8300-05 - Homing target position

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-05	S32	R/W**	0	-8388608 … 8388607	[user]	Homing target position
'Explanation of the elements'...page 129						

This object defines the target position for the homing and is signed. If the homing and the mechanical structure are configured correctly, this position should not be reached during homing. It thus serves for:

- set a maximum traversing position, if the initial position is not reached
- to specify the traversing direction by the sign

0x8300-06 - Homing velocity V1

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-06	S32	R/W**	0	-8388608 … 8388607	[user]	Homing velocity V1
'Explanation of the elements'...page 129						

This object specifies the search speed for traversing to the initial position. Homing *Mode 17* is a two step process.

1. With velocity V1 (0x8300-06) it is traversed toward the target position (0x8300-05) until the homing switch is overrun.
2. Then it is decelerated to speed 0 and again accelerated (0x8300-08 and 09) and moved in the negative direction at velocity V1.
3. If the reference switch is overrun again it is again slowed down and it is again accelerated in the positive direction at velocity V2 (0x8300-07).
4. With the third overrun of the homing switch the initial position is set and moved to.

0x8300-07 - Homing velocity V2

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-07	S32	R/W**	0	-8388608 … 8388607	[user]	Homing velocity V2
'Explanation of the elements'...page 129						

This object specifies the velocity V2 for traversing to the initial position. The velocity V2 (0x8300-07) is used in the final stage of homing when approaching the initial position.

0x8300-08 - Homing acceleration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-08	S32	R/W**	1000	1000 … 10000000	[user]	Homing acceleration
'Explanation of the elements'...page 129						

This object specifies the value for the homing acceleration for traversing the initial position.

0x8300-09 - Homing deceleration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-09	S32	R/W**	1000	1000 … 10000000	[user]	Homing deceleration
'Explanation of the elements'...page 129						

This object specifies the value for the homing deceleration for traversing the initial position.

0x8300-10 - Homing offset value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8300-10	S32	R/W**	0	-8388608 … 8388607	[user]	Homing offset value
'Explanation of the elements'...page 129						

This object specifies the offset between the zero position of the application and the reference point (by homing determined) of the drive. The value is to specify with sign. If the homing is completed and the initial position is reached, the offset is added to the initial position.

5.2.12 Parameter for the PtP positioning profile - 0x8400

0x8400-00 - Positioning profile - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8400-00	U08	R	5	5		Positioning profile - number of entries
'Explanation of the elements'...page 129 *'PtP positioning profile'...page 65*						

0x8400-02 - Positioning profile target position

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8400-02*	S32	R/W**	0	-8388608 … 8388607	[user]	Positioning profile target position
'Explanation of the elements'...page 129						

For the "PtP positioning profile" in this object the new target position is to be specified in user units. *'0x8180-02 - Gear factor'...page 147* You can find this object in the I/O area and it should not be written via the *Acyclic channel*, since the value is overwritten with the next cycle. The positioning is active, if:

- the operation mode "PtP positioning profile" is selected
- the System SLIO motion module is in state *'Operation enabled'*

The positioning must not be started specifically by *'0x8100-01 - Control word'...page 137*. During an ongoing positioning or after reaching the target position 0x8400-02 can be changed and it starts positioning to the new target value. For complete configuration of a positioning and to execute other objects of the index group 0x8400 are required.

0x8400-03 - Positioning profile target velocity

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8400-03*	S32	R/W**	0	-8388608 … 8388607	[user]	Positioning profile target velocity
'Explanation of the elements'...page 129						

With *'PtP positioning profile'...page 65* this object specifies the speed for traversing to the initial position and is processed as absolute value. With *'Velocity profile'...page 83* the sign determines the direction of rotation. You can find this object in the I/O area and it should not be written via the *Acyclic channel*, since the value is overwritten with the next cycle. During a running positioning 0x8400-03 can be changed. It is directly accelerated or decelerated, provided the remaining room allows the positioning to the new target value.

0x8400-04 - Positioning profile target acceleration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8400-04*	S32	R/W**	10000	300 … 100000000	[user]	Positioning profile target acceleration
'Explanation of the elements'...page 129						

This object specifies the acceleration for traversing to the initial position and is processed as absolute value. You can find this object in the I/O area and it should not be written via the *Acyclic channel*, since the value is overwritten with the next cycle. During a running positioning 0x8400-04 can be changed and is immediately active.

0x8400-05 - Positioning profile target deceleration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8400-05*	S32	R/W**	10000	300 … 100000000	[user]	Positioning profile target deceleration
'Explanation of the elements'...page 129						

This object specifies the deceleration for traversing to the initial position and is processed as absolute value. You can find this object in the I/O area and it should not be written via the *Acyclic channel*, since the value is overwritten with the next cycle. During a running positioning 0x8400-05 can be changed and is immediately active.

5.2.13 Positions and limit values - 0x8480

0x8480-00 - Positions and limits - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-00	U08	R	17	17		Positions and limits - number of entries
'Explanation of the elements'...page 129						

0x8480-02 - Position actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-02*	S32	R	0	-8388608 … 8388607	[user]	Position actual value
'Explanation of the elements'...page 129						

This object specifies the value of the actual position. It also can be found in the input area *'In-/Output area'...page 115*. In open-loop operation, the object has an internally calculated value, not the current encoder value.

0x8480-03 - Target position

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-03	S32	R	0	-8388608 … 8388607	[user]	Target position
'Explanation of the elements'...page 129						

For the operating mode "PtP positioning profile", this object specifies the internal value of the target position at the input of the position controller. It is generated by the superior modules (e.g. PtP ramp generator).

For the operating mode "cycle synchronous positioning" in this object, the new target position is to be specified in user units. *'0x8180-02 - Gear factor'...page 147* This object can also be found in the dynamically assigned word 4 in the output area and should not be written via the *acyclic channel*, as the value is overwritten with the next cycle.

0x8480-05 - Software position limit positive direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-05	S32	R/W**	8388607	-8388608 … 8388607	[user]	Software position limit positive direction
'Explanation of the elements'...page 129						

This object indicates the positive limit for the target position. Each target position is checked against this limit. Before matching always the reference offset *'0x8300-10 - Homing offset value'...page 153* is subtracted.

- Is a specified target position above the positive limit:
  - the positioning process is not performed
  - Bit 11: "Internal limitation active" in *'0x8100-02 - Status word'...page 138* is set
  - Bit 10: "Target position" reached in *'0x8100-02 - Status word'...page 138* is **not** set
  - Bit 9: in *'0x8100-04 - Limit active bits'...page 141* is set
- Is a measured actual position above the positive limit:
  - Bit 8: in *'0x8100-04 - Limit active bits'...page 141* is set

0x8480-06 - Software position limit negative direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-06	S32	R/W**	-8388608	-8388608 … 8388607	[user]	Software position limit negative direction
'Explanation of the elements'...page 129						

This object indicates the negative limit for the target position. Each target position is checked against this limit. Before matching always the reference offset 0x8300-10 is subtracted.

- Is a specified target position below the negative limit:
  - the positioning process is not performed
  - Bit 11: "Internal limitation active" in *'0x8100-02 - Status word'...page 138* is set
  - Bit 10: "Target position" reached in *'0x8100-02 - Status word'...page 138* is **not** set
  - Bit 9: in *'0x8100-04 - Limit active bits'...page 141* is set
- Is a measured actual position below the negative limit:
  - Bit 8: in *'0x8100-04 - Limit active bits'...page 141* is set

0x8480-07 - Range limit positive direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-07	S32	R/W	8000000	10000 … 8388607	[User]	Range limit positive direction
'Explanation of the elements'...page 129						

This object defines the positive overflow limit for the processing of position values. When this value is exceeded, the position values are set to *'0x8480-08 - Range limit negative direction'...page 156*. Together with the object 0x8480-07 you can define a position range. For example, by presetting *'0x8480-05 - Software position limit positive direction'...page 155* and *'0x8480-06 - Software position limit negative direction'...page 156* out of the range you will get an endless movement, since the software limits can never be reached during the movement.

For a smooth switch-over with open loop and pseudo closed loop, the range limit should be defined at a full step and not at an intermediate micro step. This can be achieved by selecting a multiple of *'0x8180-02 - Gear factor'...page 147*/1000 as range limit.

0x8480-08 - Range limit negative direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-08	S32	R/W	-8000000	-8388608 … -10000	[user]	Range limit negative direction
'Explanation of the elements'...page 129						

This object defines the negative overflow limit for the processing of position values. When this value is exceeded, the position values are set to *'0x8480-07 - Range limit positive direction'...page 156*. Together with the object 0x8480-08 you can define a position range. For example, by presetting *'0x8480-05 - Software position limit positive direction'...page 155* and *'0x8480-06 - Software position limit negative direction'...page 156* out of the range you will get an endless movement, since the software limits can never be reached during the movement.

For a smooth switch-over with open loop and pseudo closed loop, the range limit should be defined at a full step and not at an intermediate micro step. This can be achieved by selecting a multiple of *'0x8180-02 - Gear factor'...page 147*/1000 as range limit.

0x8480-09 - In-position window

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-09	U32	R/W**	10	0 … 8388607	[user]	In-position window
'Explanation of the elements'...page 129						

This object specifies with relation to the target position a symmetrical range, within which the target position is reached. With 0 the In-position window is disabled.

0x8480-10 - Lag error

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-10*	S32	R	0	-8388608 … 8388607	[user]	Lag error
'Explanation of the elements'...page 129						

This object contains the current system deviation as a deviation between target position and current value. This deviation is called *Lag error*. You can find this object in the I/O area.

0x8480-11 - Lag error warning

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-11	S32	R/W**	100	-8388608 … 8388607	[user]	Lag error warning
'Explanation of the elements'...page 129						

This object specifies a limit for the position difference (lag error). When the limit is reached, this is reported as a warning. *'0x8100-02 - Status word'...page 138 '0x8100-05 - Warnings active bits'...page 142* With 0 you will receive a warning at the slightest deviation.

0x8480-12 - Lag error error

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-12	S32	R/W**	1000	0 … 8388607	[user]	Lag error error
'Explanation of the elements'...page 129						

This object specifies a limit for the position difference (lag error). When the limit is reached, this is reported as a error and the motion module switches to error status *'0x8100-02 - Status word'...page 138 '0x8100-06 - Error active bits'...page 143*

By entering 0, you can deactivate the lag error monitoring.

0x8480-13 - Position control P-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-13	U16	R/W**	120	0 … 32000		Position control P-part
'Explanation of the elements'...page 129						

P-part of the position control.

0x8480-14 - Position control I-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-14	U16	R/W**	80	0 … 32000		Position control I-part
'Explanation of the elements'...page 129						

I-part of the position control.

0x8480-15 - Position control D-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-15	U16	R/W**	0	0 … 32000		Position control D-part
'Explanation of the elements'...page 129						

D-part of the position control

0x8480-16 - Position control shift factor

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-16	U16	R/W	12	0 … 24		Position control shift factor
'Explanation of the elements'...page 129						

This parameter is used to limit the generated speed during the positioning. The smaller the value, the greater the limitation.

0x8480-17 - Pseudo closed loop: Number of correction cycles

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8480-17	U16	R/W	0	0 … 100		Number of correction cycles in pseudo closed loop until error shutdown. 0: Continuously
'Explanation of the elements'...page 129						

This parameter allows you to define the maximum number of correction cycles with pseudo closed loop. If the maximum number of correction cycles has been reached and the actual position value is outside *'0x8480-09 - In-position window'...page 157*, an error is returned.

'0x8100-03 - Error code'...page 139

'0x8100-06 - Error active bits'...page 143 Bit: 9

With the value 0, the correction cycles are repeated until *'0x8480-09 - In-position window'...page 157* is reached or the profile run is stopped.

5.2.14 Velocities and limit values - 0x8500

0x8500-00 - Velocity - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-00	U08	R	13	13		Velocity - number of entries
'Explanation of the elements'...page 129						

0x8500-01 - Velocity control configuration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-01	U32	R/W	0	0 … 0xFFFFFFFF		Velocity control configuration
'Explanation of the elements'...page 129						

With this object, you can disable the PtP position profile respectively the velocity profile for the velocity control. Here, the target velocity setting happens by the following objects:

- 0: Velocity control via PtP position profile and velocity profile with set point velocity setting via *'0x8400-03 - Positioning profile target velocity'...page 154*. This is the default setting.
- 1: Velocity control exclusively velocity profile with set point velocity setting via *'0x8500-03 - Velocity control target value'...page 159*.

0x8500-02 - Velocity control actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-02*	S32	R	0	-10000000 … 10000000	[user]	Velocity control actual value
'Explanation of the elements'...page 129						

This object specifies the value of the actual velocity. It also can be found in the input area *'In-/Output area'...page 115*. In open loop operation, the object has an internally calculated value, not determined from the current encoder value.

0x8500-03 - Velocity control target value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-03	S32	R/W**	0	-10000000 … 10000000	[user]	Velocity control target value
'Explanation of the elements'...page 129						

This object specifies the internal value of the target velocity at the input of the velocity controller. It is generated by the superior modules (e.g. PtP ramp generator).

0x8500-04 - Velocity control limit positive direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-04	S32	R/W**	100000	0 … 10000000	[user]	Velocity control limit positive direction
'Explanation of the elements'...page 129						

This object indicates the positive limit for velocity. Each target velocity is checked against this limit.

0x8500-05 - Velocity control limit negative direction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-05	S32	R/W**	-100000	-10000000 … 0	[user]	Velocity control limit negative direction
'Explanation of the elements'...page 129						

This object indicates the negative limit for velocity. Each target velocity is checked against this limit.

0x8500-06 - Velocity control range for torque limit

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-06	S32	R/W**	-20000	-1000000 … 1000000	[user]	Velocity control range for torque limit
'Explanation of the elements'...page 129						

For the operating mode *Torque control* *'0x8280-01 - Operating mode requested'...page 149* here you can specify an area for the velocity limitation. This area is a measure for deceleration as soon as the corresponding limit value *'0x8500-04 - Velocity control limit positive direction'...page 159* respectively *'0x8500-05 - Velocity control limit negative direction'...page 160* is exceeded.

0x8500-07 - Velocity control limit type for torque mode

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-07	U32	R/W**	0	0 … 0xFFFFFFFF		Velocity control limit type for torque mode
'Explanation of the elements'...page 129						

- 0: Smooth velocity limit
  - The pre-set velocity limit *'0x8500-04 - Velocity control limit positive direction'...page 159* respectively *'0x8500-05 - Velocity control limit negative direction'...page 160* is always reached. When the limit is exceeded, no abrupt deceleration takes place. A slight overshoot is allowed. Here, the current set point is, dependent on the difference between current velocity and permissible limit range *'0x8500-06 - Velocity control range for torque limit'...page 160* linearly reduced to "0".
- 1: Hard velocity limit
  - The pre-set velocity limit *'0x8500-04 - Velocity control limit positive direction'...page 159* respectively *'0x8500-05 - Velocity control limit negative direction'...page 160* is reached with maximum permissible current. When the limit is exceeded, an abrupt deceleration takes place.

0x8500-11 - Velocity control P-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8500-11	U16	R/W**	20	0 … 65535		Velocity control P-part
'Explanation of the elements'...page 129						

P-part of the velocity control

5.2.15 Acceleration and deceleration - 0x8580

0x8580-00 - Acceleration and deceleration - number entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8580-00	U08	R	6	6		Acceleration and deceleration - number entries
'Explanation of the elements'...page 129						

0x8580-02 - Acceleration/Deceleration actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8580-02*	S32	R	0	-100000000 … 100000000	[user]	Acceleration/Deceleration actual value
'Explanation of the elements'...page 129						

This object specifies the value of the actual acceleration (positive sign) respectively deceleration (negative sign). It also can be found in the input area *'In-/Output area'...page 115*. In open loop operation, the object has an internally calculated value, not determined from the current encoder value.

0x8580-03 - Deceleration quick stop value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8580-03	S32	R/W**	10000	10 … 100000000	[user]	Deceleration quick stop value
'Explanation of the elements'...page 129						

This object specifies the value of the target deceleration in case of a *quick stop*.

0x8580-04 - Acceleration limit

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8580-04	S32	R/W**	100000	10 … 100000000	[user]	Acceleration limit
'Explanation of the elements'...page 129						

This object indicates the bidirectional limit value for the set point acceleration value. Each set point acceleration value is checked against this limit value. Please note that the lower limit is unequal 0. As soon as a set point velocity value is active, the movement starts, although the set point acceleration is 0.

0x8580-06 - Deceleration limit

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8580-06	S32	R/W**	100000	10 … 100000000	[user]	Deceleration limit
'Explanation of the elements'...page 129						

This object indicates the bidirectional limit value for the set point deceleration value. Each set point deceleration value is checked against this limit value. Please note that the lower limit is unequal 0. As soon as a set point velocity value is active, the movement starts, although the set point deceleration is 0.

5.2.16 Currents - 0x8600

0x8600-00 - CUR current number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-00	U08	R	21	21		Current - number of entries
'Explanation of the elements'...page 129						

0x8600-02 - Current actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-02*	S16	R	0	-15000 … 15000	[mA]	Current actual value
'Explanation of the elements'...page 129						

With open loop and pseudo closed loop, the value of the effective current value is shown in mA.

With closed loop, the value corresponds to the torque and is shown depending on the direction of rotation and with the correct sign

0x8600-03 - Current target value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-03*	S16	R/W**	0	-15000 … 15000	[mA]	Current target value
'Explanation of the elements'...page 129						

With *open loop*, *pseudo closed loop* and *torque control* this object specifies the value of the target current in mA. The actual value of the winding current can therefore be higher by factor √2 (peak), depending on the micro step number 0 ... 63. If e.g. a 0x8600-03 - Current target value of 2000mA is set and the motor is at its peak value, so the measured current is 2828mA. During the movement the target value and the measured value are equal at functioning and well controlled current controller.

Please note that the target current is set via the cyclical target value setting and is 0mA at system restart. Thus the motor can operate, you should set the current set value that corresponds to the application and corresponds to the rated motor current.

0x8600-04 - Current limit

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-04*	S16	R/W**	5000	0 … 15000	[mA]	Current limit symmetrical
'Explanation of the elements'...page 129						

With this object the current limit for the setpoint current can be defined. This value is symmetrical and thus also defines the negative current limit.

0x8600-06 - Current control P-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-06	U16	R/W**	12000	0 … 65535		Current control P-part
'Explanation of the elements'...page 129						

P-part of the current controller.

0x8600-07 - Current control I-part

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-07	U16	R/W**	50	0 … 65535		Current control I-part
'Explanation of the elements'...page 129						

I-part of the current controller.

0x8600-09 - Current control filter factor

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-09	U16	R/W**	1	0 … 7		Current control filter factor
'Explanation of the elements'...page 129						

To reduce high-frequency interferences at the current sensor, here you can set the filter factor of the low-pass filter for the current sensor.

0x8600-10 - Current actual value winding A

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-10	S16	R	0	-15000 … 15000	[mA]	Current actual value winding A
'Explanation of the elements'...page 129						

Effective value in mA of the actual current in winding A.

0x8600-11 - Current actual value winding B

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-11	S16	R	0	-15000 … 15000	[mA]	Current actual value winding B
'Explanation of the elements'...page 129						

Effective value in mA of the actual current in winding B.

0x8600-12 - Current target value winding A

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-12	S16	R	0	-15000 … 15000	[mA]	Current target value winding A
'Explanation of the elements'...page 129						

Effective value in mA of the set current in winding A.

0x8600-13 - Current target value winding B

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8600-13	S16	R	0	-15000 … 15000	[mA]	Current target value winding B
'Explanation of the elements'...page 129						

Effective value in mA of the set current in winding B.

5.2.17 Voltages - 0x8680

0x8680-00 - Voltages - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-00	U08	R	8	8		Voltages - number of entries
'Explanation of the elements'...page 129						

0x8680-01 - Blanking time

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-01	U16	R/W	0	0 … 1000	[ms]	Blanking time voltage monitoring
'Explanation of the elements'...page 129						

To avoid incorrect messages, you can use this object to define a period of time that the system waits after axis enable to check the supply voltage.

0x8680-02 - Power section supply voltage actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-02	U16	R	0	1600 … 6000	[0.01V]	Power section supply voltage actual value
'Explanation of the elements'...page 129						

This object specifies the level of the actual supply voltage and shows the following behavior:

- < DC 16V: Value is below the value range. 0V is returned.
- DC 16V ... 60V: Value is returned which is within the value range.
- > DC 60V: Value is above the value range. 90V is returned.

0x8680-04 - Power section supply voltage min. warning level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-04	U16	R/W	2200	2000 ... 6000	[0.01V]	Power section supply voltage min. warning level
'Explanation of the elements'...page 129						

This object specifies a lower limit for the supply voltage of the module. If the limit is exceeded, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-05 - Warnings active bits'...page 142* a warning is shown.

0x8680-05 - Power section supply voltage max. warning level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-05	U16	R/W	5500	2000 ... 6000	[0.01V]	Power section supply voltage max. warning level
'Explanation of the elements'...page 129						

This object specifies an upper limit for the supply voltage of the module. If the limit is exceeded, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-05 - Warnings active bits'...page 142* a warning is shown.

0x8680-06 - Power section supply voltage min. error level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-06	U16	R/W	2100	2000 ... 6000	[0.01V]	Power section supply voltage min. error level
'Explanation of the elements'...page 129						

This object specifies a lower limit for the supply voltage of the module. If the limit is undershot, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-06 - Error active bits'...page 143* an error is shown.

0x8680-07 - Power section supply voltage max. error level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-07	U16	R/W	6000	2000 ... 6000	[0.01V]	Power section supply voltage max. error level
'Explanation of the elements'...page 129						

This object specifies an upper limit for the supply voltage of the module. If the limit is exceeded, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-06 - Error active bits'...page 143* an error is shown.

0x8680-08 - 24V monitoring

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8680-08	U08	R	0	0 ... 255		24V monitoring of the power section supply
'Explanation of the elements'...page 129						

Bit 0

- 1: The 24V monitoring is disabled.
  - Bit 14 in *'0x8100-05 - Warnings active bits'...page 142* is set.
- 0: The 24V monitoring enabled.
  - On failure of the DC 24V power section supply, via *'0x8100-03 - Error code'...page 139* code 0x3250 respectively *'0x8100-06 - Error active bits'...page 143* an error is shown.

Bit 7 ... 1

- reserved

5.2.18 Temperatures - 0x8780

0x8780-00 - Temperatures - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-00	U08	R	9	9		Temperatures - number of entries
'Explanation of the elements'...page 129						

0x8780-02 - Temperature µ-Controller actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-02	S16	R	0	-50 … 120	[degC]	Temperature µ-Controller actual value
'Explanation of the elements'...page 129						

This object specifies the measured temperature of the µ-Controller of the motion module.

0x8780-03 - Temperature µ-Controller warning level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-03	S16	R/W	90	-50 … 120	[degC]	Temperature µ-Controller warning level
'Explanation of the elements'...page 129						

This object specifies the temperature limit of the µ-Controller of the motion module. If the temperature limit is exceeded, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-05 - Warnings active bits'...page 142* a warning is shown.

0x8780-04 - Temperature µ-Controller error level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-04	S16	R/W	105	-50 … 120	[degC]	Temperature µ-Controller error level
'Explanation of the elements'...page 129						

This object specifies the temperature limit of the µ-Controller of the motion module. If the limit is reached, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-06 - Error active bits'...page 143* an error is shown and the status of the motion module changes to *'Fault reaction active'*.

0x8780-07 - Temperature power stage actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-07	S16	R	0	-50 … 120	[degC]	Temperature power stage actual value
'Explanation of the elements'...page 129						

This object specifies the measured temperature of the internal power stage.

0x8780-08 - Temperature power stage warning level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-08	S16	R/W	90	-50 … 120	[degC]	Temperature power stage warning level
'Explanation of the elements'...page 129						

This object specifies a temperature limit for the internal power stage. If the temperature limit is exceeded, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-05 - Warnings active bits'...page 142* a warning is shown.

0x8780-09 -Temperature power stage error level

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8780-09	S16	R/W	105	-50 … 120	[degC]	Temperature power stage error level
'Explanation of the elements'...page 129						

This object specifies a temperature limit for the internal power stage. If the temperature limit is reached, via *'0x8100-02 - Status word'...page 138* respectively *'0x8100-06 - Error active bits'...page 143* an error is shown and the status of the motion module changes to *'Fault reaction active'*.

5.2.19 SYNC parameters - 0x8B00

0x8B00-00 - SYNC parameter - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8B00-00	U08	R	2	2		SYNC parameters - number of entries
'Explanation of the elements'...page 129						

0x8B00-01 - SYNC parameter - max. missing SYNC signals

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8B00-01	U08	RW	3	1 ... 255		SYNC parameters - max. number of missing SYNC signals before error shut-down
'Explanation of the elements'...page 129						

This object is used in the operating mode *'Cyclic synchronous positioning'...page 98*. Enter here the upper limit of missing SYNC signals, which, if exceeded, should result in an error response.

0x8B00-02 - SYNC parameter - Error reaction

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8B00-02	U08	RW	0	0 ... 255		SYNC parameter - error reaction in case of loss SYNC signal
'Explanation of the elements'...page 129						

This object is used in the operating mode *'Cyclic synchronous positioning'...page 98*. Specify the error reaction for *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167* here.

Value	Description
0	If the number of missing SYNC signals exceeds the value of *'0x8B00-01 - SYNC parameter - max. missing SYNC signals'...page 167*, an error reaction occurs: ■ *'0x8100-02 - Status word'...page 138* Bit 8 = 0 ■ *'0x8100-06 - Error active bits'...page 143* Bit 27 = 1 ■ Error 0xF040 is output
>0	There is no error reaction.

5.2.20 Motor data - 0x8C00

0x8C00-00 - Motor data - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8C00-00	U08	R	10	10		Motor data - number of entries
'Explanation of the elements'...page 129						

0x8C00-04 - Motor max. current

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8C00-04	U16	R/W	5000	0 … 15000	[mA]	Motor max. current
'Explanation of the elements'...page 129						

This object specifies the maximum effective value of the motor current and must be configured. Exceeds the actual current in operation this value, there is a fault response of the motion module, which is shown in *'0x8100-02 - Status word'...page 138* respectively *'0x8100-06 - Error active bits'...page 143* bit 0.

The rated current of a motor is usually indicated by the manufacturer for full step operation. Here follow the manufacturer's instructions. In this operating mode, both windings are simultaneously fully powered. In the micro step mode, both windings are powered in sine-cosine shape. Thus, both windings are never simultaneously fully powered. To achieve full load the current of a winding can be increased by the factor √ 2 = 1.41.

0x8C00-07 - Motor max. velocity

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8C00-07	U16	R/W	3000	0 … 32000	[rpm]	Motor max. velocity
'Explanation of the elements'...page 129						

This object specifies the max. velocity of the motor and must be configured. At this velocity, the output of the position controller is limited. If the actual velocity exceeds the specified value by 110%, the error 0x8400 is triggered. *'0x8100-06 - Error active bits'...page 143* Bit: 4

5.2.21 Stepper parameter - 0x8D00

0x8D00-00 - Stepper number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8D00-00	U08	R	9	9		STM stepper number of entries
'Explanation of the elements'...page 129						

0x8D00-02 - Stepper full steps per revolution

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8D00-02	U16	R/W	200	100 … 2000	[stp]	Stepper full steps per revolution
'Explanation of the elements'...page 129						

This object specifies the number of full steps of a stepping motor for one revolution and is to be configured.

0x8D00-03 - Stepper micro steps per full step

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8D00-03	U16	R/W**	8	1 … 8	[stp]	Stepper micro steps per full step

'Explanation of the elements'...page 129

This object specifies the number of micro steps for controlling a stepper motor. Mostly a stepper motor is controlled in full step half step operation. With each pulse the currents of the motor windings of a stepper motor are switched on or off according to a certain pattern. This causes the motor to rotate jerkily by a small angle. In operation this creates a disturbing torque ripple. A jerky movement of the motor shaft can be avoided, by switching to *Micro step operation*. Here the winding currents are not switched, instead they are output in a continuous sine respectively cosine curve.

Please note that only switching to micro step operation with high resolution does not mean, that the motor can execute these fine steps. External influences and structurally-related factors such as internal friction, tolerances, and lubrication of the bearing can cause that the rotor is not able to follow the control signal.

Settings

Value	Number of micro steps per step
1	Full step (2 phase)
2	Full step (1 phase)
3	Half step
4	4 µ steps per step
5	8 µ steps per step
6	16 µ steps per step
7	32 µ steps per step
8	64 µ steps per step

0x8D00-04 - Stepper drive free before commutation finding

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8D00-04	U8	R/W	0	0, 1		Stepper drive free before commutation finding

'Explanation of the elements'...page 129

This object can be used to activate a drive free before commutation finding. *'Commutation finding'...page 114*

- 0: Drive free before commutation finding ist disabled.
- 1: Drive free before commutation finding ist enabled.
  - Before the drive makes a commutation finding, it is driven free by 10°. This may be necessary if the motor axis cannot rotate freely because it is at a stopper.

0x8D00-05 - Stepper duration per full step at commutation finding

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8D00-05	U16	R/W	500	200 ... 2000	[ms]	Duration per full step at commutation finding *'Commutation finding'...page 114*
'Explanation of the elements'...page 129						

5.2.22 Encoder parameters - 0x8F00

0x8F00-00 - Encoder - number of entries

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8F00-00	U08	R	3	3		Encoder - number of entries
'Explanation of the elements'...page 129						

0x8F00-01 - Encoder feedback configuration

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8F00-01	U32	R/W	0	0 … 5		Encoder feed-back configuration
'Explanation of the elements'...page 129						

- *When using closed loop, a commutation finding must always be done after the system start-up. Otherwise you will get an error message.*
- *During communication finding the motor axis must be able to rotate freely. There must be no counteracting external torque. Activate 'x8D00-04 - Stepper drive free before commutation finding'...page 170 before the commutation finding.*

'Commutation finding'...page 114

Setting options

0x8F00-01	Loop type	Supported operating modes
0	Open Loop	■ PtP positioning profile ■ Velocity profile ■ Homing ■ Cycle synchronous positioning
	■ 0 is output at *'0x8F00-02 - Encoder actual value'...page 172*. ■ No encoder is used.	
1	Open Loop	■ PtP positioning profile ■ Velocity profile ■ Homing ■ Cycle synchronous positioning
	■ The current encoder value is output at *'0x8F00-02 - Encoder actual value'...page 172*. ■ The encoder value is not used for control.	
3	Closed loop	■ PtP positioning profile ■ Velocity profile ■ Homing ■ Torque control ■ Cycle synchronous positioning ■ Commutation finding
	■ The current encoder value is output at *'0x8F00-02 - Encoder actual value'...page 172*. ■ The encoder value is used for field-oriented control (FOC). *'Closed Loop - Field-oriented control (FOC)'...page 113*	
5	Pseudo Closed Loop	■ PtP positioning profile ■ Homing
	■ The current encoder value is output at *'0x8F00-02 - Encoder actual value'...page 172*. The encoder value is used for control.	

0x8F00-02 - Encoder actual value

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8F00-02*	U16	R	0	0 … 65535	[inc]	Encoder current value
'Explanation of the elements'...page 129						

With this object you can get the actual value of a possibly connected encoder. When using the *'PtP positioning profile'...page 65*, via *'0x8F00-01 - Encoder feedback configuration'...page 171* you can define the use of the encoder signal. If encoder usage is disabled, the value 0 is output.

0x8F00-03 - Encoder resolution

Index-Sub	Type	RW	Default	Value range	Unit	Description
0x8F00-03	U16	R/W	4000	0 … 65535	[inc/rot]	Encoder resolution
'Explanation of the elements'...page 129						

With this object, you can configure the encoder resolution of the connected encoder. The encoder resolution defines the number of pulses per rotation.