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EQUIPMENT MANUAL

SINAMICS

G220

Converters
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G220
SINAMICS G220 converters

Equipment Manual

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1 Introduction

1.1 About SINAMICS

Description

SINAMICS converters are the optimum solution for all drive applications extending from low voltage through to DC. All Siemens drive components, such as converters, motors, and controls, are matched to each other and can be integrated into your existing automation systems.

More information



You can find more information via the SINAMICS YouTube playlist:

YouTube playlist (https://www.youtube.com/playlist?list=PLw7lLwXw4H53rtHeTeifKtVMr2aXTYt0X)

1.2 About this manual

1.2.1 Content

Overview

These Operating Instructions provide a summary of all of the information required to operate the converter under safe conditions.

The Operating Instructions enable the target groups being addressed to assembly, install, connect, and commission the converter safely and in the correct manner.

To illustrate possible application areas for our products, typical use cases are listed in this product documentation and in the online help. These are purely exemplary and do not constitute a statement on the suitability of the respective product for applications in specific individual cases. Unless explicitly contractually agreed, Siemens assumes no liability for such suitability. Suitability for a particular application in specific individual cases must be assessed by the user, taking into account all technical, legal, and other requirements on a case-by-case basis. Always observe the descriptions of the technical properties and the applicable constraints of the respective product provided in the product documentation.

1.2.2 What's new?

Description

The essential additions with respect to Edition 03/2026 that was last published:

- Description
  - Current reduction as a function of the installation altitude and ambient temperature, IP20 (Page 1090)
  - Requirements for the 24 V supply (Page 82)
  - Explanation of the article number (Page 47)
  - Nameplate (Page 46)
  - Converter frame size and rated power, degree of protection IP20 (Page 49)
  - Converter frame size and rated power, degree of protection IP55 (Page 51)
  - Option Module OM-AIO (Page 68)
    Ordering data for option modules (Page 69) (OM-AIO)
  - Sine-wave filter (Page 56)
- Application planning
  - Maximum permissible signal cable lengths, expansion rack for option modules (ER-OM) (Page 105)
  - EMC measures for braking resistors, Clean Power converter, degree of protection IP55 (Page 110)
  - Achievable EMC category and maximum motor cable length (Page 99) (sine-wave filter)
- Mounting
  - Weight, option modules (Page 141) (OM-AIO)
  - Dimension drawing OM-AIO (Page 154) (OM-AIO)
  - Weight, sine-wave filter (Page 117)
  - Unpacking the converter, delivered without pallet (Page 117)
  - Removing the transport lock, converter in degree of protection IP20 (Page 123)
  - Strain relief (Page 113)
- Mounting
  - Sine-wave filter (Page 183)

- Connecting
  - Option Module OM-AIO (Page 279)
  - Opening the ground connection of the integrated line filter, degree of protection IP20 (Page 222)
  - Opening the ground connection of the integrated line filter, degree of protection IP55 (Page 223)
  - Connection overview, converter in degree of protection IP20 with sine-wave filter (Page 198)
  - G220 block diagram (Page 190)
  - G220 Clean Power block diagram (Page 191)
- Functions
  - Pulse frequency wobble (Page 788)
- Technical data
  - Expansion Rack for Option Modules (ER-OM) (Page 1123)
  - Option Module OM-AIO (Page 1122)
  - Current derating depending on the pulse frequency (Page 1093)
  - Current reduction at lower output frequencies (Page 1095)
  - Rated power, input current, output current (Page 1083)
  - Electrical data, sine-wave filter (Page 1129)
  - Current reduction as a function of the installation altitude and ambient temperature, IP20 (Page 1090)
  - Current reduction as a function of the installation altitude and ambient temperature, IP55 (Page 1092)

1.2.3 Target group

Overview

The Operating Instructions address the following target groups:

- Planning engineers
- Project engineers
- Technologists
- Installation personnel
- Programmers
- Commissioning engineers
- Machine operators
- Service and maintenance personnel

1.2.4 Standard scope

The functions of the system as delivered can only be found in the order documents.

Further functions may be executable in the system, which are not explained in this documentation. However, there is no entitlement to these functions in the case of a new delivery or service.

This documentation does not contain all detailed information on all types of the product. Furthermore, this documentation cannot take into consideration every conceivable type of installation, operation and service/maintenance.

The machine manufacturer must document any additions or modifications they make to the product themselves.

1.2.5 Use of third-party products in this documentation

Siemens does not accept any warranty for the use of third-party products. Suppliers recommended by Siemens are listed on the following Internet page (https://www.siemens.com/global/en/company/partners/product-partners-industry.html).

1.2.6 Websites of third-party companies

This document may contain hyperlinks to third-party websites. Siemens is not responsible for and shall not be liable for these websites and their content. Siemens has no control over the information which appears on these websites and is not responsible for the content and information provided there. The user bears the risk for their use.

1.3 Product documentation

Description

The product documentation for the converter is available on the Internet:

SiePortal SINAMICS (https://support.industry.siemens.com/cs/ww/en/view/109807358)

You can display documents or download them in PDF and HTML5 format.

The product documentation for the converter comprises the following documents:

Table 1-1 Product documentation

Information	Document	Contents
Information about the converter	Original SINAMICS G220, G210, G210X operating instructions	Compact information and safety instructions for the converter family
	SINAMICS G220 Equipment Manual	Installing, commissioning, and maintaining the converter
	Supplement to the equipment manual SINAMICS G210/G210X/ G220	Supplements the equipment manual to include the Braking Module.
	List Manual SINAMICS G220	Meaning, setting options and dependencies of the parameters and messages of the converter
	Protective devices SINAMICS G220	Suitable components for overcurrent protection of the converter Expansion of components contained in the equipment manual
	Application Manual SINAMICS Marine Systems	Requirements when using converters exclusively in marine applications Marine-specific measures and components
General information	Configuration Manual Industrial Cybersecurity	Industrial Cybersecurity functions and safe operation of the converter
Information about optional components	Operating instructions Smart Drive Interface SDI Pro 5.5"	Commissioning and performing diagnostics of the converter using the Smart Drive Interface SDI Pro 5.5" operating unit
	Operating instructions SINAMICS Smart Adapter	Installing a local wireless network with the SINAMICS Smart Adapter to commission and diagnose the converter using an operating unit
	Equipment Manual SINAMICS S220 Control Units and supplementary system components	Installation and connection of DRIVE-CLiQ components that can also be operated on the SINAMICS G220.

1.4 Service and Support

1.4.1 ID link and Siemens Online Support

You can find additional information about the product:

- via ID link
- using the Siemens Industry Online Support
  - Website: SiePortal (https://support.industry.siemens.com/cs/ww/en/)
  - App Industry Online Support (for Apple iOS and Android)

Product-specific information via ID link

There is a QR code on your product and the product packaging which contains an identification link (ID link).
The ID link serves as a Digital Nameplate (DNP) and is a globally unique identifier in accordance with IEC 61406-1. It links the product to the associated information from the Digital Product Passport (DPP).

Scan the QR code on the product or the packaging label with a smartphone camera, barcode scanner, or suitable app.

The ID link gives you access to relevant product information such as:

- Product data
- Manuals
- Declarations of Conformity
- Certificates



Figure 1-1 QR code with ID link

The ID link is characterized by a frame with a black corner at the bottom right.

Content of Siemens Online Support

- Product support
- Global forum for information and best practice sharing between users and specialists
- Local contact persons via the contact person database (→ Contact)
- Product information
- FAQs (frequently asked questions)
- Application examples
- Manuals
- Downloads
- Compatibility tool
- Newsletter with product selection
- Catalogs/brochures
- Certificates

1.4.2 Spare parts services

The "Spares on Web (https://www.sow.siemens.com)" online spare parts service offers spare parts for specific products.

1.4.3 Extended Warranty – Service Protect

Service Protect provides an extended warranty period for your registered hardware product, covering repair or replacement. The specific duration(s) of the extended warranty offering and the terms for repair or replacement are determined by the product type. Product registration @ myReg (https://myregistration.siemens.com/) is required.

1.5 Important product information

1.5.1 Names of drive technology terms

Overview

This manual contains simplified names of drive technology terms which have other names in normal usage or in a different context.

Description

Drive, frequency converter, AC/AC converter, servo converter or converter is the name for an electronic device for variable speed control of an electric motor. The electric motor is available in different versions as an induction motor, synchronous motor or synchronous reluctance motor.

In this document, Siemens uses the names "converter" and "drive" to mean the same thing and regardless of whether a converter or servo converter is meant.

A drive system means all of the components that are required to implement a drive task. For instance, a drive system comprises line-side switchgear, rectifier transformers, converters, output filters, motors, encoders, conductors, monitoring equipment, open-loop and closed-loop controlling systems.

In this document, Siemens uses the term "drive system" regardless of whether a converter or servo converter is meant in the context of a motor and cables.

A drive line-up is a system of converters that are supplied via a shared DC link or that communicate via DRIVE-CLiQ with a shared Control Unit.

Examples for converters that form a drive line-up:

- Several SINAMICS S210 with common DC link
- A SINAMICS S120 or SINAMICS S220 with a central Control Unit and components connected via DRIVE-CLiQ

In this document, Siemens uses the term "converter" regardless of whether a single converter or a drive line-up is meant.

1.5.2 Intended use

Precondition

⚠ WARNING

Death or serious injury if not used for the intended purpose

Not using for the intended purpose can result in hazardous states.

- Carefully observe the description of intended use.

Note

It cannot be guaranteed that EMC emission limits are complied with if the products are connected to an isolated line supply grounded through a high ohmic connection or a line supply with grounded line conductor.

When operating a Smart Line Module without line filter connected to a TN or TT system, EMC emission limits are not complied with.

- Draw-up an EMC plan to comply with the EMC requirements of the intended application.

Description

The products described in this document, together with software, accessories and options, form an electric drive to supply low-voltage, three-phase motors.

The products are professional devices for stationary indoor use in industrial, light-industrial and commercial applications and are intended for supply from a non-public (industrial) low-voltage network. The products are not intended for use in residential areas and are not intended for supply from a public low-voltage grid.

The products must be correctly transported and stored and must be installed, commissioned and maintained by professionals who have adequate knowledge to implement the safety, cybersecurity and EMC measures in accordance with the specifications described in this manual and recognized state-of-the-art engineering practice.

You may only use the products when the following requirements are complied with:

- All regulations and directives that are applicable at the place of final use, especially with regard to electrical safety, functional safety and electromagnetic compatibility (EMC).
- All instructions, notes, technical specifications, safety information, and cybersecurity information contained in this document and other supporting documentation.

The products are part of a machine or system. They must guarantee the safety of persons and material assets as well as electromagnetic compatibility by applying suitable measures when designing the system.

A risk assessment of the complete application, including third-party products and implementation of adequate safety and cybersecurity measures must be performed before you use the product.

Products without protective enclosure (IP00 or IP20) are intended for installation in control panels or control cabinets that provide the required level of protection.

Any other use that is not expressly permitted can result in malfunctions and unpredictable hazards.

1.5.3 Firmware updates and constraints

Description

Firmware updates and constraints for the converters with the current firmware are available in the Internet:

Updates and constraints, SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109807094)

1.5.4 Open-source software (OSS)

Description

The license conditions and copyright information of the open-source software components used by the device are saved on the device itself. You can download license and copyright information onto your PC via the support page of the integrated web server.

1.5.5 Compliance with the General Data Protection Regulation

Description

Siemens complies with the principles of the **General Data Protection Regulation (EU),** in particular the principle of data minimization ("privacy by design"). For this SINAMICS product, this means:

- **User management and access control (UMAC)**
  The product processes or stores the following personal data:
  - Login data for user management and access control:
    User name, group, password, role, rights.

  The data for user management and access control is stored in the converter and optionally on a memory card.
- **Support data (optional)**
  For optimal support in service cases, the end user or machine manufacturer (OEM) can optionally store contact data (header, email address, telephone number, homepage) in the converter.
  If this data is created, the author must give thought to data protection consent for this optional data. Siemens takes no responsibility for this data.
  This support contact data can be read and is freely accessible in, for example, the user interface as well as in the diagnostics report. This data is not encrypted.

This data is used for user management and access control (UMAC) and for the support function. The storage of this data is appropriate and limited to what is necessary, as it is essential to identify the authorized operators and service contact.

The personal data is also available as part of the backup system to ensure fast recovery of use cases.

The above-mentioned personal data cannot be stored anonymously or pseudonymized, as it serves the purpose of identifying the operating personnel. The anonymization or pseudonymization, e.g. of the login data, must be performed using suitable login names and contact data by the plant/machine operator.

Our product does not provide any functions for automatically deleting personal data. Individual UMAC data can be deleted manually by authorized personnel as soon as this is deemed recommended/required.

Fundamental safety instructions

2

2.1 General safety instructions



⚠ WARNING

Electric shock and danger to life due to other energy sources

Touching live components can result in death or severe injury.

- Only work on electrical devices when you are qualified for this job.
- Always observe the country-specific safety rules.

Generally, the following steps apply when establishing safety:

1. Prepare for disconnection. Notify all those who will be affected by the procedure.
2. Isolate the drive system from the power supply and take measures to prevent it being switched back on again.
3. Wait until the discharge time specified on the warning labels has elapsed.
4. Check that there is no voltage between any of the power connections, and between any of the power connections and the protective conductor connection.
5. Check whether the existing auxiliary supply circuits are de-energized.
6. Ensure that the motors cannot move.
7. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water. Switch the energy sources to a safe state.
8. Check that the correct drive system is completely locked.

After you have completed the work, restore the operational readiness in the inverse sequence.



⚠ WARNING

Risk of electric shock and fire from supply networks with an excessively high impedance

Excessively low short-circuit currents can lead to the protective devices not tripping or tripping too late, and thus causing electric shock or a fire.

- In the case of a conductor-conductor or conductor-ground short-circuit, ensure that the short-circuit current at the point where the converter is connected to the line supply at least meets the minimum requirements for the response of the protective device used.
- You must use an additional residual-current device (RCD) if a conductor-ground short circuit does not reach the short-circuit current required for the protective device to respond. The required short-circuit current can be too low, especially for TT supply systems.



⚠ WARNING

Risk of electric shock and fire from supply networks with an excessively low impedance

Excessively high short-circuit currents can lead to the protective devices not being able to interrupt these short-circuit currents and being destroyed, and thus causing electric shock or a fire.

- Ensure that the prospective short-circuit current at the line terminal of the converter does not exceed the breaking capacity (SCCR or Icc) of the protective device used.



⚠ WARNING

Electric shock in the absence of grounding

For products with protection class I, a faulty protective conductor connection means that the product is not grounded in conformance with the applicable regulations. In the absence of grounding, high voltages may be present in open, exposed parts, which can result in serious injury or death if touched.

- Ground the product in conformance with the applicable regulations.



⚠ WARNING

Electric shock due to connection to an unsuitable power supply

When equipment is connected to an unsuitable power supply, exposed components may carry a hazardous voltage. Contact with hazardous voltage can result in severe injury or death.

- Only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV- (Protective Extra Low Voltage) output voltages for all connections and terminals of the electronics modules.



⚠ WARNING

Electric shock from a damaged product

Improper handling can damage the product. If a product is damaged, hazardous voltages may be present on the housing or exposed components, which can result in serious injury or death if touched.

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Never use a damaged product.



⚠ WARNING

Electric shock due to unconnected cable shield

Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields.

- As a minimum, connect cable shields and the conductors of power cables that are not used (e.g. brake cores) at one end at the grounded housing potential.



⚠ WARNING

Arcing when a plug connection is opened during operation

Opening a plug connection when a system is in operation can result in arcing that may cause serious injury or death.

- Only open plug connections when the equipment is in a voltage-free state, unless it has been explicitly stated that they can be opened in operation.



⚠ WARNING

Electric shock due to residual charges in power components

Because of the capacitors, a hazardous voltage is present for up to 5 minutes after the power supply has been switched off. Contact with live parts can result in death or serious injury.

- Wait for 5 minutes before you check that the unit really is in a no-voltage condition and start work.

NOTICE

Product damage caused by an unsuitable screw-tightening tool

Unsuitable screw-tightening tools or tightening methods can damage the product screws.

- Use a screw-tightening tool that fits the screw head exactly.
- Tighten the screws with the torque specified in the technical documentation.
- Use a torque wrench or a mechanical precision nut runner with a dynamic torque sensor and speed limitation system.
- Regularly calibrate the screw-tightening tool used.

NOTICE

Property damage due to loose power connections

An insufficient tightening torque or vibrations can result in loose power connections. This can result in damage due to fire, product defects, or malfunctions.

- Tighten all power connections to the prescribed torque.
- Regularly check all power connections, particularly after equipment has been transported.

⚠ WARNING

Electromagnetic interference due to inadequate shield support

A lack of adequate shield support for the power cables can cause malfunctions and impermissibly high levels of interference.

- Use the shield connection plates supplied or recommended.
- Use the shield connection clips recommended.

⚠ WARNING

Active implant malfunctions due to electromagnetic fields

Converters generate electromagnetic fields (EMF) in operation. Electromagnetic fields may interfere with active implants, e.g. pacemakers. People with active implants in the immediate vicinity of an converter are at risk.

- As the operator of an EMF-emitting installation, assess the individual risks of persons with active implants.
- Observe the data on EMF emission provided in the product documentation.

⚠ CAUTION

Symptomatic respiratory and skin reaction to chemicals

A newly purchased product might contain traces of substances that are identified as sensitizers.

Sensitizers are substances which can cause sensitization in the lungs and skin after exposure to them.

Once sensitized, individuals can have severe reactions to further exposure, even in small amounts. In the most extreme cases, individuals might develop asthma or dermatitis respectively.

- If the product has a strong smell, keep it in a well-ventilated area for 14 days.

⚠ WARNING

Unexpected machine motion caused by radio devices or cell phones

Radio devices, cell phones, or mobile WLAN devices in the immediate vicinity of the product can cause the product to malfunction or damage the product. The malfunction may impair the functional safety of machines and can therefore endanger persons or result in material damage.

- Avoid operating radio devices, cell phones, and mobile WLAN devices in the direct vicinity of converters and operating units.
- Scan the machine readable code, e.g. a QR code at least 0.4 m away from the converter, or switch off the converter power supply before scanning.
- Only operate built-in devices with the control cabinet doors closed.
- When the control cabinet doors are open, only qualified personnel may perform service and maintenance work.

⚠ CAUTION

Radio frequency interference in residential areas

When you operate products with EMC category C2 in residential areas, the products may cause radio frequency interference.

When you operate products with EMC category C3 or C4 in residential areas, it is to be expected that the devices will cause radio frequency interference.

- Do not operate products with EMC category C2 in residential areas.
- Do not operate products with EMC category C3 or C4 in public low-voltage grids that supply residential buildings.

NOTICE

Damage to motor insulation due to excessive voltages

When operated on systems with grounded line conductors or in the event of a ground fault in the IT system, the motor insulation can be damaged by the higher voltage against ground. If you use motors that have insulation that is not designed for operation with grounded line conductors, you must perform the following measures:

- IT system: Use a ground fault monitor and eliminate the fault as quickly as possible.
- TN or TT systems with grounded line conductor: Use an isolating transformer on the line side.



⚠ WARNING

Electric shock due to unsuitable motor temperature evaluation system

Voltage flashovers to the electronics of the converter can occur in motors without safe electrical separation of the temperature sensors in accordance with IEC 61800-5-1 when the motor develops a fault.

- Install a temperature monitoring relay 3RS1... or 3RS2...
- Evaluate the temperature monitoring relay output using a digital input of the converter, e.g. using the "External fault" function.

⚠ WARNING

Fire due to inadequate ventilation clearances

Inadequate ventilation clearances can cause the product to overheat and result in fire and smoke. A fire with smoke development can result in serious injury or death. Overheating increases the probability of failure and shortens product service life.

- Observe the minimum distances specified for the product as ventilation clearances.

NOTICE

Overheating due to inadmissible mounting position

The product can overheat and therefore be damaged if mounted in an incorrect position.

- Only operate the product in approved mounting positions.

⚠ WARNING

Unrecognized dangers due to missing or illegible warning labels

Dangers might not be recognized if warning labels are missing or illegible. Unrecognized dangers may cause accidents resulting in serious injury or death.

- Check that the warning labels are complete based on the documentation.
- Attach any missing warning labels to the components, where necessary in the national language.
- Replace illegible warning labels.

NOTICE

Product damage caused by improper insulation resistance testing

High test voltages can damage the product.

- Measure the insulation resistance of low voltage circuits of machines or systems only with ≤ 500 V DC.
- Measure the insulation resistance of SELV circuits of machines or systems only with ≤ 250 V DC.

NOTICE

Product damage caused by improper voltage testing

High test voltages can damage the product. Capacitive leakage currents can distort the test results.

- Disconnect the products before carrying out voltage testing on the machine. [1)]

[1)] The products are subject to a voltage test in accordance with the IEC 61800-5-1 product standard and must be disconnected during testing in accordance with IEC 60204-1:2021 Section 18.4.

⚠ WARNING

Unexpected movement of machines caused by inactive safety functions

Inactive or non-adapted safety functions can trigger unexpected machine movements that may result in serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.
- Perform a function test.
- Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

⚠ WARNING

Malfunctions of the machine as a result of incorrect or changed parameter settings

As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect the parameterization against unauthorized access.
- Handle possible malfunctions by taking suitable measures, e.g. EMERGENCY STOP or EMERGENCY OFF.

2.2 Product damage due to electric fields or electrostatic discharge

Electrostatic sensitive devices (ESDs) are electronic devices, modules, or individual components with freely accessible contacts, e.g. products with signal and communication interfaces or modules without an enclosed housing, which can be damaged by electrostatic fields or electrostatic discharges.



NOTICE

Product damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can damage individual electronic components, integrated circuits, and modules. A pre-damaged or damaged product causes malfunctions, which in turn increase the probability of failure and a shortened service life.

- Only pack, store, transport, and ship individual electronic components, modules, or products in their original packaging or in other suitable materials, e.g. conductive ESD foam or aluminum foil.
- When you open the product, e.g. to replace a component or a module, or if you touch electrical contacts, then ground yourself using one of the following measures:
  - Wear an ESD armband
  - Wear ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic modules or individual components on a conductive surface, e.g. on an ESD surface, on ESD foam, on an ESD packaging bag, or an ESD transport container.

2.3 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment, or any eventuality which may arise. Application examples do not represent customer-specific solutions, but merely serve to provide assistance with typical tasks.

As the user you yourself are responsible for ensuring that the products described are operated correctly. Application examples do not relieve you of your responsibility for safe handling when using, installing, operating and maintaining the equipment.

2.4 Cybersecurity information

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial cybersecurity concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial cybersecurity measures that may be implemented, please visit
https://www.siemens.com/cybersecurity-industry.

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Cybersecurity RSS Feed under
https://www.siemens.com/cert.

Further information is provided on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/ww/en/view/109975311)

⚠ WARNING

Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a state-of-the-art, integrated industrial cybersecurity concept for the installation or machine.
- Make sure that you include all installed products in the integrated industrial cybersecurity concept.
- Protect files stored on exchangeable storage media from malicious software with suitable protection measures, e.g. virus scanners.
- Carefully check all cybersecurity-related settings once commissioning has been completed.

2.5 Residual risks of power drive systems

When assessing the machine or system-related risk in accordance with the respective local regulations (e.g. EC Machinery Directive), the machine manufacturer or system integrator must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine or system components during commissioning, operation, maintenance, and repairs caused by, for example,
   - Hardware faults and/or software errors in the sensors, control system, actuators, and connections
   - Response times of the control system and of the drive
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of wireless devices/mobile phones in the immediate vicinity of electronic components
   - External influences/damage
   - X-ray, ionizing radiation and cosmic radiation
2. Unusually high temperatures inside and outside the components, including open flames, as well as emissions of light, noise, particles, gases, etc. due to fault conditions, e.g.:
   - Component failure
   - Software errors
   - Operation and/or environmental conditions outside the specification
   - External influences/damage
   - Short circuits or ground faults in the intermediate DC circuit of the converter
3. Hazardous shock voltages caused by, for example:
   - Component failure
   - Influence during electrostatic charging
   - Induction of voltages in moving motors
   - Operation and/or environmental conditions outside the specification
   - Condensation/conductive contamination
   - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

6. Influence of network-connected and wireless communications systems, e.g. ripple-control transmitters or data communication via the network or mobile radio, WLAN or Bluetooth.
7. Motors for use in potentially explosive areas:
   When moving components such as bearings become worn, this can cause enclosure components to exhibit unexpectedly high temperatures during operation, creating a hazard in areas with a potentially explosive atmosphere.

For more information about the residual risks of the drive system components, see the relevant sections in the technical user documentation.

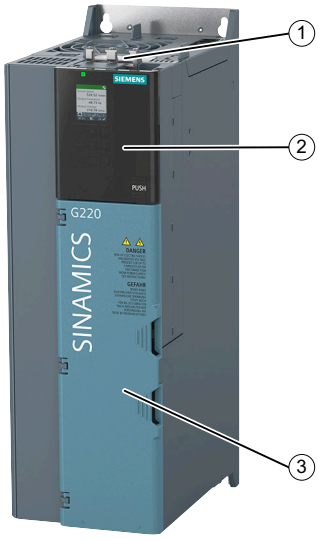
Description

3

3.1 Converters with degree of protection IP20 or UL open type

Description

The converter in degree of protection IP20 or UL open type is intended for installation in a control cabinet.



① Fieldbus connection
② Front flap to access the following components:
- SINAMICS SDI Standard operator interface
- Service interface for commissioning tool
- Memory card slot

③ Front cover or front door for connecting cables

Figure 3-1 Converter in degree of protection IP20, frame size FSC

3.2 Scope of supply, converters with degree of protection IP20 or UL open type

Description

The delivery comprises the following components:

- 1 ready-to-run converter with loaded firmware
- 1 auxiliary fan, if more than 1 option module is ordered with the converter.

- 1 hole drilling template for converter installation
- 1 set of printed documentation with warning notes in several languages
- 1 set of printed documentation with information on warranty conditions
- 1 adhesive label with danger and warning notes for the North American market
- Adhesive warning labels in several languages
- 1 set of upper shield plates, including mounting hardware
- Converters with integrated line filter: 1 set of lower shield plates, including mounting hardware
- The converter contains open source software.
  The license conditions for the open source software are saved in the converter and can be read out using a commissioning tool.

3.3 Converter in degree of protection IP55 or UL type 12

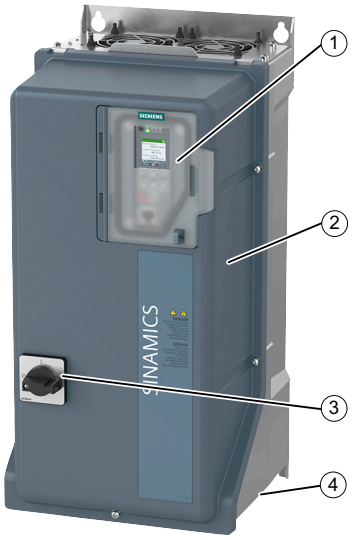
Precondition

NOTICE
Damage to the maintenance switch when it is actuated while a motor is operational
Interrupting the converter input current when actuating the maintenance switch while a motor is operational can result in an overvoltage condition. An overvoltage can damage the maintenance switch. • Only actuate the maintenance switch if the motor is switched off.

Description

The converter with degree of protection IP55/UL type 12 is intended for cabinet-free installation.

The converter housing is not UV-resistant, which means that it must only be installed indoors.



① Front door to access the following components:
- SINAMICS SDI Standard operator interface
- Service interface for commissioning tool

② Enclosure cover to access the following components:
- Memory card slot
- Connecting cables

③ Maintenance switch

The optional maintenance switch allows the converter to be electrically isolated from the line supply.

④ Bushing for connection cables

Figure 3-2 Converter with degree of protection IP55, frame size FSC

The converter complies with degree of protection IP55/UL type 12 under the following conditions:

- The enclosure cover is attached.
- The front door is closed.
  When using the SINAMICS SDI Pro 5.5" in the converter, the SINAMICS SDI Pro 5.5" is correctly mounted in the IP55 mounting frame.
- All entries for the connecting cables in the gland plate are sealed using screw glands, which are suitable for degree of protection IP55/UL type 12.
- The fan unit is installed in the converter.

3.4 Scope of delivery, degree of protection IP55 or UL type 12

Description

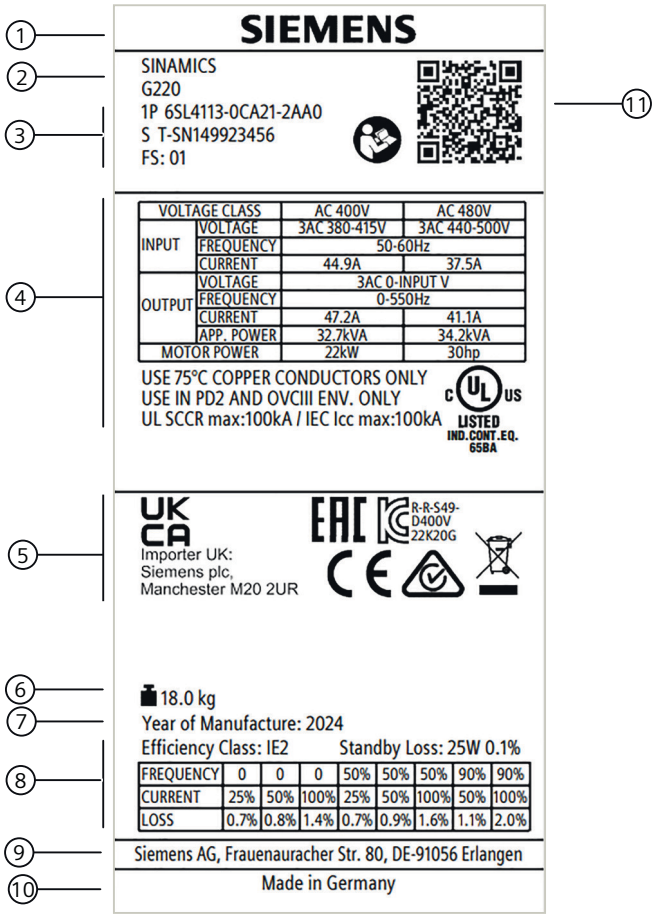
The delivery comprises the following components:

- 1 ready-to-run converter with loaded firmware
- 1 gland plate for the connecting cables
- 1 auxiliary fan, if more than 1 option module is ordered with the converter.
- 1 hole drilling template for converter installation
- 1 set of printed documentation with warning notes in several languages
- 1 set of printed documentation with information on warranty conditions
- 1 adhesive label with danger and warning notes for the North American market
- Adhesive warning labels in several languages
- The converter contains open source software.
  The license conditions for the open source software are saved in the converter and can be read out using a commissioning tool.

3.5 Nameplate

Description

The nameplate contains information about the converter.



① Manufacturer
② Product designation
③ 1P Article number
S Serial number
FS Functional state
(Edition or hardware release)
④ Technical data
⑤ Certificates
⑥ Weight
⑦ Production year
⑧ Power loss data
⑨ Manufacturer's address
⑩ Country of origin
⑪ QR code

Figure 3-3 Converter type plate

3.6 Explanation of the article number

Overview

The converter nameplate contains the Article No. in which the technical features of the converter are coded.

Description

6SL411	☐	-	☐	☐	☐	☐	☐	-	☐	☐	☐	0	+	Z option
											A	Converter without communication module		
											B	Communication Module Modbus RTU		
											D	Communication Module PROFIBUS		
											F	Communication Module PROFINET/Ethernet		
										A	Without option module			
										B	Option module OM-DQ			
										E	Option module OM-IIoT			
										F	Option module OM-SMT			
									0	Without line filter				
									2	Line filter for EMC category C2				
									3	Line filter for EMC category C3				
						.	.	Coding for the rated power						
					A	Basic version								
					P	Gland plate for connecting cables with degree of protection IP55 according to IEC								
					Q	Gland plate for connecting cables with UL type 12 degree of protection								
				C	Degree of protection UL open type, IP20, Class 3C2									
				D	Degree of protection UL open type, IP20, Class 3C3									
				J	UL type 12, degree of protection IP55, Class 3C2									
				K	UL type 12, degree of protection IP55, Class 3C3									
				L	UL type 12, degree of protection IP55, Class 3C2, maintenance switch									
				M	UL type 12, degree of protection IP55, Class 3C3, maintenance switch									
			0	Converter in the standard version										
			2	Clean Power Converter										
	2	3 AC 200 ... 240 V												
	3	3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V												

Overview Z option:

- T01: Option module OM-DQ
- T04: Option module OM-IIoT
- T05: Option module OM-SMT
- T06: Option module OM-ENC
- T10: Option module OM-DIO
- T11: Option module OM-AIO

- T40: SDI blind cover
- T43: SDI Pro 5.5", IP55

Table 3-1 Coding for the rated power

6SL411 . - . . .	☐	☐	- . . . 0
	0	5	0.55 kW
	0	6	0.75 kW
	0	8	1.1 kW
	1	0	1.5 kW
	1	1	2.2 kW
	1	2	3 kW
	1	3	4 kW
	1	5	5.5 kW
	1	6	7.5 kW
	1	7	11 kW
	1	8	15 kW
	2	0	18.5 kW
	2	1	22 kW
	2	3	30 kW
	2	4	37 kW
	2	6	45 kW
	2	7	55 kW
	3	0	75 kW
	3	1	90 kW
	3	3	110 kW
	3	5	132 kW
	3	6	160 kW

3.7 Converter frame size and rated power, degree of protection IP20

Description

Table 3-2 Line voltage 3 AC 200 V ... 240 V, degree of protection IP20

Converter in the standard version	
Frame size	**Rated power in kW**
FSA	0.55
	0.75
	1.1
	1.5
	2.2

Converter in the standard version	
Frame size	**Rated power in kW**
FSB	3
	4
FSC	5.5
	7.5
FSD2	11
	15
	18.5
FSE	22
	30
FSF1	37
	45
	55

Table 3-3 Line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP20

Converter in the standard version		**Clean Power Converter**	
Frame size	**Rated power in kW**	**Frame size**	**Rated power in kW**
FSA	1.1	-	-
	1.5		
	2.2		
	3		
	4		
FSB	5.5		
	7.5	FSD1	7.5
FSC	11		11
	15		15
FSD1	18.5		18.5
	22		22
FSD2	30	FSD2	30
	37		37
FSE	45	FSE	45
	55		55
FSF1	75	FSF1	75
	90		90
	110		110
FSF2	132	FSF2	132
	160		160

3.8 Converter frame size and rated power, degree of protection IP55

Description

Table 3-4 Line voltage 3 AC 200 V ... 240 V, degree of protection IP55

Converter in the standard version	
Frame size	**Rated power in kW**
FSB	1.1
	1.5
	2.2
	3
	4
FSC	5.5
	7.5
FSD2	11
	15
	18.5
FSE	22
	30
FSF1	37
	45
	55

Table 3-5 Line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP55

Converter in the standard version		**Clean Power Converter**	
Frame size	**Rated power in kW**	**Frame size**	**Rated power in kW**
FSB	1.1	-	-
	1.5		
	2.2		
	3		
	4		
	5.5		
	7.5	FSD1	7.5
FSC	11		11
	15		15
FSD1	18.5		18.5
	22		22
FSD2	30	FSD2	30
	37		37

Converter in the standard version		Clean Power Converter	
Frame size	**Rated power in kW**	**Frame size**	**Rated power in kW**
FSE	45	FSE	45
	55		55
FSF1	75	FSF1	75
	90		90
	110		110

3.9 Optional components

3.9.1 Braking Module

3.9.1.1 Function of the Braking Module

Description

An external Braking Module is optionally available for converters with a rated power of 132 kW ... 160 kW, frame size FSF2.

While the motor brakes, the Braking Module monitors the DC link voltage of the converter.

When reaching the set braking voltage, the Braking Module pulses the braking resistors. As a consequence, the Braking Module limits the voltage in the DC link and protects the converter against overvoltage.

More information

Operating Instructions SINAMICS G210/G210X/G220 Braking Module Supplement contains more information. See Product documentation (Page 24).

3.9.1.2 Order data, Braking Module

Table 3-6 Order data, Braking Module, degree of protection IP20, 3 AC 400 ... 480 V +10 %

Rated power of the converter in kW	Braking Module
132 ... 160	NW2:160BC2LC-15-S01

3.9.2 Braking resistor

3.9.2.1 Function of the braking resistor

Description

When the motor is in regenerative mode, the braking resistor converts the braking energy of the motor into heat. This enables the converter to actively and dynamically brake the motor and the load machine attached to the motor.

Because the braking resistor heats up strongly during braking, the braking resistor is only suitable for short-duration braking operations.

To prevent overheating of the braking resistor, the converter must monitor the temperature of the resistor:

- Monitoring of the temperature switch in the braking resistor
- Additionally, optional activation of temperature monitoring using a thermal model in the software

3.9.2.2 Order data, braking resistor, 3 AC 200 ... 240 V

Table 3-7 Order data braking resistor, degree of protection IP20

Rated power of the converter	Braking resistor
0.55 kW ... 2.2 kW	JJY:023151720007
3 kW ... 4 kW	JJY:023163720018
5.5 kW ... 7.5 kW	JJY:023433720001

Table 3-8 Order data for braking resistor, degree of protection IP21

Rated power of the converter	Braking resistor
11 kW ... 18.5 kW	JJY:023422620002
22 kW ... 30 kW	JJY:023423320001
37 kW ... 55 kW	JJY:023434020003

3.9.2.3 Order data, braking resistor, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Table 3-9 Order data braking resistor, degree of protection IP20

Rated power of the converter	Braking resistor
1.1 kW ... 1.5 kW	6SL3201-0BE14-3AA0
2.2 kW ... 4 kW	6SL3201-0BE21-0AA0
5.5 kW ... 7.5 kW	6SL3201-0BE21-8AA0
11 kW ... 15 kW	6SL3201-0BE23-8AA0

Table 3-10 Order data for braking resistor, degree of protection IP21

Rated power of the converter	Braking resistor
18.5 kW ... 22 kW	JJY:023422620001
30 kW ... 37 kW	JJY:023424020001
45 kW ... 55 kW	JJY:023434020001
75 kW	JJY:023454020001
90 kW ... 110 kW	JJY:023464020001[1)] JJY:023434020001 ‖ JJY:023434020001

[1)] The article number contains two braking resistors, which are connected in parallel.

3.9.3 dV/dt filter plus Voltage Peak Limiter

3.9.3.1 Function of the dv/dt filter plus Voltage Peak Limiter

Requirement

The following conditions apply when using the dv/dt filter plus Voltage Peak Limiter:

- Output frequency of the converter ≤ 150 Hz
- Pulse frequency of the converter ≤ 4 kHz

NOTICE
Damage to the dv/dt filter when incorrectly parameterized A converter with incorrect parameterization can damage the dv/dt filter in operation. • Parameterize the dv/dt filter with p0230.

Description

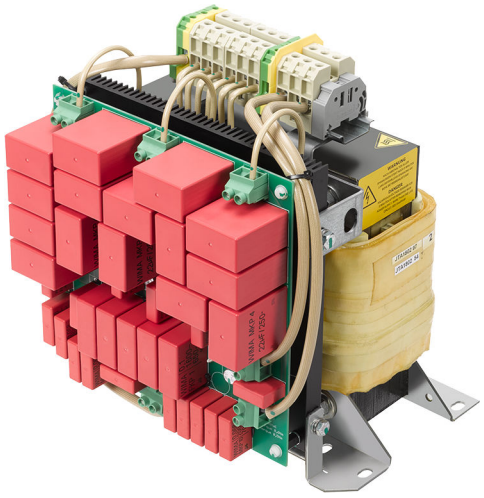


Figure 3-4 dv/dt filter plus Voltage Peak Limiter (VPL)

The dv/dt filter plus Voltage Peak Limiter is intended for motors for converter operation where the voltage strength is either unknown or is not adequate.

The dv/dt filter plus Voltage Peak Limiter limits the voltage rate of rise at the converter output and the voltage peaks.

The dv/dt filter plus Voltage Peak Limiter also increases the permissible motor cable length.

3.9.3.2 Order data for du/dt filter plus Voltage Peak Limiter

Table 3-11 Order data du/dt filter plus Voltage Peak Limiter, degree of protection IP00 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Rated power of the converter	du/dt filter plus VPL[1)]
18.5 kW	JTA:TEF1203-0HB
22 kW	JTA:TEF1203-0JB
30 kW ... 45 kW	JTA:TEF1203-0KB
55 kW	JTA:TEF1203-0LB
75 kW ... 110 kW	JTA:TEF1203-0MB

1) Install the du/dt filter plus VPL in an enclosure

3.9.4 External line filters for converter in degree of protection IP20, IP55, 3 AC 200 ... 240 V

Description

In certain cases, there are external line filters for unfiltered 3 AC 200 ... 240 V converters The external line filters make it possible to achieve EMC category C3.

More information

You can find more information on the Internet:

External line filters (https://support.industry.siemens.com/cs/ww/en/view/109995256)

3.9.5 Sine-wave filter

3.9.5.1 Sine-wave filter function

Description

The sine-wave filter limits the voltage gradient and the capacitive recharging currents that generally occur in converter operation. Therefore, when a sine-wave filter is used, longer screened motor feeder cables are possible and the motor service life reaches the same values that are achieved when the motor is connected directly to the line supply.

When using a sine-wave filter, observe the following restrictions:

- Operation is only permissible with pulse frequencies from 4 kHz ... 8 kHz.

  Note

  Operation with a pulse frequency of 2 kHz will overheat the sine-wave filter.

- It must be ensured that the automatic pulse frequency reductions are deactivated.
- The output frequency must not exceed 150 Hz.
- For UL applications: Operation is only permissible up to a maximum ambient temperature of 40 °C.
- Operation and commissioning may only be performed with the motor connected because the sine-wave filter is not no-load proof.
- An output reactor is not required.

NOTICE
Damage to the sine-wave filter if it is not activated during commissioning The sine-wave filter may be damaged if it is not activated during commissioning. • Activate the sine-wave filter during commissioning via parameter p0230. • Activate the sine-wave filter during commissioning according to the electric specifications.

3.9.5.2 Sine-wave filter order data

Table 3-12 Order data sine-wave filter, degree of protection IP20, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Rated power of the converter in kW	Sine-wave filter
1.1 ... 2.2	6SL3202-0AE21-1SA0
3 ... 4	6SL3202-0AE21-4SA0
5.5	6SL3202-0AE22-0SA0

Table 3-13 Order data sine-wave filter, degree of protection IP00, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Rated power of the converter in kW	Sine-wave filter
7.5 ... 15	6SL3202-0AE24-6SA0
18.5 ... 22	6SL3202-0AE26-2SA0
30 ... 37	6SL3202-0AE28-8SA0
45 ... 55	6SL3202-0AE31-8SA0

3.9.6 PROFINET cable, converter in degree of protection IP55 or UL type 12

Description

The restricted space between the PROFINET interface and the housing cover requires a PROFINET cable with a variable connector.

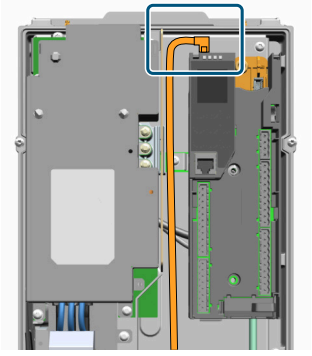


Figure 3-5 PROFINET cable with variable connector

Depending on the frame size, we recommend the following cable lengths:

PROFINET cable		
Converter frame size	**PROFINET cable length**	**Article number**
FSB	0.4 m	HTG:09488411745004
FSC, FSD1, FSD2	0.5 m	HTG:09488411745005
FSE, FSF1	0.6 m	HTG:09488411745006
	0.7 m	HTG:09488411745007
	0.8 m	HTG:09488411745008

3.9.7 PROFIBUS adapter cable order data

The restricted space between the PROFIBUS interface and the housing cover requires an adapter cable.

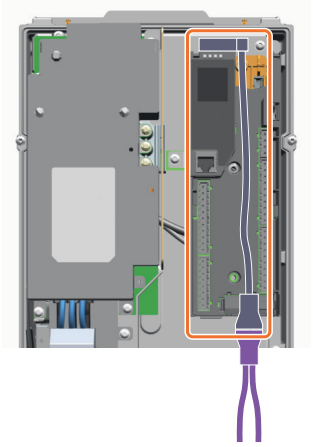


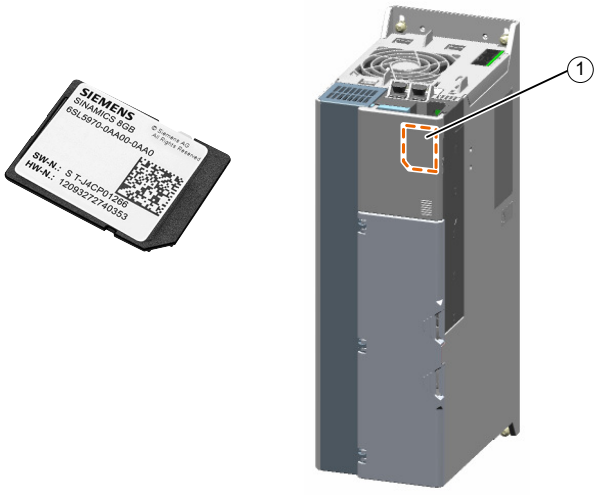
Figure 3-6 PROFIBUS adapter cable for converters with degree of protection IP55

PROFIBUS adapter cable	
Designation	**Article number**
Adapter cable for converters of frame sizes FSB, FSC, IP55	6SL4950-0AJ00-0AD0

3.9.8 Memory card

3.9.8.1 Memory card function

Function description



① Memory card slot

Figure 3-7 Memory card, slot based on example of converter in degree of protection IP20

The converter supports FAT32-format memory cards with a capacity of up to 32 GB.

The converter can be operated with or without a memory card inserted.

A permanently inserted memory card from Siemens is required to use functions that require a license.

We recommend a memory card from Siemens for the following cases:

- Transfer of the converter settings from one converter to another
- Firmware update

3.9.8.2 Memory card ordering data

Memory card (SD card)		
Memory card content	**Article number**	**Z option**
empty	6SL5970-0AA00-0AA0	
Firmware V6.7	6SL4170-1GH00-0AA0	
SINAMICS Safety Integrated Extended	6SL5977-0AA00-2HA0	F01
SINAMICS Drive Control Chart Advanced	6SL5977-0AA00-3FA0	J04
SINAMICS Drive Control Chart Extended	6SL5977-0AA00-2FA0	J03
SINAMICS High Output Frequency	6SL5977-0AA02-0AA0	J01
SINAMICS OPC UA Single Extended	6SL5977-0AA00-1GA0	H80

Memory card (SD card)		
Memory card content	**Article number**	**Z option**
SINAMICS Positioning Advanced	6SL5977-0AA00-3EA0	E02
SINAMICS Positioning Extended	6SL5977-0AA00-2EA0	E01
SINAMICS Vibration Suppression Extended	6SL5977-0AA00-7EA0	E14

Example:

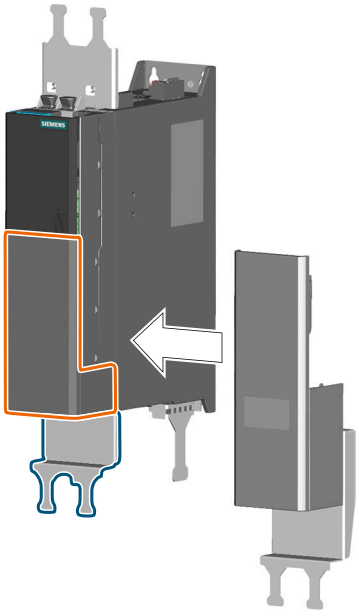
Article number of an empty memory card with licenses "SINAMICS Safety Integrated Extended" and "SINAMICS Drive Control Chart Extended":

6SL5970-0AA00-0AA0-Z F01 + J03

3.9.9 Expansion adapter for option modules

3.9.9.1 Function of the expansion adapter

Description



The expansion adapter for option modules expands the options for operating option modules in converters with degree of protection IP20 in frame size FSA.

The expansion adapter for option modules replaces the front cover and the lower shield plate of the converter.

3.9.9.2 Order data, expansion adapter for option modules

Expansion adapter for option modules	
Description	**Article number**
The expansion adapter for option modules can be ordered with the "Shield connection kit 1 FSA"	6SL4900-0AM20-0AA0

3.9.10 Expansion Rack for Option Modules (ER-OM)

3.9.10.1 Function, Expansion Rack for Option Modules (ER-OM)

Overview

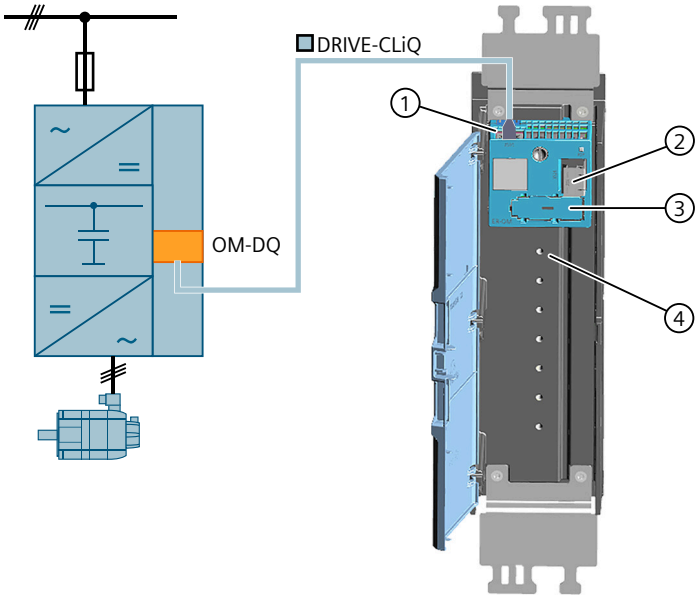
The Expansion Rack for Option Modules (ER-OM) in degree of protection IP20 has additional slots for option modules.

Requirement

Operating the ER-OM requires the following:

- External 24 V power supply at terminal strip X524
- Converter with OM-DQ option module and DRIVE-CLiQ cable

Description



① DRIVE-CLiQ connection at the ER-OM
② Terminal strip X524
③ Slot for the optional auxiliary fan
④ Option slot for option modules

Figure 3-8 Expansion Rack for Option Modules (ER-OM)

3.9.10.2 Order data of the Expansion Rack for Option Modules (ER-OM)

Expansion Rack for Option Modules ER-OM and accessories	
Description	**Article number**
Expansion Rack for Option Modules (ER-OM)	6SL4960-0AM00-0AA0
SINAMICS DRIVE-CLiQ signal cable[1)]	6FX2002-1DC00-....

1) Not included in the scope of delivery

3.9.11 Option module OM-SMT

Overview

The Option Module OM-SMT extends the functional scope of the converter.

In hazardous areas, the Option Module OM-SMT is suitable for monitoring the temperature of explosion-protected motors with the following explosion protection types:

- db, eb, and pxb for gas
- tb and pxb for dust

Requirement

For the certified shutdown of the explosion protected motors according to Directive 2014/34/EU (ATEX) or Regulation 2016 No. 1107 (UKEX), only suitable explosion protected motors having a type A sensor in accordance with IEC 60947-8 are permitted to be used in the corresponding hazardous zones.

The explosive areas must be defined by the operator in accordance with Directive 1999/92/EC. The OM-SMT and the converter must be located outside the explosive areas.

Description



Figure 3-9 Option module OM-SMT

Option module OM-SMT can be installed in the converter or in the expansion rack ER-OM.

The Option Module OM-SMT monitors the temperature of motors via connected PTC temperature sensors. The Option Module OM-SMT also detects short circuits and line breaks in the connecting cables.

The Option Module OM-SMT is certified according to ATEX (guideline 2014/34/EU) and UKEX (UKSI 2016 No. 1107) according to EN 50495:2010 and EN IEC 60079-0:2018.

The OM-SMT is maintenance-free until the end of its service life.

3.9.12 Option module OM-IIoT

Overview

Option module OM-IIoT extends the functional scope of the converter.

Option module OM-IIoT allows the converter to access the Industrial Internet of Things (IIoT).

Requirement

An external 24 V power supply at the converter terminal strip or at the ER-OM expansion rack is required to operate option module OM-IIoT.

Description



Figure 3-10 Option module OM-IIoT

Option module OM-IIoT can be installed in the converter or in the ER-OM expansion rack.

The Ethernet interface of option module OM-IIoT connects the converter with an edge device.

3.9.13 Option module OM-DQ

Overview

Option module OM-DQ extends the functional scope of the converter.

Option module OM-DQ connects the converter to DRIVE-CLiQ components

Requirement

When OM-DQ supplies the connected component with 24 V, then an external 24 V power supply is required at the converter terminal strip or at the ER-OM expansion rack.

Description



Figure 3-11 Option module OM-DQ

Option module OM-DQ can be installed in the converter.

The OM-DQ connects the converter to DRIVE-CLiQ components that are installed outside the converter

3.9.14 Option module OM-ENC

Overview

The option module OM-ENC extends the functional scope of a converter by enabling connections to a temperature sensor and an encoder.

Description



Figure 3-12 Option Module OM-ENC

The option module OM-ENC is an interface module that mounts on the converter or the ER-OM for connection to a temperature sensor and an encoder.

The OM-ENC achieves a degree of protection rated IP20/UL Open Type.

Compatibility

The OM-ENC supports the connection of the following devices:

- Encoders:
  - Synchronous serial interface (SSI) encoder, 5 V/24 V
  - Transistor-transistor logic (TTL) encoder, bipolar, 5 V/24 V
  - High threshold logic (HTL) encoder, unipolar/bipolar, 24 V
- Temperature sensors:
  - KTY84 sensor
  - Pt1000 sensor
  - PTC sensor

Diagnostic capabilities

The OM-ENC also includes diagnostic features to detect and monitor cable faults for connected devices. The tables below outline the diagnostic capabilities for each device type:

Table 3-14 Monitoring functions for encoders

Device type	Remote sense for power supply voltage	Track monitoring
SSI encoder	-	-
HTL encoder (unipolar)	-	-
HTL encoder (bipolar)	-	✓
TTL encoder (5 V)	✓	✓
TTL encoder (24 V)	-	✓

Table 3-15 Monitoring functions for sensors

Device type	Wire break monitoring	Short-circuit monitoring
KTY84 sensor	✓	✓
Pt1000 sensor	✓	✓
PTC sensor	-	✓

3.9.15 Option Module OM-DIO

Overview

The option module OM-DIO extends the functional scope of a converter by providing additional digital inputs and outputs to enhance the control capabilities of the converter.

Requirement

When the digital outputs are used, the OM-DIO additionally requires an external 24 V power supply connected to the option module for proper functionality.

Description



Figure 3-13 Option Module OM-DIO

The option module OM-DIO provides three relay outputs and four digital inputs that can be switched to digital outputs. The configuration fulfills the requirements of the NAMUR Recommendation NE189.

The option module achieves a degree of protection rated IP20/UL Open Type.

3.9.16 Option Module OM-AIO

Overview

The option module OM-AIO extends the functional scope of a converter by providing additional analog inputs and outputs to enhance the control capabilities of the converter.

Description



The option module OM-AIO offers three analog inputs and two analog outputs. The analog inputs and outputs support both the voltage and current modes. The configuration fulfills the requirements of the NAMUR Recommendation NE189.

The option module achieves a degree of protection rated IP20/UL Open Type.

3.9.17 Ordering data for option modules

Option module	
Designation	**Article number**
OM-SMT	6SL4950-0AL00-0FA0 (valid up to firmware V6.4)
OM-IIoT	6SL4950-0AL00-0EA0
OM-DQ	6SL4950-0AL00-0BA0
OM-ENC	6SL4950-0AL00-0GA0
OM-DIO	6SL4950-0AL00-0LA0
OM-AIO	6SL4950-0AL00-0MA0
ER-OM	6SL4960-0AM00-0AA0

3.9.18 CM-PN communications module

Description



Figure 3-14 CM-PN communications module

The CM-PN communications module connects the converter with PROFINET and EtherNet/IP.

Table 3-16 Technical specifications of the CM-PN communications module

Property	Value
Maximum transfer rate	100 Mbit/s

3.9.19 CM-DP communications module

Description



Figure 3-15 CM-DP communications module

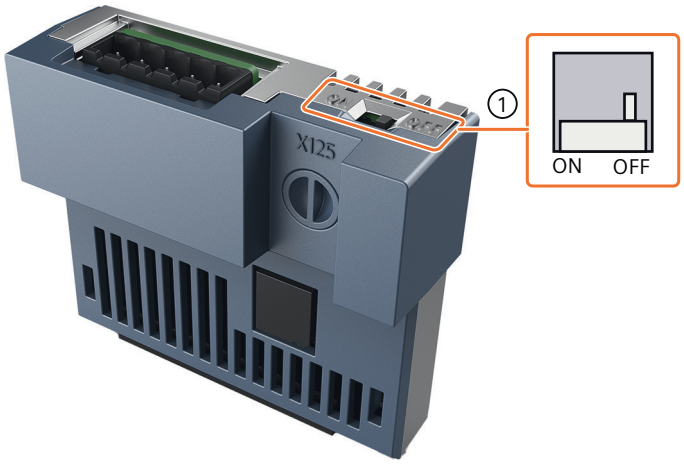
The CM-DP communications module connects the converter with PROFIBUS.

Table 3-17 Technical data, communications module CM-DP

Property	Value
Maximum transmission rate	12 Mbits/s

3.9.20 CM-RS485 communications module

Description



① Bus terminating resistor

Figure 3-16 CM-RS485 communications module

The CM-RS485 communications module connects the converter with Modbus RTU.

Table 3-18 Technical data, communications module CM-RS485

Property	Value
Maximum transfer rate	187.5 kbit/s

3.9.21 Order data, communications modules

Communications modules	
Designation	**Article number**
CM-PN communications module	6SL4950-0AK00-0AF0
CM-DP communications module	6SL4950-0AK00-0AD0
CM-RS485 communications module	6SL4950-0AK00-0AB0

3.9.22 DRIVE-CLiQ components

Overview

The functionality of the converter can be extended by external components with DRIVE-CLiQ interface.

Description

The following components can be operated at the converter with OM-DQ option module:

- DRIVE-CLiQ encoder
- SMC10 Sensor Module
  Article No. 6SL3055-0AA00-5AA3
- SMC20 Sensor Module
  Article No. 6SL3055-0AA00-5BA3
- SMC30 Sensor Module
  Article No. 6SL3055-0AA00-5CA2
- VSM10 Voltage Sensing Module
  Article No. 6SL3053-0AA00-3AA1
- Expansion rack for option modules (ER-OM)
  Article No. 6SL4960-0AM00-0AA0

More information

You can find more information on the Internet:

Equipment Manual (https://support.industry.siemens.com/cs/ww/en/view/109782370)

The information applies to all converters at which the Sensor Module is operated.

3.9.23 SINAMICS Smart Adapter

3.9.23.1 Function of the SINAMICS Smart Adapter

Description

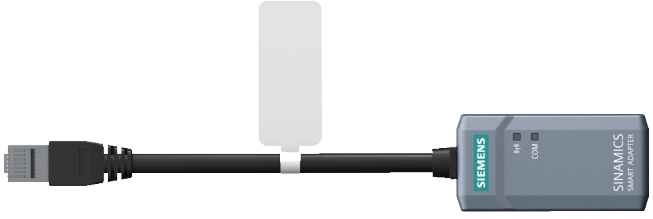


Figure 3-17 SINAMICS Smart Adapter

The SINAMICS Smart Adapter establishes a WLAN connection between the converter's X127 service interface and an operating unit, for example a tablet, smartphone, panel or PC.

Once plugged into the converter, the SINAMICS Smart Adapter is ready to use. No battery is required.

The SINAMICS Smart Adapter may only be installed temporarily for commissioning and service activities. It may not be used permanently with the converter.

The SINAMICS Smart Adapter supports WPA3 WLAN encryption.

3.9.23.2 SINAMICS Smart Adapter ordering data

SINAMICS Smart Adapter	
Designation	**Article number**
SINAMICS Smart Adapter	6SL4950-0AJ00-0AA0

3.9.24 SINAMICS SDI Pro 5.5"

3.9.24.1 Function of the SINAMICS SDI Pro 5.5"

Description

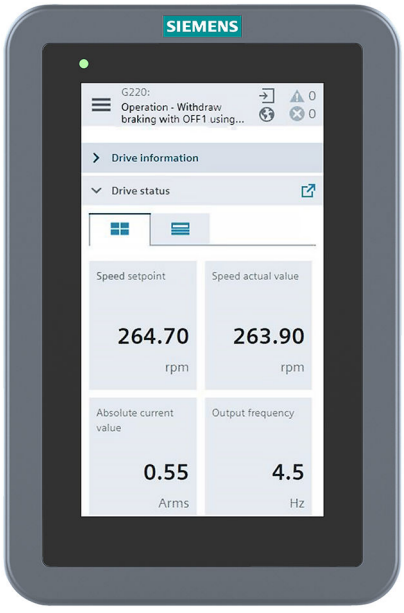


Figure 3-18 SINAMICS SDI Pro 5.5"

The SINAMICS SDI Pro 5.5" operating unit supports commissioning and troubleshooting a drive.

3.9.24.2 SINAMICS SDI Pro 5.5" order data

SINAMICS SDI Pro 5.5"	
Designation	**Article number**
SINAMICS SDI Pro 5.5"	6SL4950-0AH35-2AA0

3.9.25 SINAMICS SDI blind cover

3.9.25.1 Function of the SINAMICS SDI blind cover

Description



① LED status indicator
② X127 service interface

Figure 3-19 SINAMICS SDI blind cover

The SINAMICS SDI blind cover supports commissioning and status monitoring of the converter.

3.9.25.2 Order data SINAMICS SDI blind cover

SINAMICS SDI blind cover	
Designation	**Article number**
SINAMICS SDI blind cover	6SL4950-0AH00-0AA0

3.9.26 Supplementary optional components

Description

In addition to the optional components offered by Siemens, supplementary components are also available from selected partners.

More information

More information is provided on the Internet below:

Drive Options Partners (www.siemens.com/drives-options-partner)

3.10 Directives and standards

EC Declaration of Conformity

CE

European Machinery Directive

The product complies with the requirements stipulated in machinery directive 2006/42/EC, assuming it falls within the scope of this directive.

The product has been fully assessed for compliance with the essential health and safety regulations of this directive when used in a typical machine application

European Low-Voltage Directive

The product complies with the requirements stipulated in the Low-Voltage Directive 2014/35/EU, assuming it falls within the scope of this directive.

Directive 2011/65/EU

The product complies with the requirements of Directive 2011/65/EU regarding the restriction of the use of certain hazardous substance in electrical and electronic devices (RoHS).

European EMC Directive

The compliance of the product with the regulations of Directive 2014/30/EU has been verified through full compliance with IEC/EN 61800-3.

Ecodesign Directive 2009/125/EC

The product complies with the requirements of Ecodesign Directive 2009/125/EC.

UKCA Declaration of Conformity

UK CA

A product with this marking complies with the requirements for the British market (England, Wales and Scotland).

ATEX directive



The test symbol shown is a specific marking for protection against explosion. The correspondingly marked option module OM-SMT complies with the requirements of directive 2014/34/EU for devices and protection systems intended for use in potentially explosive (hazardous) zones.

Only use OM-SMT and Safety Integrated Function SMT in productive operation if the following documents are available:

- Valid prototype test certificate for OM-SMT (https://sieportal.siemens.com/su/bm3tS)
- Manufacturer's declaration issued for the firmware version used in the converter and covering the Safety Integrated Function SMT and the OM-SMT with the appropriate hardware version

The equipment group, equipment category, type of protection and the equipment protection level for gas and dust must correspond to those of the connected motor.

They can also be used for hazardous zones with the lower requirements of Zones 2 and 22, whereby the type of protection must be taken into account.

More information is provided in the operating instructions of the connected explosion-protected motor.

The markings II (2) G or II (2) D on the nameplate of the OM-SMT are applicable for equipment according to Article 1 Paragraph 1 of directive 2014/34/EU outside hazardous zones, categories "Ex db", "Ex eb", "Ex pxb", "Ex tb", which can be connected, for example, to equipment of category 2 or 3.

Compliance with the ATEX directive is based on a risk assessment and compliance with EN 50495 and EN 60079-0 standards.

Underwriters Laboratories (North American market)



A product with this marking complies with the requirements for the North American market as a component of drive applications and is appropriately listed.

Australia and New Zealand (RCM)



The product complies with requirements relating to electromagnetic compatibility for Australia and New Zealand.

EMC requirements for South Korea



A product with this marking complies with requirements relating to electromagnetic compatibility for South Korea.

Standard SEMI F47-0706

The product complies with the requirements of standard SEMI F47-0706.

China Compulsory Certification

The product does not fall in the area of validity of the China Compulsory Certification (CCC).

China RoHS

The product complies with the requirements for China RoHS assuming that it is appropriately marked or a certificate is provided via the ID Link.



The number indicated in the logo, e.g. 50, indicates the Environmentally Friendly Use Period (EFUP) in years.

When used as intended, the product does not release any hazardous substances during its environmentally friendly service life.

The EFUP does not constitute a guarantee or warranty period, however.



The green logo means that the product does not contain any hazardous substances above the defined Chinese limits.

Eurasian conformity



A product with this marking complies with the requirements of the customs union of Russia/ Belorussia/Kazakhstan.

ISO 9001 and ISO 14001 quality systems

Siemens employs a quality management system that complies with the requirements of ISO 9001 and ISO 14001.

ISO/IEC 80079-34

Siemens has a quality management system that meets the requirements of ISO/IEC 80079-34 for option module OM-SMT.

Taking back and recycling waste electrical and electronic equipment (WEEE)

The product complies with the requirements laid down in Directive 2012/19/EU with regard to returning and recycling scrap electrical and electronic equipment.

3.11 Device disposal

Description



For environmentally-friendly recycling and disposal of your old device, contact a company certified for the disposal of waste electrical and electronic equipment, and dispose of the old device as prescribed in the respective country of use.

Application planning

4

4.1 Protection of persons from electromagnetic fields

Precondition

⚠ WARNING

Negative impact on health from electromagnetic fields

During operation, converters generate electromagnetic fields (EMF). Electromagnetic fields can have a negative impact on your health and can even cause death.

- As operating company, carefully design workplaces so that workers are protected from impermissibly strong electromagnetic fields.
- When working close to the converter, carefully comply with the data on electromagnetic compatibility (EMC) provided in the product documentation.
- Maintain the minimum clearances to the converter.

The converter components are installed according to the EMC guidelines in the technical documentation:

- Components with degree of protection IP20 are operated inside a metal control cabinet.
- The motor connection cables are shielded.

Protection against electromagnetic fields (EMF) is defined in the following guidelines and regulations, for example:

- European EMF-Guideline 2013/35/EU
- 26th BImSchV (German Federal Immission Protection Regulations)

Limit values according to ICNIRP 2010 and ICNIRP 2020 for a workplace are the basis for assessing electromagnetic fields.

Description

To determine the minimum clearance, the electromagnetic field of the converter was evaluated as follows:

- At the pulse frequency, e.g. 4 kHz
- At a multiple of the pulse frequency up to a maximum of 100 kHz

The following tables contain the evaluation of the electromagnetic fields and the minimum clearances to the converter components.

The minimum clearance is applicable for the head and the entire torso of the human body. Shorter distances are possible for extremities.

Table 4-1 Evaluation of the electromagnetic fields

	Frequency range	
	0 Hz ... 100 kHz	**100 kHz ... 300 GHz**
Electric field strength	Limit values not exceeded	Limit values not exceeded
Magnetic flux density	Evaluation in the following table	Limit values not exceeded

Table 4-2 Minimum clearance based on magnetic flux density (0 Hz ... 100 kHz)

General		Individuals with active implants	
Converter with degree of protection IP20 in a closed control cabinet	**Converter with degree of protection IP20 in an open control cabinet or converter with degree of protection IP55**	**Converter with degree of protection IP20 in a closed control cabinet**	**Converter with degree of protection IP20 in an open control cabinet or converter with degree of protection IP55**
0 mm (0 in)	250 mm (10 in)	The limit value of 100 µT (RMS) at 50 Hz is not exceeded. Must be assessed depending on the active implant.	Must be assessed depending on the active implant.

4.2 Installation requirements

Requirement



⚠ WARNING

Electric shock when a converter is freely accessible

As soon as you have connected the converter to the line supply, the converter and the cables are at hazardous voltage levels.
Freely accessible converters represent a danger to life as live components can be touched.

- Install a converter with degree of protection IP20 in a cabinet.
- Operate the converter with the cabinet closed.
- Protect the converter and cables that are at hazardous voltage levels against damage or inadvertent access.

Description

The requirements are applicable for operation of the converter with degree of protection IP20.

4.3 Protection against the spread of fire

Precondition

⚠ WARNING

Personal injury caused by fire

When operating the converter with degree of protection IP20, in the case of a fire there is no protection against the fire propagating.
When a fire propagates, this can result in death or severe injuries.

- Only operate the converter with degree of protection IP20 and the expansion rack for option modules (ER-OM), if used, in:
  - Closed housings
  - Higher-level control cabinets with closed protective covers, using all protective devices.
- Ensure that the converter is installed in a metal control cabinet or is protected with another equivalent measure that prevents the propagation of fire and emissions outside the control cabinet.

Description

The requirements are applicable for operation of the converter with degree of protection IP20.

4.4 Protection against condensation and conductive pollution

Description

Protect the converter with degree of protection IP20 and the expansion rack for option modules (ER-OM), if used, by installing it in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12, for example. Further measures may be necessary for particularly critical operating conditions.

If condensation or conductive pollution can be excluded at the installation site, a lower degree of protection of the control cabinet is permitted.

If required, install a heater or a dryer to prevent condensation.

4.5 Requirements for the 24 V supply

Overview

Whether an external 24 V supply for the converter is required and which current demand the external 24 V supply has depends on the configuration of the converter.

Description

The converter supplies its control electronics with an internal 24 V supply. Optionally, an external 24 V supply can be connected.

An external 24 V supply is required for specific converter configurations if the total current requirement increases to $I_{Total} \geq 1500$ mA.

The total current requirement I_{total} of the external 24 V supply is the sum of the current demand of the converter, the utilized functions, and the inserted components:

$I_{total} = I_{converter} + \sum I_{function} + \sum I_{component}$

An external 24 V supply is required when an expansion rack is used for option modules (ER-OM). The current that this external 24 V supply must provide depends on the configuration of the ER-OM.

Table 4-3 Current demand of the external 24 V supply

		Current demand in mA	External 24 V supply
Converter including SINAMICS SDI Standard		500	Optional
Function used	10 V supply	0 ... 15	Optional
	24 V supply VS1; X130: 1	0 ... 200	Optional
	24 V supply VS2; X130: 5	0 ... 200	Optional
	Active fail-safe digital output F-DO	700	Required
Inserted component	OM-DQ option module	100	Optional
		300[1]	Required
	OM-SMT option module	100	Optional
	OM-IIoT option module	200	Required
	OM-ENC option module	100[2]	Optional
		350[3]	Required
	OM-DIO option module	100	Optional
	Option module OM-AIO	150	Optional
	CM-DP communications module	15	Optional
	CM-PN communications module	35	Optional
	CM-RS485 communications module	15	Optional
	Supplementary fan for option modules	30	Optional

1) Current demand of each component that the converter supplies with 24 V via DRIVE-CLiQ

2) Current requirement without encoder connection

3) Current requirement for the encoder supply

4.6 Requirements for the protective conductor, converter in degree of protection IP20

Overview

A high leakage current flows through the protective conductor in converter operation. The protective conductor of the converter must not be interrupted to ensure safe touch protection in converter operation.

Precondition



⚠ WARNING

Electric shock due to a high leakage current

The leakage current via the protective conductor can exceed 5 % of the rated input current of the converter.
Touching conductive parts can result in death or serious injury.

- Ensure that equipotential bonding is provided between freely accessible conductive parts up to a distance of 2.5 m from the converter.
- Connect the protective conductor of the individual components with PE:
  - Protective conductor of the converter
  - Protective conductor of the motor
  - Protective conductor of the housing
  - Protective conductor of the cabinet



⚠ WARNING

Electric shock due to interrupted protective conductor

The drive components conduct a leakage current via the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

- Comply with the requirements for the protective conductor.

⚠ WARNING

Electric shock as a result of missing protective conductor

When only one protective conductor is connected at the converter, frame sizes FSA, FSB and FSD1 high voltages can be present at the housing, which when touched, can result in death or severe injury.

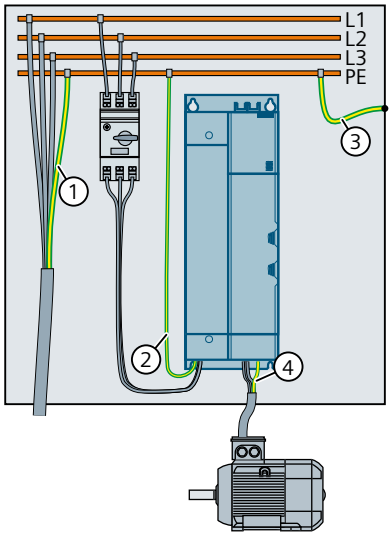
- For converters, frame sizes FSA, FSB and FSD1, connect a protective conductor to the housing as well as to line supply terminal X1.

Description

The leakage current via the protective conductor of the converter can exceed the following values:

- 3.5 mA alternating current
- 10 mA direct current

This results in minimum requirements for the protective conductor.



① Protective conductor of the power supply cord
② Protective conductor of the converter power supply cord
③ Protective conductor between PE and control cabinet
④ Protective conductor of the motor connection cable

Figure 4-1 Example: Protective conductor for degree of protection IP20

The minimum cross-section of the protective conductor ① ... ④ depends on the cross-section of the line connection cable:

- Line feeder cable ≤ 16 mm^2
  ⇒ Minimum cross-section of the protective conductor = cross-section of the line connection cable
- 16 mm^2 < line connection cable ≤ 35 mm^2
  ⇒ Minimum cross-section of the protective conductor = 16 mm^2
- Line feeder cable > 35 mm^2
  ⇒ Minimum cross-section of the protective conductor = ½ cross-section of the line connection cable

Observe the local regulations for protective conductors subject to a high leakage current at the operating location.

Only a fixed connection is permissible.

Additional requirements apply to protective conductors ① and ② according to IEC 61800-5-1:

The cross-sectional area of every PE conductor that does not form part of the multi-conductor supply cable or cable enclosure shall, in any case, be not less than

- 2.5 mm^2 if mechanical protection is provided or
- 4 mm^2 if mechanical protection is not provided.

In addition, one of the following requirements must be satisfied:

- The protective conductor has a cross-section ≥ 10 mm^2 Cu.
- A 2nd protective conductor is connected. The cross-section of the 2nd protective conductor is identical with the cross-section of the 1st protective conductor.
- The protective conductor is routed so that it is protected against damage along its complete length.
  Cables routed inside electrical cabinets or enclosed machine housings are considered to be adequately protected against mechanical damage.

4.7 Requirements for the protective conductor, converter in degree of protection IP55

Overview

A high leakage current flows through the protective conductor in converter operation. The protective conductor of the converter must not be interrupted to ensure safe touch protection in converter operation.

Precondition



⚠ WARNING

Electric shock due to a high leakage current

The leakage current via the protective conductor can exceed 5 % of the rated input current of the converter.
Touching conductive parts can result in death or serious injury.

- Ensure that equipotential bonding is provided between freely accessible conductive parts up to a distance of 2.5 m from the converter.
- Connect the protective conductor of the individual components with PE:
  - Protective conductor of the converter
  - Protective conductor of the motor
  - Protective conductor of the housing
  - Protective conductor of the cabinet



⚠ WARNING

Electric shock due to interrupted protective conductor

The drive components conduct a high leakage current through the protective conductor. Touching conductive parts when the protective conductor is interrupted can result in death or serious injury.

- Comply with the requirements for the protective conductor.

⚠ WARNING

Electric shock as a result of missing protective conductor

When only one protective conductor is connected at the converter, frame sizes FSA, FSB and FSD1 high voltages can be present at the housing, which when touched, can result in death or severe injury.

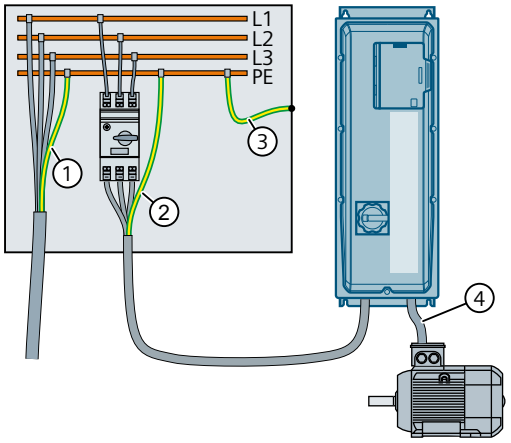
- For converters, frame sizes FSA, FSB and FSD1, connect a protective conductor to the housing as well as to line supply terminal X1.

Description

The leakage current via the protective conductor of the converter can exceed the following values:

- 3.5 mA alternating current
- 10 mA direct current

This results in minimum requirements for the protective conductor.



① Protective conductor of the power supply cord
② Protective conductor of the converter power supply cord
③ Protective conductor between PE and control cabinet
④ Protective conductor of the motor connection cable

Figure 4-2 Example: Protective conductor for degree of protection IP55

The minimum cross-section of the protective conductor ① ... ④ depends on the cross-section of the line connection cable:

- Line feeder cable ≤ 16 mm²
  ⇒ Minimum cross-section of the protective conductor = cross-section of the line connection cable
- 16 mm² < line connection cable ≤ 35 mm²
  ⇒ Minimum cross-section of the protective conductor = 16 mm²
- Line feeder cable > 35 mm²
  ⇒ Minimum cross-section of the protective conductor = ½ cross-section of the line connection cable

Observe the local regulations for protective conductors subject to a high leakage current at the operating location.

Only a fixed connection is permissible.

Additional requirements apply to protective conductors ① and ② according to IEC 61800-5-1:

The cross-sectional area of every PE conductor that does not form part of the multi-conductor supply cable or cable enclosure shall, in any case, be not less than

- 2.5 mm² if mechanical protection is provided or
- 4 mm² if mechanical protection is not provided.

In addition, one of the following requirements must be satisfied:

- The protective conductor has a cross-section ≥ 10 mm^2 Cu.
- A 2nd protective conductor is connected. The cross-section of the 2nd protective conductor is identical with the cross-section of the 1st protective conductor.
- The protective conductor is routed so that it is protected against damage along its complete length.
  Cables routed inside electrical cabinets or enclosed machine housings are considered to be adequately protected against mechanical damage.

4.8 Fault protection for the motor circuit

Description

The converter provides short-circuit protection at the motor output terminals.

The manufacturer's declaration describes the conditions regarding protection against electric shock in the event of an insulation failure in the motor circuit.

More information

You can find more information on the Internet:

Manufacturer's declaration (https://support.industry.siemens.com/cs/ww/en/view/109476638)

4.9 Operation on a TN system

Overview

The converter is suitable for operation on a TN system.

Requirement

The following applies when connecting converters to a TN system:

- Converter with integrated or external line filter:
  - Operation on TN systems with grounded neutral point permissible
  - Operation on TN systems with grounded line conductor not permissible
- Converter without line filter:
  - Operation on all TN systems permissible

Description

The TN system transfers the PE protective conductor to the installed electrical installation using a conductor.

Generally, in a TN system the neutral point is grounded. There are versions of a TN system with grounded line conductor, e.g. with grounded L1.

The TN system transfers the neutral conductor N and the PE protective conductor either separately or combined as PEN conductor.

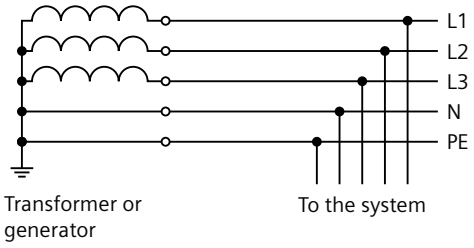


Figure 4-3 TN system, example: separate transfer of N and PE, grounded neutral point

4.10 Operation on a TT system

Overview

The converter is suitable for operation on a TT system.

Precondition

The following applies when connecting converters to a TT system:

- Operation in installations according to IEC and UL
  - Operation on TT systems is permissible for installations in compliance with IEC.
  - For installations according to UL, operation on TT systems is not permissible.
- Converter with integrated or external line filter
  - Operation on TT systems with grounded neutral point permissible
  - Operation on TT systems with grounded line conductor not permissible
- Converter without line filter
  - Operation on all TT systems permissible

Description

In a TT system, the PE protective conductor of the transformer and the installed system are independent of one another.

There are TT systems with and without transfer of the neutral conductor N.

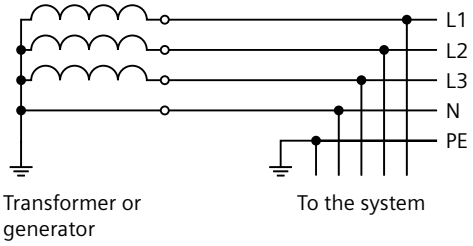


Figure 4-4 TT system, example: transfer of N, grounded neutral point

4.11 Operation on an IT system

Overview

The converter is suitable for operation on an IT line system.

Requirement

You opened the ground connection of the integrated line filter before connecting the converter with the integrated line filter to an IT line system.

Description

In an IT line system, all active conductors are isolated from ground or are connected to ground through a high-resistance impedance.

Under defined conditions, it is also possible to include the neutral conductor N in an IT line system.

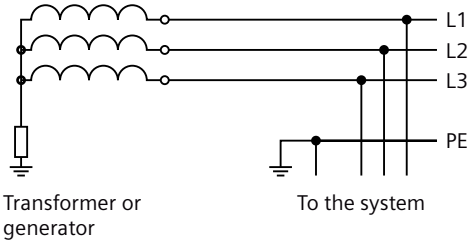


Figure 4-5 IT line system, example: without neutral conductor

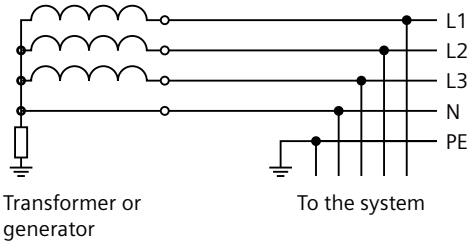


Figure 4-6 IT line system, example: with N conductor

4.12 Permissible line system configuration as a function of the installation altitude

Description

From an installation altitude of 2 000 m above sea level and higher, the following constraints apply to the line system configuration.

Converter input voltage	Permissible line system configuration for installation altitudes 2000 m to 4000 m above sea level
3 AC 200 V ... 240 V	Connection to a TN or TT system with upstream isolation transformer Connection to an IT line system with upstream isolation transformer with the secondary side grounded at the neutral point
3 AC 380 V ... 415 V 3 AC 440 V ... 500 V	Connection to an IT line system with upstream isolation transformer with the secondary side grounded at the neutral point Alternative for TN or TT system: • Line supply with grounded neutral point • Connection with upstream isolating transformer with the secondary side grounded at the neutral point

4.13 Overload capability of the converter

Description

The overload capability is the property of the converter to temporarily supply a current that is higher than the output current defined for a continuous load.

Two typical duty cycles are defined to select and dimension a converter to match the application.

"Low Overload" duty cycle

The "Low Overload" duty cycle fits a uniform base load with low requirements placed on brief acceleration phases.

"High Overload" duty cycle

The "High Overload" duty cycle permits dynamic acceleration phases at a reduced continuous load.

If not specified otherwise, the power and current data in the technical data always refer to a duty cycle with Low Overload.

Example

Typical applications for the two duty cycles:

"Low Overload" duty cycle

Typical applications when designing according to "Low Overload" include:

- Pumps, fans and compressors
- Wet or dry blasting technology
- Mills, mixers, kneaders, crushers or agitators
- Basic spindles
- Rotary furnaces
- Extruders

"High Overload" duty cycle

Typical applications when designing according to "High Overload" include:

- Horizontal and vertical conveyor technology, e.g. conveyor belts, roller conveyors, chain conveyors
- Centrifuges
- Escalators/moving stairways
- Lifting or lowering equipment
- Elevators
- Gantry cranes
- Cable railways
- Storage and retrieval machines

More information

We recommend using the "TIA Selection Tool" configuring software to select the converter.

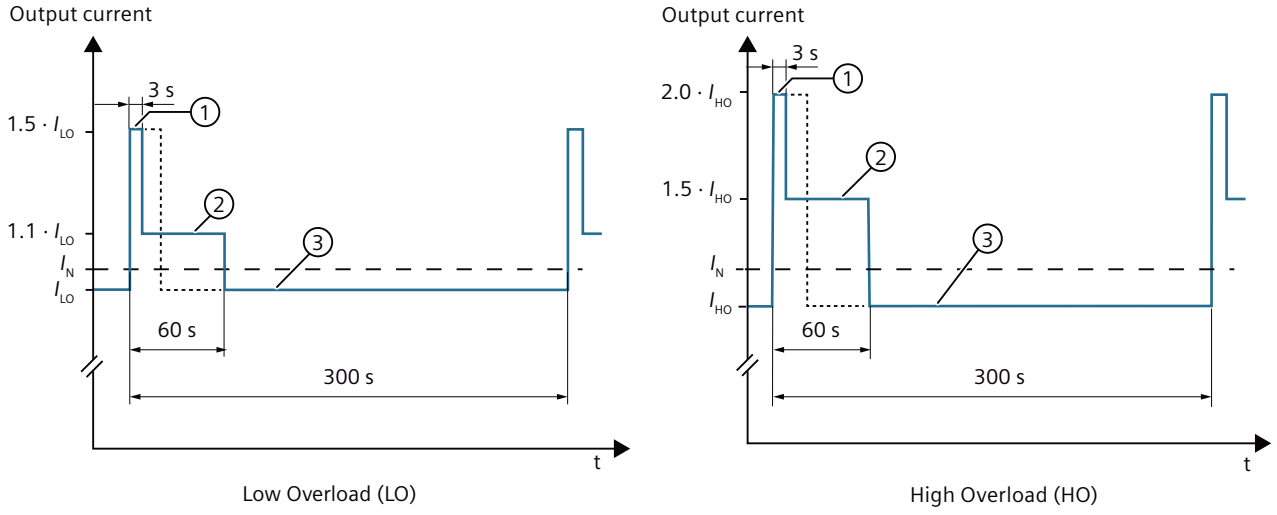
More information about the "TIA Selection Tool" is available on the Internet:

TIA Selection Tool (https://www.siemens.com/tia-selection-tool)

4.13.1 "Low Overload" and "High Overload" duty cycles

Technical data

The following diagrams show the duty cycle definitions of the converter when operating a standard induction motor with "Low Overload" and "High Overload".



① Short-time current
② Overload current
③ Base-load current
I_N Rated current (continuous)
I_{LO} Base-load current for "Low Overload" (LO)
I_{HO} Base-load current for "High Overload" (HO)

Figure 4-7 "Low Overload" and "High Overload" duty cycles

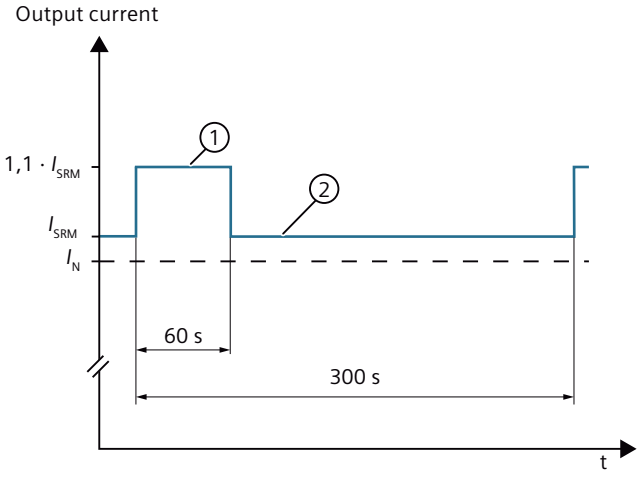
Table 4-4 "Low Overload" and "High Overload" duty cycles, total duration 300 s

Duty cycle	Base load		Overload			
	Base-load current	Duration in s	Short-time current as a % of base-load current	Duration in s	Overload current as a % of base-load current	Duration in s
Low Overload (LO)	I_{Lo}	240	150	3	110	57
High Overload (HO)	I_{HO}	240	200	3	150	57

4.13.2 Duty cycle for synchronous reluctance motors

Technical data

The following diagram shows the overload capability of the converter when operating a synchronous reluctance motor.



① Overload current
② Base-load current
I_N Rated current (continuous)
I_{SRM} Base-load current when operating a synchronous-reluctance motor

Table 4-5 Duty cycle when operating a synchronous-reluctance motor

Duty cycle	**Base load**		**Overload**	
	Base-load current	**Duration in s**	**Overload current as a % of base-load current**	**Duration in s**
SRM	I_{SRM}	240	110	60

4.14 Permissible speed of a synchronous motor

Requirement

⚠ CAUTION

Overvoltage in the converter due to driven synchronous motor

If a fault occurs, or after an OFF2 command, the load machine may continue to drive the permanent-magnet synchronous motor. This causes the permanent-magnet synchronous motor to charge the capacitor in the DC link of the converter. Above a certain charge, the DC link voltage of the converter reaches an impermissibly high value. An excessively high DC link voltage damages the converter.

- Ensure that no overvoltage occurs in the converter even when the converter is disconnected from the power supply, e.g. by taking one of the following measures:
  - Limit the maximum speed to the permissible value.
  - Install an appropriately dimensioned overvoltage protection.
  - Install a brake on the load machine.
  - Use a backstop with pumps.

Description

The voltage induced in the synchronous motor must not exceed the available converter output voltage. This limits the permissible maximum speed of a synchronous motor operating at the converter.

The permissible maximum speed is calculated using the following formula:

$$n_{max} = \frac{60\ s}{min} \cdot \sqrt{\frac{3}{2}} \cdot \frac{U_{DC\ max}}{2\pi \cdot k_T}$$

$U_{DC\ max}$ Maximum permissible DC link voltage of the converter:
- $U_{DC\ max}$ = 860 V for line voltage 3 AC 380 V ... 500 V
- $U_{DC\ max}$ = 410 V for line voltage 3 AC 200 V ... 240 V

k_T Torque constant of the synchronous motor according to the motor rating plate or data sheet

4.15 Star connection of the motor or 87 Hz delta connection

Overview

A standard induction motor with a rated voltage of 230 V/400 V (265 V/460 V) can be operated at the converter either in a star connection or in a delta connection.

In a star connection with rated voltage U_{YN} = 400 V (460 V) the corresponding motor rated values apply, e.g. power or torque.

In a delta connection with a rated voltage of $U_{\Delta N}$ = 230 V (265 V) at a frequency of 87 Hz, the motor provides a power higher than its rated power.

Function description

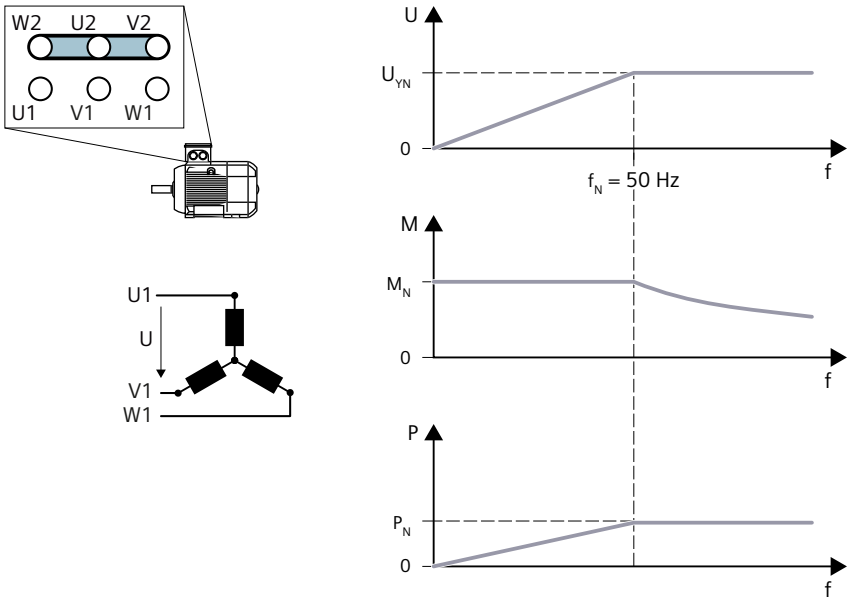


Figure 4-8 Motor in star connection

In a star connection with rated voltage U_{YN} = 400 V (460 V), the motor can provide its rated torque M_N in the range 0 ... rated frequency f_N.

Rated voltage U_{YN} is available at the motor terminals at rated frequency f_N = 50 Hz.

The motor goes into field weakening above the rated frequency. In field weakening, the available motor torque decreases proportionally with 1/f. In field weakening, the available power remains constant.

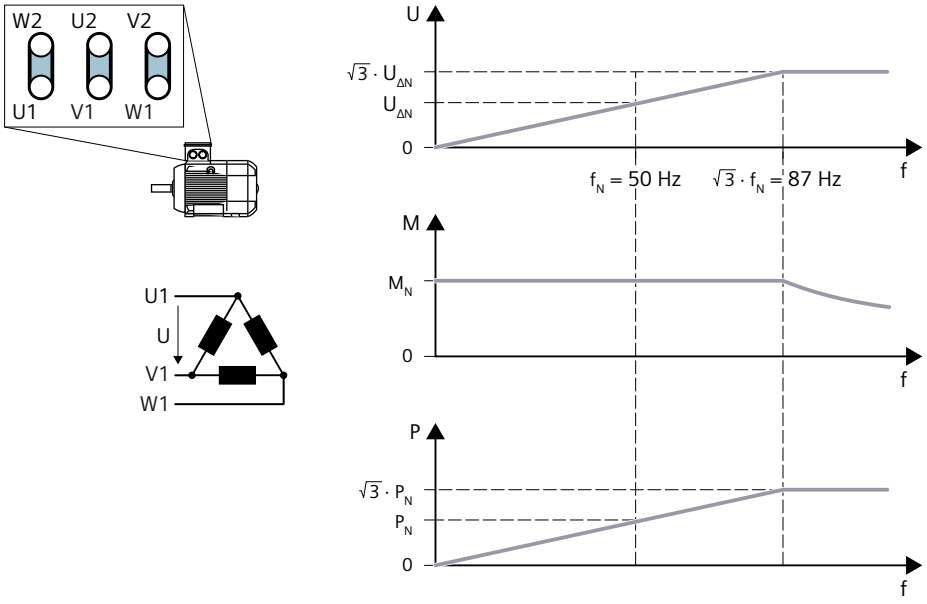


Figure 4-9 Motor in delta connection with 87 Hz characteristic

In a delta connection with rated voltage $U_{\Delta N}$ = 230 V (265 V), the motor is operated above its rated voltage and frequency. As a consequence, the motor power output is increased by the factor $\sqrt{3} \approx 1.73$.

In the range f = 0 ... 87 Hz, the motor can output its rated torque M_N.

The maximum voltage $\sqrt{3} \cdot U_{\Delta N}$ is available at frequency f = $\sqrt{3} \cdot 50$ Hz ≈ 87 Hz.

The motor goes into field weakening above 87 Hz.

The higher motor power output when operated with an 87 Hz characteristic has the following disadvantages:

- The converter must supply approximately 1.73 times the current.
  We recommend that a converter is dimensioned based on its rated current and not its rated power.
- The motor temperature increases more significantly than when operated with f ≤ 50 Hz.
- The motor must have windings that are approved for a voltage > rated voltage U_N.
- When operating at 87 Hz, a motor is louder than a motor with a correspondingly higher power rating operating at 50 Hz.

4.16 Electromagnetic compatibility (EMC)

4.16.1 Electromagnetic compatibility (EMC)

Description

Interference suppression measures increase the electromagnetic compatibility (EMC).

EMC interference suppression measures allow the product to function correctly. As a consequence, the product is neither a source of interference for other products nor an interference sink that can be disturbed by other products.

More information

Fundamental information for EMC-compliant planning and EMC-compliant installation is provided in the Internet:

EMC Design Guidelines Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/60612658)

4.16.2 EMC requirements for South Korea

Description

⚠ **경고**
카테고리 C2
제2환경용 정격 전압 <1000 V 고정식 구동 시스템.
카테고리 C2 구동 시스템은 전문 인력에 의해 설치 및 커미셔닝이 수행되며 고조파 전류 한계가 준수되는 경우에만 제1환경(주거 환경)에서 사용할 수 있습니다.
주거 환경에서 본 제품은 고주파 간섭을 유발할 수 있으며, 간섭 방지 조치가 필요합니다.
- 설치 및 커미셔닝 시 전문 인력이 적절한 간섭 방지 조치를 취하도록 하십시오.

⚠ **Warning**
Category C2
Stationary drive systems with a rated voltage < 1000 V for operation in the second environment.
Drive systems of Category C2 may only be used in the first environment (residential environment) if they are installed and commissioned by an expert and the limit values for harmonic currents are complied with.
In a residential environment, this product can cause radio-frequency interference, which may make interference suppression measures necessary.
- Have qualified personnel carry out the installation and commissioning with appropriate radio interference suppression measures.

⚠ **경고**
카테고리 C3
제2환경에서만 사용하도록 설계된 정격 전압 <1000 V 구동 시스템.
주거 환경에서 본 제품은 고주파 간섭을 유발할 수 있습니다.
- 본 장치를 제1환경(주거 환경)에서는 사용하지 마십시오.

⚠ **Warning**
Category C3
Drive systems with a rated voltage < 1000 V that are solely intended for use in the second environment.
In a residential environment, this product may cause radio interference.
- Do not use this device in the first environment (residential environment).

4.17 EMC-compliant installation

4.17.1 Achievable EMC category and maximum motor cable length

Precondition

Reliable and disturbance-free converter operation is only ensured for EMC-compliant installation.

⚠ CAUTION

Radio frequency interference in residential areas

The product can cause radio frequency interference if you operate the product in a residential environment.

- Do not operate the product in residential areas.

Description

The achievable EMC category is dependent on the motor cable length and the line system configuration. The following conditions apply to the permissible application environment.

EMC Category according to IEC 61800-3		**C2** [1) 2)]	**C3**	**No EMC properties (C4)** [4)]			
Converter frame size		All frame sizes	All frame sizes	FSA ... FSC	FSD1 ... FSE	FSF1 ... FSF2 (132 kW)	FSF2 (160 kW)
Converter design		Converter with integrated line filter [3)]	FSA ... FSF1[3)]: Converter without integrated line filter with an external line filter	Converter without integrated line filter[3)] Converter connected to an IT line supply system with open ground connection of the integrated line filter			
			FSF2: Converter with integrated line filter				
Installation location	Residential environment	Not possible	Not possible	Not possible			
	Light industry and commerce	Yes	Not possible	Not possible			
	Industry	Yes	Yes	Yes			
Line supply	Public	Yes	Not possible	Not possible			
	Non-public	Yes	Yes	Yes			
Permissible line system configuration		TN or TT system with grounded neutral point	TN or TT system with grounded neutral point	Any			

EMC Category according to IEC 61800-3		**C2** [1) 2)]	**C3**	**No EMC properties (C4)** [4)]			
Length	Shielded motor cable	≤ 150 m CY cable required	≤ 150 m CY cable required	≤ 200 m	≤ 200 m ≤ 525 m with dv/dt filter	≤ 300 m ≤ 525 m with dv/dt filter	≤ 300 m ≤ 300 m with dv/dt filter
				≤ 200 m With sine-wave filter		≤ 300 m With sine-wave filter	
	Unshielded motor cable	Not possible	Not possible	≤ 300 m	≤ 300 m ≤ 700 m with dv/dt filter	≤ 450 m ≤ 800 m with dv/dt filter	≤ 450 m ≤ 450 m with dv/dt filter
				≤ 300 m With sine-wave filter		≤ 450 m With sine-wave filter	
	Shielded cable to the braking resistor	≤ 10 m CY cable required	≤ 10 m CY cable required	≤ 10 m			

1) Operation with the default pulse frequency

2) For SINAMICS G220 converters, frame size FSA, EMC category C2 is not complied with if the following conditions are met at the same time:
- Input voltage > 415 V
- Motor cable length > 125 m
- Uninterrupted duty with output frequency < 20 Hz

3) The lower shield plate is required for the converter.

4) In the case of complex line supplies such as IT line systems or special large-scale plants in industrial environments, we cannot specify any EMC properties for the product. To enable operation nevertheless, an EMC plan to ensure EMC conformity is required.

The converter complies with the requirements of IEC 61000-3-12 under the following condition:
Relative short-circuit power $R_{SCE} \geq 120$ at the connection point between the line side of the converter and the public grid

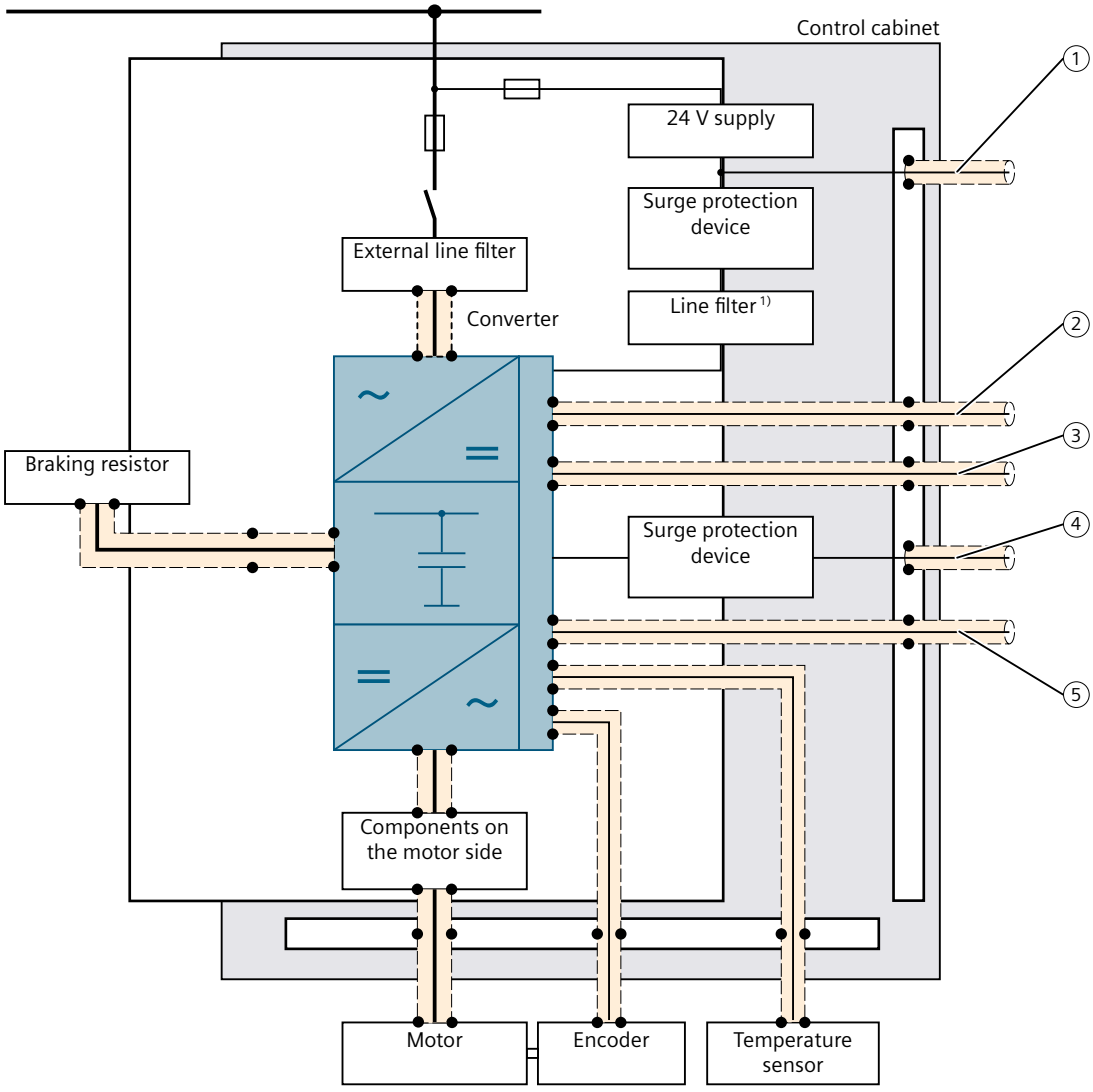
The operating company is responsible in ensuring that requirement $R_{SCE} \geq 120$ is complied with. If required, contact the local grid operator.

On the public grid, you must comply with the requirements of the local grid operator, especially IEC 61000-3-12, Table 4, for an $R_{SCE} \geq 120$. Also take into account the compatibility levels for harmonic voltage distortion according to IEC 61000-2-2 or IEC 61000-2-4.

When operating the device on the public grid, it must be ensured that voltage drop d_c does not exceed a value of 3.3 % according to IEC 61000-3-3 and IEC 61000-3-11. In case of doubt, we recommend that you contact the local power utility.

4.17.2 Shielded cables, converter in degree of protection IP20

Description



1) Recommended when operating with an OM-DQ option module

① 24 V supply cable
② Fieldbus cable
③ Cables to the Edge device
④ Cables for digital inputs and digital outputs
⑤ Cables for analog inputs and analog outputs

Figure 4-10 EMC-compliant cable shielding

When using the CM-DP communications module, it is recommended that the cable shield is additionally connected to a shield plate.

The following cables must be shielded to comply with EMC category C2 regulations:

- In the electrical cabinet:
  - Cable between the converter and an external line filter
  - Cable between the converter and the motor
  - Cable between the converter and the braking resistor
  - Fieldbus cable
  - Cables for analog inputs and analog outputs
  - DRIVE-CLiQ cable to the encoder
  - Cable to the temperature sensor
- Outside the electrical cabinet, all cables with the exception of the line supply cable

4.17.3 Maximum permissible signal cable lengths, converter in degree of protection IP20

Technical data

Table 4-6 Maximum permissible signal cable lengths, IP20

Connection at the converter	Maximum cable length, no EMC properties	Maximum cable length to achieve EMC categories C2 and C3	Additional measures to achieve EMC categories C2 and C3
24 V supply (terminals X124:1...4)	---	---	In the following cases, you require a line filter, e.g. Schurter FPBB 3-103-715 or similar. • When operating with an OM-DQ option module with an encoder, type 6FX • If conducted disturbances occur on the 24V cable A surge protection device is additionally required for connection cables longer than 30 m.
Digital input Fail-safe digital input Digital output DO 0	1000 m for shielded cable 500 m for unshielded cables	1000 m	A surge protection device is required for connection cables longer than 30 m.
Relay output DO 1, DO 2 Fail-safe digital output	1000 m for shielded cable 500 m for unshielded cables	1000 m	A surge protection device is required for connection cables longer than 30 m.
Temperature sensor	300 m	300 m	---

Connection at the converter	Maximum cable length, no EMC properties	Maximum cable length to achieve EMC categories C2 and C3	Additional measures to achieve EMC categories C2 and C3
Analog input Analog output 10 V output voltage	30 m	30 m	---
24 V output voltage	1000 m	1000 m	A surge protection device is required for connection cables longer than 30 m.
PROFIBUS, PROFINET, Modbus TCP, EtherNet/IP	100 m	100 m	---
Modbus RTU	100 m	100 m	---
DRIVE-CLiQ	100 m	100 m	---

4.17.4 Using surge protection devices

Overview

To protect the 24 V supply and the digital inputs/outputs against overvoltages, a surge protection device is required for connection cables longer than 30 m.

Description

Every digital input/output as well as each associated reference potential requires its own dedicated surge protection device.

When selecting surge protection devices, the following technical requirements apply:

Table 4-7 Technical requirements relating to surge protection devices

Property	Unit	24 V supply	Digital inputs, digital output DO 0, 24 Volt output voltages	Digital outputs DO 1, DO 2, F-DO 0
Highest continuous voltage	V	≥ 35	≥ 30	≥ 30
Rated current	A	≥ 6[1)]	≥ 0.5	≥ 0.5
Surge protection device class	-	Type 3 / 2 / 1[2)]	Type 3 / 2 / 1[2)]	Type 3 / 2 / 1[2)]
C1 rated discharge current	kA	≥ 0.8	≥ 0.5	≥ 0.5
C2 rated discharge current	kA	-	-	-
Protection level (L-N)	V	≤ 180	-	≤ 60
Protection level (L/N-PE)	V	≤ 90	≤ 60	≤ 60

Property	Unit	24 V supply	Digital inputs, digital output DO 0, 24 Volt output voltages	Digital outputs DO 1, DO 2, F-DO 0
Frequency limit	MHz	-	≥ 1	≥ 1
Example		Dehn company Article No.: 927989 - BCO CL2 E 48	Dehn company Article No.: 927924 - BCO CL2 BE 24	Dehn company Article Nos.: 927924 - BCO CL2 BE 24 927944 - BCO CL2 BD 24

1) Several devices of a drive line-up can share a common surge protection device as long as the total current of all connected current connections does not exceed the rated current of the protective device. Otherwise, several overcurrent protection devices are required in order to distribute the load.

2) Type 1 permissible for impulse category C1 or C2

4.17.5 Maximum permissible signal cable lengths, converter in degree of protection IP55

Technical data

Table 4-8 Maximum permissible signal cable lengths, IP55

Connection at the converter	Maximum cable length, no EMC properties	Maximum cable length to achieve EMC category C2	Additional measures to achieve EMC category C2
24 V supply (terminals X124:1...4)	---	---	If conducted disturbances occur on the 24V cable, then you require a line filter, e.g. Schurter FPBB 3-103-715 or similar.
Digital input Fail-safe digital input Digital output DO 0 Relay output DO 1, DO 2 Fail-safe digital output	1000 m for shielded cable	1000 m	---
Temperature sensor	300 m	300 m	---
Analog input Analog output 10 V output voltage	30 m	30 m	---
24 V output voltage	1000 m	1000 m	---
PROFIBUS, PROFINET, Modbus TCP, EtherNet/IP	100 m	100 m	
Modbus RTU	100 m	100 m	---
DRIVE-CLiQ	100 m	100 m	

4.17.6 Maximum permissible signal cable lengths, option module OM-SMT

Requirement

Only cables with an insulation that is designed for an ambient temperature of 75 °C are permissible.

Technical data

Sensor cable	Cable length (copper cable)	Cable cross-section
Without short-circuit detection	≤ 500 m	0.5 mm² / AWG 21
	≤ 1 500 m [1)]	1.5 mm² / AWG 16
	≤ 2 500 m [1)]	2.5 mm² / AWG 14
With short-circuit detection	≤ 50 m	0.5 mm² / AWG 21
	≤ 150 m	1.5 mm² / AWG 16
	≤ 250 m	2.5 mm² / AWG 14

[1)] ≤ 1 000 m for the temperature monitoring of explosion-protected motors, i.e. to comply with guideline 2014/34/EU (ATEX) or regulation 2016 No. 1107 (UKEX)

The temperature monitoring of explosion-protected motors requires short-circuit protection of the sensor cable depending on the sensor cable length:

- Sensor cable length ≤ 250 m: Short-circuit detection by the OM-SMT
- Sensor cable length > 250 m: Additional short-circuit protective measures, e.g. separate routing or special rails
  The protective measures must be evaluated in a risk analysis.

4.17.7 Maximum permissible signal cable lengths, expansion rack for option modules (ER-OM)

Technical data

Table 4-9 Maximum permissible signal cable lengths

Connection at the expansion rack for option modules (ER-OM)	Maximum cable length, EMC category C4	Maximum cable length to achieve EMC categories C2 and C3	Additional measures to achieve EMC categories C2 and C3
24 V supply (terminals X524:1...4)	---	---	A surge protection device is additionally required for connection cables longer than 30 m.
DRIVE-CLiQ	30 m connection to the converter	30 m connection to the converter	---

4.17.8 Maximum permissible cable length, option module OM-ENC

Technical data

Maximum permissible cable lengths for temperature sensor, HTL encoder, and TTL encoder connection

Signal type	Interface on the option module	Maximum permissible cable length (m)
HTL encoder, unipolar[1)]	X231	100
HTL encoder, bipolar	X231	300
TTL encoder, bipolar	X231	100
Remote sense for 5 V TTL encoder	X232	100
Temperature sensor	X232	100

1) For reliable signal transmission, Siemens recommends that you use bipolar connection for HTL encoders whenever feasible. Use unipolar connection only if the encoder does not support push-pull signal output.

Maximum permissible cable length for SSI encoder connection

For SSI encoders, the maximum permissible cable length is reduced when the SSI baud rate exceeds 500 kbaud.

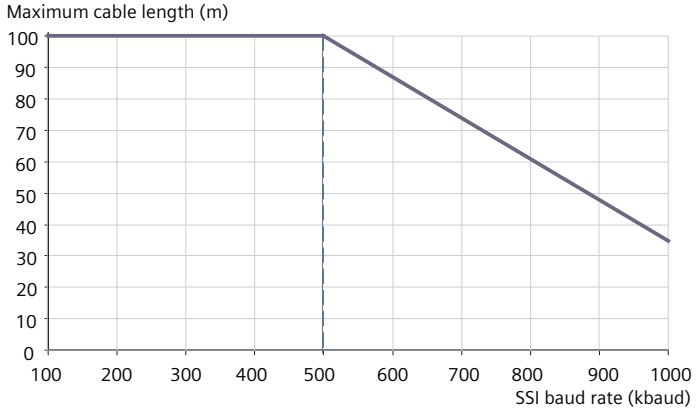


Figure 4-11 Permissible cable length as a function of the SSI baud rate

4.17.9 Maximum permissible cable length, option module OM-DIO

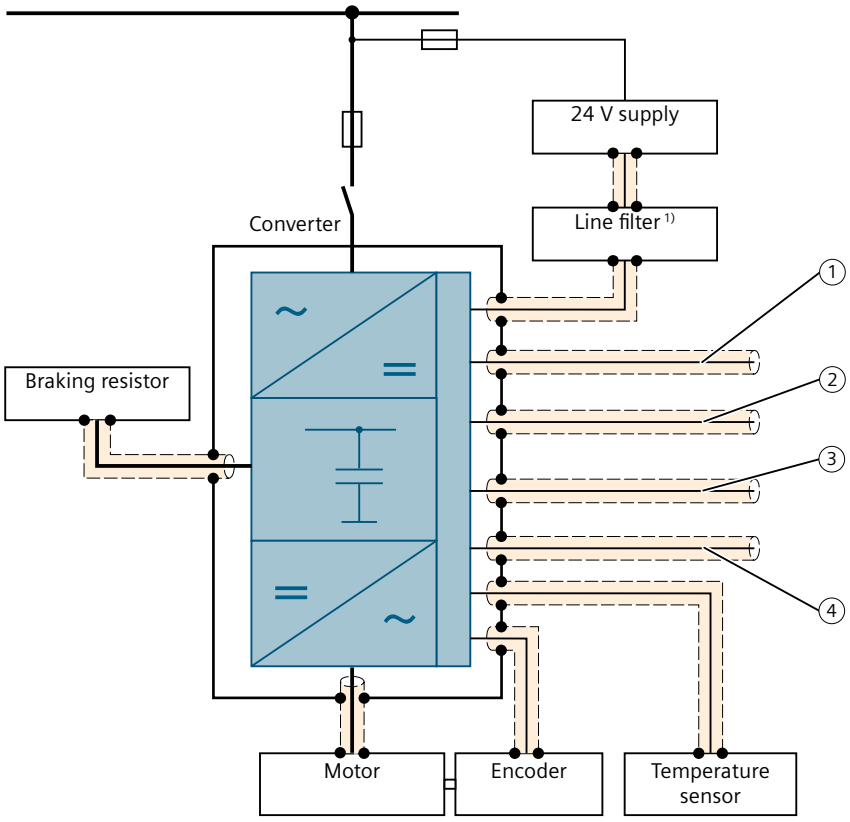
Description

Table 4-10 Maximum permissible cable lengths for the option module OM-DIO

Connection type	Interface on the option module	Maximum permissible cable length	Additional measures
External 24 V power supply	X235:8...9	No restriction	A surge protection device is required for unshielded cables longer than 30 m.
FMO (DO)	X235:1...2	• 1000 m for shielded cables • 30 m for unshielded cables	A surge protection device is required for unshielded cables longer than 30 m.
Bidirectional digital inputs/outputs DI/DO 0...3	X235:3...7		
Relay outputs DO 4...7	X236 and X237		None

4.17.10 Shielded cables, converter in degree of protection IP55

Description



1) Optional external line filter
① Fieldbus cable
② Cable to the Edge device
③ Cables for digital inputs and digital outputs
④ Cables for analog inputs and analog outputs

Figure 4-12 EMC-compliant cable shielding

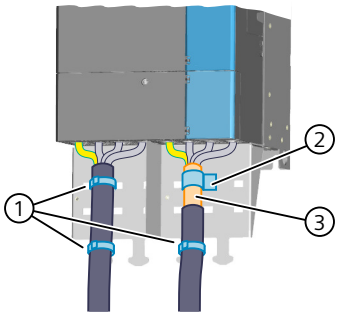
With the exception of the line supply cable, all cables must be shielded to comply with EMC category C2.

When using the CM-DP communications module, it is recommended that the cable shield is additionally connected to a shield plate.

4.17.11 EMC measures for Clean Power converter with frame size FSF1 with degree of protection IP20

Description

For frame size FSF1, we recommend the following measures to secure conformance with EMC standards:



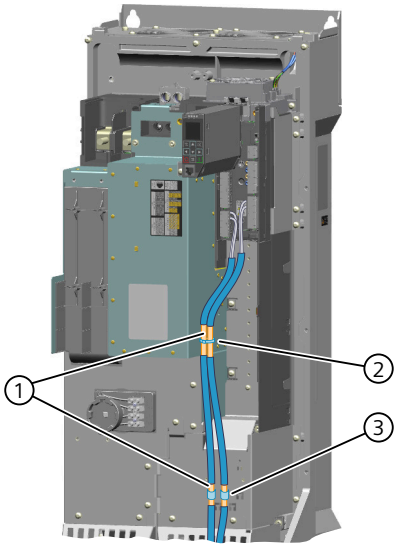
① Line supply and motor connecting cables fixed to the shield plate
② Shield support
③ Route the shield of the motor connection cable as far as possible up to the connecting terminals without any interruption

Figure 4-13 EMC measures for Clean Power converters in frame size FSF1

4.17.12 EMC measures for Clean Power converters in frame size FSF1 with degree of protection IP55

Description

For frame size FSF1, we recommend the following measures to secure conformance with EMC standards:



① Freely exposed shield of the signal cables for digital inputs and digital outputs
② Fixing the signal cables to the metal enclosure
③ Shield support of the signal cables

Figure 4-14 EMC measures for Clean Power converters in frame size FSF1

4.17.13 EMC measures for braking resistors, Clean Power converter, degree of protection IP55

Description

For frame sizes FSD1 ... FSE, from functional state FS: 02, when connecting the braking resistor we recommend the following measures are taken to ensure compliance with EMC standards:

- Select a suitable braking resistor cable, e.g. Lapp ÖLFLEX® CLASSIC 110 CY or equivalent
- Route the shield of the braking resistor cable up to the connecting terminals without any interruption
- Shield support of the braking resistor cable as shown below

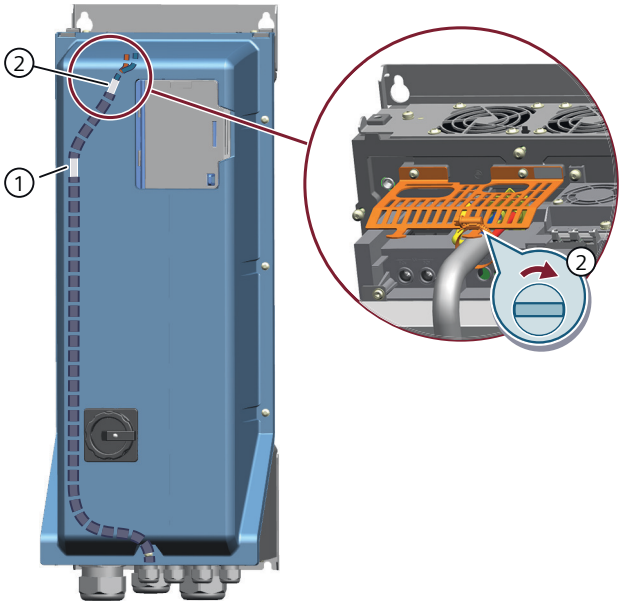


Figure 4-15 EMC measures when connecting a braking resistor using a Clean Power converter as example

EMC measure		Converter standard version			Clean Power Converter		
		Frame size			Frame size		
		FSD1	FSD2	FSE	FSD1	FSD2	FSE
①	Shield support of the braking resistor cable at the converter	✓	✓	✓	✓	✓	✓
②	Shield support of the braking resistor cable at the shield plate above the connecting terminals	---	---	✓	✓	✓	✓

4.18 PROFIBUS connection, converter with degree of protection IP55

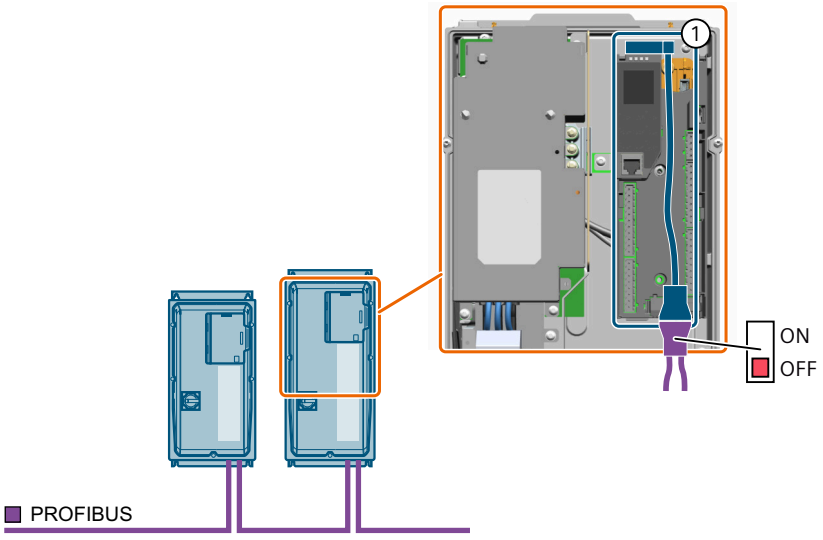
Overview

Depending on the converter frame size, as a result of the limited space above the PROFIBUS interface, an adapter cable is required. The adapter cable is a spur line in PROFIBUS and is therefore not suitable for all data transfer rates.

Description

For converters with frame size FSD1 or larger, we recommend a bus connector with 90° cable outlet.

An adapter cable is required for converters with frame sizes FSB and FSC.



① Adapter cable

The bus terminating resistor must be switched-out before the spur line.

Figure 4-16 Converter PROFIBUS connection, frame size FSB and FSC

The adapter cable is a spur line in PROFIBUS.

A spur line reduces the maximum possible data transfer rate. The sum of all spur line lengths is also limited.

Data transfer rates ≤ 1.5 Mbit/s are possible when using spur lines when complying with the spur line lengths specified in the table.

Table 4-11 Maximum possible data transfer rate when using spur lines

Transfer rate	**Total permitted capacity**	**Maximum possible sum of all spur line lengths** [1] **Length of adapter cable: 0.3 m**
>1.5 Mbit/s	Data transfer rates > 1.5 Mbit/s are not possible when using spur lines.	
1.5 Mbit/s	0.2 nF	6.7 m
500 Mbit/s	0.6 nF	20 m
187.5 kbit/s	1.0 nF	33 m
93.75 kbit/s	3.0 nF	100 m
19.2 kbit/s	15 nF	500 m

[1] Calculated with a type A PROFIBUS cable at 30 pF/m

4.19 Strain relief

Description

Using suitable resources and measures, ensure that all connected conductors are strain-relieved so that no inadmissible mechanical forces act on the conductors or the terminals.

Resources and measures to provide strain relief for the converter:

- Converter with degree of protection IP55:
  Strain relief resources are not part of the scope of delivery.
  Suitable measures include gland plates for connection cables according to IEC 62444 or equivalent installation measures that ensure the same mechanical protection and strain relief.
- Converter with degree of protection IP20:
  Suitable measures include shield plates or equivalent installation measures that ensure strain relief.

Installation

5

5.1 Weight, converter in degree of protection IP20

Technical data

Table 5-1 Weight of converter without option modules

Property		Unit	FSA	FSB	FSC	FSD1	FSD2	FSE	FSF1	FSF2	
										C2	C3
Converter 3 AC 200 ... 240 V		kg	4.0	6.5	9.0	-	22.5	32.5	63.1	-	
Converter 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V	Without integrated filter		4.0	6.5	9.0	16.5	22.5	33.0	64.4	-	
	With integrated filter		4.5	7.0	10.0	18.0	25.5	36.5	67.8	93.0	96.8
	Clean Power		-	-	-	16.9	24.8	34.3	64.0	92.2	-

Weight data without shield plate

The weight of the converter can vary by up to 3% from the specified values.

5.2 Weight, converter in degree of protection IP55

Technical data

Table 5-2 Weight of converter without option modules

Property			Unit	FSB	FSC	FSD1	FSD2	FSE	FSF1
Converter 3 AC 200 ... 240 V	Without maintenance switch		kg	17.3	21.1	---	34	47	97.8
	With maintenance switch			17.4	21.2	---	33.9	48.1	100.4
Converter 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V	Without integrated filter	Without maintenance switch		16.7	21.5	25	34.6	48	99.4
		With maintenance switch		16.8	21.4	25	34.5	49.1	102
	With integrated filter	Without maintenance switch		17.2	22	26.8	37.4	54.5	106.7
		With maintenance switch		18	22.2	26.7	37.2	55.4	109.3
	Clean Power	Without maintenance switch		---	---	25.8	36.4	54	100.8
		With maintenance switch		---	...	25.8	36.5	55.4	103.4

The weight of the converter can vary by up to 3% from the specified values.

5.3 Weight, braking resistor

Technical data

Table 5-3 Weight, line voltage 3 AC 200 ... 240 V

Braking resistor		
Article number	**Unit**	**Weight**
JJY:023151720007	kg	0.7
JJY:023163720018		1.1
JJY:023433720001		2.0
JJY:023422620002		7.0
JJY:023423320001		8.5
JJY:023434020003		13.5

Table 5-4 Weight, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Braking resistor		
Article number	**Unit**	**Weight**
6SL3201-0BE14-3AA0	kg	1.5
6SL3201-0BE21-0AA0		1.8
6SL3201-0BE21-8AA0		2.7
6SL3201-0BE23-8AA0		6.2
JJY:023422620001		7.0
JJY:023424020001		9.5
JJY:023434020001		13.5
JJY:023454020001		20.5
JJY:023464020001		27.0

5.4 Weight, du/dt filter plus VPL

Technical data

Table 5-5 Weight, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

du/dt filter plus VPL		
Article number	**Unit**	**Weight**
JTA:TEF1203-0HB	kg	29
JTA:TEF1203-0JB		46
JTA:TEF1203-0KB		77
JTA:TEF1203-0LB		97
JTA:TEF1203-0MB		172

5.5 Weight, sine-wave filter

Technical data

Table 5-6 Weight, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Sine-wave filter	
Article No.	**Weight in kg**
6SL3202-0AE21-1SA0	6
6SL3202-0AE21-4SA0	10
6SL3202-0AE22-0SA0	12
6SL3202-0AE24-6SA0	24
6SL3202-0AE26-2SA0	34
6SL3202-0AE28-8SA0	45
6SL3202-0AE31-8SA0	80

5.6 Unpacking the converter, delivered without pallet

Overview

The following converters are supplied without pallet:

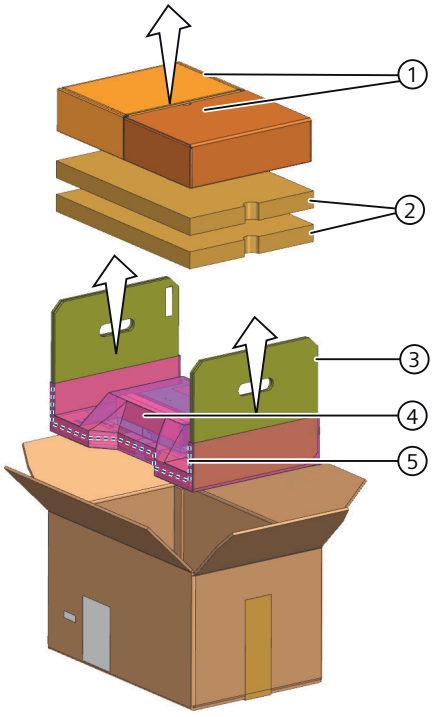
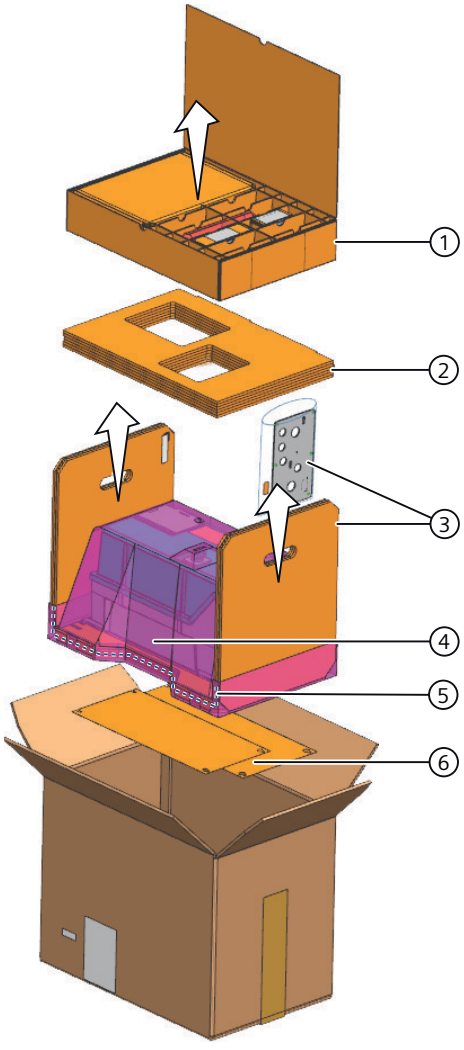
- Converter with degree of protection IP20, frame sizes FSA ... FSD1
- Converter with degree of protection IP55, frame sizes FSB and FSC

Precondition

Tool required: A knife to open the outer packaging and to remove the packaging foil from the converter

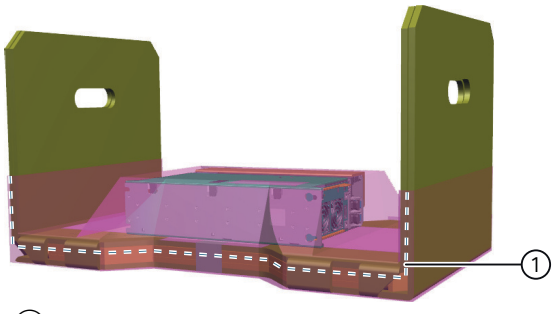
NOTICE
Material damage when incorrectly removing the protective foil from the converter Improper removal of the protective film using sharp tools such as a knife can cause irreparable damage to the converter. • Cut open the protective foil along the side of the backing.

Procedure

Converter with degree of protection IP20		Converter with degree of protection IP55
		
①	Accessory box 1 contains the accessory kit, for example shield plates, hole drilling template. Accessory box 2 contains the optional components.	The accessory box contains the optional components.
②	Spacer The number of spacers depends on the converter frame size	Spacer
③	Tray packaging	Tray packaging with the optionally available gland plate for connection cables
④	Converter packed in the foil	Converter packed in the foil
⑤	Recommended cutting line to remove the packaging foil	Recommended cutting line to remove the packaging foil
⑥	-	2 hole drilling templates

Procedure to unpack the converter:

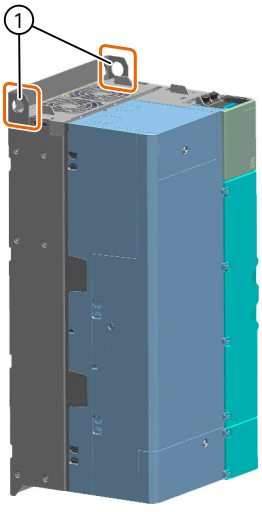
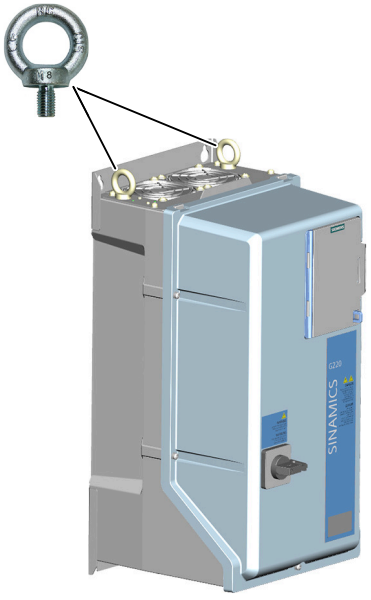
1. Place the packed converter on a stable surface with the underside down.
2. Open the outer packaging on the upper side.
3. Remove the accessory box/accessory boxes and the spacer(s).
4. For converters delivered with degree of protection IP55, remove the optionally provided gland plate for connecting cables.
   The gland plate is located between the lateral layers of the tray packaging.
5. Remove the outer packaging as follows:
   - Lift the following converters out of the outer packaging using the side handholds in the tray packaging:
     Converter with degree of protection IP20, frame sizes FSA to FSC
     Converter with degree of protection IP55, frame size FSB
   - For large converters we recommend that the outer packaging is completely cut open:
     Converter with degree of protection IP20, frame size FSD1
     Converter with degree of protection IP55, frame size FSC
6. Remove the protective foil from the converter.
   Cut open the foil along the recommended cutting line at the side of the base, as shown in the diagram for the converter with degree of protection IP20.



① Recommended cutting line to remove the packaging foil

7. Lift larger converters from the outer packaging that has been cut open:
   – Converter with degree of protection IP20, frame size FSD1
   – Converter with degree of protection IP55, frame size FSC

   We recommend using lifting equipment attached to the converter attachment points.

Converter with degree of protection IP20	Converter with degree of protection IP55
 ① Attachment points for lifting equipment	 Converters in frame size FSC have 2 tapped holes on the top for M8 lifting eyebolts.

8. For converters delivered with degree of protection IP55, remove the outer packaging of the hole drilling templates.
   For converters with frame sizes FSB and FSC, the hole drilling templates are included in the scope of delivery.
   Only use the hole drilling template supplied with the converter.

5.7 Unpacking the converter, delivered on pallets

Overview

The following converters are supplied on a pallet:

- Converter with degree of protection IP20, from frame size FSD2
- Converter with degree of protection IP55, from frame size FSD1

Precondition

Tool required:

- A knife to open the packaging
- A TX 40 Torx screwdriver to remove the transport lock screws
- A Torx screwdriver to remove the sheet metal handles for the hoisting equipment:

Converter		Torx screwdriver
Degree of protection	**Frame size**	**Magnitude**
IP20	FSD2	TX 25
	FSE	
	FSF1[1)]	
	FSF2[1)]	---
IP55	FSD1	TX 25
	FSD2	
	FSE	
	FSF1	TX 50

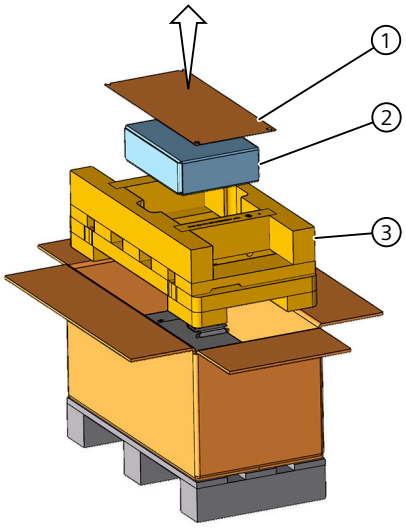
[1)] The attachment points for the hoisting equipment are permanently connected with the converter

Procedure

Procedure to unpack the converter:

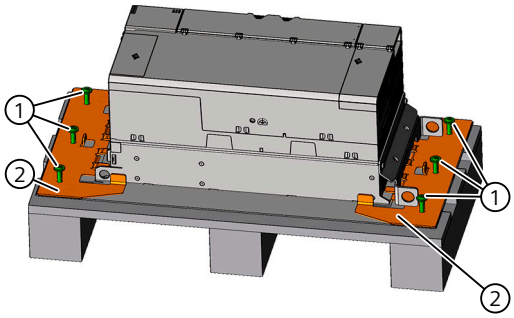
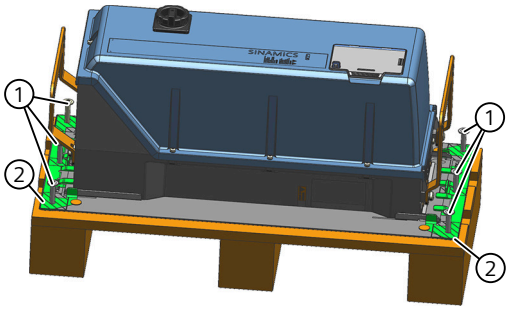
1. Place the packed converter on a stable surface with the underside down.
2. Open the packaging on the upper side.

3. Remove the hole drilling template, the separately packaged accessories and the packaging material:

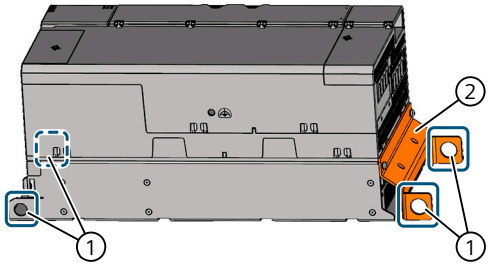
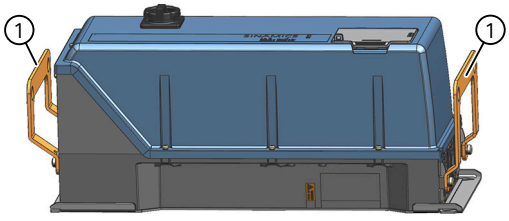


① Hole drilling template
② Accessories
③ Packaging material

4. Remove the transport lock screws and remove the transport lock.

Converter with degree of protection IP20	Converter with degree of protection IP55
	
① Transport lock screws ② Transport lock	① Transport lock screws ② Transport lock

5. Use lifting equipment attached to the converter attachment points.

Converter with degree of protection IP20	Converter with degree of protection IP55
	
① Attachment points for lifting equipment ② Plate with additional attachment points After installing the converter in an electrical cabinet, remove the plate with the additional holding points from the lower side of the converter.	① Sheet steel plates for lifting equipment After installing the converter in an electrical cabinet, remove the sheet steel plates for the lifting equipment.

5.8 Removing the transport lock, converter in degree of protection IP20

Overview

Converters, frame sizes FSB ... FSD1 in degree protection IP20 have a transport lock.

Remove the transport lock before commissioning the converter.

Requirement

You require a TX 20 torx screwdriver.

Procedure

Proceed as follows to remove the transport lock:

1. Release the screw of the transport lock using a TX 20 torx screwdriver.
2. Remove the transport lock.



Figure 5-1 Removing the transport lock

5.9 Shield plates for converter with IP20 degree of protection

5.9.1 Weight, shield plate

Technical data

Table 5-7 Weight

Converter frame size	Unit	Weight of the shield plates without packaging
FSA	kg	0.20
FSB		0.22
FSC		0.52
FSD1		0.63
FSD2		0.68
FSE		0.87
FSF1		2.1
FSF2		4.4

5.9.2 Mount the upper shield plates

Requirement

To mount the upper shield plates, you will need this screwdriver:

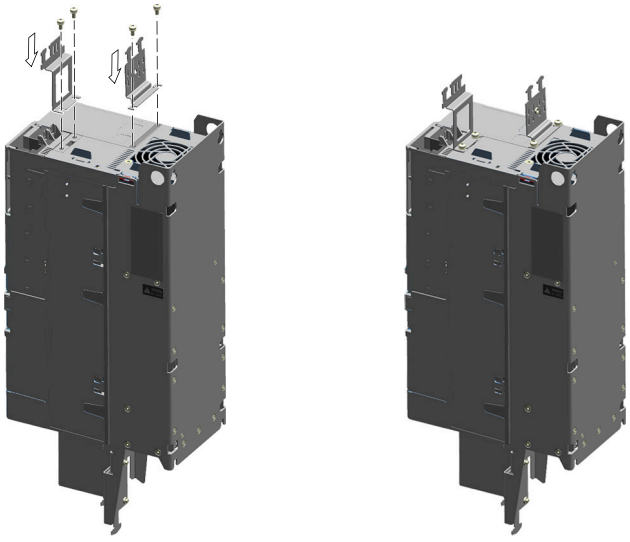
- Pozidrive or slotted screwdriver for frame sizes FSA ... FSC
- Torx screwdriver TX 25 from frame size FSD1

Procedure

The converter of frame size FSA ... FSC has only 1 upper shield plate for the fieldbus cable.

The converter of frame size FSD1 and larger has 2 upper shield plates:

- One shield plate for the fieldbus cable
- One shield plate for the power cables



Tightening torque for frame sizes FSA ... FSC: 2 Nm
Tightening torque for frame size FSD1 or larger: 3 Nm
Figure 5-2 Mounting the upper shield plates (frame size FSD1 in this example)

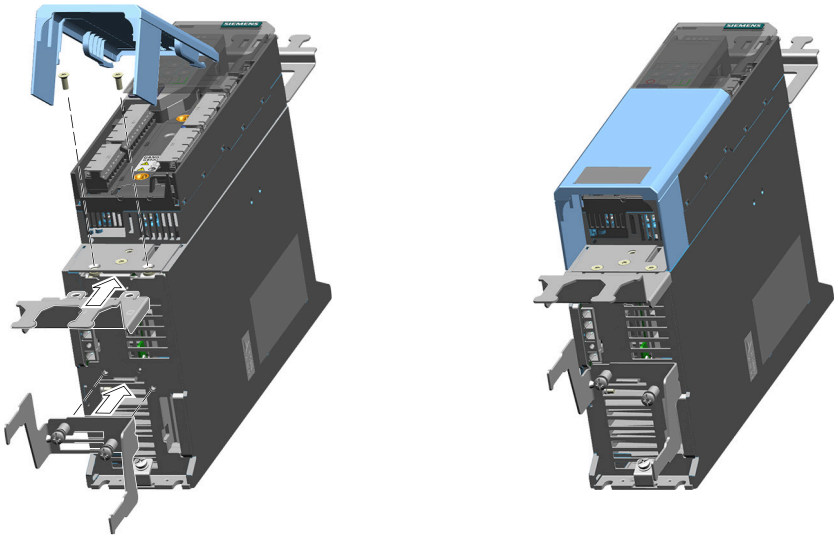
5.9.3 Mount the lower shield plates

Requirement

To mount the lower shield plates, you will need these screwdrivers:

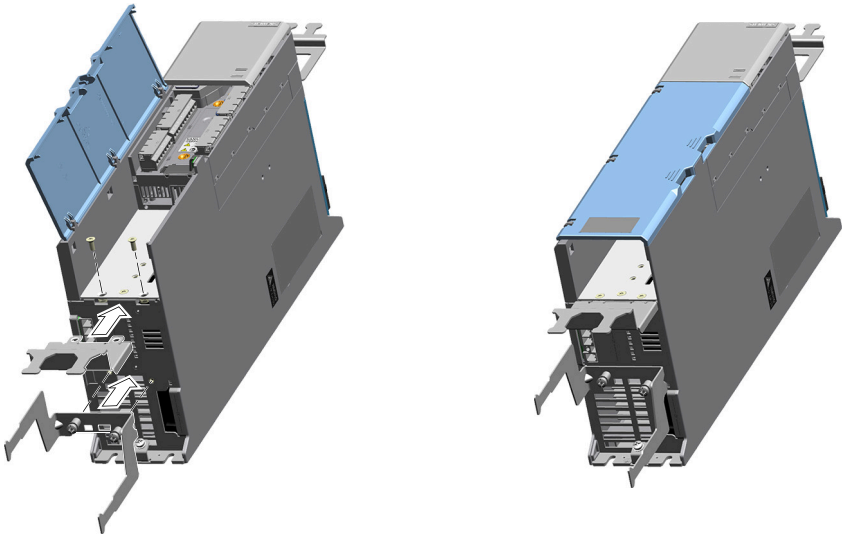
- Torx screwdriver TX 20 and Pozidrive or slotted screwdriver for frame sizes FSA ... FSC
- Torx screwdriver TX 25 from frame size FSD1

Procedure



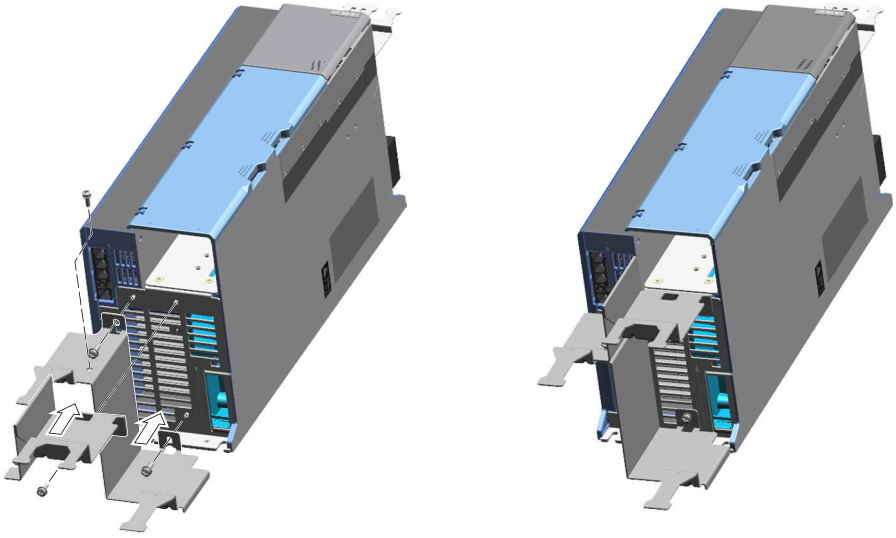
Tightening torque: 2 Nm

Figure 5-3 Mounting the lower shield plates, frame size FSA



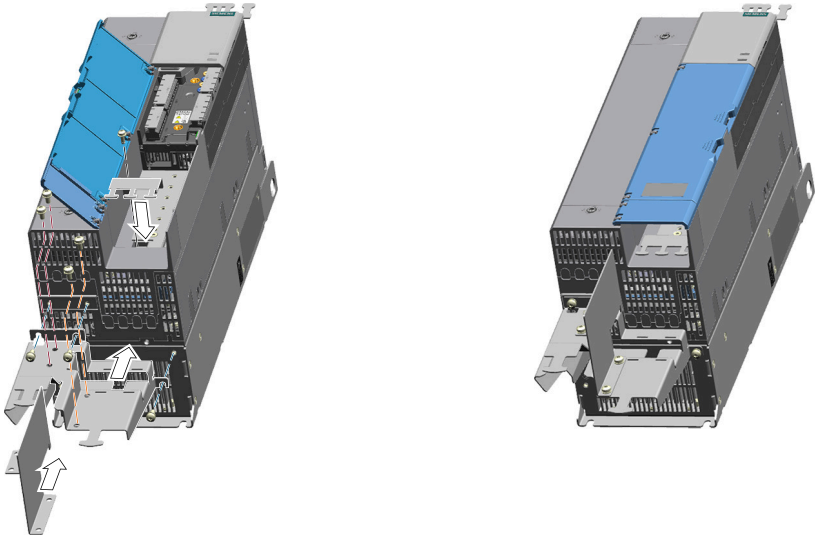
Tightening torque: 2 Nm

Figure 5-4 Mounting the lower shield plates, frame size FSB



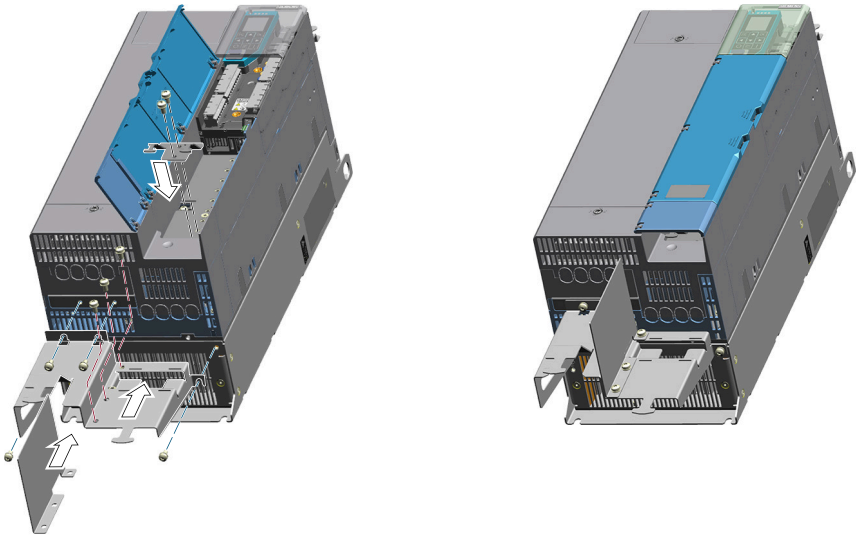
Tightening torque: 2 Nm

Figure 5-5 Mounting the lower shield plates, frame size FSC



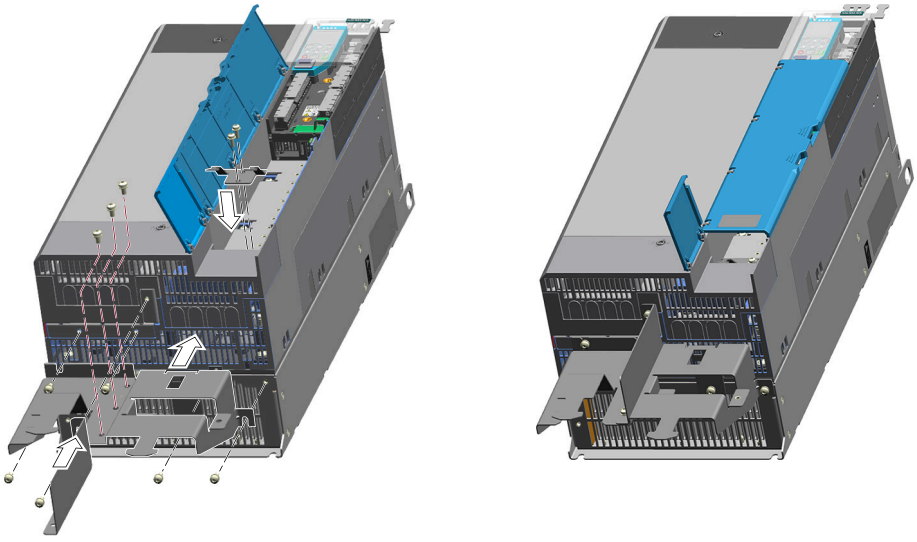
Tightening torque: 3 Nm

Figure 5-6 Mounting the lower shield plates, frame size FSD1



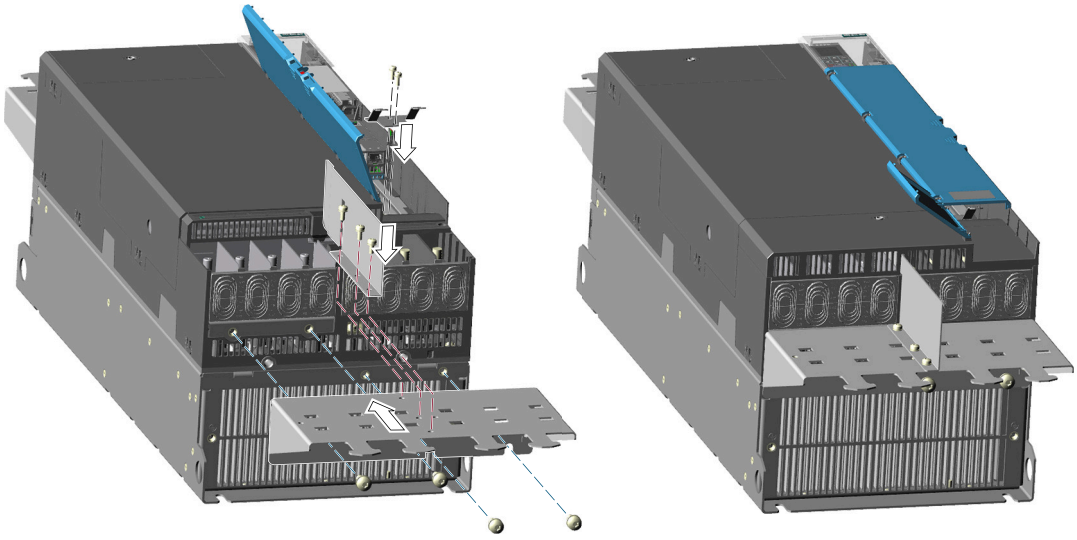
Tightening torque: 3 Nm

Figure 5-7 Mounting the lower shield plates, frame size FSD2

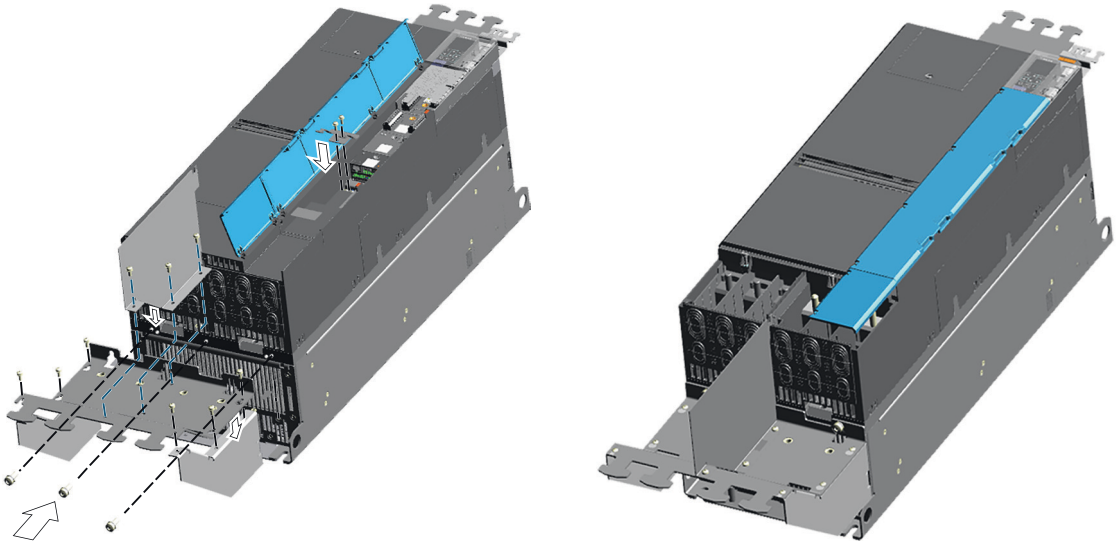


Tightening torque: 3 Nm

Figure 5-8 Mounting the lower shield plates, frame size FSE



Tightening torque: 3 Nm
Figure 5-9 Mounting the lower shield plates, frame size FSF1



Tightening torque: 3 Nm
Figure 5-10 Mounting the lower shield plates, frame size FSF2

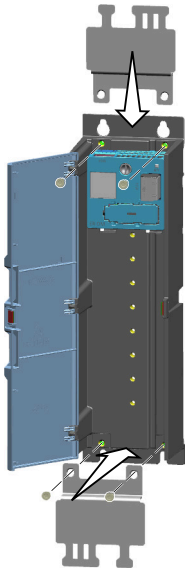
5.9.4 Mounting shield plates at the Expansion Rack for Option Modules (ER-OM)

Requirement

You require a TX 25 torx screwdriver for attaching the shield plate.

Procedure

The Expansion Rack for Option Modules (ER-OM) has a shield plate on the upper and lower sides.



Tightening torque: 2 Nm

Figure 5-11 Mounting the shield plates

5.10 Shield plate for converters with degree of protection IP55

5.10.1 Remove and install housing cover, converter with IP55 degree of protection

Overview

To connect cables, mount shield plates or replace converter components, you must remove the converter housing cover.

The description uses a graphic of a converter with frame size FSC as example

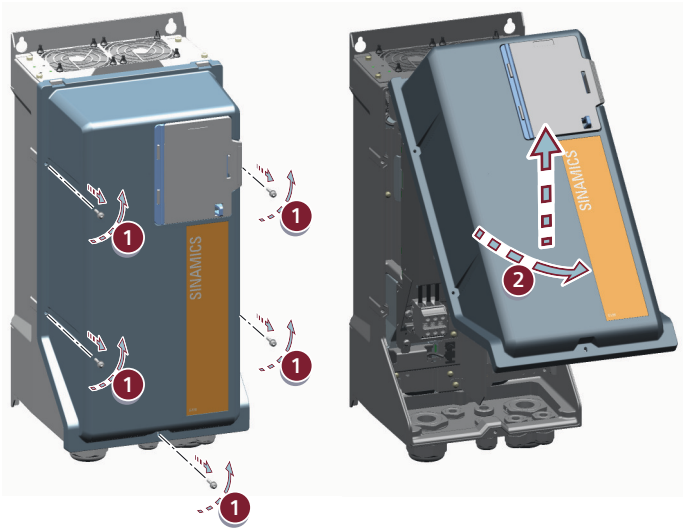
Requirement

The following requirements apply when attaching and removing the housing cover:

- Comply with ESD regulations.
- Tool required: Torx screwdriver TX 20 or TX 25
  Torx size and tightening torque depend on the converter frame size.

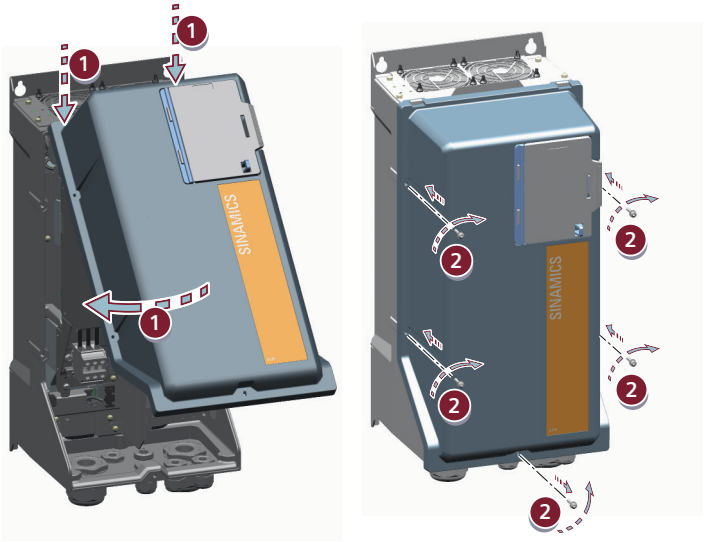
Procedure

Proceed as follows to remove the housing cover:



1. Using a torx screwdriver, release the fixing screws of the housing cover.
   The screws are connected to the housing cover and are captive.
2. Swivel the housing cover towards the front and then lift the housing cover upward.

Proceed as follows to install the housing cover:



1. Place the housing cover with the recess at the converter housing and swivel the housing cover downward.
2. Using a torx screwdriver, tighten the fixing screws of the housing cover.

Converter frame size	Fixing screws		Tightening torque in Nm	Torx screwdriver
	Quantity	Type		
FSB	5	M4x20	2	TX 20
FSC				
FSD1	7	M5x18	3	TX 25
FSD2				
FSE	10			
FSF1	12	M5x20		

5.10.2 Mounting the shield plate for braking resistor, Clean Power converter with degree of protection IP55

Requirement

Only mount the shield plate under the following conditions:

- When connecting a braking resistor
- Converter with frame size FSD2 and FSE

You need a TX 20 torx screwdriver for mounting the shield plate.

Procedure



Tightening torque: 2 Nm

Figure 5-12 Mounting shield plates for braking resistor (frame size FSE in this example)

5.11 Gland plate for connecting cables, converter with IP55 degree of protection

5.11.1 Mount the gland plate for connecting cables

Overview

In the delivery state, the underside of the converter is protected by a metal plate.

You have the following cable entry options:

- Replace the metal plate by the gland plate.
  The gland plate has different holes for the cable gland of the connecting cables.
- Use the metal plate and drill the holes required for the cables as shown in the dimension drawings.

Precondition

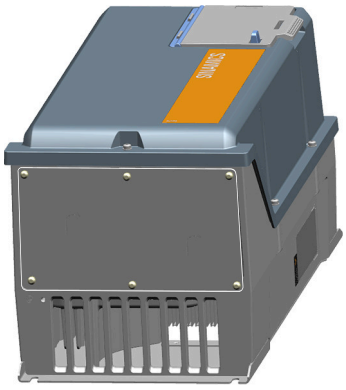
You need the following torx screwdriver to mount the gland plate:

- TX 20 for frame sizes FSA ... FSC
- TX 25 from frame size FSD1

Procedure

Proceed as follows to mount the gland plate:

1. Release the screws of the plate, which when delivered is mounted on the lower side of the converter.



2. Screw the gland plate for the connecting cables in place with the following tightening torque:
   - Frame size FSA ... FSC: 2 Nm
   - From frame size FSD1: 5 Nm



3. To ensure the degree or protection of the converter, close any unused holes and seal with an appropriate cable gland or a blanking cover.

5.11.2 Sizes of the holes in the gland plate for connecting cables

Technical data

Table 5-8 Sizes of the holes in the gland plate 3 AC 200 ... 240 V

Frame size	Rated power	Article number: 6SL4112-..☐..-...0			
		P		Q	
		Hole sizes			
	in kW	Motor and line supply cables	Signal cables	Motor and line supply cables	Signal cables
FSB	1.1	M25	*M20*	¾ "	½ "
	1.5				
	2.2				
	3				
	4				
FSC	5.5	M32	M20	1 "	½ "
	7.5				
FSD2	11	M32	M20	1½	½ "
	15	M40	M20		
	18.5	M50	M20		
FSE	22	M50	M20	2 "	½ "
	30	M63	M20		
FSF1	37	M63	M20	2 x 2 "	½ "
	45	2 x M75	M20		
	55	2 x M75	M20		

Table 5-9 Sizes of the holes in the gland plate, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Frame size	Rated power	Article number: 6SL4113-..☐..-...0			
		P		Q	
		Hole sizes			
	in kW	Motor and line supply cables	Signal cables	Motor and line supply cables	Signal cables
FSB	1.1	M25	M20	¾ "	½ "
	1.5				
	2.2				
	3				
	4				
	5.5				
	7.5				

Frame size	Rated power	Article number: 6SL4113-..☐..-...0			
		P		Q	
		Hole sizes			
	in kW	Motor and line supply cables	Signal cables	Motor and line supply cables	Signal cables
FSC	11	M32	M20	1 "	½ "
	15				
FSD1	18.5	M32	M20	1 "	½ "
	22				
FSD2	30	M40	M20	1½ "	½ "
	37	M50	M20		
FSE	45	M50	M20	2 "	½ "
	55	M63	M20		
FSF1	75	M63	M20	2 x 2 "	½ "
	90	2 x M75	M20		
	110	2 x M75	M20		

More information

You can find more information on the Internet:

Gland plate for connection cables (https://support.industry.siemens.com/cs/ww/us/en/view/110000523)

5.11.3 Sizes of the holes in the gland plate for connecting cables, Clean Power

Technical data

Table 5-10 Sizes of the holes in the gland plate, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, Clean Power

Frame size	Rated power	Article number: 6SL4113-..☐..-...0			
		P		Q	
		Hole sizes			
	in kW	Motor and line supply cables	Signal cables	Motor and line supply cables	Signal cables
FSD1	7.5	M25	M20	1 "	½ "
	11				
	15	M32	M20		
	18.5				
	22				

Frame size	Rated power	Article number: 6SL4113-..□..-...0			
		P		Q	
		Hole sizes			
	in kW	Motor and line supply cables	Signal cables	Motor and line supply cables	Signal cables
FSD2	30	M40	M20	1½ "	½ "
	37	M50	M20		
FSE	45	M50	M20	2 "	½ "
	55	M63	M20		
FSF1	75	M63	M20	2 x 2 "	½ "
	90	2 x M75	M20		
	110	2 x M75	M20		

More information

You can find more information on the Internet:

Gland plate for connection cables (https://support.industry.siemens.com/cs/ww/us/en/view/110000523)

5.12 Remove and install housing cover, converter with IP55 degree of protection

Overview

To connect cables, mount shield plates or replace converter components, you must remove the converter housing cover.

The description uses a graphic of a converter with frame size FSC as example

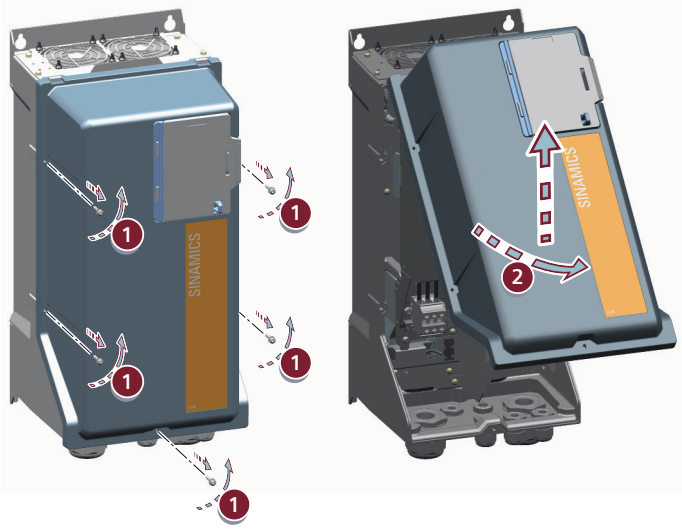
Requirement

The following requirements apply when attaching and removing the housing cover:

- Comply with ESD regulations.
- Tool required: Torx screwdriver TX 20 or TX 25
  Torx size and tightening torque depend on the converter frame size.

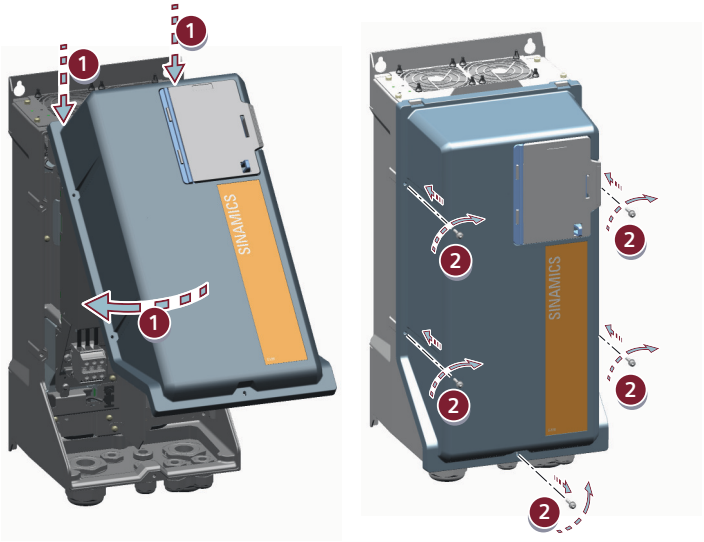
Procedure

Proceed as follows to remove the housing cover:



1. Using a torx screwdriver, release the fixing screws of the housing cover.
   The screws are connected to the housing cover and are captive.
2. Swivel the housing cover towards the front and then lift the housing cover upward.

Proceed as follows to install the housing cover:



1. Place the housing cover with the recess at the converter housing and swivel the housing cover downward.
2. Using a torx screwdriver, tighten the fixing screws of the housing cover.

Converter frame size	Fixing screws		Tightening torque in Nm	Torx screwdriver
	Quantity	Type		
FSB	5	M4x20	2	TX 20
FSC				
FSD1	7	M5x18	3	TX 25
FSD2				
FSE	10			
FSF1	12	M5x20		

5.13 Option modules

5.13.1 Maximum number of option modules in the converter

Description

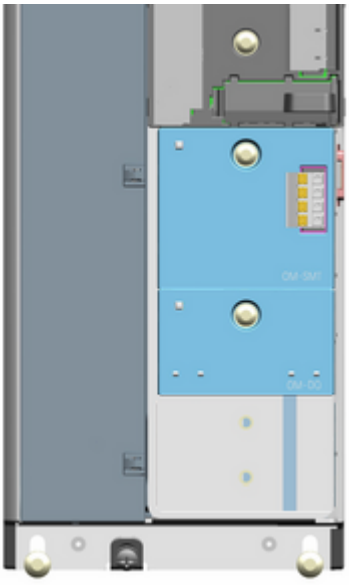


Figure 5-13 Example: IP20 converter, frame size FSC, with Option Modules OM-SMT and OM-DQ

An option module may only be inserted once.

The maximum number of Option Modules that can be mounted depends on the specific Option Module type and the frame size of the converter.

Table 5-11 Combination of Option Modules

Number of Option Modules	**Module slot**	**Converter frame size**			
		FSA	**FSA with expansion adapter for Option Modules**	**FSB ... FSD**	**FSE ... FSF2**
1 Option Module	Top	OM-DQ	Every option module		
2 Option Modules	Top	Not possible	Every option module except OM-DQ		
	Bottom		OM-DQ	Every option module	
3 Option Modules	Top	Not possible			Every option module except OM-DQ
	Center				Every option module except OM-DQ
	Bottom				Every option module

5.13.2 Maximum number of option modules in the expansion rack

Description

A maximum of 3 option modules can be inserted in the expansion rack.

An option module that is already inserted in the associated converter may not be inserted again in an expansion rack.

An option module may only be inserted once in the expansion rack.

It is not permissible that option module OM-DQ is inserted in the expansion rack.

5.13.3 Weight, option modules

Technical data

Table 5-12 Weight

Component	Unit	Weight without packaging
Option module OM-SMT	kg	0.082
Option module OM-IIoT		0.073
Option module OM-DQ		0.071
OM-ENC option module		0.084
OM-DIO option module		0.097
Option Module OM-AIO		0.084
Expansion adapter for option modules		0.25
Expansion rack for option modules (ER-OM)		0.774

5.13.4 Mounting the expansion adapter for option modules

Overview

Mount the expansion adapter for option modules if you require additional slots for option modules.

Requirement

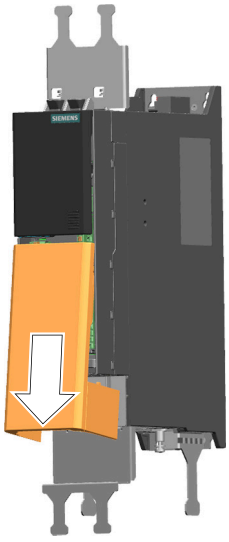
Requirements:

- The expansion adapter for option modules is only available for converters with frame size FSA in degree of protection IP20.
- A TX 20 torx screwdriver for mounting the shield plate

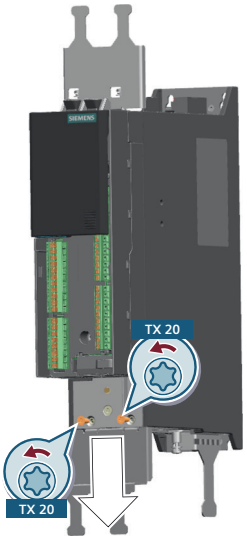
Procedure

Proceed as follows to mount the expansion adapter for option modules:

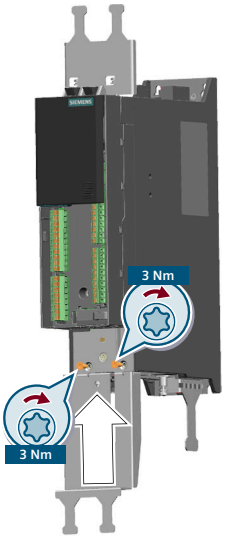
1. Pull down the front cover of the converter.



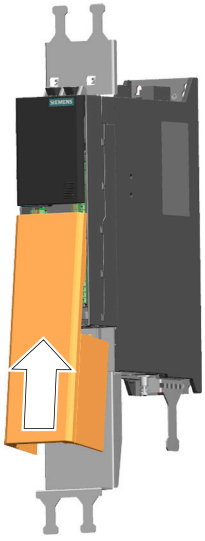
2. Release the 2 screws of the lower shield plate and remove the shield plate.



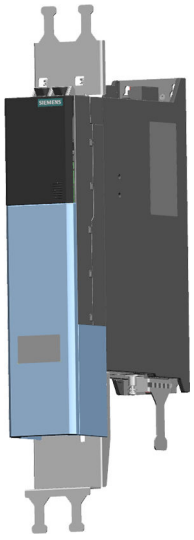
3. Mounting the shield plate of the expansion adapter.



4. Place the front cover of the expansion adapter on the converter.



Result



The expansion adapter for option modules has been mounted.

5.13.5 Installing option modules, converter with degree of protection IP20

Overview

The converter has an option slot to insert option modules.

The description uses a graphic of a converter with frame size FSC as example

Precondition

NOTICE
Damage to the option module by withdrawing and inserting under voltage (hot swapping) Withdrawing and inserting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction. • Switch off the converter power supply before you withdraw or insert the option module.

You require a TX 20 torx screwdriver.

Procedure

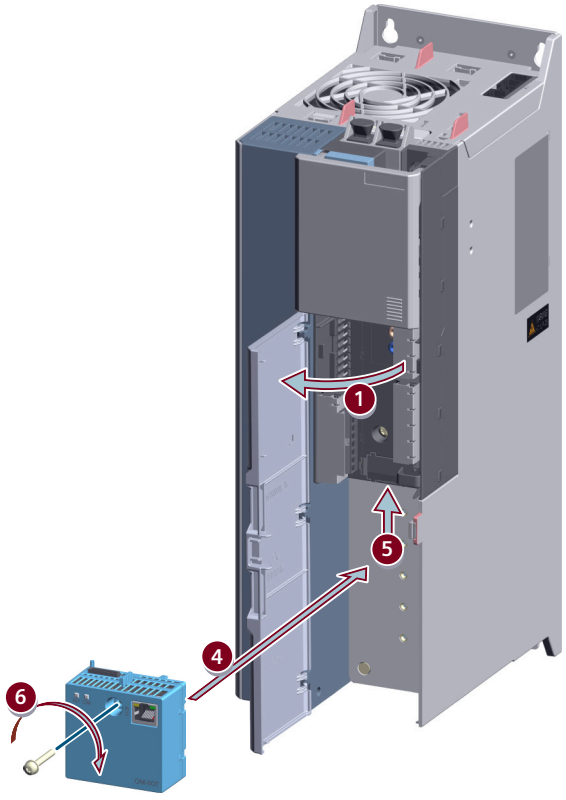


Figure 5-14 Installing option module (example: OM-IIoT) in the option slot of the converter

Proceed as follows to install the option module in the option slot of the converter:

1. Remove the front cover (frame size FSA) or open the front door of the converter.
2. Remove the cover from the interface on the underside of the Control Unit.
3. Connect the cover to the interface on the underside of the option module.
4. Insert the option module into the option slot of the converter.
5. Push up the option module until it snaps in flush.
6. Tighten the fixing screw using a TX 20 torx screwdriver with a tightening torque of 2 Nm.
7. Press the cover cap onto the fixing screw.
8. Place the front cover (frame size FSA) on the converter or close the front door of the converter.

Result

The option module is connected with the converter.

5.13.6 Installing option modules, converter with degree of protection IP55

Overview

The converter has an option slot to insert option modules.

The description uses a graphic of a converter with frame size FSC as example

Precondition

NOTICE
Damage to the option module by withdrawing and inserting under voltage (hot swapping) Withdrawing and inserting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction. • Switch off the converter power supply before you withdraw or insert the option module.

You require a TX 20 Torx screwdriver.

Procedure

Proceed as follows to install the option module in the option slot of the IP55 converter:

1. Remove the cover from the interface on the underside of the Control Unit.
2. Connect the cover to the interface on the underside of the option module.

3. Insert the option module into the option slot of the converter.

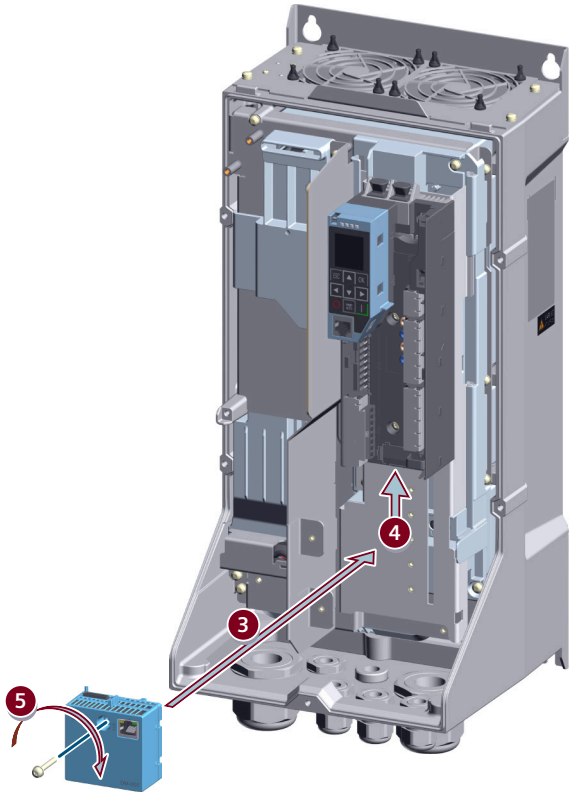


Figure 5-15 Installing option module (example: OM-IIoT) in the option slot of the converter

4. Push up the option module until it snaps in flush.
5. Tighten the fixing screw using a TX 20 torx screwdriver with a tightening torque of 2 Nm.
6. Press the cover cap onto the fixing screw.

Result

The option module is connected with the converter.

5.13.7 Option module in the Expansion Rack for Option Modules (ER-OM)

Requirement

The Expansion Rack for Option Modules (ER-OM) is connected with the converter via a DRIVE-CLiQ connection.

NOTICE
Damage to the option module by withdrawing and inserting under voltage (hot swapping) Withdrawing and inserting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction. • Switch off the external power supply at terminal strip X524 before you withdraw or insert an option module.

You require a TX 20 torx screwdriver.

Procedure

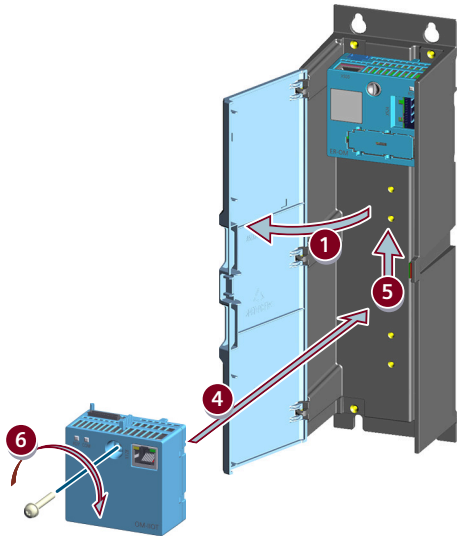


Figure 5-16 Installing option module (example: OM-IIoT) in the ER-OM

Proceed as follows to install an option module in the Expansion Rack for Option Modules (ER-OM):

1. Open the front door of the ER-OM.
2. In the ER-OM remove the cover from the interface to the option module.
3. Connect the cover to the interface on the underside of the option module.
4. Insert the option module into the ER-OM.
5. Push up the option module until it snaps in flush.
6. Tighten the fixing screw using a TX 20 torx screwdriver with a tightening torque of 2 Nm.

7. Press the cover cap onto the fixing screw.
8. Close the front door.

Result

The option module is connected to the ER-OM.

5.13.8 Auxiliary fan for option modules, converter in degree of protection IP20

Overview

The auxiliary fan is not mounted in the factory.

Under certain preconditions, you must subsequently mount the auxiliary fan to cool the converter.

Requirement

The auxiliary fan is delivered together with the converter.

The auxiliary fan is required if both requirements are simultaneously fulfilled:

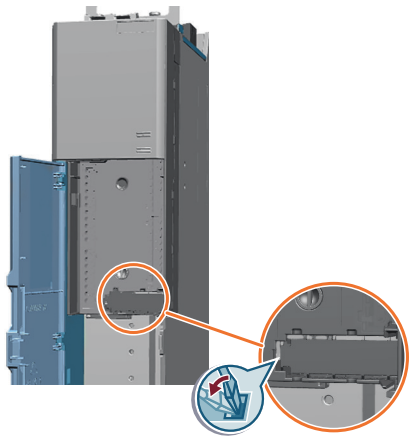
- Ambient temperature > 50 °C
- More than 1 option module is mounted in the converter.

Procedure

Proceed as follows to mount the auxiliary fan:

1. Switch off the converter supply voltage.
2. Open the front door of the converter.
3. If required, temporarily remove the control cables that prevent the auxiliary fan from being mounted.

4. Using a suitable tool, e.g. a slotted screwdriver, remove the breakout for the auxiliary fan slot.



5. Insert the auxiliary fan into its slot until it interlock audibly snaps into place.
6. Reconnect all of the converter control cables if you removed the control cables.
7. Close the front door of the converter.
8. Switch on the converter supply voltage.

5.13.9 Auxiliary fan for option modules, converter in degree of protection IP55

Overview

The auxiliary fan is not mounted in the factory.

Under certain preconditions, you must subsequently mount the auxiliary fan to cool the converter.

Requirement

The auxiliary fan is delivered together with the converter.

The auxiliary fan is required if both requirements are simultaneously fulfilled:

- Ambient temperature > 45 °C

AND

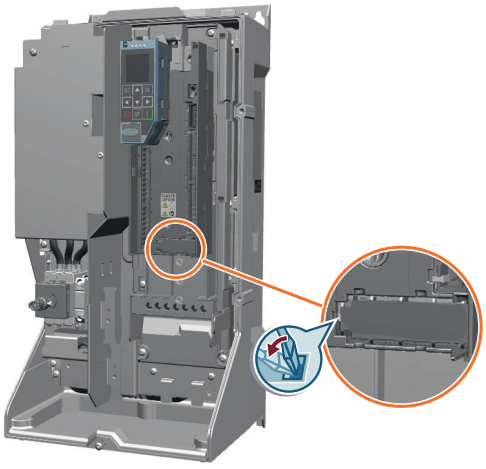
- More than 1 option module is installed in the converter
  OR
  The CM-DP or the CM-RS485 communications module is installed in the converter

Procedure

Proceed as follows to mount the auxiliary fan:

1. Switch off the converter supply voltage.
2. Remove the housing cover.

3. If required, temporarily remove the control cables that prevent the auxiliary fan from being mounted.
4. Using a suitable tool, e.g. a slotted screwdriver, remove the breakout for the auxiliary fan slot.



5. Insert the auxiliary fan into its slot until it interlock audibly snaps into place.
6. Reconnect all of the converter control cables if you removed the control cables.
7. Attach the housing cover.
8. Switch on the converter supply voltage.

5.13.10 Dimension drawing OM-SMT

Dimension drawing

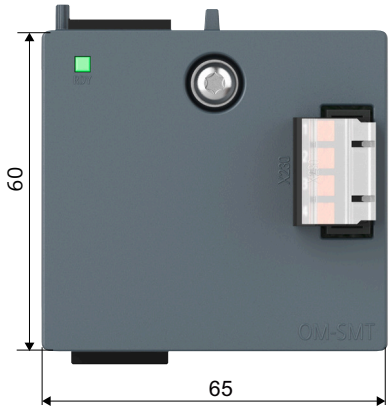


Figure 5-17 Dimensions of Option Module OM-SMT

5.13.11 Dimension drawing OM-IIoT

Dimension drawing

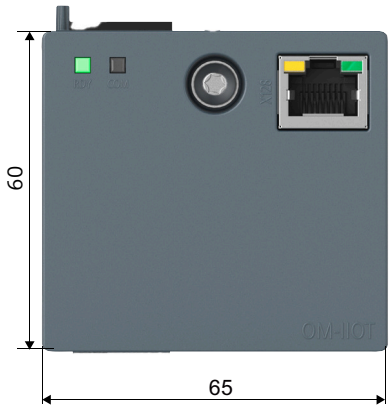


Figure 5-18 Dimensions of Option Module OM-IIoT

5.13.12 Dimension drawing OM-DQ

Dimension drawing



Figure 5-19 Dimensions of Option Module OM-DQ

5.13.13 Dimension drawing OM-ENC

Dimension drawing

All dimensions are specified in millimeters.

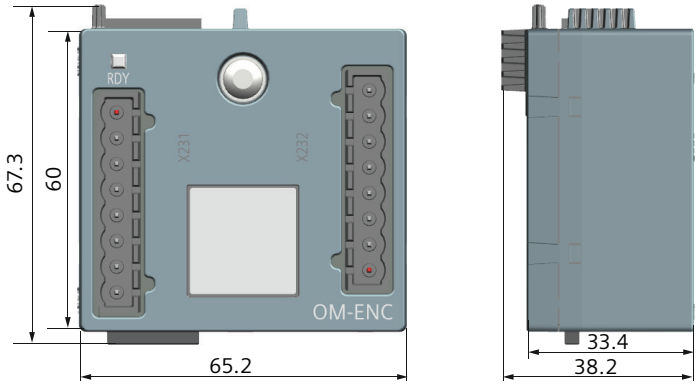


Figure 5-20 Dimensions of the OM-ENC

5.13.14 Dimension drawing OM-DIO

Dimension drawing

All dimensions are specified in millimeters.

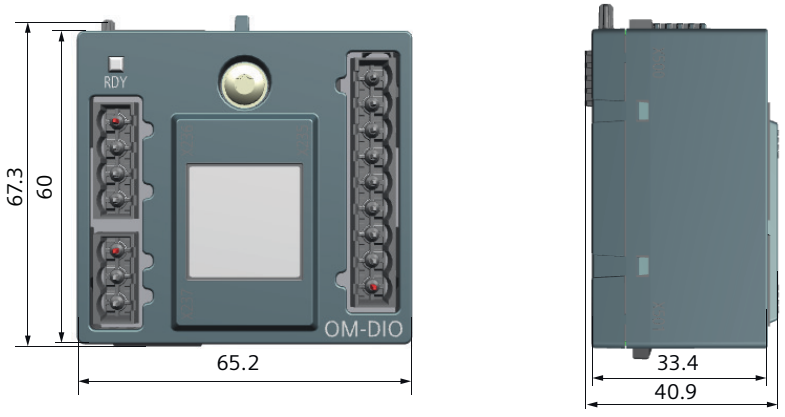


Figure 5-21 Dimensions of the OM-DIO

5.13.15 Dimension drawing OM-AIO

Dimension drawing

All dimensions are specified in millimeters.

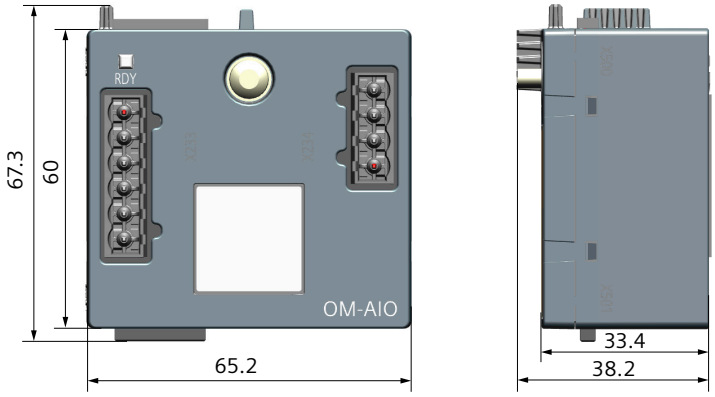


Figure 5-22 Dimensions of the OM-AIO

5.14 Communications modules

5.14.1 Weight, communications modules

Technical specifications

Table 5-13 Weight

Component	Unit	Weight
CM-PN communications module	kg	0.120
CM-DP communications module	kg	0.120
CM-RS485 communications module	kg	0.115

5.14.2 Mounting the communications module, converter with degree of protection IP20

Overview

1 communications module can be inserted in the converter.

Requirement

NOTICE
Material damage by withdrawing and inserting the communications module under voltage (hot swapping) Withdrawing and inserting the communications module when the power supply is switched on can damage the communications module or cause the communications module to malfunction. • Switch off the converter power supply before you withdraw or insert the communications module.

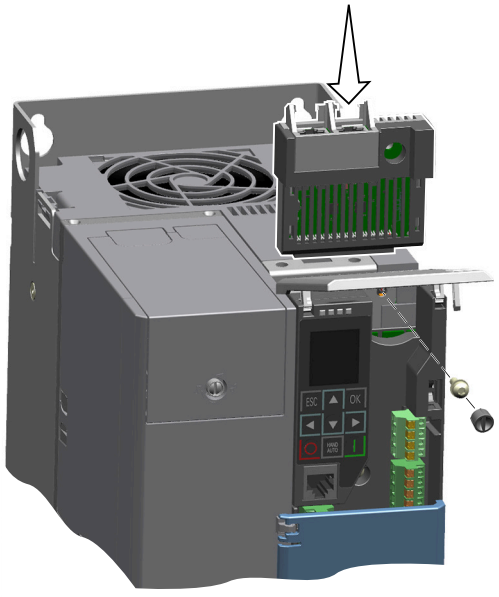
Required tools:

- Torx screwdriver TX 20
- Needle-nose pliers

Procedure

Proceed as follows to insert a communications module into the communications slot of a converter with degree of protection IP20:

1. Remove the shield plate for the fieldbus cable.
2. If a communications module is already inserted, remove the cover cap over the fixing screw using needle-nose pliers and open the fixing screw.
3. Withdraw the inserted communications module or the blanking cover from the communications slot.
4. Insert the communications module flush into the communications slot.



5. Tighten the communications module screw with a Torx screwdriver.
   Tightening torque: 2 Nm
6. Press the cover cap onto the fixing screw.
7. Mount the shield plate for the fieldbus cable.

Result

The communications module is connected with the converter.

5.14.3 Installing the communications module; converter with degree of protection IP55

Overview

1 communications module can be inserted in the converter.

Requirement

NOTICE
Material damage by withdrawing and inserting the communications module under voltage (hot swapping) Withdrawing and inserting the communications module when the power supply is switched on can damage the communications module or cause the communications module to malfunction. • Switch off the converter power supply before you withdraw or insert the communications module.

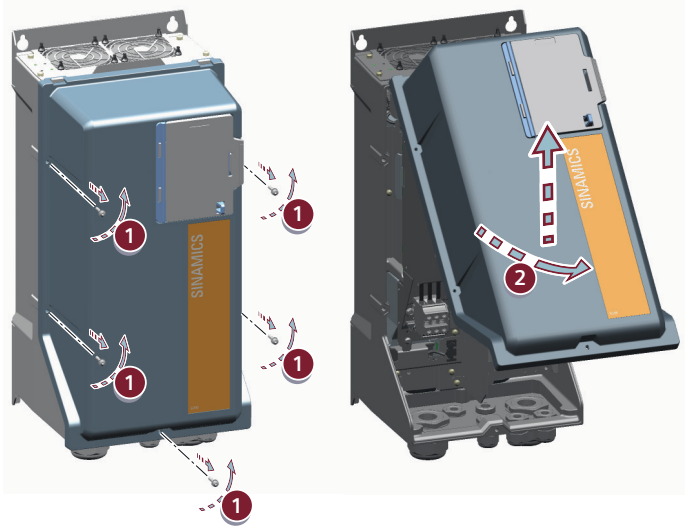
The following requirements apply:

- Required tools:
  - Torx screwdriver
  - Needle-nose pliers
- Comply with the specifications when attaching and removing the housing cover.
  The converter frame size defines the Torx size and the tightening torque.

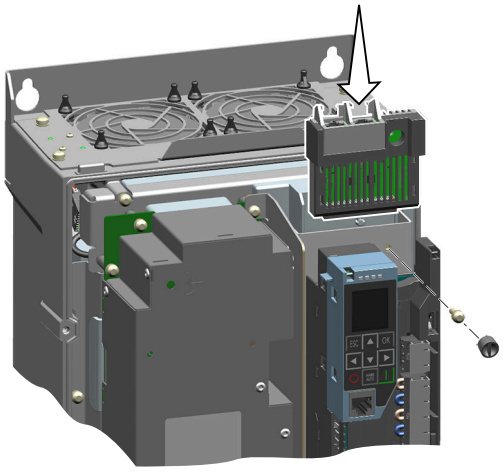
Procedure

Proceed as follows to insert a communications module into the communications slot of a converter with degree of protection IP55:

1. Release the screws of the housing cover using the Torx screwdriver specified for the converter.



2. Swivel the housing cover upward and then lift the housing cover off in an upward direction.
3. If a communications module is already inserted, remove the cover cap over the fixing screw using needle-nose pliers and open the fixing screw.
4. Withdraw the inserted communications module or the blanking cover from the communications slot.
5. Insert the communications module flush into the communications slot.



6. Tighten the communications module screw with a Torx screwdriver.
   Tightening torque: 2 Nm
7. Press the cover cap onto the fixing screw.
8. Reattach the housing cover and tighten the screws using the Torx screwdriver and tightening torque specified for the converter.

Result

The communications module is connected with the converter.

6 Mounting



⚠ CAUTION

Burns and thermal damage caused by hot surfaces

Temperatures above 100 °C may occur on the surfaces of motors, converters, and other drive components.

Touching hot surfaces may result in burns. Hot surfaces may damage or destroy temperature sensitive parts.

- Ensure that temperature-sensitive parts do not come into contact with hot surfaces.
- Mount drive components so that they are not accessible during operation.

Measures when maintenance is required:

- Allow drive components to cool off before starting any work.
- Use appropriate personnel protection equipment, e.g. gloves.

6.1 Converter

⚠ WARNING

Spread of fire

In the event of a fault, a converter with an open design (built-in devices) can cause a fire or a pressure wave, which can result in severe personal injury and material damage. The higher the power rating of a converter, the more dangerous the effects of an arc or pressure wave.

- Install the converter in a robust metal control cabinet that is designed to prevent fire from escaping.
- Only operate the converter with the control cabinet doors closed.
- When the control cabinet doors are open, only qualified personnel may perform service and maintenance work.
- Comply with the minimum control cabinet volume.

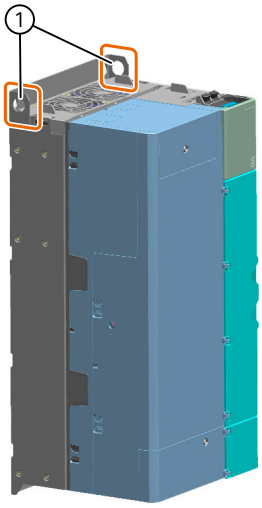
Information on the minimum control cabinet volume is available on the Internet:

Protective devices for SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109823568)

6.1.1 Installation aid

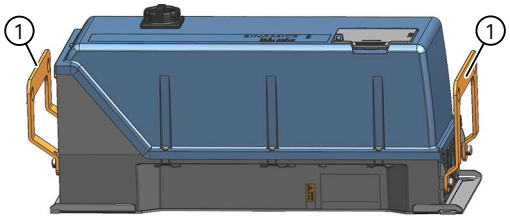
Description

Converters weighing approx. 20 kg or more have attachment points or holding plates for lifting equipment.



① Attachment points for lifting equipment

Figure 6-1 Example of attachment points, degree of protection IP20



① Holding plates for lifting equipment

Figure 6-2 Example of holding plates, degree of protection IP55

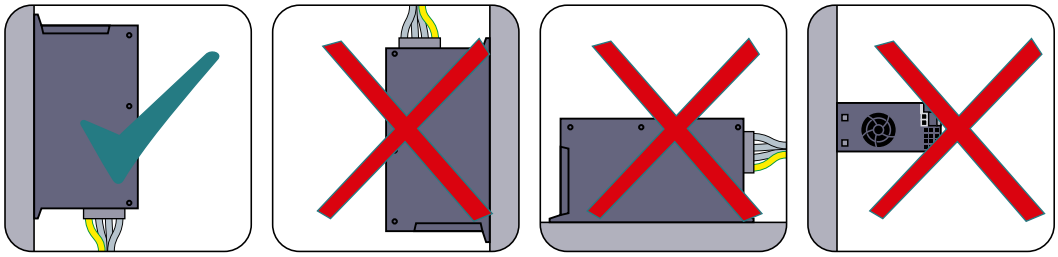
6.1.2 Mounting position

Requirement

NOTICE
Overheating due to impermissible mounting position
The converter can overheat and therefore be damaged if mounted in an impermissible position. • Only mount the converter in a permissible position.

Description

Installation is only permissible in the vertical position with the line connection at the bottom.



6.1.3 Dimensions, converter in degree of protection IP20

Dimension drawing

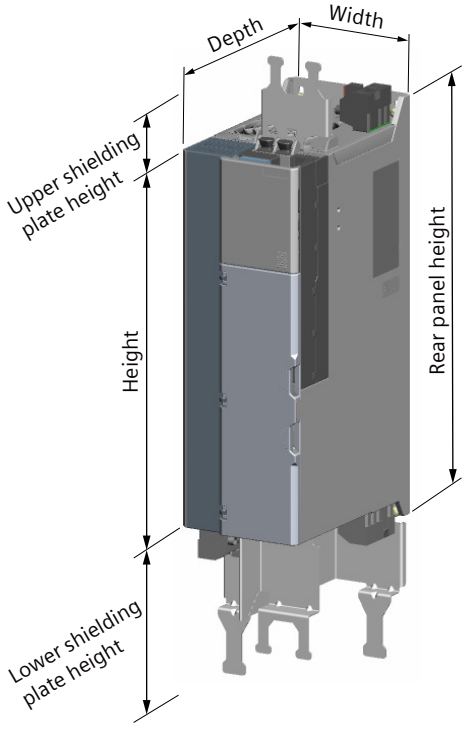


Figure 6-3 Dimensions, IP20 degree of protection

Table 6-1 Dimensions

Property	Unit	FSA	FSB	FSC	FSD1	FSD2	FSE	FSF1	FSF2
Height	mm	250	355	355	400	442	520	640	708
Height with expansion adapter for Option Modules	mm	310	-	-	-	-	-	-	-
Width	mm	73	85	125	150	200	250	300	300
Depth	mm	208	208	209	245	245	245	290	358
Upper shield plate height	mm	85	85	85	90	90	90	167	235
Lower shield plate height	mm	85	108	149	160	160	193	193	289
Rear panel height	mm	288	395	395	443	492	566	708	784

6.1.4 Installation, converter in degree of protection IP20

Description

The converter is intended for mounting in the control cabinet on a bare metal plate or on a metal chassis system. The control cabinet must be permanently mounted on a wall or the floor.

The hole spacings of the converter align with a chassis system with 25 mm pitch perforation.

Table 6-2 Rear view of the converter and mounting parts, frame sizes FSA ... FSC, IP20 degree of protection

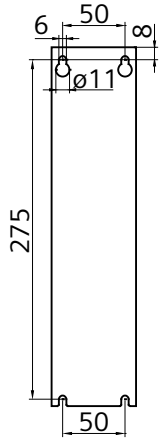
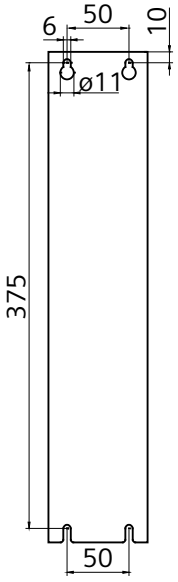
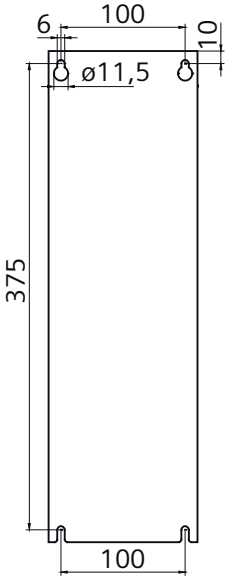
	FSA	**FSB**	**FSC**
Rear view of the converter All dimensions in mm			
Mounting parts	4 × M5 screws 4 × M5 washers	4 × M5 screws 4 × M5 washers	4 × M5 screws 4 × M5 washers
Tightening torque	6 Nm	6 Nm	6 Nm

Table 6-3 Rear view of the converter and mounting parts, frame sizes FSD1, FSD2, IP20 degree of protection

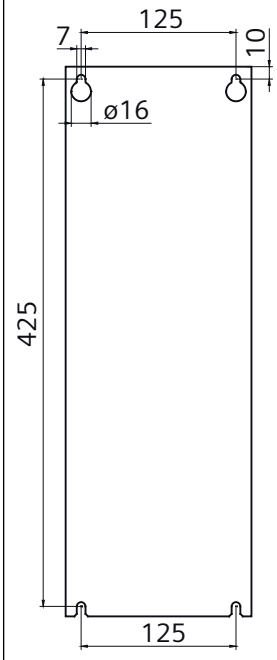
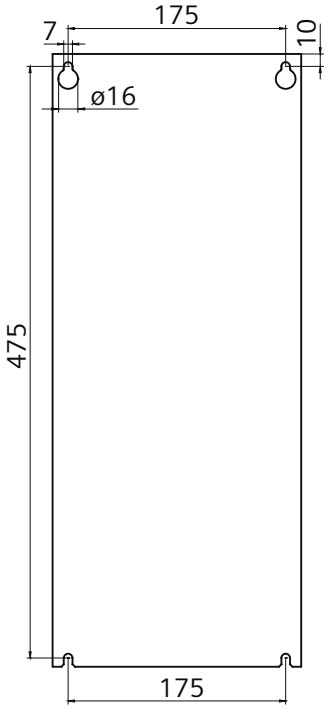
	FSD1	**FSD2**
Rear view of the converter All dimensions in mm		
Mounting parts	4 × M6 screws 4 × M6 washers	4 × M6 screws 4 × M6 washers
Tightening torque	10 Nm	10 Nm

Table 6-4 Rear view of the converter and mounting parts, frame sizes FSE and FSF1, IP20 degree of protection

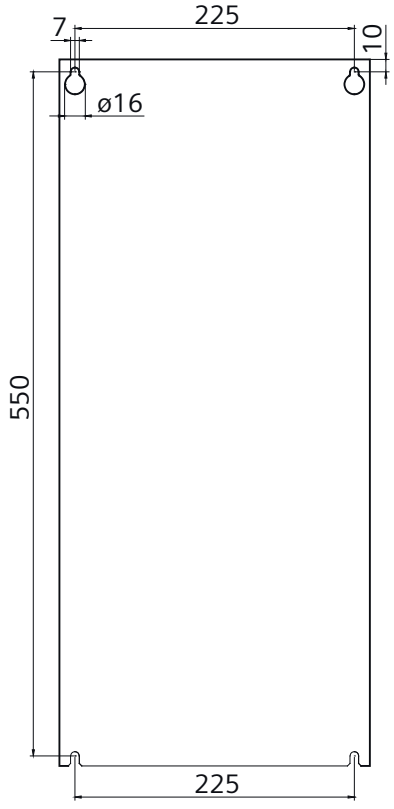
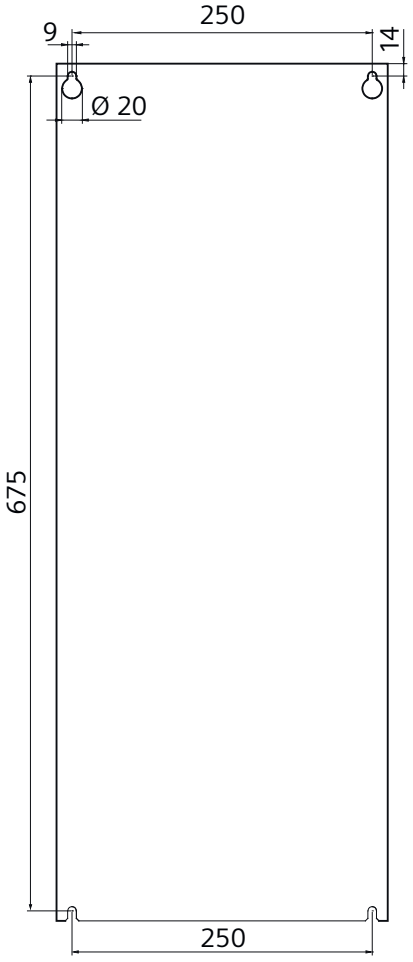
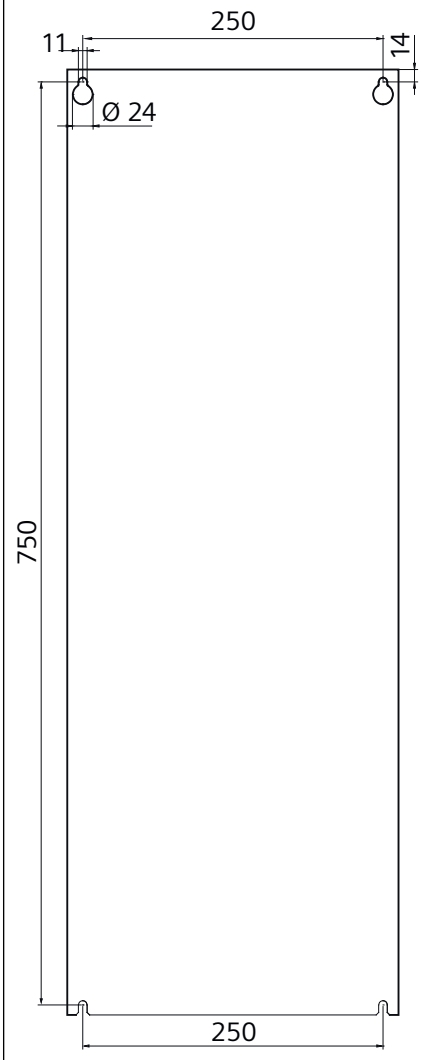
	FSE	**FSF1**
Rear view of the converter All dimensions in mm		
Mounting parts	4 × M6 screws 4 × M6 washers	4 × M8 screws 4 × M8 washers
Tightening torque	10 Nm	25 Nm

Table 6-5 Rear view of the converter and mounting parts, frame size FSF2, degree of protection IP20

	FSF2
Rear view of the converter All dimensions in mm	
Mounting parts	4 × M10 screws 4 × M10 washers
Tightening torque	50 Nm

6.1.5 Minimum clearances, converter in degree of protection IP20

Overview

Ventilation clearances are required above and below the converter. A lateral clearance to additional converters or components is not required.

Dimension drawing

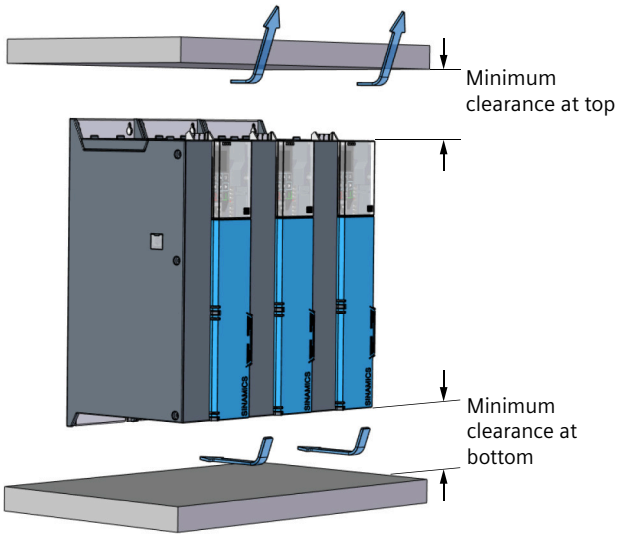


Figure 6-4 Minimum clearances, converter in degree of protection IP20

Table 6-6 Minimum clearances

	Unit	FSA	FSB	FSC	FSD1	FSD2	FSE	FSF1	FSF2
Minimum clearance at top	mm	85	85	85	90	90	90	167	180
Minimum clearance at bottom	mm	85	108	149	160	160	193	193	200
Minimum lateral clearance	mm	0	0	0	0	0	0	0	0
Recommended minimum clearance at the front	mm	10	10	10	10	10	10	10	10

6.1.6 Cooling air flow, converter with IP20 degree of protection

Technical data

Table 6-7 Cooling air flow, converter with IP20 degree of protection

Frame size	Unit	Value	Unit	Value
FSA	m^3/s	0.010	cfm	21.19
FSB	m^3/s	0.016	cfm	33.90
FSC	m^3/s	0.036	cfm	76.28

Frame size	Unit	Value	Unit	Value
FSD1	m^3/s	0.039	cfm	82.64
FSD2	m^3/s	0.050	cfm	105.94
FSE	m^3/s	0.067	cfm	141.96
FSF1	m^3/s	0.100	cfm	211.89
FSF2	m^3/s	0.24	cfm	508.53

6.1.7 Dimensions, converter in degree of protection IP55

Dimension drawing

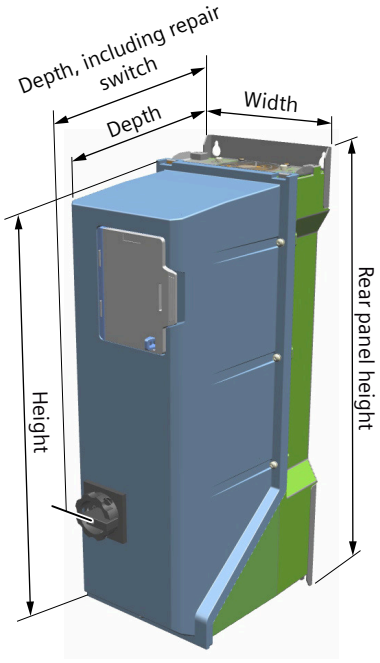


Figure 6-5 Dimensions, IP55 degree of protection

Table 6-8 Dimensions

Property	Unit	FSB	FSC	FSD1	FSD2	FSE	FSF1
Height	mm	415	460	571	650	778	950
Width	mm	225	245	209	270	327	380
Depth	mm	225	250	284	284	315	453
Depth, including maintenance switch	mm	265	283	319	318	379	504
Rear panel height	mm	455	500	610	695	820	1000

6.1.8 Installation, converter in degree of protection IP55

Description

The converter is designed for wall mounting. The mounting surface must be capable of carrying the weight of the converter and must be adequately stable.

Table 6-9 Rear view of the converter and mounting parts, frame sizes FSB ... FSD1, degree of protection IP55

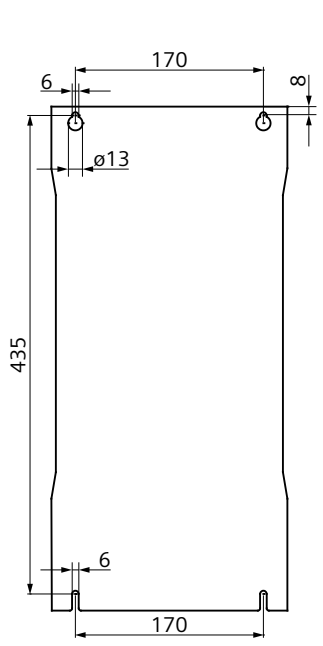
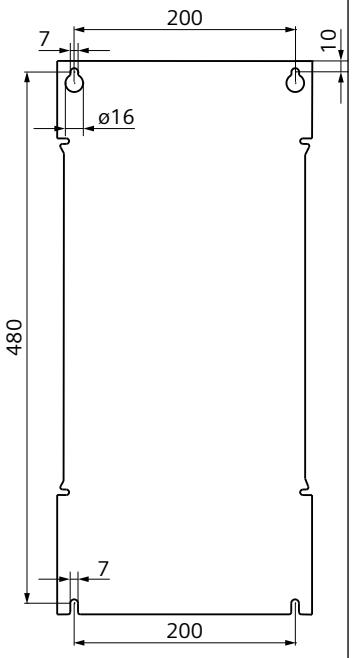
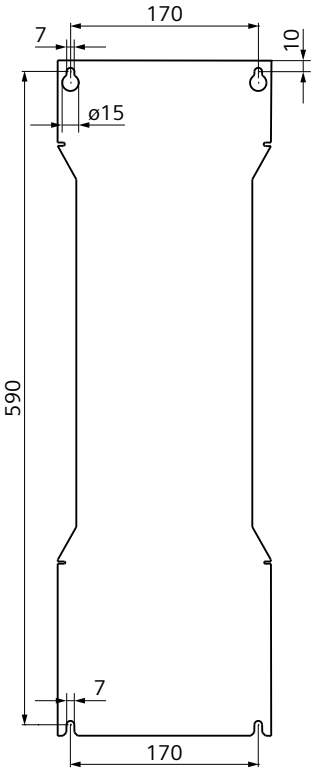
	FSB	**FSC**	**FSD1**
Rear view of the converter [mm]			
Mounting parts	4 × M5 screws 4 × M5 washers	4 × M6 screws 4 × M6 washers	4 × M6 screws 4 × M6 washers
Tightening torque	6 Nm	10 Nm	10 Nm

Table 6-10 Rear view of the converter and mounting parts, frame sizes FSD2, FSE, degree of protection IP55

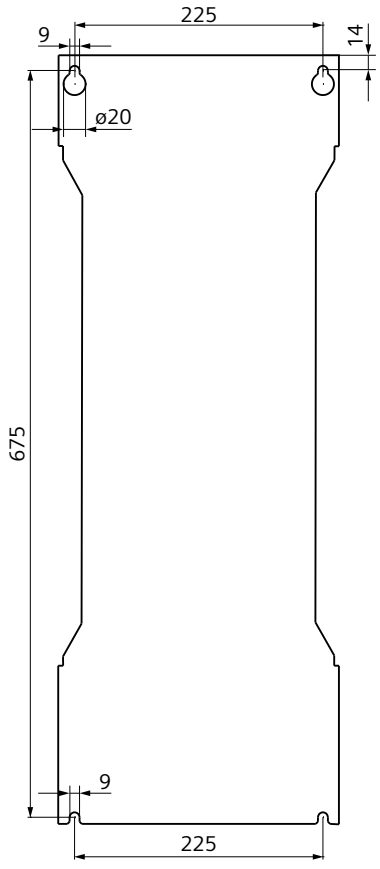
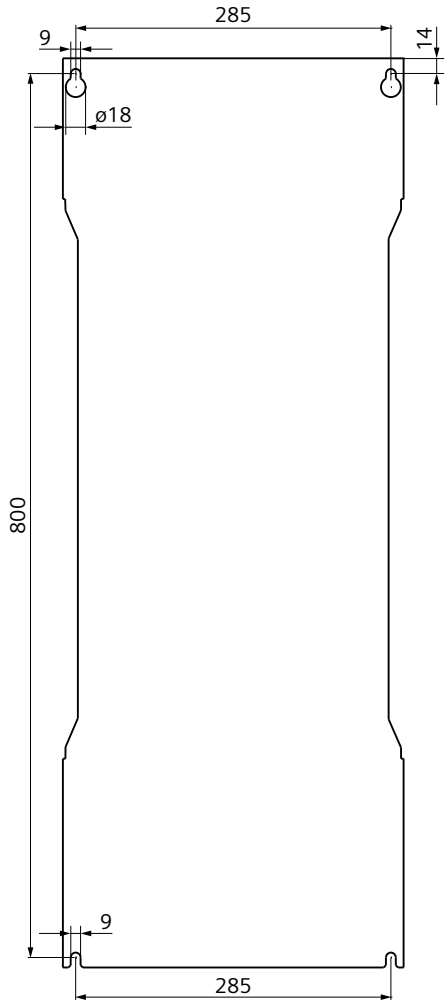
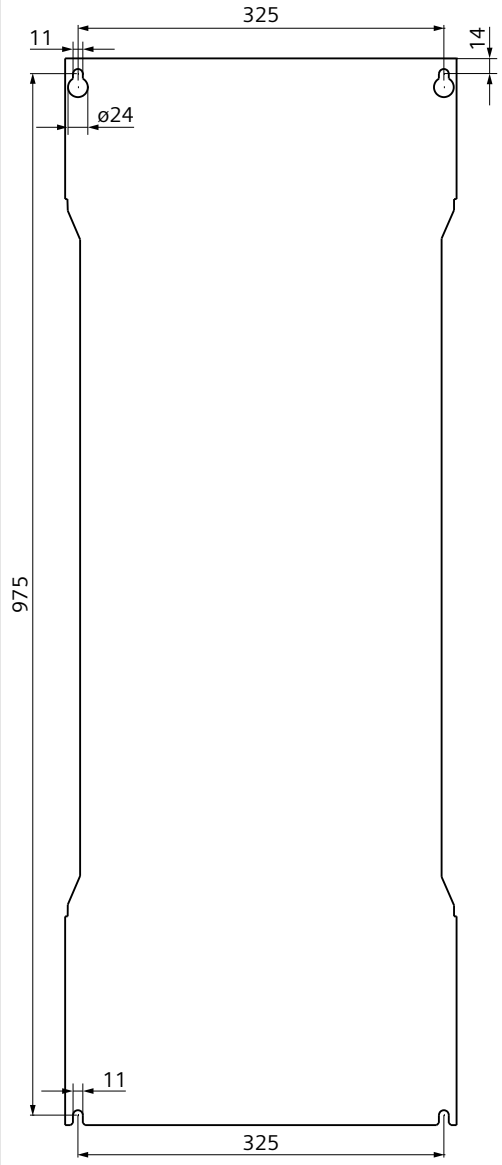
	FSD2	**FSE**
Rear view of the converter [mm]		
Mounting parts	4 × M8 screws 4 × M8 washers	4 × M8 screws 4 × M8 washers
Tightening torque	25 Nm	25 Nm

Table 6-11 Rear view of the converter and mounting parts, frame size FSF1, degree of protection IP55

	FSF1
Rear view of the converter [mm]	
Mounting parts	4 × M10 screws 4 × M10 washers
Tightening torque	50 Nm

6.1.9 Minimum clearances, converter in degree of protection IP55

Dimension drawing

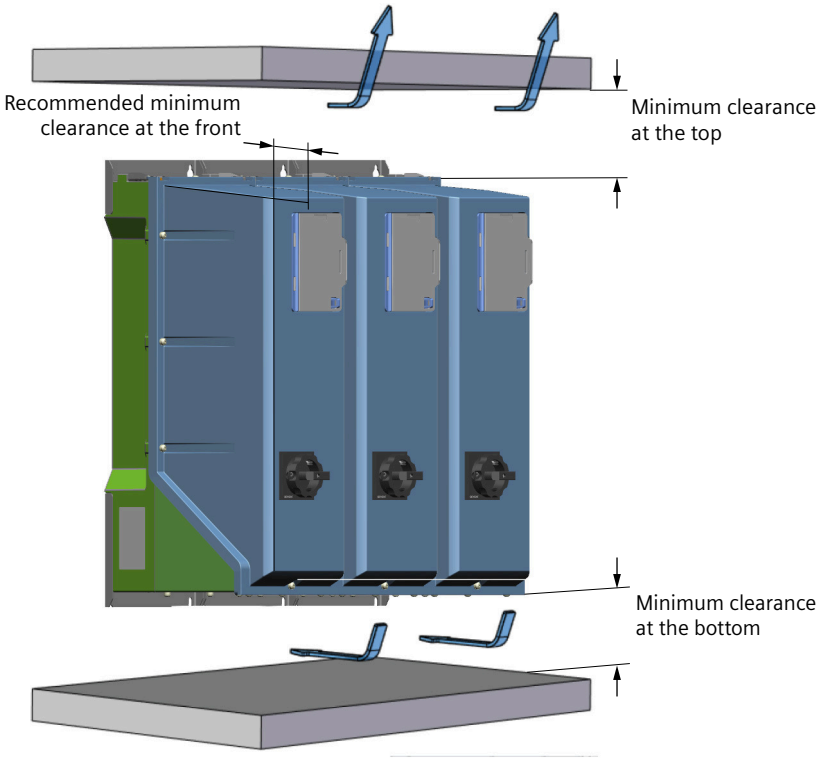


Figure 6-6 IP55 minimum clearances

Table 6-12 Minimum clearances

	Unit	FSB	FSC	FSD1	FSD2	FSE	FSF1
Minimum ventilation clearance at the top	mm	103	115	143	163	195	238
Minimum ventilation clearance at the bottom	mm	103	115	143	163	195	238
Recommended minimum clearance at the front	mm	40	40	40	45	75	75

6.1.10 Cooling air flow, converter with IP55 degree of protection

Technical data

Table 6-13 Cooling air flow, converter with IP55 degree of protection

Frame size	Unit	Value	Unit	Value
FSB	m^3/s	0.050	cfm	105.94
FSC	m^3/s	0.036	cfm	76.28
FSD1	m^3/s	0.038	cfm	80.52
FSD2	m^3/s	0.058	cfm	122.90
FSE	m^3/s	0.065	cfm	137.73
FSF1	m^3/s	0.098	cfm	207.65

6.2 Braking resistor

6.2.1 Mounting position of the braking resistor

Requirement

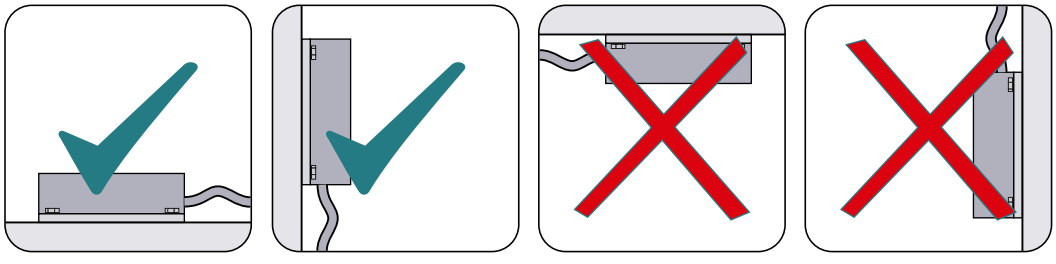
NOTICE

Overheating due to impermissible mounting position

The braking resistor can overheat and therefore be damaged if mounted in an impermissible position.

- Only mount the braking resistor in a permissible position.

Description



Mounting in a horizontal position or in a vertical position with the connections at the bottom is permissible.

Mounting with the connections at the top or mounted on a ceiling is not permissible.

6.2.2 Dimensions, braking resistor

Dimensions

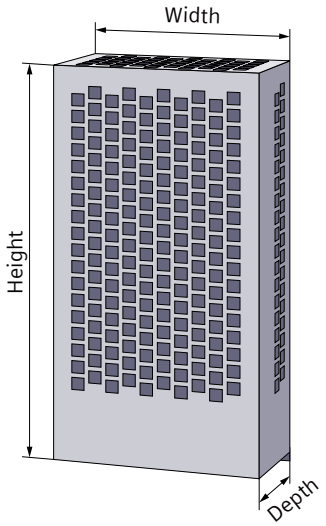


Figure 6-7 Dimensions for vertical mounting position, IP21 degree of protection

Table 6-14 Dimensions, line voltage 3 AC 200 ... 240 V

Article number	Unit	Width	Height	Depth
JJY:023151720007	mm	217	60	30
JJY:023163720018	mm	337	60	30
JJY:023433720001	mm	337	120	30
JJY:023422620002	mm	220	180	470
JJY:023423320001	mm	220	180	560
JJY:023434020003	mm	350	180	630

Table 6-15 Dimensions, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Unit	Width	Height	Depth
6SL3201-0BE14-3AA0	mm	105	295	100
6SL3201-0BE21-0AA0	mm	105	345	100
6SL3201-0BE21-8AA0	mm	175	345	100
6SL3201-0BE23-8AA0	mm	250	490	140
JJY:023422620001	mm	220	180	470
JJY:023424020001	mm	220	180	610
JJY:023434020001	mm	630	350	630

Article number	Unit	Width	Height	Depth
JJY:023454020001[1)]				
JJY:023422620001 ǁ	mm	220	180	470
JJY:023434020001	mm	630	350	630
JJY:023464020001[1)]				
JJY:023434020001 ǁ	mm	630	350	630
JJY:023434020001	mm	630	350	630

[1)] The article number contains two braking resistors, which are connected in parallel.

6.2.3 Mounting the braking resistor

Description

The braking resistor is intended to be installed on a level, heat-resistant mounting plate with a high thermal conductivity.

For installation on the outside of the control cabinet, degree of protection IP21 of the braking resistor must be taken into consideration.

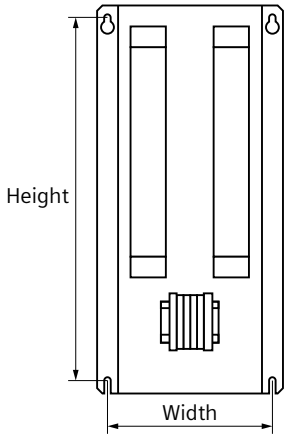


Table 6-16 Fixing, line voltage 3 AC 200 ... 240 V

Braking resistor				
Article number	Drilling dimensions			Fixing/tightening torque
	Unit	Width	Height	
JJY:023151720007	mm	72	200	M4 / 3 Nm
JJY:023163720018	mm	142	320	M4 / 3 Nm
JJY:023433720001	mm	217	325	M5 / 6 Nm
JJY:023422620002	mm	187	430	M5 / 6 Nm
JJY:023423320001	mm	187	500	M5 / 6 Nm

Table 6-17 Mounting, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Braking resistor				
Article number	**Drilling dimensions**			**Fixing/tightening torque**
	Unit	**Width**	**Height**	
6SL3201-0BE14-3AA0	mm	72	266	M4 / 3 Nm
6SL3201-0BE21-0AA0	mm	72	316	M4 / 3 Nm
6SL3201-0BE21-8AA0	mm	142	316	M4 / 3 Nm
6SL3201-0BE23-8AA0	mm	217	460	M5 / 6 Nm
JJY:023422620001	mm	187	430	M5 / 6 Nm
JJY:023424020001	mm	187	570	M5 / 6 Nm
JJY:023434020001	mm	317	570	M5 / 6 Nm
JJY:023454020001 [1)]				
JJY:023422620001 ‖	mm	187	430	M5 / 6 Nm
JJY:023434020001	mm	317	570	M5 / 6 Nm
JJY:023464020001 [1)]				
JJY:023434020001 ‖	mm	317	570	M5 / 6 Nm
JJY:023434020001	mm	317	570	M5 / 6 Nm

[1)] The article number contains two braking resistors, which are connected in parallel.

6.2.4 Minimum clearances, braking resistor

Requirement



⚠ CAUTION

Risk of burns and damage from hot surface

The braking resistor surface can assume temperatures exceeding 300 °C.

Touching the hot surface may result in burns. The hot surface may damage or destroy temperature-sensitive parts.

- Ensure that no temperature-sensitive parts come into contact with a hot surface.
- Mount the braking resistor so that it is not accessible in operation.

Measures when maintenance is required:

- Allow the braking resistor to cool down before starting any work.
- Use appropriate personnel protection equipment, e.g. gloves.

Description

A minimum clearance to other products must be maintained on account of the surface temperature of the braking resistor during operation.

The minimum clearances listed in the tables are applicable for the case that the maximum surface temperature of the braking resistor is 220 °C.

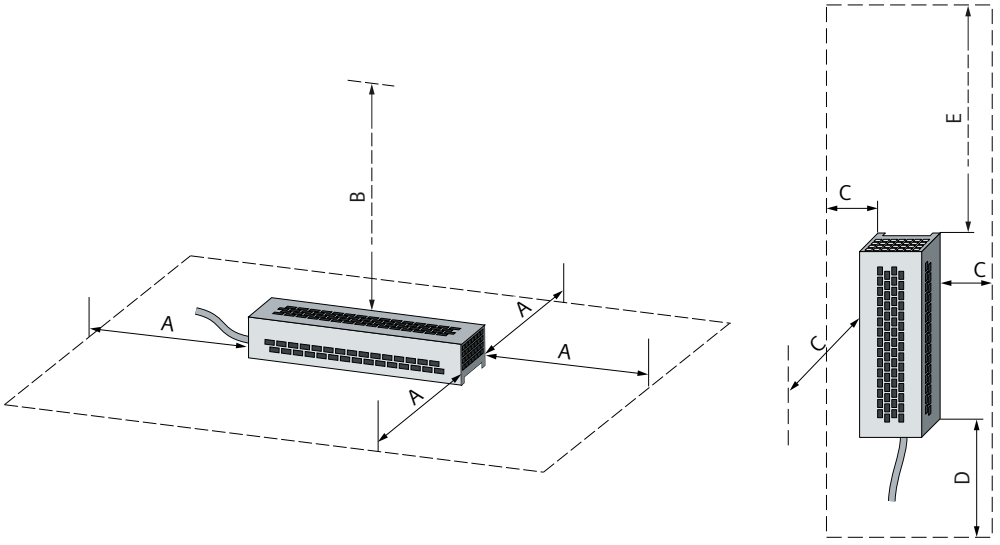


Figure 6-8 Minimum clearances for horizontal and vertical installation

Table 6-18 Minimum clearances for horizontal installation, 3 AC 200 ... 240 V

Article number	Unit	Lateral clearance A	Top clearance B
JJY:023151720007	mm	150	300
JJY:023163720018	mm	150	300
JJY:023433720001	mm	150	300
JJY:023422620002	mm	150	300
JJY:023423320001	mm	250	450
JJY:023434020003	mm	250	450

Table 6-19 Minimum clearances for horizontal installation, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Unit	Lateral clearance A	Top clearance B
6SL3201-0BE14-3AA0	mm	150	300
6SL3201-0BE21-0AA0	mm	150	300
6SL3201-0BE21-8AA0	mm	150	300
6SL3201-0BE23-8AA0	mm	150	300
JJY:023422620001	mm	250	450
JJY:023424020001	mm	250	450
JJY:023434020001	mm	250	450
JJY:023454020001	mm	250	450
JJY:023464020001	mm	250	450

Table 6-20 Minimum clearances for vertical installation, 3 AC 200 ... 240 V

Article number	Unit	Lateral clearance C	Bottom clearance D	Top clearance E
JJY:023151720007	mm	100	200	250
JJY:023163720018	mm	100	200	250
JJY:023433720001	mm	100	200	250
JJY:023422620002	mm	100	200	250
JJY:023423320001	mm	200	300	400
JJY:023434020003	mm	200	300	400

Table 6-21 Minimum clearances for vertical installation, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Unit	Lateral clearance C	Bottom clearance D	Top clearance E
6SL3201-0BE14-3AA0	mm	100	200	250
6SL3201-0BE21-0AA0	mm	100	200	250
6SL3201-0BE21-8AA0	mm	100	200	250
6SL3201-0BE23-8AA0	mm	100	200	250
JJY:023422620001	mm	200	300	400
JJY:023424020001	mm	200	300	400
JJY:023434020001	mm	200	300	400
JJY:023454020001	mm	200	300	400
JJY:023464020001	mm	200	300	400

6.3 Expansion Rack for Option Modules (ER-OM)

6.3.1 Dimensions of the Expansion Rack for Option Modules (ER-OM)

Dimension drawing

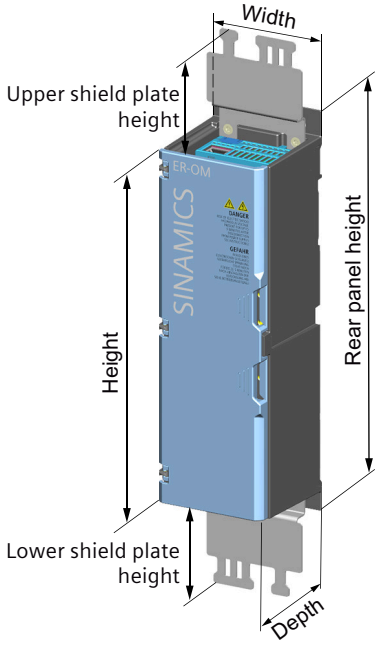


Figure 6-9 ER-OM: Dimensions

Table 6-22 Dimensions of the Expansion Rack for Option Modules (ER-OM)

Property	Unit	ER-OM
Height	mm	255.4
Width	mm	84.5
Depth	mm	79.2
Upper shield plate height	mm	73.6
Lower shield plate height	mm	73.6
Rear panel height	mm	290

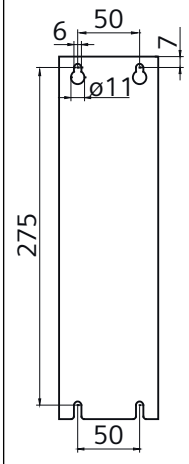
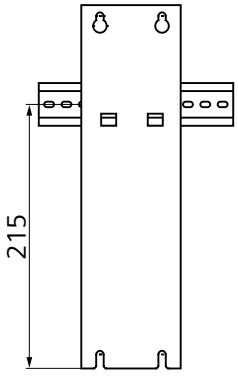
6.3.2 Installation, Expansion Rack for Option Modules (ER-OM)

Description

The Expansion Rack for Option Modules (ER-OM) is designed to be installed in a control cabinet. There are 2 mounting options:

- Mounting on a bare metal plate or on a metal chassis system.
  The hole spacings of the Expansion Rack for Option Modules (ER-OM) align with a chassis system with holes in a 25 mm pitch.
- Mounting on a DIN rail
  The DIN rail is mounted on a bare metal plate or on a metal chassis system.
  We recommend an end retainer to securely fix the Expansion Rack for Option Modules (ER-OM) onto the DIN rail.

Table 6-23 Rear view, Expansion Rack for Option Modules (ER-OM) and mounting parts

	Expansion Rack for Option Modules (ER-OM)	
Rear view of the expansion rack All dimensions in mm		
Mounting parts	4 × M5 screws 4 × M5 washers	35 mm DIN rail
Tightening torque	6 Nm	---

6.3.3 Minimum clearances, Expansion Rack for Option Modules (ER-OM)

Overview

Ventilation clearances are required above and below the Expansion Rack for Option Modules (ER-OM). A lateral clearance to the converter or other components is not required.

Dimension drawing

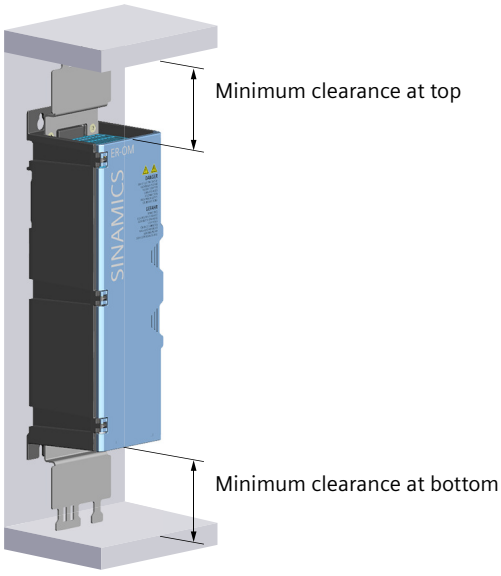


Figure 6-10 Minimum clearances, Expansion Rack for Option Modules (ER-OM)

Table 6-24 Minimum clearances

	Unit	ER-OM
Minimum clearance at top	mm	75
Minimum clearance at bottom	mm	75
Minimum lateral clearance	mm	0
Recommended minimum clearance at the front	mm	10

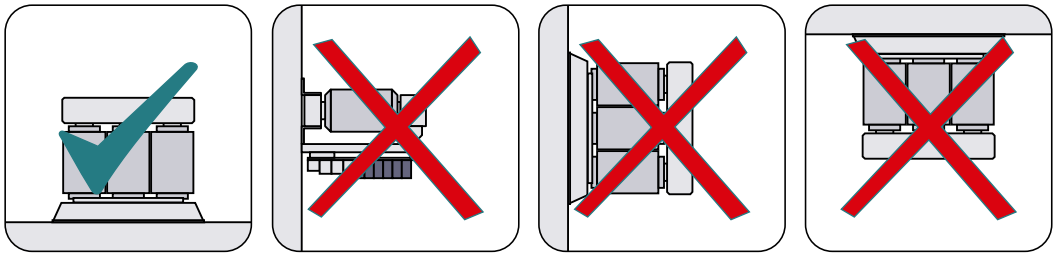
6.4 dv/dt filter plus Voltage Peak Limiter

6.4.1 Mounting position of the dv/dt filter plus VPL

Requirement

NOTICE
Overheating due to impermissible mounting position The dv/dt filter may overheat and therefore be damaged if mounted in an inadmissible position. • Only mount the dv/dt filter in a permissible position.

Description



Mounting on a horizontal surface is permissible.

Mounting on a vertical wall/panel or ceiling is not permissible.

6.4.2 Dimensions, dv/dt filter plus VPL

Dimensions

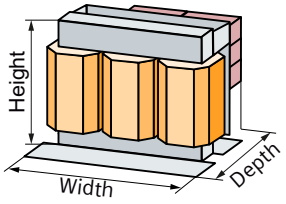


Figure 6-11 Dimensions

Table 6-25 Dimensions, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Unit	Width	Height	Depth
JTA:TEF1203-0HB	mm	264	270	240
JTA:TEF1203-0JB	mm	310	370	275
JTA:TEF1203-0KB	mm	400	320	350
JTA:TEF1203-0LB	mm	400	355	375
JTA:TEF1203-0MB	mm	460	435	445

6.4.3 Mounting the dv/dt filter plus VPL

Description

The du/dt filter is intended to be installed on a level, heat-resistant mounting plate.

Install the du/dt filter plus VPL in an enclosure

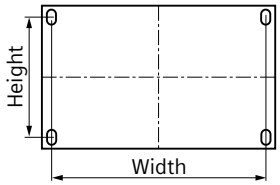


Table 6-26 Mounting, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

du/dt filter				
Article number	**Drilling dimensions**			**Fixing/tightening torque**
	Unit	**Width**	**Height**	
JTA:TEF1203-0HB	mm	249	129	M6 / 10 Nm
JTA:TEF1203-0JB	mm	289	142	M8 / 25 Nm
JTA:TEF1203-0KB	mm	379	150	M8 / 25 Nm
JTA:TEF1203-0LB	mm	379	150	M8 / 25 Nm
JTA:TEF1203-0MB	mm	356	212	M12 / 50 Nm

6.5 Sine-wave filter

6.5.1 Installation position, sine-wave filter

Requirement

NOTICE
Overheating due to impermissible mounting position If mounted in an inadmissible position, the sine-wave filter can overheat and therefore be damaged. • Only mount the sine-wave filter in the permissible mounting position.

Description

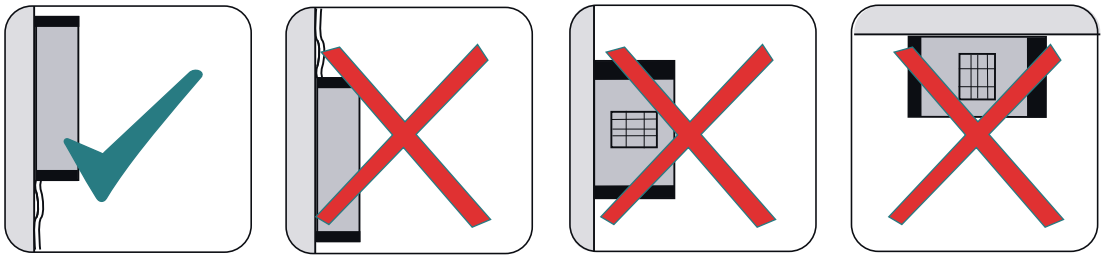


Figure 6-12 Mounting position sine-wave filter, footprint filter

Mounting position for the following sine-wave filter, footprint filter:

- 6SL3202-0AE21-1SA0
- 6SL3202-0AE21-4SA0
- 6SL3202-0AE22-0SA0

Mounting on a vertical wall/panel is permissible.

Mounting on a horizontal surface or a ceiling is not permissible.

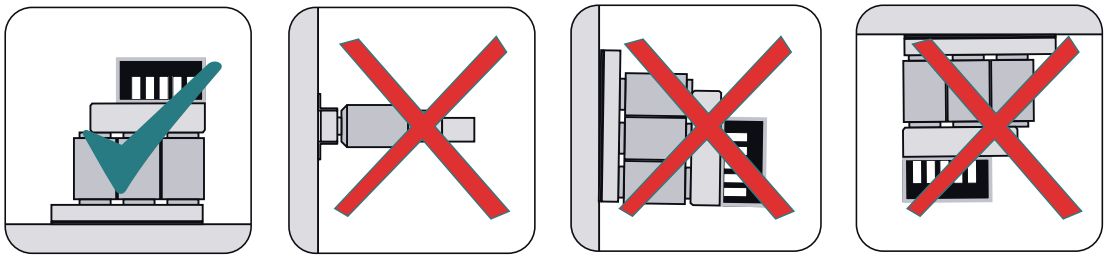


Figure 6-13 Mounting position, sine-wave filter

Mounting position for the following sine-wave filter:

- 6SL3202-0AE24-6SA0
- 6SL3202-0AE26-2SA0
- 6SL3202-0AE28-8SA0
- 6SL3202-0AE31-8SA0

Mounting on a horizontal surface is permissible.

Mounting on a vertical wall/panel or ceiling is not permissible.

6.5.2 Dimensions, sine-wave filter

Dimensions

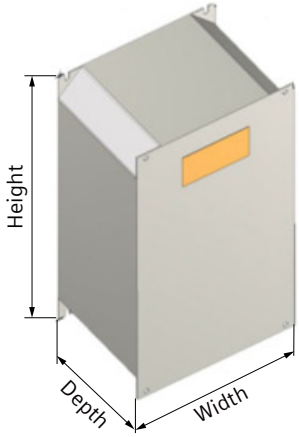


Figure 6-14 Sine-wave filter - footprint filter

Table 6-27 Dimensions, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article No.	Unit	Width	Height	Depth
6SL3202-0AE21-1SA0	mm	153	270	100
6SL3202-0AE21-4SA0		153	270	100
6SL3202-0AE22-0SA0		189	336	140

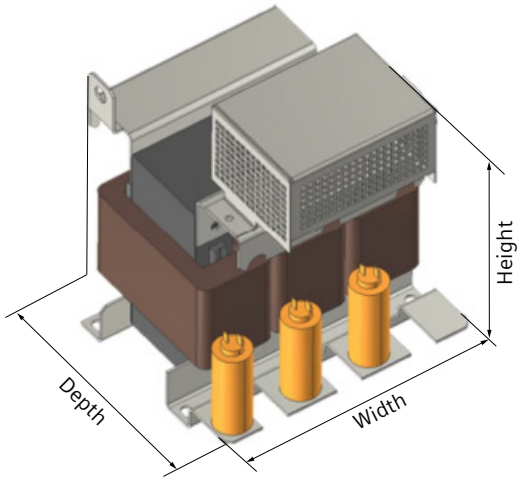


Figure 6-15 Sine-wave filter

Table 6-28 Dimensions, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article No.	Unit	Width	Height	Depth
6SL3202-0AE24-6SA0	mm	250	315	262
6SL3202-0AE26-2SA0		250	305	262
6SL3202-0AE28-8SA0		275	368	275
6SL3202-0AE31-8SA0		350	468	305

6.5.3 Installation, sine-wave filter

Description

Sine-wave filter, footprint filter, degree of protection IP20

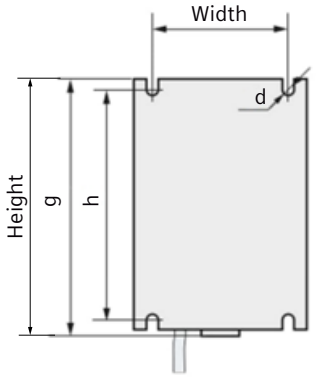


Figure 6-16 Sine-wave filter - footprint filter

Table 6-29 Mounting sine-wave filter, degree of protection IP20, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Drilling dimension in mm				Mounting	Tightening torque in Nm
	Width	Height		Hole size		
		h	g	d		
6SL3202-0AE21-1SA0	133	258	286.5	4.8	4 x M4	2
6SL3202-0AE21-4SA0	133	258	286.5	4.8	4 x M4	2
6SL3202-0AE22-0SA0	167	323	351.5	5.5	4 x M5	3

Sine-wave filter - IP00

⚠ WARNING

Electric shock when live parts are touched

Contact with live parts can result in death or serious injury.
• Install the sine-wave filter in an enclosure.

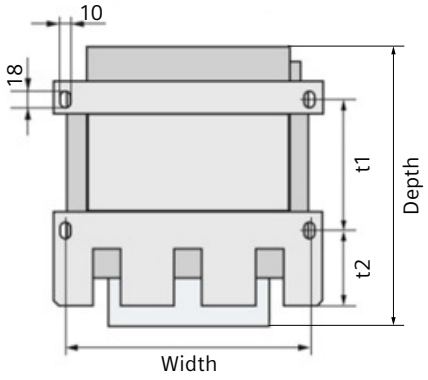


Figure 6-17 Sine-wave filter

Table 6-30 Mounting sine-wave filter, degree of protection IP00, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Article number	Drilling dimension in mm			Mounting	Tightening torque in Nm
	Width	Depth			
		t1	t2		
6SL3202-0AE24-6SA0	230	127	90.5	4 x M8	13
6SL3202-0AE26-2SA0	230	127	90.5	4 x M8	13
6SL3202-0AE28-8SA0	250	132	100.5	4 x M8	13
6SL3202-0AE31-8SA0	320	155	111	4 x M8	13

6.6 Attaching the label for the North American market

Requirement

The converter is supplied with an adhesive label with danger and warning notes for the North American market.

Procedure

Attach the label in the required language to the inside of the control cabinet where it is clearly visible.

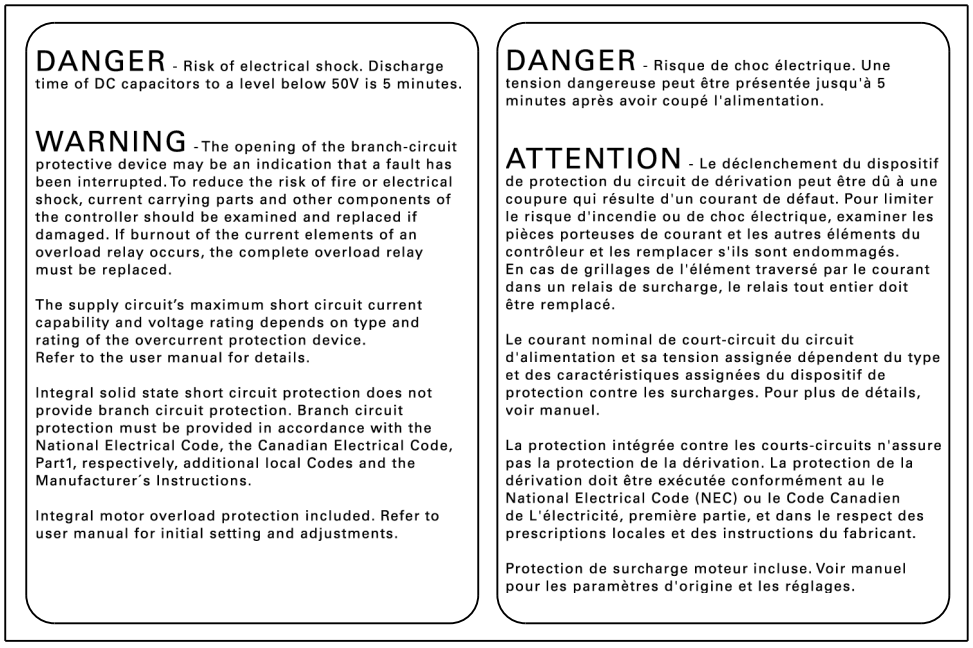


Figure 6-18 Label for the North American market

Connecting

7

7.1 Line, motor, filter and braking resistor



⚠ WARNING

Electric shock when the motor terminal box is open

As soon as the converter is connected to the line supply, the motor connections of the converter may carry dangerous voltages. When the motor is connected to the converter, there is danger to life through contact with the motor terminals if the motor terminal box is open.

- Close the motor terminal box before connecting the converter to the line supply.



⚠ WARNING

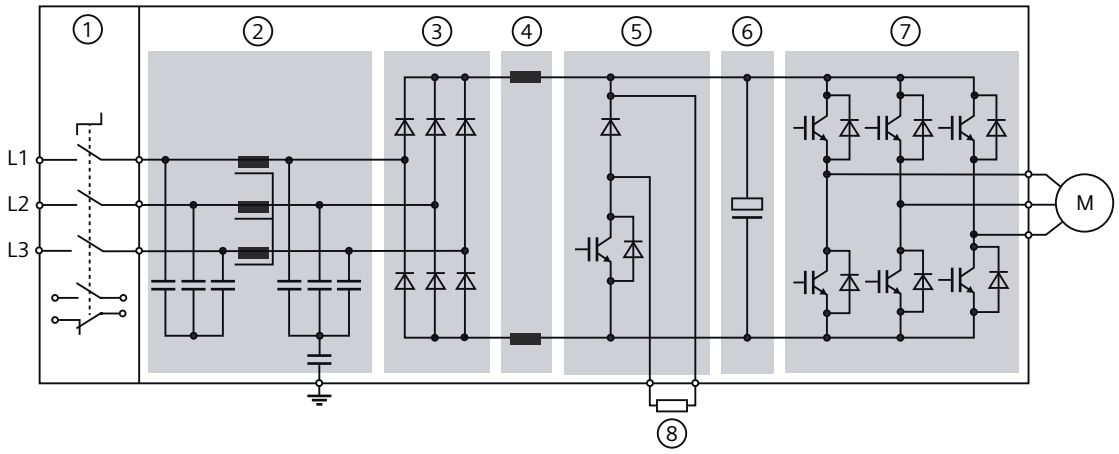
Electric shock caused by damaged cables

The cables between the line supply, converter, braking resistor, and motor are at hazardous voltage levels. Damaged cables pose a risk of death when they are touched.

- Protect cables that are under dangerous voltage from damage or accidental access.

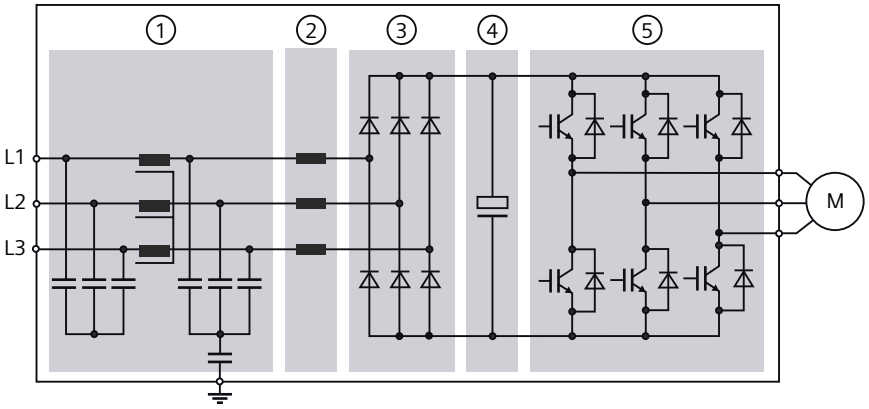
7.1.1 G220 block diagram

Block diagram



① Optional maintenance switch; only for converters with degree of protection IP55/UL type 12
② Optional line filter
③ Rectifier
④ DC link reactor
⑤ Braking chopper
⑥ DC link capacitors
⑦ Inverter
⑧ External braking resistor

Figure 7-1 Block diagram of the converter up to frame size FSF1

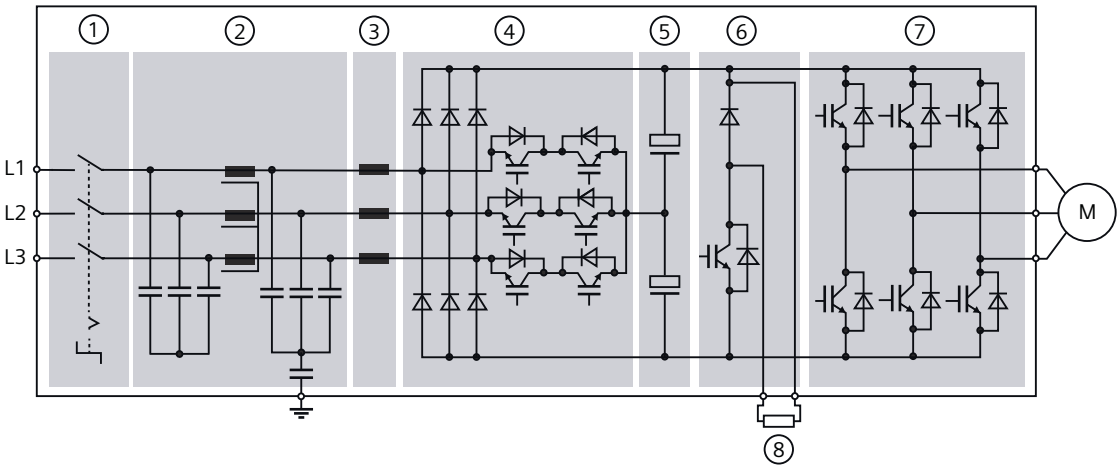


① Optional line filter
② Line reactor
③ Rectifier
④ DC link capacitors
⑤ Inverter

Figure 7-2 Block diagram of the converter, frame size FSF2

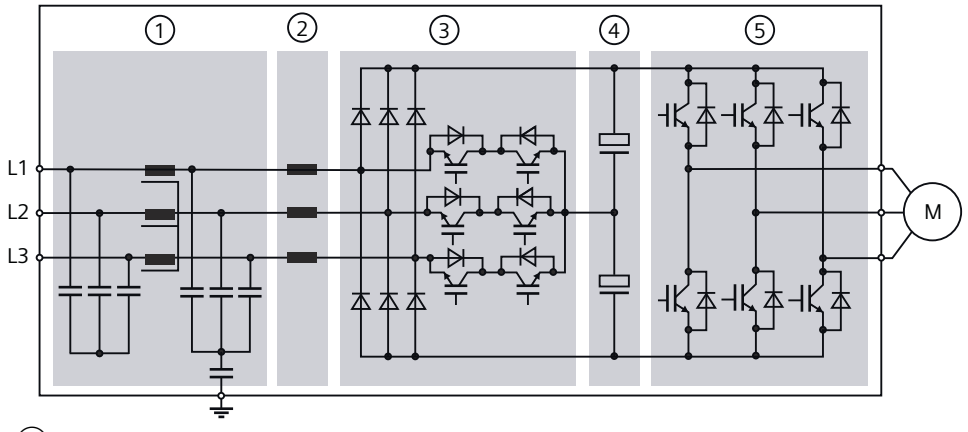
7.1.2 G220 Clean Power block diagram

Block diagram



① Optional maintenance switch; only for converters with degree of protection IP55/UL type 12
② Line filters
③ Line reactor
④ Clean Power infeed
⑤ DC link capacitors
⑥ Braking chopper
⑦ Inverter
⑧ External braking resistor

Figure 7-3 Block diagram of the Clean Power converter, up to frame size FSF1



① Line filters
② Line reactor
③ Clean Power infeed
④ DC link capacitors
⑤ Inverter

Figure 7-4 Block diagram of the Clean Power converter, frame size FSF2

7.1.3 Connecting up the converter, degree of protection IP20



⚠ WARNING

Electric shock due to incorrect installation

If the converter is incorrectly installed, components that are at hazardous voltage levels when the converter is operational, are not adequately touch protected. Touching live components can result in severe injury or death.

- Converters, frame sizes FSA ... FSC:
  Insert all connectors X1, X2 and X3.
  Connector X3 must be inserted, even if a braking resistor is not connected to the converter.
- Converter from frame size FSD1:
  Only open the covers of the connection cables as much as necessary for the outer diameter of the connection cables.
- After replacing a fan, correctly installed the fan.
- Follow the instructions provided in the product documentation before you remove or install converter components.

7.1.3.1 Connection overview, converter in degree of protection IP20

Precondition

Only copper cables with an insulation that is designed for an ambient temperature of 75 °C are permissible.

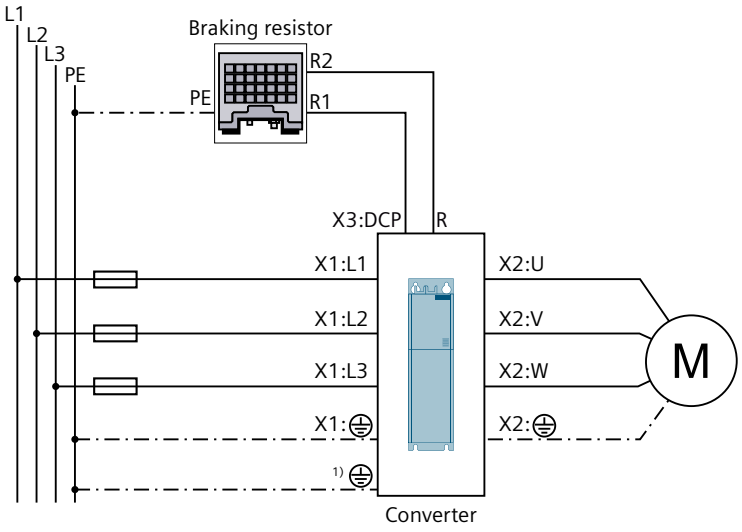
⚠ WARNING

Electric shock as a result of missing protective conductor

When only one protective conductor is connected at the converter, frame sizes FSA, FSB and FSD1 high voltages can be present at the housing, which when touched, can result in death or severe injury.

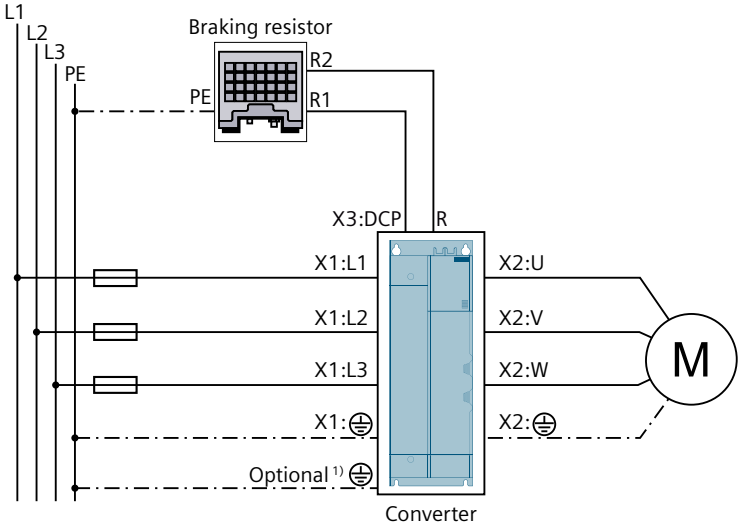
- For converters, frame sizes FSA, FSB and FSD1, connect a protective conductor to the housing and to line supply terminal X1.

Converter with degree of protection IP20



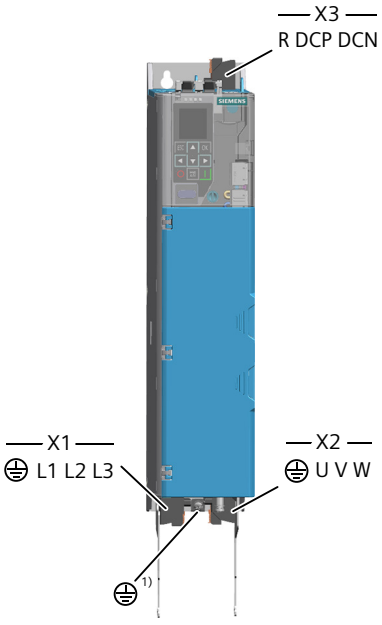
1) For converters, frame sizes FSA and FSB, the protective conductor must be connected at X1 and at the housing.

Figure 7-5 Connection overview, frame sizes FSA and FSB



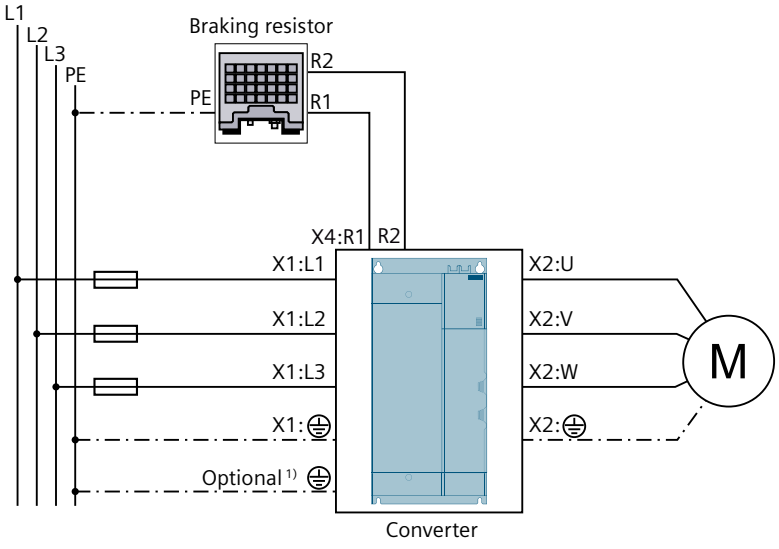
1) For converters, frame size FSC, connecting a protective conductor at the housing is optional.

Figure 7-6 Connection overview, frame size FSC



1) Additional connection option for a protective conductor at the housing

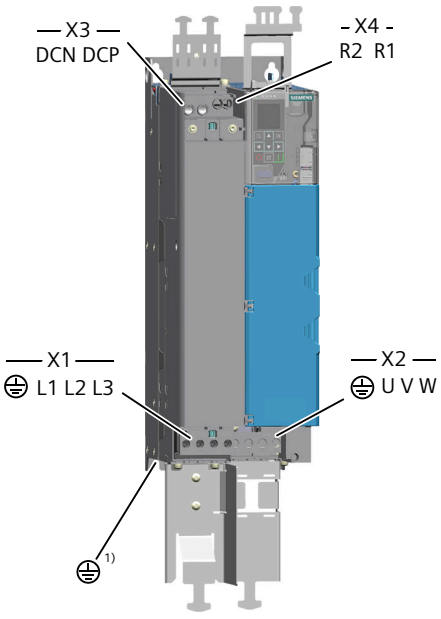
Figure 7-7 Power connections up to frame size FSC



1) For converters, frame size FSD1, a protective conductor must be connected at X1 and at the housing.

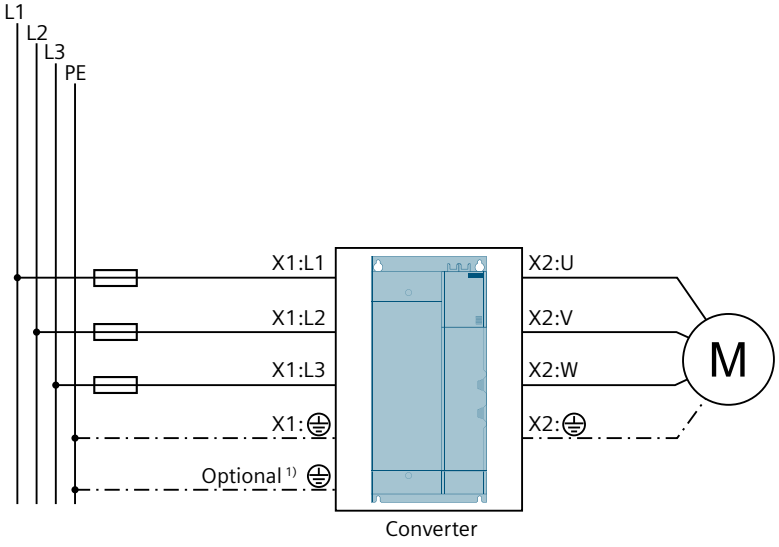
For converters from frame size FSD2 and higher, connecting a protective conductor at the housing is optional.

Figure 7-8 Connection overview for frame sizes FSD1 to FSF1



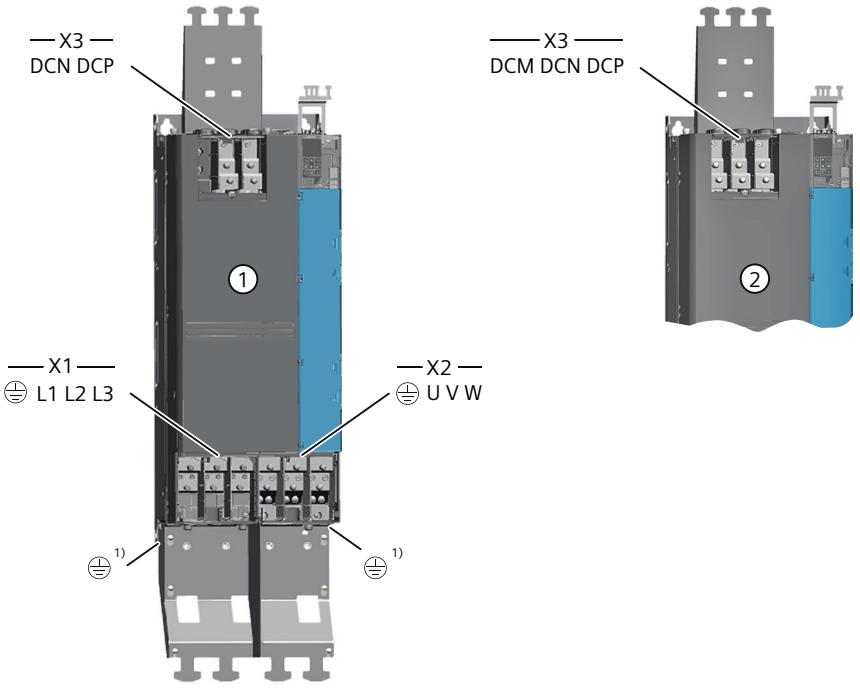
1) Additional connection option for a protective conductor at the housing

Figure 7-9 Power connections for frame sizes FSD1 to FSF1



1) For converters, frame size FSF2, connecting a protective conductor at the housing is optional.

Figure 7-10 Connection overview for frame size FSF2



1) Additional connection options for a protective conductor at the housing
① Converter in the standard version
② Clean Power Converter

Figure 7-11 Power connections for frame size FSF2

7.1.3.2 Connection overview, converter in degree of protection IP20 with dv/dt filter

Precondition

Only copper cables with an insulation that is designed for an ambient temperature of 75 °C are permissible.

For an ambient temperature of > 40 °C, the motor connection cables must have a thermal stability of 90 °C.

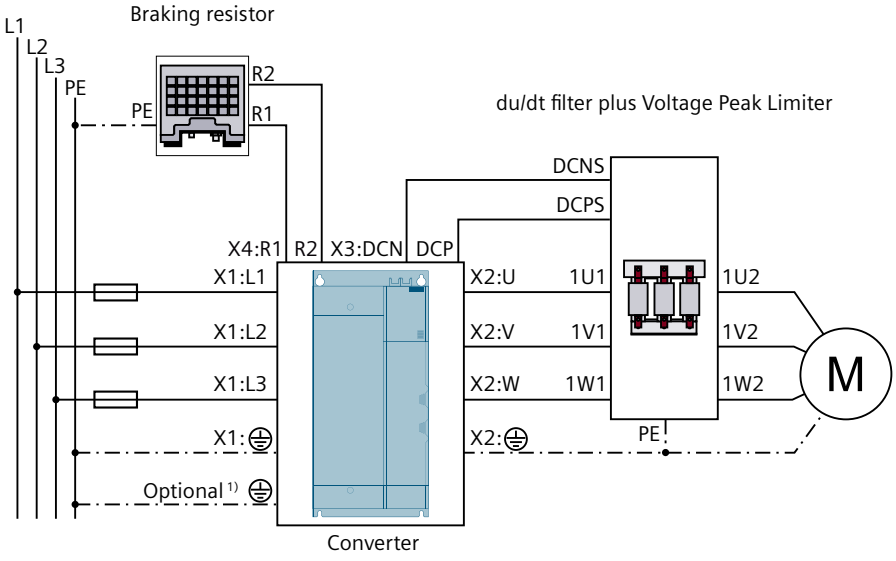
⚠ WARNING

Electric shock as a result of missing protective conductor

When only one protective conductor is connected at the converter, frame sizes FSA, FSB and FSD1 high voltages can be present at the housing, which when touched, can result in death or severe injury.

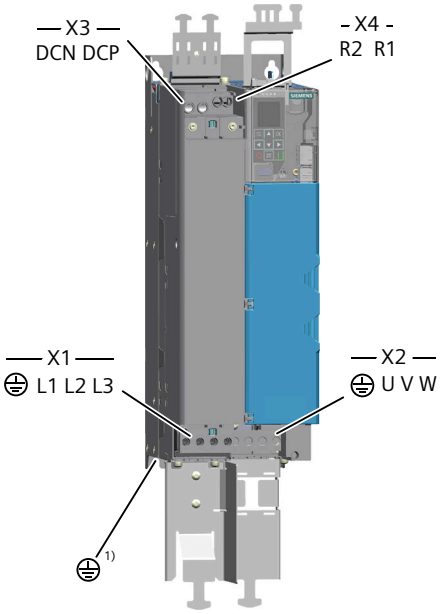
- For converters, frame size FSD1, connect a protective conductor to the housing as well as to line supply terminal X1.

Converter with degree of protection IP20



1) For converters, frame size FSD1, a protective conductor must be connected at X1 and at the housing.
For converters from frame size FSD2 and higher, connecting the protective conductor at the housing is optional.

Figure 7-12 Connection overview with dv/dt filter, from frame size FSD1



1) Additional connection option for a protective conductor at the housing

Figure 7-13 Power connections from frame size FSD1

7.1.3.3 Connection overview, converter in degree of protection IP20 with sine-wave filter

Precondition

Only copper cables with an insulation that is designed for an ambient temperature of 75 °C are permissible.

For an ambient temperature of > 40 °C, the motor connection cables must have a thermal stability of 90 °C.

⚠ WARNING

Electric shock as a result of missing protective conductor

When only one protective conductor is connected at the converter, frame sizes FSA, FSB and FSD1 high voltages can be present at the housing, which when touched, can result in death or severe injury.

- For converters, frame sizes FSA, FSB and FSD1, connect a protective conductor to the housing and to line supply terminal X1.

NOTICE

Overheating of the sine-wave filter as a result of an inadmissible pulse frequency

Operating the sine-wave filter with an inadmissible pulse frequency can result in overheating and damage to the sine-wave filter.

- Operate the sine-wave filter with a pulse frequency of 4 to 8 kHz.
- Deactivate the automatic pulse frequency reduction.

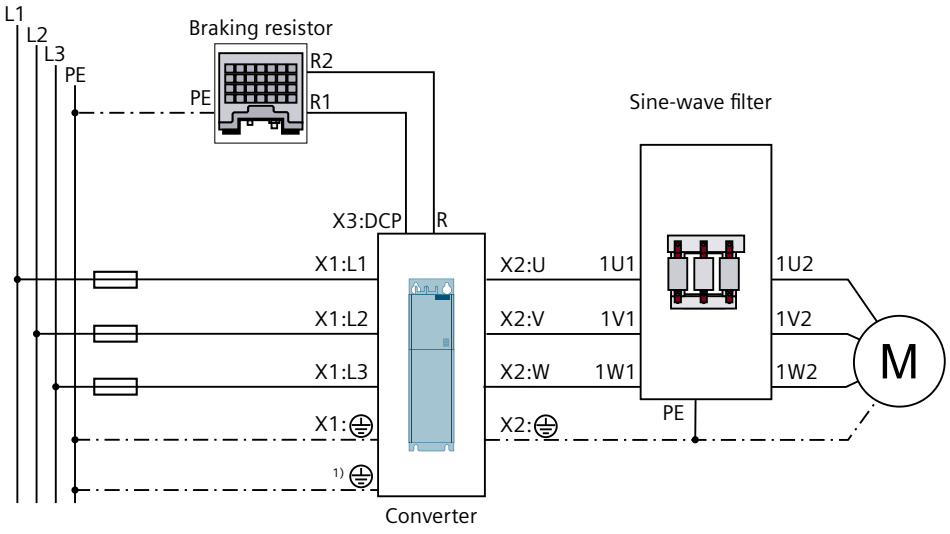
NOTICE

Overheating of the sine-wave filter as a result of an excessively high output frequency

An excessively high output frequency can result in overheating and damage to the sine-wave filter.

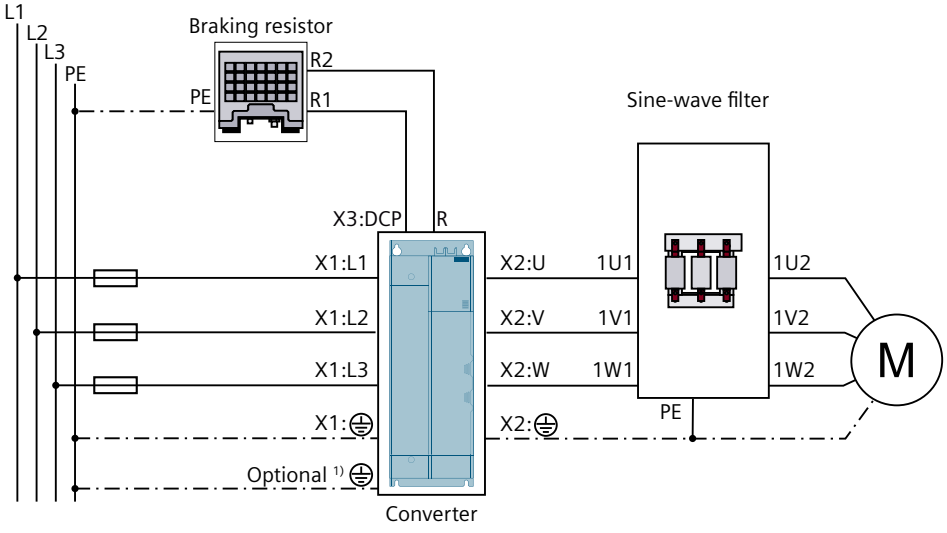
- In the standard version, limit the output frequency at the converter to a maximum of 150 Hz and at a Clean Power converter to a maximum of 60 Hz.

Converter with degree of protection IP20



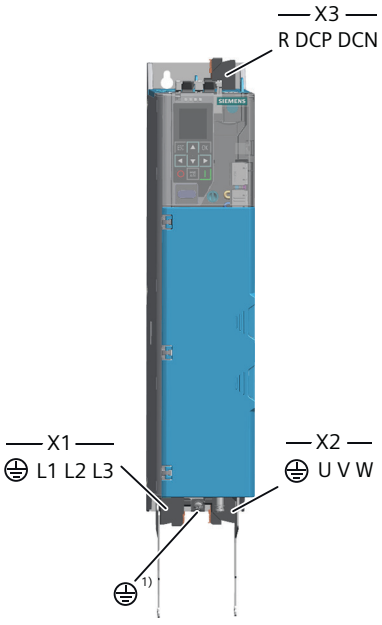
1) For converters, frame sizes FSA and FSB, the protective conductor must be connected at X1 and at the housing.

Figure 7-14 Connection overview, frame sizes FSA and FSB



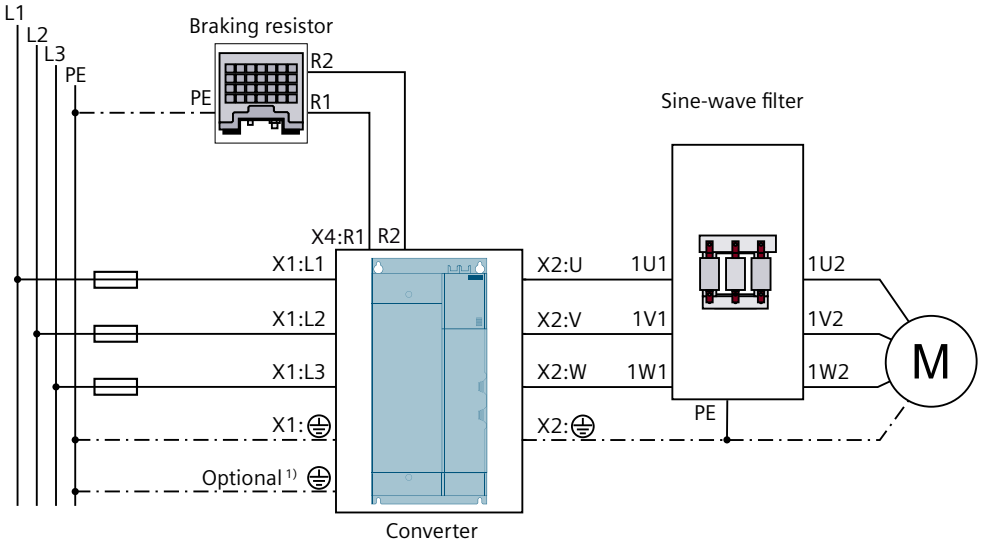
1) For converters, frame size FSC, connecting a protective conductor at the housing is optional.

Figure 7-15 Connection overview, frame size FSC



1) Additional connection option for a protective conductor at the housing

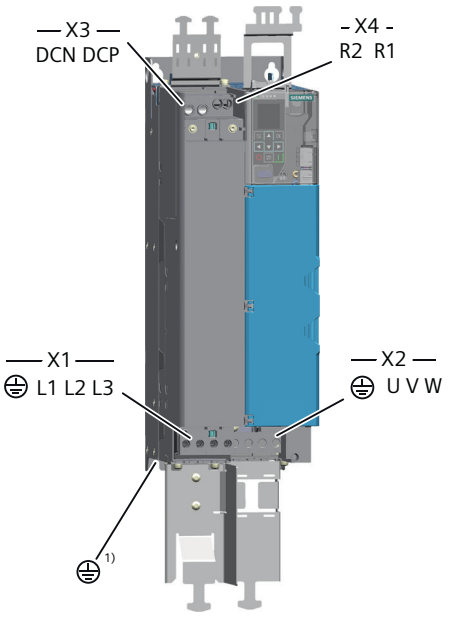
Figure 7-16 Power connections up to frame size FSC



1) For converters, frame size FSD1, a protective conductor must be connected at X1 and at the housing.

For converters from frame size FSD2 and higher, connecting a protective conductor at the housing is optional.

Figure 7-17 Connection overview for frame sizes FSD1 and FSD2



1) Additional connection option for a protective conductor at the housing

Figure 7-18 Power connections for frame sizes FSD1 and FSD2.

7.1.3.4 Access to the power connections, converters with degree of protection IP20 from frame size FSD1

Overview

From frame size FSD1 and higher, the converter power connections are located in the housing behind a cover. For the converter connecting cables, you must open the recesses provided in the cover. The opening must match the outer diameter of the connecting cables to guarantee the IP20 degree of protection.

Precondition

Tool required:

- Slotted screwdriver
- Diagonal cutter or fine saw

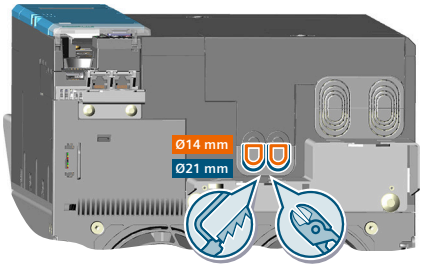
Procedure

Proceed as follows, to access the converter power connections from frame size FSD1:

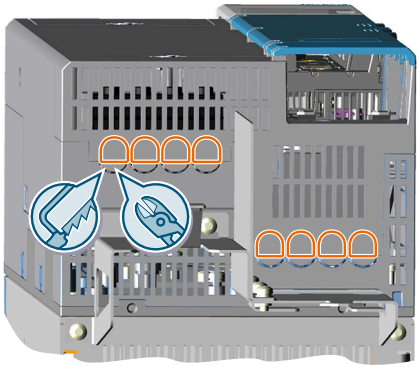
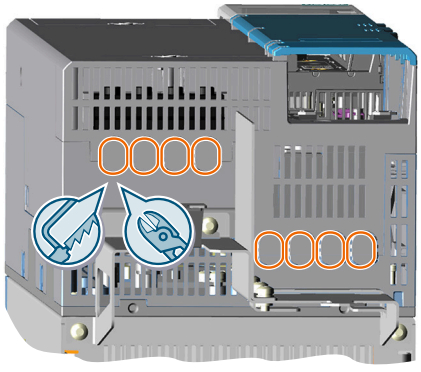
1. Remove the converter connection covers.

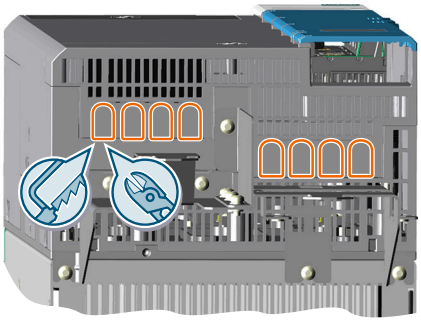
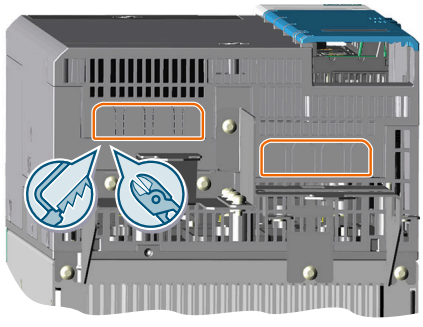


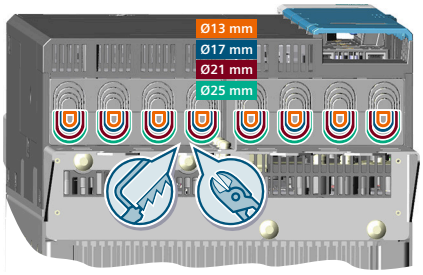
2. If you are using your own braking resistor, break-out or saw-out the openings for the braking resistor connection from the upper cover.

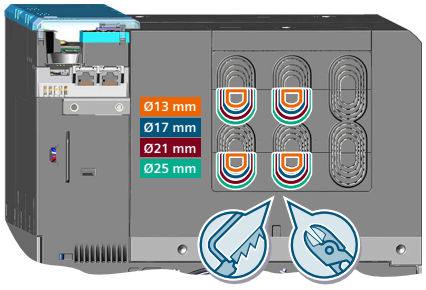
Frame size	Openings required for the line and motor connection
FSD1 ... FSE	
FSF1	 Adapt the openings to the outer diameter of the connecting cables. View of the converter from below

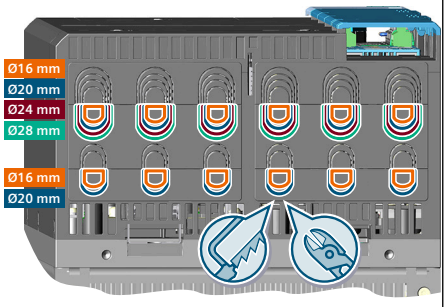
3. Break-out or saw-out the openings for the line and motor connection from the lower connection cover.
   The images show the converter from below.

<table>
<tr><th>Frame size</th><th colspan="2">Openings required for the line and motor connection</th></tr>
<tr><td>FSD1</td><td colspan="2">
Conductor cross-section 6 mm² ... 35 mm²</td></tr>
<tr><td>FSD2</td><td>
Conductor cross-section 10 mm² ... 35 mm²</td><td>
Conductor cross-section 50 mm²

Also remove the additional recesses in the housing.</td></tr>
<tr><td>FSE</td><td>
Conductor cross-section 35 mm² ... 70 mm²</td><td>
Conductor cross-section 95 mm²</td></tr>
</table>

<table>
<tr><th>Frame size</th><th>Openings required for the line and motor connection</th></tr>
<tr><td>FSF1</td><td>

Adapt the openings to the outer diameter of the connecting cables.
Also remove the upper recesses if you connect 2 conductors to each terminal.</td></tr>
<tr><td rowspan="2">FSF2</td><td colspan="2">Adapt the openings to the outer diameter of the connecting cables.
To connect a maximum of two connecting cables, use the upper connection point.
The lower connection point is suitable for connecting cables with a maximum cross-section of 50 to 70 mm².</td></tr>
<tr><td>

Upper terminal cover</td><td>

Lower terminal cover</td></tr>
</table>

4. Re-attach the converter connection covers to the converter.

7.1.3.5 Connection, converter in degree of protection IP20, 3 AC 200 ... 240 V

Description

Finely stranded conductors with end sleeves and rigid conductors can be connected.

For converters up to frame size FSE, 1 cable can be connected to each terminal.

For converters, frame size FSF1, a maximum of 2 cables can be connected to each terminal.

Table 7-1 Line connection (line voltage 3 AC 200 ... 240 V, IP20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			**Terminals X1**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
05 ... 11	FSA	0.55... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	FSB	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	FSC	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (5.3 ... 17.7)	12 (0.5)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

Table 7-2 Motor connection (line voltage 3 AC 200 ... 240 V, IP20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			**Terminals X2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
05 ... 11	FSA	0.55 ... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	FSB	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	FSC	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (5.3 ... 17.7)	12 (0.5)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

Table 7-3 Connection at the converter for the braking resistor (line voltage 3 AC 200 ... 240 V, IP20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			**Terminals X3 for frame sizes FSA ... FSC Terminals X4 from frame size FSD2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
05 ... 11	FSA	0.55 ... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	FSB	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	FSC	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10.6 ... 13.3)	12 (0.5)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	10 ... 16 (8 ... 6) 10 (8)[1)]	1.2 ... 1.5 (10.6 ... 13.3)	10 (0.4)	Screw terminal
21 ... 23	FSE	22 ... 30	16 ... 35 (6 ... 2)	3.7 ... 4.5 (32.7 ... 39.8)	18 (0.7)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

[1)] Conductor with end sleeve

Table 7-4 Additional connection option for a protective conductor at the housing (line voltage 3 AC 200 ... 240 V, IP20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			**Protective conductor connection at the housing**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
05 ... 11	FSA	0.55... 2.2	1.5 ... 4 (16 ... 11)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
12 ... 13	FSB	3 ... 4	1.5 ... 6 (16 ... 9)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
15 ...16	FSC	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (7 ... 1)	4.0 ... 5.0 (35.4 ... 44.3)	M5 threaded hole for ring cable lug
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	4.0 ... 5.0 (35.4 ... 44.3)	M5 threaded hole for ring cable lug
24 ... 27	FSF1	37 ... 55	16 ... 2 · 120 (6 ... 2 · 4/0)	22 ... 25 (195 ... 221)	M8 threaded hole for ring cable lug

7.1.3.6 Connection, converter in degree of protection IP20, 3 AC 380 ... 415 / 3 AC 440 ... 500 V

Description

Finely stranded conductors with end sleeves and rigid conductors can be connected.

For converters up to frame size FSE, 1 cable can be connected to each terminal.

For converters, frame size FSF1, a maximum of 2 cables can be connected to each terminal.

For converters from frame size FSF2 and higher, a maximum of 4 cables can be connected to each terminal.

Table 7-5 Line connection (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP20)

Converter 6SL4113-.C.□□-...0 6SL4113-.D.□□-...0			**Terminals X1**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSA	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	FSB	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10 ... 17.7)	12 (0.5)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (10 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
16 ... 21[1]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug
35 ... 36	FSF2	132 ... 160	50 ... 2 · 185 (0 ...2 · 350 kcmil)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Clean Power Converter

Table 7-6 Power output of the converter (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP20)

Converter 6SL4113-.C.□□-...0 6SL4113-.D.□□-...0			**Terminals X2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSA	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	FSB	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10 ... 17.7)	12 (0.5)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (10 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
16 ... 21[1]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

Converter **6SL4113-.C.□□-...0** **6SL4113-.D.□□-...0**			**Terminals X2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
30 ... 33	FSF1	75 ... 110	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug
35 ... 36	FSF2	132 ... 160	50 ... 4 · 70 ... 2 ·185 (0 ... 4 · 2/0 ... 2 · 350 kcmil)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Clean Power Converter

Table 7-7 Connection at the converter for the braking resistor (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP20)

Converter **6SL4113-.C.□□-...0** **6SL4113-.D.□□-...0**			**Terminals X3 for frame sizes FSA ... FSC** **Terminals X4 from frame size FSD1**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSA	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	FSB	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10.6 ... 13.3)	12 (0.5)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	6 ... 16 (10 ... 6)	1.2 ... 1.5 (10.6 ... 13.3)	12 (0.5)	Screw terminal
16 ... 21[1]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	10 ... 16 (8 ... 6)	1.2 ... 1.5 (10.6 ... 13.3)	10 (0.4)	Screw terminal
26 ... 27	FSE	45 ... 55	16 ... 35 (6 ... 2)	3.7 ... 4.5 (32.7 ... 39.8)	18 (0.7)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal
35 ... 36	FSF2[2]	132 ... 160	-	-	-	-

[1] Clean Power Converter

[2] No internal braking chopper

Table 7-8 Connection at the converter for the dv/dt filter (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP20)

Converter **6SL4113-..□□-..F0**			**Terminals X3**			
-..□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (/ lbf in)**	**Stripped length in mm (/ in)**	**Connection type**
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (9 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
16 ... 21[1]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	10 ... 50 (7 ... 1/0)	5 ... 6 (44.3 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

Converter 6SL4113-..□□-..F0			Terminals X3			
-..□□-	Frame size	Rated power in kW	Conductor cross-section in mm² (AWG)	Tightening torque in Nm (/ lbf in)	Stripped length in mm (/ in)	Connection type
30 ... 33	FSF1	75 ... 110	35 ... 120 (2 ... 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug
35 ... 36	FSF2	132 ... 160	50 ... 120 (0 ... 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

1) Clean Power Converter

Table 7-9 Additional connection option for a protective conductor at the housing (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP20)

Converter 6SL4113-.C.□□-...0 6SL4113-.D.□□-...0			Protective conductor connection at the housing		
-...□□-	Frame size	Rated power in kW	Conductor cross-section in mm² (AWG)	Tightening torque in Nm (lbf in)	Connection type
08 ... 13	FSA	1.1... 4	1.5 ... 4 (16 ... 11)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
15 ... 16	FSB	5.5 ... 7.5	1.5 ... 6 (16 ... 9)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
17 ... 18	FSC	11 ... 15	1.5 ... 16 (16 ... 6)	2.0 ... 3.0 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (9 ... 2)	4.0 ... 5.0 (35.4 ... 44.3)	M5 threaded hole for ring cable lug
16 ... 21[1)]		7.5 ... 22			
23 ... 24	FSD2	30 ... 37	10 ... 50 (7 ... 1)	4.0 ... 5.0 (35.4 ... 44.3)	M5 threaded hole for ring cable lug
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	4.0 ... 5.0 (35.4 ... 44.3)	M5 threaded hole for ring cable lug
30 ... 33	FSF1	75 ... 110	16 ... 2 · 120 (6 ... 2 · 4/0)	13 ... 15 (115 ... 133)	M8 threaded hole for ring cable lug
35 ... 36	FSF2	132 ... 160	25 ... 2 · 185 (3 ... 350 kcmil)	15 ... 17 (133 ... 150)	M10 threaded hole for ring cable lug

1) Clean Power Converter

7.1.4 Connecting up the converter, degree of protection IP55

7.1.4.1 Connection overview, converter in degree of protection IP55

Precondition

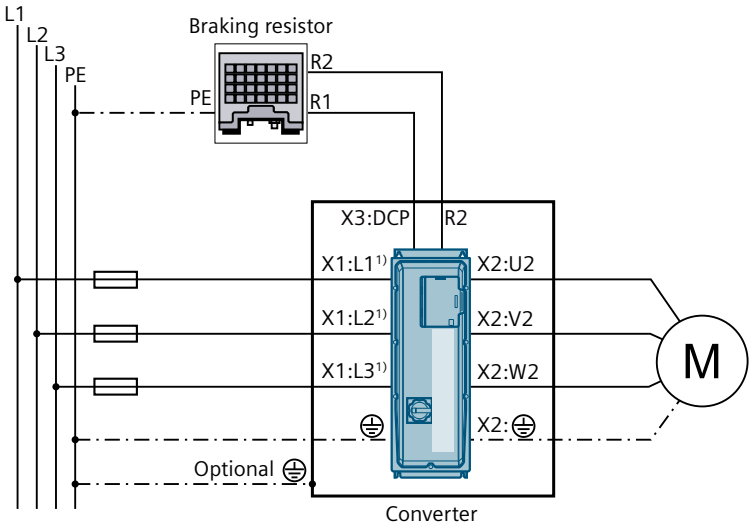
Only copper cables with an insulation that is designed for an ambient temperature of 75 °C are permissible.

Converter with degree of protection IP55

The converter has 2 connections for the line supply protective conductor:

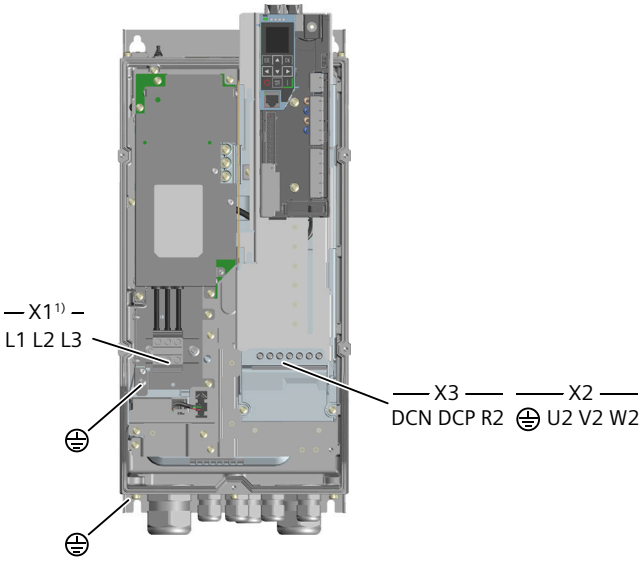
- Connection inside the enclosure next to terminals X1
- Connection at the housing

Connecting the line protective conductor at the housing is optional.



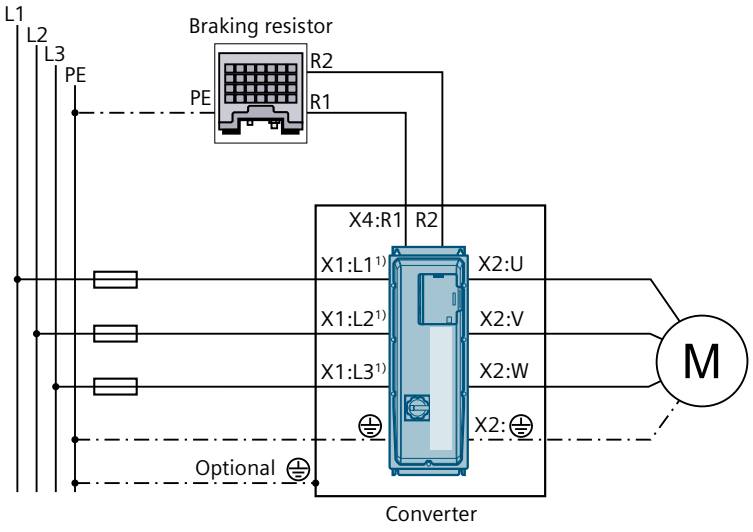
1) For converters with maintenance switch, terminals X1 are labeled with T1, T2, T3.

Figure 7-19 Connection overview up to frame size FSC



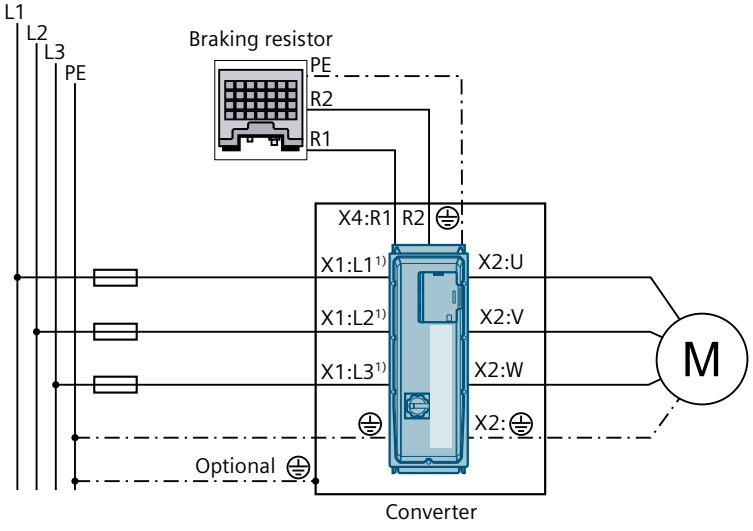
1) For converters with maintenance switch, terminals X1 are labeled with T1, T2, T3.

Figure 7-20 Power connections up to frame size FSC



1) For converters with maintenance switch, terminals X1 are labeled with T1, T2, T3.

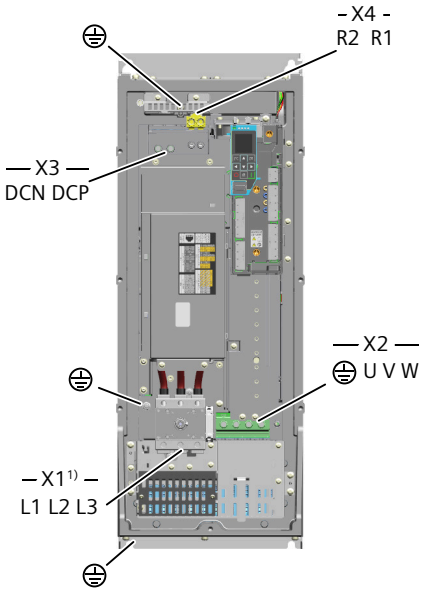
Figure 7-21 Connection overview for frame size FSD1



1) For converters with maintenance switch, terminals X1 are labeled with T1, T2, T3.

Figure 7-22 Connection overview from frame size FSD2 and higher

To avoid excessively tight bending radii, the braking resistor cables are not connected directly to X4 from frame size FSD1, but to a terminal adapter.



1) For converters with maintenance switch, terminals X1 are labeled with T1, T2, T3.

Figure 7-23 Power connections from frame size FSD1

There is a protective conductor connection next to the X4 terminal on the converter from size FSD2.

7.1.4.2 Accessing power connections, converters with degree of protection IP55

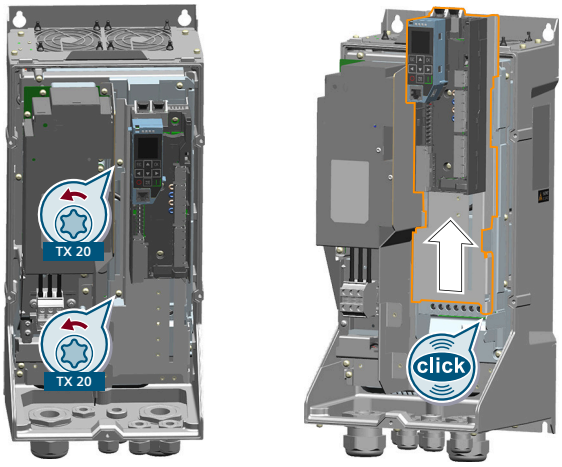
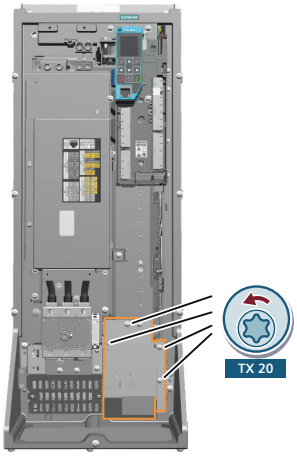
Requirement

The housing cover has been removed.

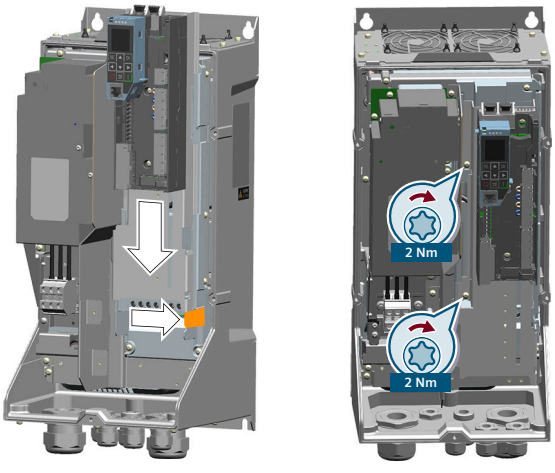
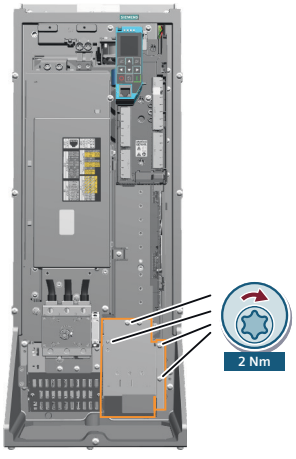
Tool required: Torx screwdriver TX 20

Procedure

Proceed as follows to access the converter power connections:

Converter up to frame size FSC	Converter from frame size FSD1
Figure with frame size FSC as example:  1. Release the two screws marked in the diagram. 2. Slide the sheet metal plate marked in the diagram upwards until the lower side of the sheet-metal edge engages with the catch.	Figure with frame size FSD2 as example:  Release the screws of the terminal cover and remove the terminal cover.

Proceed as follows after connecting the power cables:

Converter up to frame size FSC	Converter from frame size FSD1
Figure with frame size FSC as example:  1. Press the catch marked in the diagram to the right and slide the sheet-metal plate down again. 2. Tighten the two screws with a tightening torque of 2 Nm.	Figure with frame size FSD2 as example:  Attach the terminal cover.

7.1.4.3 Connection, converter in degree of protection IP55, 3 AC 200 ... 240 V

Precondition

⚠ CAUTION

Property damage due to loose terminal adapter connections

For converters with frame size FSD2 or larger, the braking resistor cable is connected to a terminal adapter. In the case of a converter with frame size FSF1, for manufacturing reasons the terminal adapter may be tightened with insufficient tightening torque. Insufficient tightening torques can result in loose power connections. This can result in damage due to fire, converter defects or malfunctions.

- Tighten the terminals X4 for the terminal adapter in converters with frame size FSF1 to the specified tightening torque.

Description

Finely stranded conductors with end sleeves and rigid conductors can be connected.

For converters up to frame size FSE, 1 cable can be connected to each terminal.

For converters, frame size FSF1, a maximum of 2 cables can be connected to each terminal.

Table 7-10 Line connection, converter without maintenance switch (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.J.□□-...0** **6SL4112-.K.□□-...0**			**Terminals X1**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSB	1.1 ... 4	1.5 ... 6 (15 ...9)	1.2 (10.6)	12 (0.5)	Screw terminal
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13... 5)	2.5 ... 3.4 (22.1 ... 30.1)	14 (0.6)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	16 ... 50 (5 ... 0)	5.6 (49.6)	25 (1)	Screw terminal
21 ... 23	FSE	22 ... 30	35 ... 70 (2 ... 2/0)[1] 35 ... 95 (2 ... 3/0)[2]	10.2 (90.3)	30 (1.2)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Finely stranded conductor with end sleeve

[2] Rigid cable

Table 7-11 Line connection, converter with maintenance switch (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.L.□□-...0** **6SL4112-.M.□□-...0**			**Terminals X1 at the maintenance switch**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSB	1.1 ... 4	2.5 ... 6 (13 ... 9)	2.0 ... 2.5 (17.7 ... 22.1)	9.5 (0.4)	Screw terminal
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13 ...5)	2.0 ... 2.5 (17.7 ... 22.1)	14 (0.6)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	10 ... 35[1] (7 ... 2) 10 ... 50[2] (7 ... 0)	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	9.5 ... 10 (84.1 ... 88.5)	15 (0.6)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 2 · 120 (2 ... 4/0)	22 ... 25 (194.7 ... 221.3)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Finely stranded conductor with end sleeve

[2] Rigid cable

Table 7-12 Protective conductor for line connection (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.J.□□-...0** **6SL4112-.K.□□-...0** **6SL4112-.L.□□-...0** **6SL4112-.M.□□-...0**			**Protective conductor next to terminals X1**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 13	FSB	1.1 ... 4	2.5 ...6 (13 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	M5 threaded hole for ring cable lug
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13 ... 5)	1.5 ... 1.7 (13.3 ... 15.0)	M4 threaded hole for ring cable lug
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (7 ... 0)	5.0 ... 6.0 (44.2 ... 53.1)	M8 threaded bolts for ring cable lug
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	8.0 ... 9.0 (70.8 ... 79.6)	M8 threaded bolts for ring cable lug
24 ... 27	FSF1	37 ... 55	16 ... 2 · 120 (5 ... 4/0)	15 ... 17 (132.8 ... 150.5)	M10 threaded bolts for ring cable lug

Table 7-13 Motor connection (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.J.□□-...0** **6SL4112-.K.□□-...0** **6SL4112-.L.□□-...0** **6SL4112-.M.□□-...0**			**Terminals X2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 13	FSB	1.1 ... 4	2.5 ... 6 (13 ... 9)	1.3 (11.5)	12 (0.5)	Screw terminal
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13 ... 5)	1.3 ... 1.4 (1.3 ... 12.4)	12 (0.5)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (7 ... 0)	5.0 ... 6.0 (44.2 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

Table 7-14 Connection at the converter for the braking resistor (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.J.□□-...0** **6SL4112-.K.□□-...0** **6SL4112-.L.□□-...0** **6SL4112-.M.□□-...0**			**Terminals X3 for frame sizes FSB and FSC** **Terminals X4 from frame size FSD2**				
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**		**Stripped length in mm (in)**	**Connection type**
				Terminals	**Terminal adapter**		
08 ... 13	FSB	1.1 ... 4	2.5 ... 6 (13 ... 9)	1.3 (11.5)	-	12 (0.5)	Screw terminal
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13 ... 5)	1.3 ... 1.4 (11.5 ... 12.4)	-	1 (0.5)	Screw terminal
17 ... 20	FSD2	11 ... 18.5	2.5 ... 16 (13 ... 5)	1.2 ... 1.76 (10.6... 15.6)	1.5 ... 2.5 (13.3 ... 22.1)	11 ... 12 (0.4 ... 0.5)	Screw terminal
21 ... 23	FSE	22 ... 30	16 ... 50 (5 ... 0)	3.8 ... 4.5 (33.6 ... 39.8)	8 ... 9 (70.8 ... 79.7)	18 ... 19 (0.7 ... 0.7)	Screw terminal
24 ... 27	FSF1	37 ... 55	35 ... 70 (2 ... 2/0)	14 ... 15 (123.9 ... 132.8)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

Table 7-15 Additional connection option for a protective conductor at the housing (line voltage 3 AC 200 ... 240 V, IP55)

Converter **6SL4112-.J.□□-...0** **6SL4112-.K.□□-...0** **6SL4112-.L.□□-...0** **6SL4112-.M.□□-...0**			**Protective conductor at the housing**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 13	FSB	1.1 ... 4	2.5 ... 6 (13 ... 9)	2 ... 3 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
15 ... 16	FSC	5.5 ... 7.5	2.5 ... 16 (13 ... 5)	2 ... 3 (17.7 ... 26.6)	M4 threaded hole for ring cable lug
17 ... 20	FSD2	11 ... 18.5	10 ... 50 (7 ... 0)	5.0 ... 6.0 (44.2 ... 53.1)	M6 threaded hole for ring cable lug
21 ... 23	FSE	22 ... 30	35 ... 95 (2 ... 3/0)	8 ...9 (70.8 ... 79.6)	M8 threaded hole for ring cable lug
24 ... 27	FSF1	37 ... 55	16 ... 2 · 120 (6 ... 2 · 4/0)	22 ... 25 (194.7 ... 221.3)	M10 threaded hole for ring cable lug

7.1.4.4 Connection, converter in degree of protection IP55, 3 AC 380 ... 480 V/500 V

Precondition

⚠ CAUTION

Property damage due to loose terminal adapter connections

For converters with frame size FSD1 or larger, the braking resistor cable is connected to a terminal adapter. In the case of a converter with frame size FSF1, for manufacturing reasons the terminal adapter may be tightened with insufficient tightening torque. Insufficient tightening torques can result in loose power connections. This can result in damage due to fire, converter defects or malfunctions.

- Tighten the terminals X4 for the terminal adapter in converters with frame size FSF1 to the specified tightening torque.

Description

Finely stranded conductors with end sleeves and rigid conductors can be connected.

For converters up to frame size FSE, 1 cable can be connected to each terminal.

For converters, frame size FSF1, a maximum of 2 cables can be connected to each terminal.

Table 7-16 Line connection without maintenance switch (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0**			**Terminals X1**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 16	FSB	1.1 ... 7.5	1.5 ... 6 (15 ... 9)	1.2 (10.6)	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	2.5 ... 3.4 (22.1 ... 30.1)	14 (0.6)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	16 ... 35 (5 ... 2)	5.6 (49.6)	25 (1)	Screw terminal
16 ... 21[1]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	16 ... 50 (5 ... 0)	5.6(49.6)	25 (1)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 70 (2 ... 2/0)[2] 35 ... 95 (2 ... 3/0)[3]	10.2 (90.3)	30 (1.2)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (194.7 ... 221.3)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Clean Power Converter

[2] Finely stranded conductor with end sleeve

[3] Rigid cable

Table 7-17 Line connection with maintenance switch (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Terminals X1 at the maintenance switch**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 16	FSB	1.1 ... 7.5	2.5 ... 6 (13 ... 9)	2.0 ... 2.5 (17.7 ... 22.1)	9.5 (0.4)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	2.0 ... 2.5 (17.7 ... 22.1)	14 (0.6)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	6 ... 16[2] (9 ... 5)	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
16 ... 21[1]		7.5 ... 22	6 ... 35[3] (9 ... 2)			
23 ... 24	FSD2	30 ... 37	10 ... 35 (7 ... 2) [2] 10 ... 50 (7 ... 2)[3]	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	9.5 ... 10 (84.1 ... 88.5)	15 (0.6)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (194.7 ... 221.3)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1] Clean Power Converter

[2] Finely stranded conductor with end sleeve

[2] Rigid cable

Table 7-18 Protective conductor for line connection (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0** **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Protective conductor next to terminals X1**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 16	FSB	1.1 ... 7.5	2.5 ... 6 (13 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	M4 threaded hole for ring cable lug
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	1.5 ... 1.7 (13.3 ... 15.0)	M4 threaded hole for ring cable lug
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (9 ...2)	3.5 ... 4.0 (31.0 ... 35.4)	M6 threaded bolts for ring cable lug
16 ... 21[1)]		7.5 ... 22			
23 ... 24	FSD2	30 ... 37	10 ... 50 (7 ...0)	5.0 ... 6.0 (44.2 ... 53.1)	M6 threaded bolts for ring cable lug
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	8.0 ... 9.0 (70.8 ... 79.6)	M8 threaded bolts for ring cable lug
30 ... 33	FSF1	75 ... 110	16 ... 2 · 120 (5 ... 2 · 4/0)	15 ... 17 (132.8 ... 150.5)	M10 threaded bolts for ring cable lug

[1)] Clean Power Converter

Table 7-19 Motor connection (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0** **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Terminals X2**			
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Stripped length in mm (in)**	**Connection type**
08 ... 16	FSB	1.1 ... 7.5	2.5 ... 6 (13 ... 9)	1.3 (11.5)	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	1.3 ... 1.4 (11.5 ... 12.4)	12 (0.5)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (9 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
16 ... 21[1)]		7.5 ... 22				
23 ... 24	FSD2	30 ... 37	10 ... 50 (7 ... 0)	5.0 ... 6.0 (44.2 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 2 · 120 (2 ... 2 · 4/0)	22 ... 25 (195 ... 221)	Dependent on the ring cable lug being used	M10 threaded bolts for ring cable lug

[1)] Clean Power Converter

Table 7-20 Connection at the converter for the braking resistor (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-0J.□□-...0** **6SL4113-0K.□□-...0** **6SL4113-0L.□□-...0** **6SL4113-0M.□□-...0**			**Terminals X3 for frame sizes FSB and FSC** **Terminals X4 from frame size FSD1**				
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**		**Stripped length in mm (in)**	**Connection type**
				Terminals	**Terminal adapter**		
08 ... 16	FSB	1.1 ... 7.5	2.5 ... 6 (13 ... 9)	1.3 (11.5)	-	12 (0.5)	Screw terminal
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	1.3 ... 1.4 (11.5 ... 12.4)	-	12 (0.5)	Screw terminal
20 ... 21	FSD1	18.5 ... 22	2.5 ... 16 (13 ... 5)	1.5 ... 2.5 (13.3 ... 22.1)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
23 ... 24	FSD2	30 ... 37	2.5 ... 16 (13 ...5)	1.5 ... 2.5 (13.3 ... 22.1)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
26 ... 27	FSE	45 ... 55	16 ... 50 (5 ... 0)	8 ... 9 (70.8 ... 79.7)	8 ... 9 (70.8 ... 79.7)	13 (0.5)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 70 (2 ... 2/0)	10 ... 12 (88.5 ... 106.2)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

Table 7-21 Connection at the Clean Power converter for a braking resistor (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-2J.□□-...0** **6SL4113-2K.□□-...0** **6SL4113-2L.□□-...0** **6SL4113-2M.□□-...0**			**Terminals X4**				
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**		**Stripped length in mm (in)**	**Connection type**
				Terminal	**Terminal adapter**		
16 ... 21	FSD1	7.5 ... 22	2.5 ... 16 (13 ... 5)	1.5 ... 2.5 (13.3 ... 22.1)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
23 ... 24	FSD2	30 ... 37	2.5 ... 16 (13 ...5)[1]	1.5 ... 2.5 (13.3 ... 22.1)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
26 ... 27	FSE	45 ... 55	16 ... 50 (5 ... 0) [1] [2]	8 ... 9 (70.8 ... 79.7)	8 ... 9 (70.8 ... 79.7)	13 (0.5)	Screw terminal
30 ... 33	FSF1	75 ... 110	35 ... 70 (2 ... 2/0)	10 ... 12 (88.5 ... 106.2)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

[1] Connecting cable for conductor cross-section 16 mm²: ÖLFLEX® CLASSIC 110 CY 2 x 16 or equivalent

[2] You can obtain recommendations for connecting cables with larger cross-sections through Customer Support

Table 7-22 Additional connection option for a protective conductor at the housing (line voltage 3 AC 380 ... 415 / 3 AC 440 ... 500 V, IP55)

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0** **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Protective conductor at the housing**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 16	FSB	1.1 ... 7.5	2.5 ... 6 (13 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	M4 threaded hole for ring cable lug
17 ... 18	FSC	11 ... 15	2.5 ... 16 (13 ... 5)	1.5 ... 1.7 (13.3 ... 15.0)	M4 threaded hole for ring cable lug
20 ... 21	FSD1	18.5 ... 22	6 ... 35 (9 ... 2)	5.0 ... 6.0 (44.2 ... 53.1)	M8 threaded hole for ring cable lug
16 ... 21[1)]		7.5 ... 22			
23 ... 24	FSD2	30 ... 37	10 ... 50 (7 ... 0)	5.0 ... 6.0 (44.2 ... 53.1)	M8 threaded hole for ring cable lug
26 ... 27	FSE	45 ... 55	35 ... 95 (2 ... 3/0)	5.0 ... 6.0 (44.2 ... 53.1)	M8 threaded hole for ring cable lug
30 ... 33	FSF1	75 ... 110	16 ... 2 · 120 (5 ... 2 · 4/0)	22 ... 25 (194.7 ... 221.3)	M10 threaded hole for ring cable lug

[1)] Clean Power Converter

7.1.5 Requirements relating to the dimensions of the ring cable lugs

Description

To ensure the required voltage clearances, the ring cable lugs for connecting converters from size FSF1 must comply with the specified dimensions.

For mechanical reasons, when using 2 ring cable lugs per connection, an additional condition applies to the dimensions of the ring cable lugs.

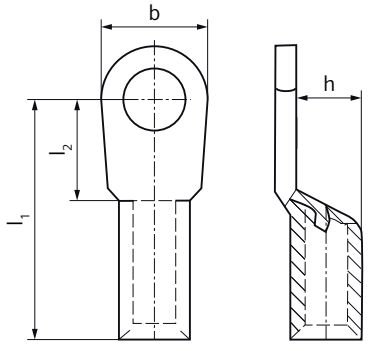


Figure 7-24 Ring cable lug

Table 7-23 Dimensions of the ring cable lugs/line connection, motor connection

Converter frame size	Maximum width b	Maximum length l_1	Minimum length l_2 when using 2 ring cable lugs per connection	Maximum overhang h	
				Connection point	
				Top	Bottom
	mm	mm	mm	mm	
FSF1	31.5	65	12	18	
FSF2	36	64	12	22	16

Table 7-24 Dimensions of the ring cable lugs/DC link connection, terminal X3

Converter frame size	Maximum width b	Maximum length l_1	Minimum length l_2 when using 2 ring cable lugs per connection	Maximum overhang h
	mm	mm	mm	mm
FSF1	31.5	65	12	18
FSF2	34	64	14	20

7.1.6 Opening the ground connection of the integrated line filter, degree of protection IP20

Overview

When connecting the converter with integrated line filter to an IT line system, the ground connection of the integrated line filter must be open.

Precondition

You have a converter, frame size:

- FSA to FSF2
  Clean Power converters, frame size FSF1 from functional state FS: 02

You have switched off the power supply of the converter.

⚠ CAUTION

Damage to the converter when connected to an IT line system

The converter will be damaged if it is operated with integrated line filter on an IT line system.

- Open the ground connection of the integrated line filter.



⚠ WARNING

Electric shock as a result of a residual charge in power components

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the residual charge is at a non-hazardous level. Touching live components can result in death or severe injury.

- Check that there is absolutely no voltage between any of the power connections, or between them and the protective conductor connection.

Procedure

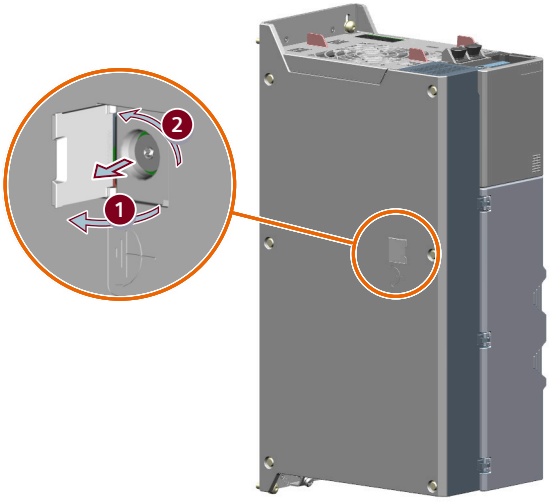


Figure 7-25 Remove screw for the ground connection (example: Converter with frame size FSC)

Proceed as follows to open the ground connection of the integrated line filter:

1. Open the protective flap at the converter housing, e.g. using a slotted screwdriver.
2. Release the screw for the ground connection and remove it.

7.1.7 Opening the ground connection of the integrated line filter, degree of protection IP55

Overview

When connecting the converter with integrated line filter to an IT line system, the ground connection of the integrated line filter must be open.

Precondition

You have a converter with the following frame size:

- FSA to FSE
- FSF1 from functional state FS: 02

The following requirements apply when the housing cover is removed:

- You have switched off the power supply of the converter.
- Comply with ESD regulations.
- You require a TX 20 Torx screwdriver.
- The following requirements apply when the housing cover is attached and removed:
  - Selecting a Torx screwdriver depending on the converter frame size
  - Tightening torque, depending on the converter frame size

⚠ CAUTION

Damage to the converter when connected to an IT line system

The converter will be damaged if it is operated with integrated line filter on an IT line system.

- Open the ground connection of the integrated line filter.



⚠ WARNING

Electric shock as a result of a residual charge in power components

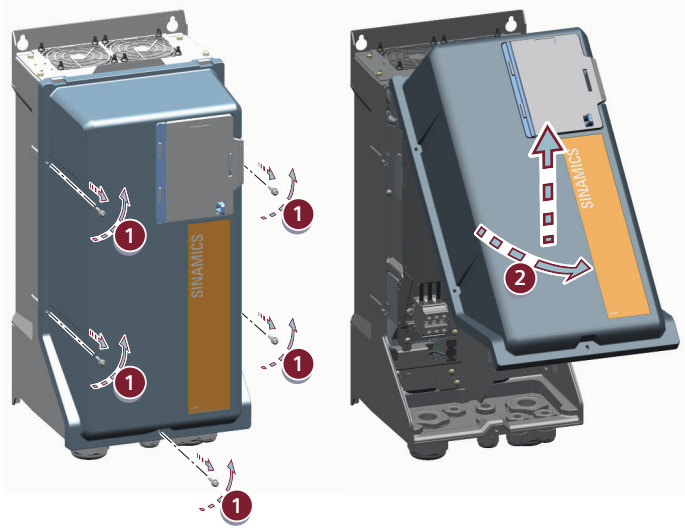
After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the residual charge is at a non-hazardous level. Touching live components can result in death or severe injury.

- Check that there is absolutely no voltage between any of the power connections, or between them and the protective conductor connection.

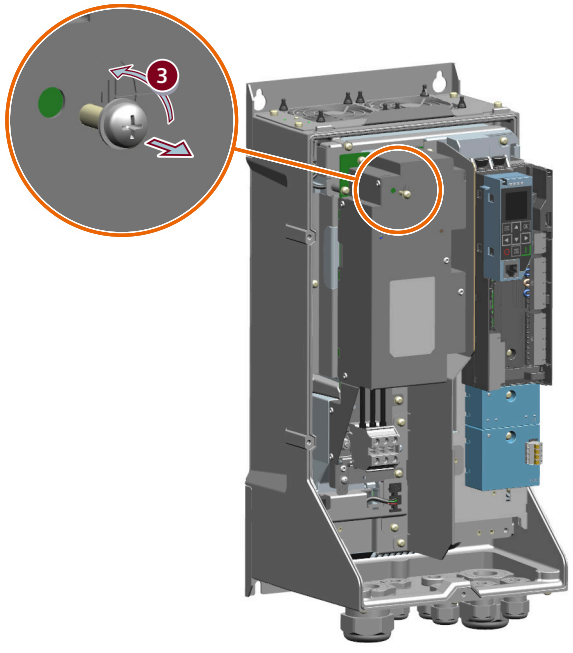
Procedure

Proceed as follows to open the ground connection of the integrated line filter:

1. Release the screws of the converter housing cover using the specified Torx screwdriver. The screws are connected to the housing cover and are captive.



2. Remove the housing cover.
3. Release the screw for the ground connection and remove it.



4. Place the housing cover with the recess at the converter housing and swivel the housing cover downward.
5. Reattach the housing cover and tighten the screws using the specified Torx screwdriver. Comply with the specified tightening torque.

7.1.8 Overcurrent protection and fault current protection

7.1.8.1 Overcurrent protection devices

Description

Overcurrent protection devices, e.g. standard fuses or semiconductor fuses, are not part of the converter and must be installed externally.

⚠ WARNING

Fire and electric shock due to unsuitable overcurrent protection devices

Unsuitable overcurrent protection devices can cause the converter temperature to increase significantly. This can damage the converter or cause it to catch fire, resulting in electric shock and death.

- Use only suitable overcurrent protection devices.
- Carefully ensure that cables and conductors are professionally and adequately dimensioned.
- Comply with the standards of the respective country and jurisdiction.

The following standards apply dependent on the jurisdiction:

- IEC jurisdiction
  - IEC standard 60364
  - In addition, all local standards and regulations for electrical installations.
- UL/CSA jurisdiction
  - UL Standard National Electrical Code (NEC) for the USA
  - CSA Standard Canadian Electrical Code (CEC) Part I for Canada
  - In addition, all local rules and regulations

More information

You can find more information about overcurrent protective devices on the Internet:

Protective devices for SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109823568)

7.1.8.2 Overcurrent protection, 3 AC 200 ... 240 V

Description

Table 7-25 Standard fuses according to IEC standard, 3 AC 200 ... 240 V

Converter		Standard fuse				Minimal control cabinet envelope dimensions for converters with degree of protection IP20	
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 240 V		
0.55	6SL4112-0..05-...0	3NA3801	6	0.15	100	0.192 m³	6.78 ft³
0.75	6SL4112-0..06-...0	3NA3803	10	0.25	100		
1.1	6SL4112-0..08-...0	3NA3803	10	0.25	100		
1.5	6SL4112-0..10-...0	3NA3805	16	0.4	100		
2.2	6SL4112-0..11-...0	3NA3805	16	0.4	100		
3	6SL4112-0..12-...0	3NA3807	20	0.5	100	0.24 m³	8.48 ft³
4	6SL4112-0..13-...0	3NA3810	25	0.62	100		
5.5	6SL4112-0..15-...0	3NA3817	40	1.0	100	0.12 m³	4.24 ft³
7.5	6SL4112-0..16-...0	3NA3820	50	1.25	100		
11	6SL4112-0..17-...0	3NA3824	80	2.0	100	0.36 m³	12.71 ft³
15	6SL4112-0..18-...0	3NA3824	80	2.0	100		
18.5	6SL4112-0..20-...0	3NA3830	100	2.5	100		
22	6SL4112-0..21-...0	3NA3832	125	3.12	100	0.384 m³	13.56 ft³
30	6SL4112-0..23-...0	3NA3836	160	4.0	100		
37	6SL4112-0..24-...0	3NA3836	160	4.0	100	0.48 m³	16.95 ft³
45	6SL4112-0..26-...0	3NA3140	200	5.0	100		
55	6SL4112-0..27-...0	3NA3144	250	7.5	100		

Table 7-26 Fuses according to IEC standard, 3 AC 200 ... 240 V, converters with maintenance switches

Converter		Fuse			
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 240 V
1.1	6SL4112-0..08-...0	3NA3803	10	0.25	100
1.5	6SL4112-0..10-...0	3NA3805	16	0.4	100
2.2	6SL4112-0..11-...0	3NA3805	16	0.4	100
3	6SL4112-0..12-...0	3NA3807	20	0.5	100
4	6SL4112-0..13-...0	3NA3810	25	0.62	100
5.5	6SL4112-0..15-...0	3NE1803-0	35	0.53	100
7.5	6SL4112-0..16-...0	3NE1803-0	35	0.53	100
11	6SL4112-0..17-...0	3NA3822	63	1.57	100
15	6SL4112-0..18-...0	3NA3822	63	1.57	100
18.5	6SL4112-0..20-...0	3NE1021-0	100	1.5	100
22	6SL4112-0..21-...0	3NA3830	100	2.5	100

Converter		Fuse			
Rated power / kW	**Article number**	**Article number**	**Rated current / A**	**$I_{CP,MR}$ / kA**	**I_{CC} / kA @ 240 V**
30	6SL4112-0..23-...0	3NA3832	125	3.12	100
37	6SL4112-0..24-...0	3NE1224-0	160	2.4	100
45	6SL4112-0..26-...0	3NE1225-0	200	3.0	100
55	6SL4112-0..27-...0	3NE1227-0	250	5.0	100

Check whether the selected fuse is suitable for the load cycle in your specific application.

Table 7-27 Fuses according to UL/CSA standard, 3 AC 200 ... 240 V

Converter		Fuses		Minimal control cabinet envelope dimensions for converters with degree of protection UL open type	
Rated power / hp	**Article number**	**Rated current / A** [1]	**SCCR / kA @ 240 V**		
0.75	6SL4112-0..05-...0	6	100	0.192 m³	6.78 ft³
1	6SL4112-0..06-...0	8	100		
1.5	6SL4112-0..08-...0	10	100 5 [2]		
2	6SL4112-0..10-...0	12	100 5 [2]		
3	6SL4112-0..11-...0	15	100 5 [2]		
4	6SL4112-0..12-...0	20	100 5 [2]	0.24 m³	8.48 ft³
5	6SL4112-0..13-...0	30	100 5 [2]		
7.5	6SL4112-0..15-...0	40	100 5 [2]	0.12 m³	4.24 ft³
10	6SL4112-0..16-...0	50	100 5 [2]		
15	6SL4112-0..17-...0	70	100 5 [2]	0.36 m³	12.71 ft³
20	6SL4112-0..18-...0	90	100 5 [2]		
25	6SL4112-0..20-...0	110	100 5 [2]		
30	6SL4112-0..21-...0	125	100 10 [2]	0.384 m³	13.56 ft³
40	6SL4112-0..23-...0	150	100 10 [2]		

Converter		Fuses		Minimal control cabinet envelope dimensions for converters with degree of protection UL open type	
Rated power / hp	Article number	Rated current / A [1]	SCCR / kA @ 240 V		
50	6SL4112-0..24-...0	150	100 10 [2]	0.48 m³	16.95 ft³
60	6SL4112-0..26-...0	175	100 10 [2]		
75	6SL4112-0..27-...0	250	100 10 [2]		

[1] Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters with frame sizes FSA to FSC, fuses of classes CC and G can also be used.

[2] For converters with maintenance switch

More information

Additional overcurrent protective devices are available on the Internet:

Protective devices for SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109823568)

7.1.8.3 Overcurrent protection, 3 AC 380 V ... 415 V / 3 AC 440 V... 500 V

Description

Table 7-28 Standard fuses according to IEC standard, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Converter		Standard fuse				Minimal control cabinet envelope dimensions for converters with degree of protection IP20	
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 500 V		
1.1	6SL4113-0..08-...0	3NA3801	6	0.15	100	0.192 m³	6.78 ft³
1.5	6SL4113-0..10-...0	3NA3803	10	0.25	100		
2.2	6SL4113-0..11-...0	3NA3803	10	0.25	100		
3	6SL4113-0..12-...0	3NA3805	16	0.4	100		
4	6SL4113-0..13-...0	3NA3805	16	0.4	100		
5.5	6SL4113-0..15-...0	3NA3807	20	0.5	100	0.24 m³	8.48 ft³
7.5	6SL4113-0..16-...0	3NA3810	25	0.62	100		
11	6SL4113-0..17-...0	3NA3817	40	1.0	100	0.12 m³	4.24 ft³
15	6SL4113-0..18-...0	3NA3820	50	1.25	100		
18.5	6SL4113-0..20-...0	3NA3822	63	1.57	100	0.16 m³	5.65 ft³
22	6SL4113-0..21-...0	3NA3824	80	2.0	100		
30	6SL4113-0..23-...0	3NA3824	80	2.0	100	0.36 m³	12.71 ft³
37	6SL4113-0..24-...0	3NA3830	100	2.5	100		

Converter		Standard fuse				Minimal control cabinet envelope dimensions for converters with degree of protection IP20	
Rated power / kW	**Article number**	**Article number**	**Rated current / A**	**$I_{CP,MR}$ / kA**	**I_{CC} / kA @ 500 V**		
45	6SL4113-0..26-...0	3NA3832	125	3.12	100	0.384 m^3	13.56 ft^3
55	6SL4113-0..27-...0	3NA3836	160	4.0	100		
75	6SL4113-0..30-...0	3NA3836	160	4.0	100	0.48 m^3	16.95 ft^3
90	6SL4113-0..31-...0	3NA3140	200	5.0	100		
110	6SL4113-0..33-...0	3NA3144	250	7.5	100		
132	6SL4113-0..35-...0	3NA3250	300	9.0	100		
160	6SL4113-0..36-...0	3NA3254	355	10.65	100		

Table 7-29 Fuses according to IEC standard, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, converters with maintenance switches

Converter		Fuse			
Rated power / kW	**Article number**	**Article number**	**Rated current / A**	**$I_{CP,MR}$ / kA**	**I_{CC} / kA @ 500 V**
1.1	6SL4113-0..08-...0	3NA3801	6	0.15	100
1.5	6SL4113-0..10-...0	3NA3803	10	0.25	100
2.2	6SL4113-0..11-...0	3NA3803	10	0.25	100
3	6SL4113-0..12-...0	3NA3805	16	0.4	100
4	6SL4113-0..13-...0	3NA3805	16	0.4	100
5.5	6SL4113-0..15-...0	3NA3807	20	0.5	100
7.5	6SL4113-0..16-...0	3NA3810	25	0.62	100
11	6SL4113-0..17-...0	3NE1803-0	35	0.53	100
15	6SL4113-0..18-...0	3NE1803-0	35	0.53	100
18.5	6SL4113-0..20-...0	3NA3820	50	1.25	100
22	6SL4113-0..21-...0	3NA3820	50	1.25	100
30	6SL4113-0..23-...0	3NA3822	63	1.57	100
37	6SL4113-0..24-...0	3NE1820-0	80	1.2	100
45	6SL4113-0..26-...0	3NA3830	100	2.5	100
55	6SL4113-0..27-...0	3NA3832	125	3.12	100
75	6SL4113-0..30-...0	3NE1224-0	160	2.4	100
90	6SL4113-0..31-...0	3NE1225-0	200	3.0	100
110	6SL4113-0..33-...0	3NE1227-0	250	5.0	100

Check whether the selected fuse is suitable for the load cycle in your specific application.

Table 7-30 Fuses according to UL/CSA standard, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Converter		**Fuses**		**Minimal control cabinet envelope dimensions for converters with degree of protection UL open type**	
Rated power / hp	**Article number**	**Rated current / A** [1]	**SCCR / kA @ 480 V**		
1.5	6SL4113-0..08-...0	6	100 5 [2]	0.192 m³	6.78 ft³
2	6SL4113-0..10-...0	8	100 5 [2]		
3	6SL4113-0..11-...0	10	100 5 [2]		
4	6SL4113-0..12-...0	12	100 5 [2]		
5	6SL4113-0..13-...0	15	100 5 [2]		
7.5	6SL4113-0..15-...0	20	100 5 [2]	0.24 m³	8.48 ft³
10	6SL4113-0..16-...0	30	100 5 [2]		
15	6SL4113-0..17-...0	40	100 5 [2]	0.12 m³	4.24 ft³
20	6SL4113-0..18-...0	50	100 5 [2]		
25	6SL4113-0..20-...0	60	100 5 [2]	0.16 m³	5.65 ft³
30	6SL4113-0..21-...0	70	100 5 [2]		
40	6SL4113-0..23-...0	90	100 5 [2]	0.36 m³	12.71 ft³
50	6SL4113-0..24-...0	110	100 5 [2]		
60	6SL4113-0..26-...0	125	100 10 [2]	0.384 m³	13.56 ft³
75	6SL4113-0..27-...0	150	100 10 [2]		
100	6SL4113-0..30-...0	150	100 10 [2]	0.48 m³	16.95 ft³
125	6SL4113-0..31-...0	175	100 10 [2]		
150	6SL4113-0..33-...0	250	100 10 [2]		
175	6SL4113-0..35-...0	250	100		
200	6SL4113-0..36-...0	350	100		

[1] Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters with frame sizes FSA to FSC, fuses of classes CC and G can also be used.

[2] For converters with maintenance switch

More information

You can find more information about overcurrent protective devices on the Internet:

Protective devices for SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109823568)

7.1.8.4 Overcurrent protection, Clean Power converter

Description

Table 7-31 Standard fuses according to IEC standard, 3 AC 380 ... 415 V / 3 AC 440 V... 500 V

Converter		Standard fuse				Minimal control cabinet envelope dimensions for converters with degree of protection IP20	
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 500 V		
7.5	6SL4113-2..16-...0	3NA3810	25	0.62	100	0.16 m³	5.65 ft³
11	6SL4113-2..17-...0	3NA3817	40	1.0	100		
15	6SL4113-2..18-...0	3NA3820	50	1.25	100		
18.5	6SL4113-2..20-...0	3NA3822	63	1.57	100		
22	6SL4113-2..21-...0	3NA3824	80	2.0	100		
30	6SL4113-2..23-...0	3NA3824	80	2.0	100	0.36 m³	12.71 ft³
37	6SL4113-2..24-...0	3NA3830	100	2.5	100		
45	6SL4113-2..26-...0	3NA3832	125	3.12	100	0.384 m³	13.56 ft³
55	6SL4113-2..27-...0	3NA3836	160	4.0	100		
75	6SL4113-2..30-...0	3NA3836	160	4.0	100	0.48 m³	16.95 ft³
90	6SL4113-2..31-...0	3NA3836	160	4.0	100		
110	6SL4113-2..33-...0	3NA3140	200	5.0	100		
132	6SL4113-2..35-...0	3NA3144	250	7.5	100	0.54 m³	19.07 ft³
160	6SL4113-2..36-...0	3NA3250	300	9.0	100		

Table 7-32 Fuses according to IEC standard, 3 AC 380 ... 415 V / 440 V ... 500 V, converters with maintenance switches

Converter		Fuse			
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 500 V
7.5	6SL4113-2..16-...0	3NA3810	25	0.62	100
11	6SL4113-2..17-...0	3NA3817	40	1.0	100
15	6SL4113-2..18-...0	3NA3817	40	1.0	100
18.5	6SL4113-2..20-...0	3NA3820	50	1.25	100
22	6SL4113-2..21-...0	3NA3820	50	1.25	100
30	6SL4113-2..23-...0	3NA3822	63	1.57	100

Converter		Fuse			
Rated power / kW	**Article number**	**Article number**	**Rated current / A**	**$I_{CP,MR}$ / kA**	**I_{CC} / kA @ 500 V**
37	6SL4113-2..24-...0	3NE1820-0	80	1.2	100
45	6SL4113-2..26-...0	3NA3830	100	2.5	100
55	6SL4113-2..27-...0	3NA3832	125	3.12	100
75	6SL4113-2..30-...0	3NE1224-0	160	2.4	100
90	6SL4113-2..31-...0	3NE1225-0	200	3.0	100
110	6SL4113-2..33-...0	3NE1225-0	200	3.0	100

Check whether the selected fuse is suitable for the load cycle in your specific application.

Table 7-33 Fuses according to UL/CSA standard, 3 AC 380 V ... 415 V / 3 AC 440 V ... 480 V

Converter		Fuses		Minimal control cabinet envelope dimensions for converters with degree of protection UL open type	
Rated power / hp	**Article number**	**Rated current / A [1)]**	**SCCR / kA @ 480 V**		
10	6SL4113-2..16-...0	30	100 5 [2)]	0.16 m³	5.65 ft³
15	6SL4113-2..17-...0	40	100 5 [2)]		
20	6SL4113-2..18-...0	50	100 5 [2)]		
25	6SL4113-2..20-...0	60	100 5 [2)]		
30	6SL4113-2..21-...0	70	100 5 [2)]		
40	6SL4113-2..23-...0	90	100 5 [2)]	0.36 m³	12.71 ft³
50	6SL4113-2..24-...0	110	100 5 [2)]		
60	6SL4113-2..26-...0	125	100 10 [2)]	0.384 m³	13.56 ft³
75	6SL4113-2..27-...0	150	100 10 [2)]		
100	6SL4113-2..30-...0	150	100 10 [2)]	0.48 m³	16.95 ft³
125	6SL4113-2..31-...0	175	100 10 [2)]		
150	6SL4113-2..33-...0	225	100 10 [2)]		

Converter		Fuses		Minimal control cabinet envelope dimensions for converters with degree of protection UL open type	
Rated power / hp	**Article number**	**Rated current / A [1]**	**SCCR / kA @ 480 V**		
175	6SL4113-2..35-...0	250	100	0.54 m^3	19.07 ft^3
200	6SL4113-2..36-...0	300	100		

[1] Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters with frame sizes FSA to FSC, fuses of classes CC and G can also be used.

[2] For converters with maintenance switch

More information

You can find more information about overcurrent protective devices on the Internet:

Protective devices for SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109823568)

7.1.8.5 Residual current device (RCD)

Overview

Residual current devices are required in addition to overcurrent protection devices for certain network characteristics.

The residual current device must not be triggered by leakage currents caused by operation.

Precondition



⚠ WARNING

Fire or electric shock due to unsuitable residual-current devices

This product can cause a direct current to flow in the protective conductor. The current through the protective conductor can cause false tripping of the residual-current device or residual-current monitoring device. In the event of a ground fault, the fault current can contain a DC component that prevents the desired tripping of the residual-current device or residual-current monitoring device, resulting in a fire or electric shock.

- On the infeed side, only use type B residual current devices.
- For all upstream residual current devices up to the transformer of the power supply, only use type B residual current devices.
- Use the protective and monitoring devices recommended in the documentation.

If the ground-fault loop impedance of the line supply at the infeed point is too high to ensure that the overcurrent protective device disconnects within the stipulated time in the case of insulation failure (ground fault, fault to frame), then you must use an additional RCD, type B

To prevent tripping of the residual current device due to operational leakage currents, the following requirements must be met:

- The neutral point of the line supply system is grounded.
- The motor cables are shorter than 50 m (164 ft) shielded, or 100 m (328 ft) unshielded.
- Each converter must be provided with its own designated residual-current device.

Function description

The following residual-current devices are available, depending on the converter:

- RCD for converters with rated input currents ≤ 80 A based on LO:
  Siemens SIQUENCE RCCB (series 5SV364.-4), type B, short-time-delayed [K], with a rated residual current of 300 mA.
  The RCCB is connected in series with the overcurrent protection devices.
- RCD for converters with rated input currents ≤ 160 A referred to LO:
  Residual-current device RCD520B from Siemens (3VA9113-0RL21) mounted on a Siemens molded-case circuit breaker (series 3VA1).
  Recommended settings:
  - Response characteristic B
  - Residual current trip level 300 mA
  - Response delay ≥ 0.06 s
- RCD for converters with rated input currents > 160 A referred to LO:
  Modular residual current device from Siemens (MRCD, type B, 5SV8111-4KK) with current transformer (5SV870.-2K), circuit breaker (series 3VA1) and trip unit (3VA9988-0BL30).

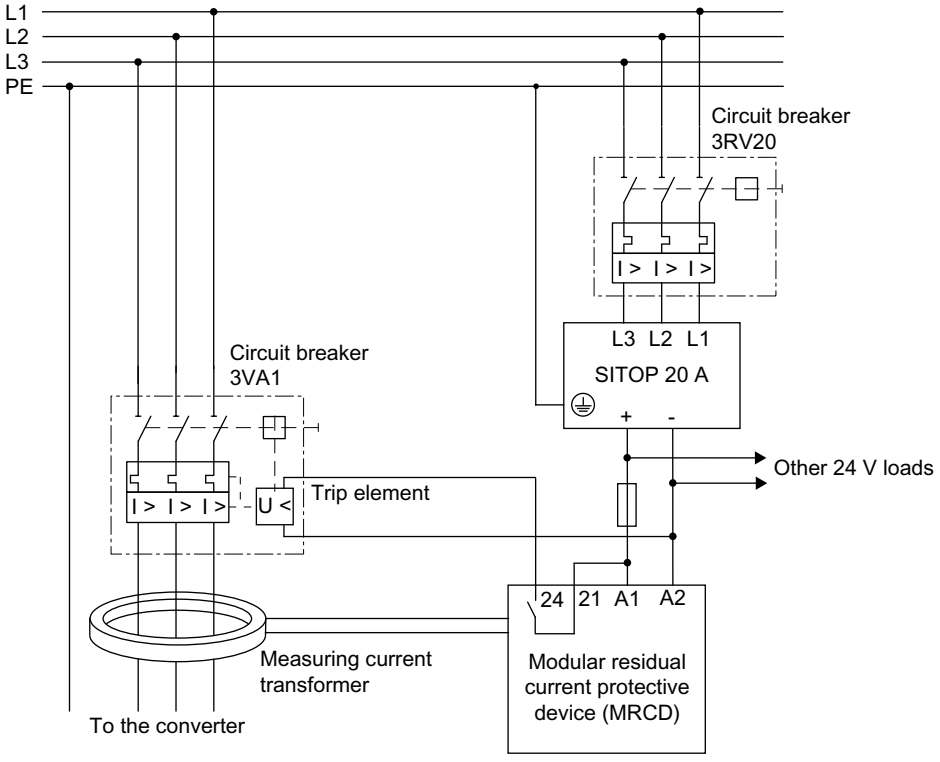


Figure 7-26 Modular residual-current device

7.2 Interfaces

7.2.1 Overview of interfaces, converter in degree of protection IP20

Requirement



NOTICE

Malfunction caused by electrostatic discharge

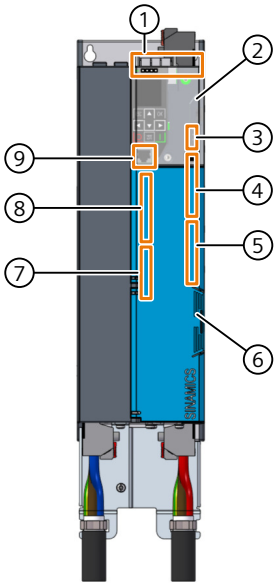
When the converter is operating, electrostatic discharge can result in malfunctions.

- Only touch the converter behind the front flap or the front cover, when you are grounded using one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring

Description

With the exception of the fieldbus connection, the interfaces for the control and the service interface are located behind a cover. The cover comprises 2 parts:

- Frame size FSA: Front cover and front flap
- For converters larger than frame size FSA: Front door and front flap



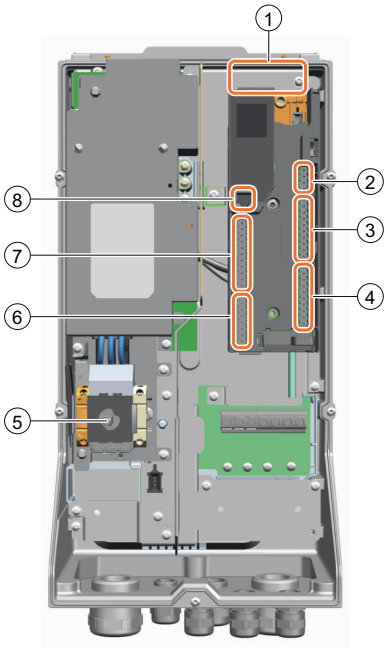
	Terminal strip	Designation		Terminal strip	Designation
①	X1xx	Communications module with fieldbus connection	⑥	---	Front cover or front door
②	---	Front flap	⑦	X133	Digital outputs
③	X124	External power supply	⑧	X132	Analog inputs, analog outputs, and temperature sensors
④	X130	Failsafe digital input, failsafe digital output	⑨	X127	Service interface for connecting an operating unit
⑤	X131	Digital inputs			

Figure 7-27 Interfaces for the controller, converter with degree of protection IP20

7.2.2 Overview of interfaces, converter in degree of protection IP55

Description

The interfaces for the controller are behind the enclosure cover of the converter.



①	X1xx	Fieldbus interface	⑤		Maintenance switch with auxiliary contact
②	X124	External power supply	⑥	X133	Digital outputs
③	X130	Failsafe digital input, failsafe digital output	⑦	X132	Analog inputs, analog outputs and temperature sensors
④	X131	Digital inputs	⑧	X127	Service interface (e.g. connection for the operating unit)

Figure 7-28 Interfaces for the controller, converter with degree of protection IP55

More information

You can find more information on the Internet:

Using PROFINET interface X150 for the CM-PN communications module (https://support.industry.siemens.com/cs/ww/en/view/109998328)

7.2.3 Connection example with internal supply voltage

Requirement

⚠ WARNING

Unexpected motor movement as a result of a digital input responding to dark pulses

The 24 V supply for terminals X130:1 and X130:5 generates dark pulses used for diagnostics. The dark pulses can interpret a non-fail-safe digital input as signal change and respond accordingly, e.g. by starting the motor. This results in unexpected motion of machine or plant parts, which can result in death or severe injury.

- If you supply a non-fail-safe digital input via terminals X130:1 or X130:5, then set the debounce time p0724 of the digital input long enough so that a response to the dark pulses is ruled out.
- If you are not using fail-safe digital inputs, then deactivate the dark pulses with p10018 = 0.

Description

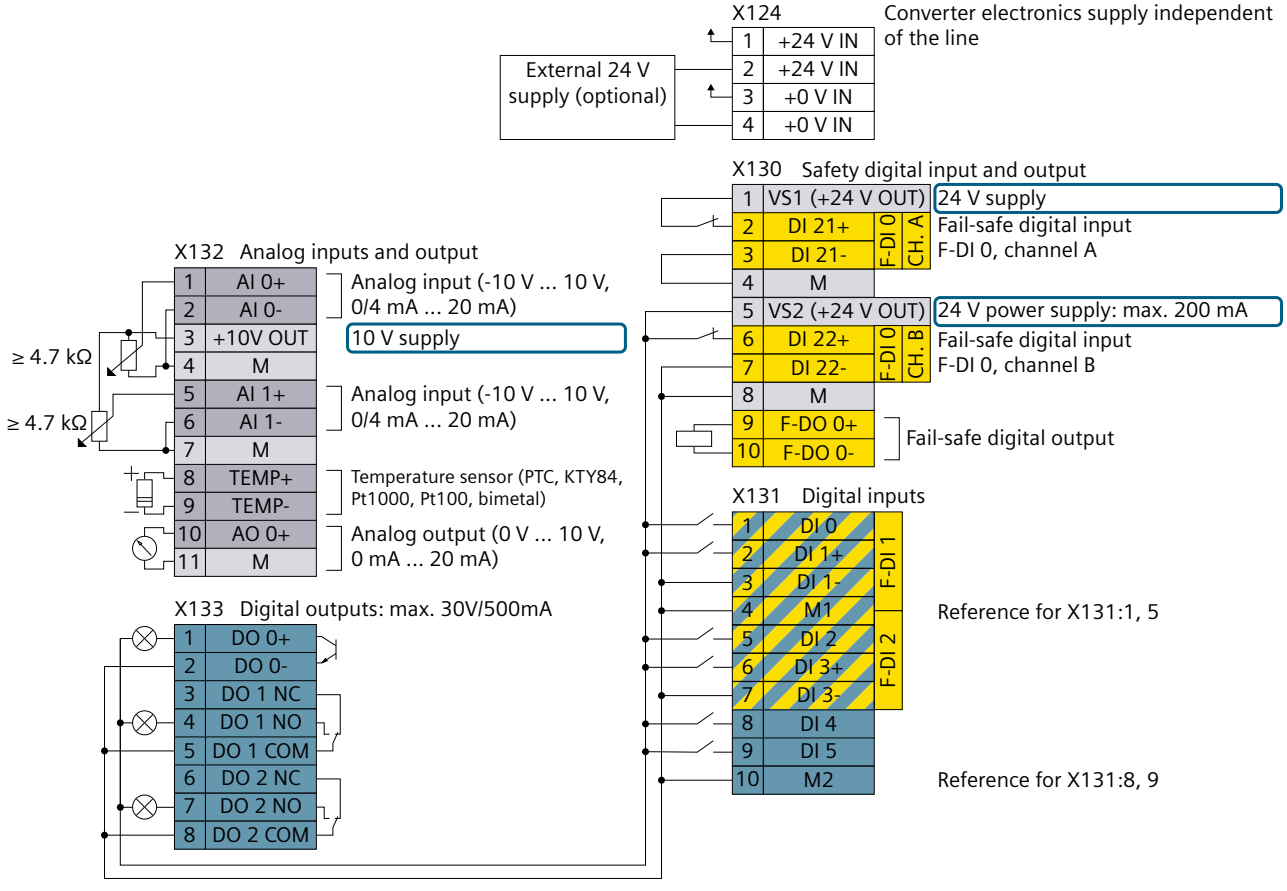


Figure 7-29 Connection example of terminal strips for internal converter supply voltages

Table 7-34 Explanation of the connection example

X130:2.3 and 6.7 F-DI 0	When delivered, wire jumpers are inserted at the F-DI 0. If you use F-DI 0, then replace the wire jumpers by connecting an appropriate sensor, e.g. an EMERGENCY STOP button If you do not require F-DI 0, and only use the terminals of the 24 V supply (VS1, VS2, M), then also remove the jumpers. To ensure a 1 signal at the F-DI 0, a connection is still required between the terminals, e.g. using separate jumpers. The max. cross-section must not be exceeded.
M	All terminals labeled "M" are internally connected with one another
M1, M2	Connect M1 and M2 to the M reference potential.

7.2.4 Connection example with external supply voltage

Precondition

NOTICE
Damage to property due to overload of a digital output Overload of a digital output can result in damage due to fire, converter defects or malfunctions. • Ensure that a digital output is not loaded in excess of 500 mA. • Install a 500 mA fuse or use the converter's internal 24 V power supply.

Description

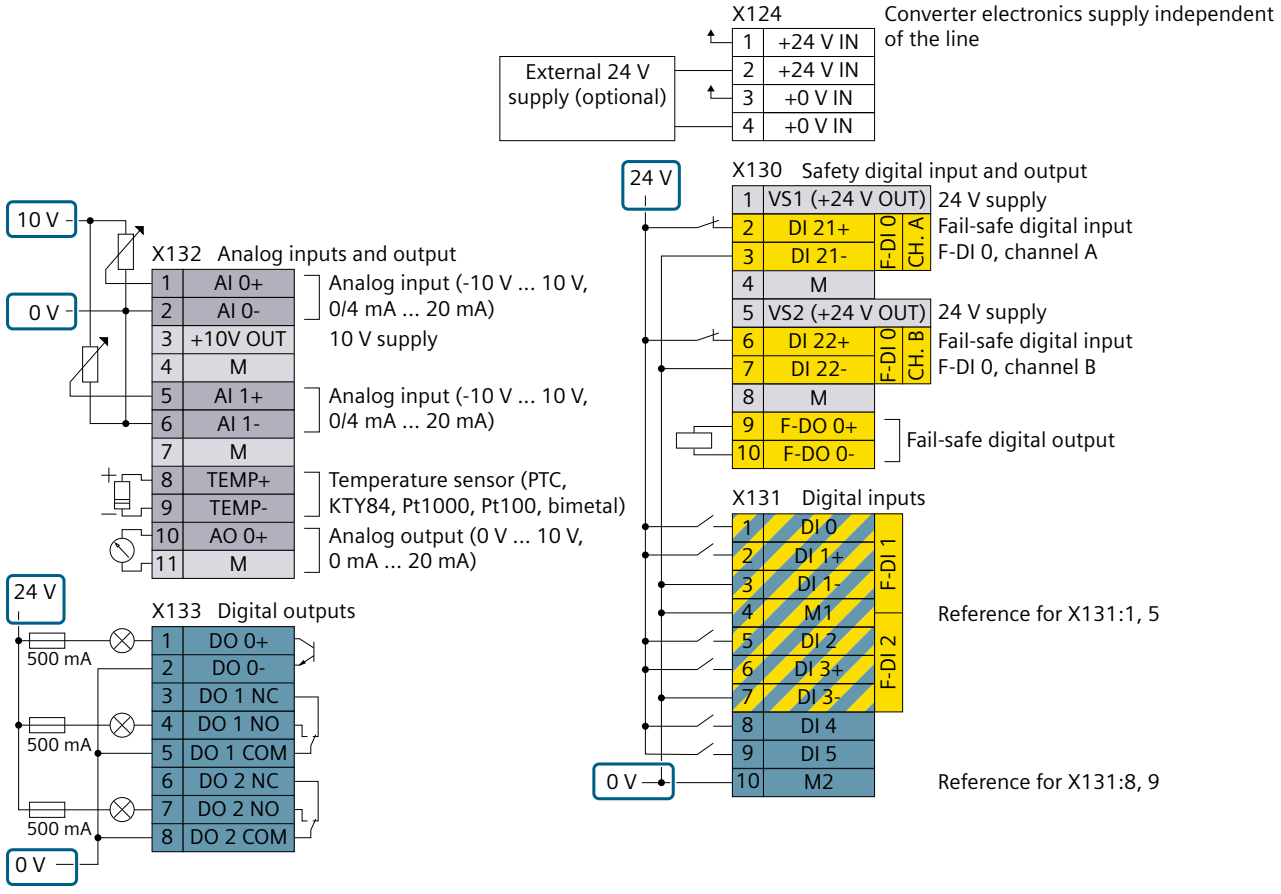


Figure 7-30 Connection example of a terminal strip for external supply voltages

Table 7-35 Explanation of the connection example

X130:2.3 and 6.7 F-DI 0	When delivered, wire jumpers are inserted at the F-DI 0. If you use F-DI 0, then replace the wire jumpers by connecting an appropriate sensor, e.g. an EMERGENCY STOP button If you do not require F-DI 0, and only use the terminals of the 24 V supply (VS1, VS2, M), then also remove the jumpers. To ensure a 1 signal at the F-DI 0, a connection is still required between the terminals, e.g. using separate jumpers. The max. cross-section must not be exceeded.

7.2.5 Control lines for terminal strip

Description

Rigid as well as flexible cables can be connected.

1 cable or 2 cables with the identical cross-section can be connected to each terminal.

Table 7-36 Connectable cross-sections of signal cables, external power supply

Terminals X124			
Connection type	**Cross-section in mm² (AWG)**	**Stripped length**	**Connection type**
Without end sleeve	0.2 ... 2.5 (24 ... 12)	10 mm (0.4 in)	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 ... 2.5 (24 ... 12)		
End sleeve with plastic sleeve	0.14 ... 2.5 (26 ... 12)		

Table 7-37 Connectable cross-section of signal cables, inputs and outputs

Terminals X130, X131, X132, X133			
Connection type	**Cross-section in mm² (AWG)**	**Stripped length**	**Connection type**
Without end sleeve	0.2 ... 1.5 (24 ... 15)	10 mm (0.4 in)	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 ... 1.5 (24 ... 15)		
End sleeve with plastic sleeve	0.14 ... 1.5 (26 ... 15)		

7.2.6 Factory setting of the terminal strips

Overview

The factory settings provide for the converter to receive its signals via the fieldbus and for functions to be assigned to some of the terminals.

Description

The converter obtains its signals via the fieldbus. With 1 signal at digital input DI 3, the motor can be traversed via the digital inputs DI 0 and DI 1.

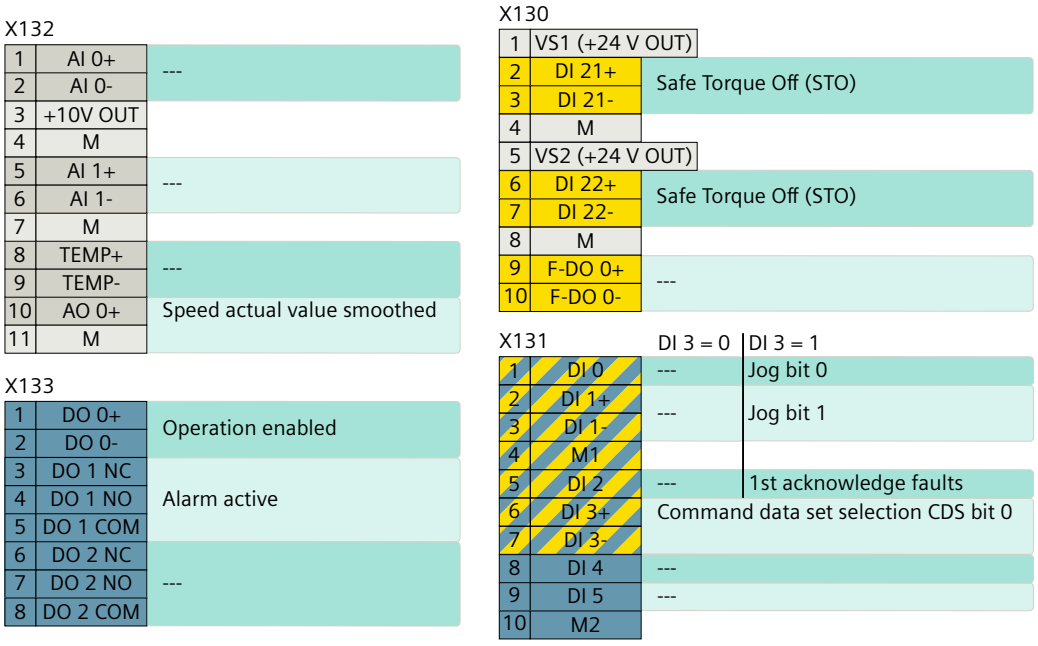


Figure 7-31 Factory settings of the terminal strip: I/O preset "Fieldbus with data set switchover"

7.2.7 Analog inputs as additional digital inputs

Description

Analog input terminals must be specifically connected to use analog inputs as additional digital inputs.

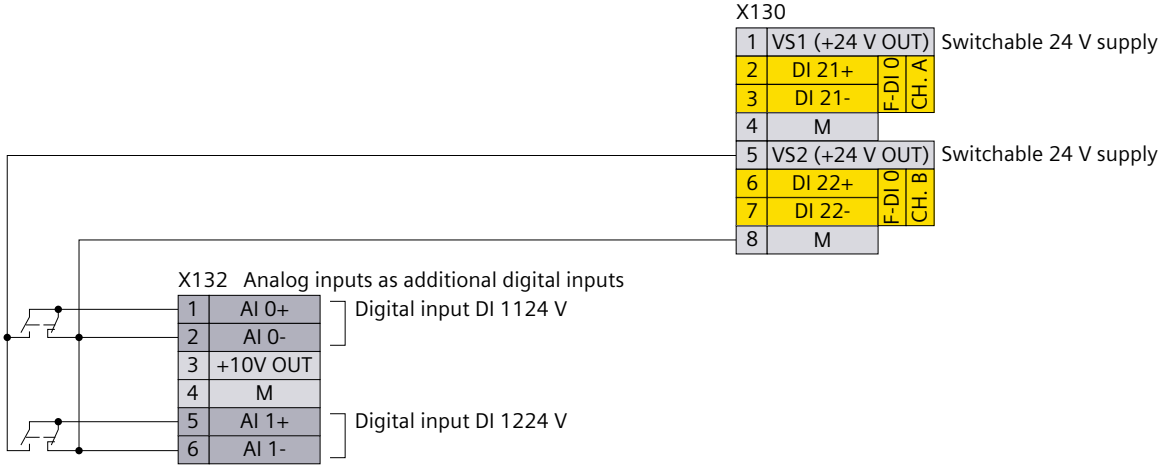


Figure 7-32 Using analog inputs as additional digital inputs connected to 24 V

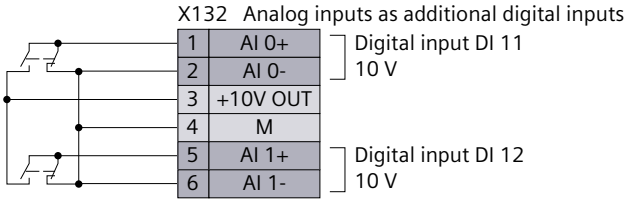


Figure 7-33 Using analog inputs as additional digital inputs connected to 10 V

7.2.8 Connection options for the fail-safe digital input

Requirement

⚠ WARNING

Unexpected movements due to long connecting cables

If a connection cable at a failsafe digital input is too long, then overvoltages can damage the failsafe digital input. It is possible that a damaged failsafe digital input can no longer detect the signals of the connected sensor. This may impair the functional safety of the machine or the system and therefore endanger people or lead to material damage.

- Use a surge protection device for cable lengths > 30 m.

Description

The fail-safe digital input is suitable for connecting the following products:

- Safety sensors, e.g. EMERGENCY STOP control devices and light curtains.
- Preprocessing products, e.g. fail-safe controllers or safety relays.
- Conditions for the quiescent current for sourcing/sourcing output or sourcing/sinking output failsafe digital outputs:
  The quiescent current must not be greater than 0.5 mA.

When setting an F-DI as NC/NC contact (see p10040), the following applies:

The converter expects signals with the same state at its failsafe digital input:

- 1 signal: The safety function is deselected.
- 0 signal: The safety function is selected.

When setting an F-DI as NC/NO contact (see p10040), the following applies:

The converter expects signals with complementary state at its failsafe digital input:

- 1 signal at the NC contact/ 0 signal at the NO contact: The safety function is deselected.
- 0 signal at the NC contact/ 1 signal at the NO contact: The safety function is selected.

Table 7-38 Category that can be achieved according to ISO 13849-1 when setting an F-DI as NC/NC contact

Category	Supply voltage	Application	Result
Cat 3	With or without using the internal supply voltage; however, without enabled self-test using specified dark pulses (p10018 = 0, p10041 = 0)	Local use, e.g. EMERGENCY STOP	The converter self-test detects errors in the circuits of the failsafe digital input.
Cat 4	Exclusive use of an internal supply voltage for PP circuit with enabled self-test using specified dark pulses at the internal supply voltage (p10041 = 1, p10018 > 0)	Protected cable routing, e.g. within a control cabinet	The converter self-test detects errors in the circuits of the failsafe digital input. The self-test of the connected cables with internally specified dark pulses detects the following errors: • Short-circuit to ground • Short-circuit to 24 V supply voltage
	Simultaneous use of both internal supply voltages for PP circuit with enabled self-test using specified dark pulses at the internal supply voltages (p10041 = 2, p10018 > 0)	Unprotected cable routing, e.g. cable carrier or free routing	The converter self-test detects errors in the circuits of the failsafe digital input. The self-test of the connected cables with internally specified staggered dark pulses detects the following errors: • Short-circuit to ground • Short-circuit to 24 V supply voltage • Cross circuit
	Without using the internal supply voltage, but with test pulses of the connected external product (p10041 = 3)	Depending on the connected external product	

When setting an F-DI as an NC/NO contact, contact, the application on the machine or system must switch the F-DI into a safe state (safety function is selected) at least once within a maximum time interval so that it can be fully tested by the converter and the desired PL and category according to ISO 13849-1 can be achieved. The following PL /categories can be achieved depending on the time interval:

- at least once per year: PL d / Category 3
- at least every three months: PL e / Category 3
- at least daily: PL e / Category 4

Note

In the NO contact path, in addition to switch failure, power supply failures and interrupted cabling with reference to functional safety must be taken into consideration.

It is recommended that the F-DI is used as NC/NC contact.

Example

The following examples correspond to Performance Level (PL) e according to ISO 13849-1 and Safety Integrity Level (SIL) 3 according to IEC 61508 and IEC 62061.

The information relating to PL and SIL applies in respect of the converter. The external connection of the converter is to be assessed on the customer side.

The maximum current of the supply voltages VS 1 and VS 2 must not be exceeded.

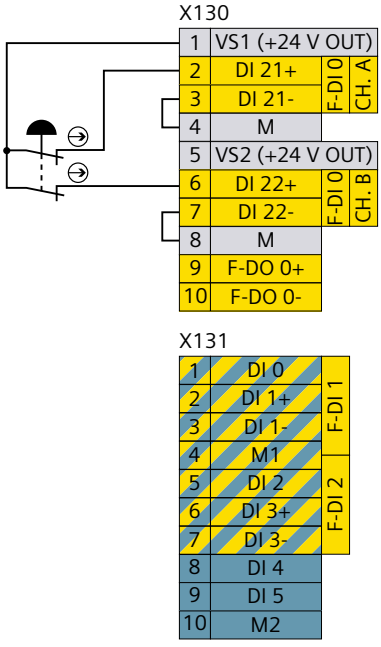


Figure 7-34 Connecting a sensor, e.g. EMERGENCY STOP pushbutton or limit switch, with protected cable routing

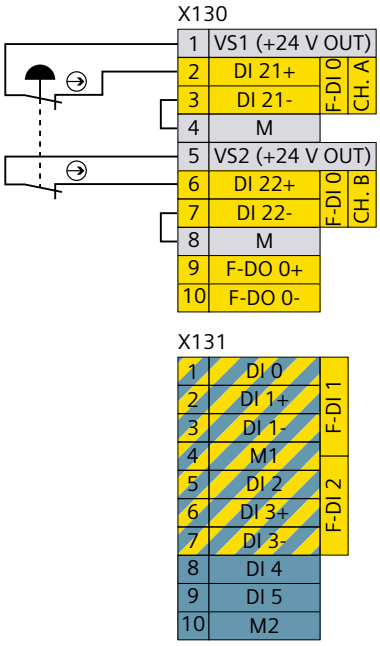


Figure 7-35 Connecting a sensor, e.g. EMERGENCY STOP pushbutton or limit switch, with unprotected cable routing

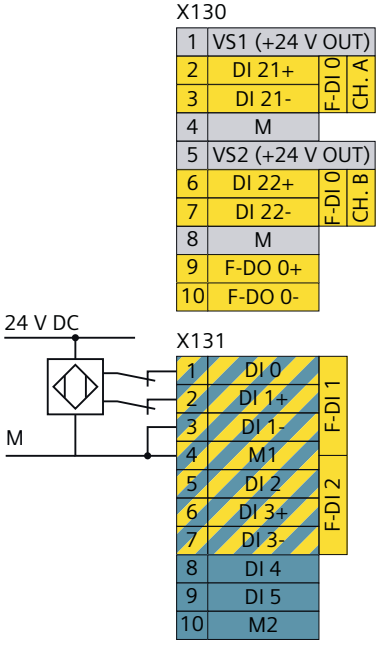
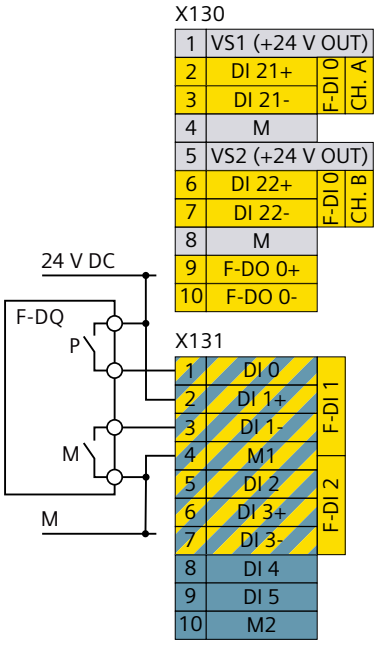


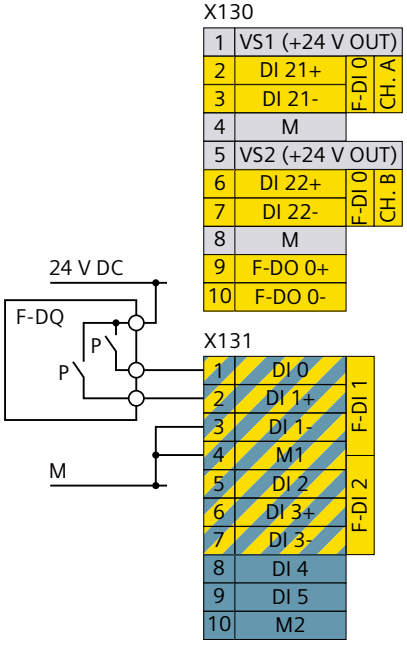
Figure 7-36 Connection of a sourcing/sourcing output OSSD sensor



Examples of F-DQ components:

- SIMATIC ET 200SP F-DQ 4x24VDC/2 A PM HF
- SIMATIC ET 200MP F-DQ 8x24VDC/2 A PPM

Figure 7-37 Connection of a sourcing/sinking output failsafe digital output



Examples of F-DQ components:

- SIMATIC ET 200MP F-DQ 8x24VDC/2 A PPM
- SIRIUS 3SK1

Figure 7-38 Connection of a sourcing/sourcing output failsafe digital output

7.2.9 Connection options for the fail-safe digital output

Requirement

A power supply is required at X124 to operate the failsafe digital output.

⚠ WARNING

Deactivated safety function after cross circuit of relay connecting cables

If there is a relay connected at the sourcing output and the sinking output, there can be a voltage at the relay due to a cross circuit between F-DO 0+ and F-DO 0- even when the failsafe digital output is switched off. This can result in the relays remaining switched on and the associated safety function being deactivated. A deactivated safety function leads to hazardous operating states that can cause personal injury and damage to property.

- Route the relay connecting cables to prevent cross circuits, for example using separately sheathed cables or separate cable ducts.

NOTICE

Reduced relay lifetime due to dark pulses

The self-test of the failsafe digital output with dark pulses can lead to a connected relay short-circuiting. A relay is designed only for a limited number of switching operations, so the dark pulses in this situation reduce the lifetime of the relay.

- Set the dark pulses to be so short that the relay does not switch in the self-test.

Description

The fail-safe digital output is suitable for connecting the following products:

- relay
- valve
- Sourcing/sinking failsafe input

Table 7-39 Category that can be achieved according to ISO 13849-1 and SIL according to IEC 61508 and IEC 62061

Category	SIL	Dark pulses	Result
Cat 3	SIL 2	Without activated converter-internal dark pulses	The converter self-test detects errors in the circuits of the failsafe digital output. No cross-circuit detection The failsafe digital output must switch from Low to High at least once a year.
	SIL 3		The converter self-test detects errors in the circuits of the failsafe digital output. No cross-circuit detection The failsafe digital output must switch from Low to High at least once in three months.
Cat 4	SIL 2 or SIL 3	With activated converter-internal dark pulses	The converter self-test detects errors in the circuits of the failsafe digital output. The converter outputs dark pulses as soon as the failsafe digital output is in the High state. The self-test detects a cross circuit. No requirement for regular switching of the failsafe digital output

Example

The following examples correspond to Performance Level (PL) e according to ISO 13849-1 and Safety Integrity Level (SIL) 3 according to IEC 61508 and IEC 62061. The information relating to PL and SIL applies in respect of the converter. The external connection of the converter is to be assessed on the customer side. If a diagnostic evaluation of the external connection is required, then this must be performed externally.

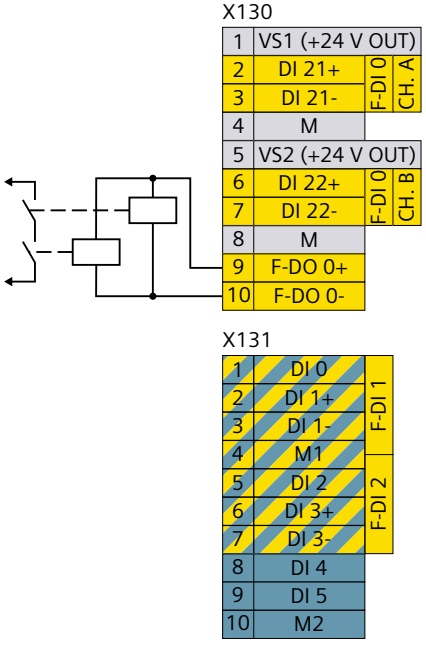


Figure 7-39 Parallel connection of two relays

If two relays are connected in parallel, the converter detects the following faults:

- Cross circuit between the F-DO terminals
  The converter switches the relays off if there is a cross circuit.
  The converter outputs dark pulses for cross-circuit detection. The dark pulses are staggered for F-DO 0+ and F-DO 0-.
- Wire break between the F-DO terminals and the two relays
  A wire break always leads to a safe state as at least one relay switches off.

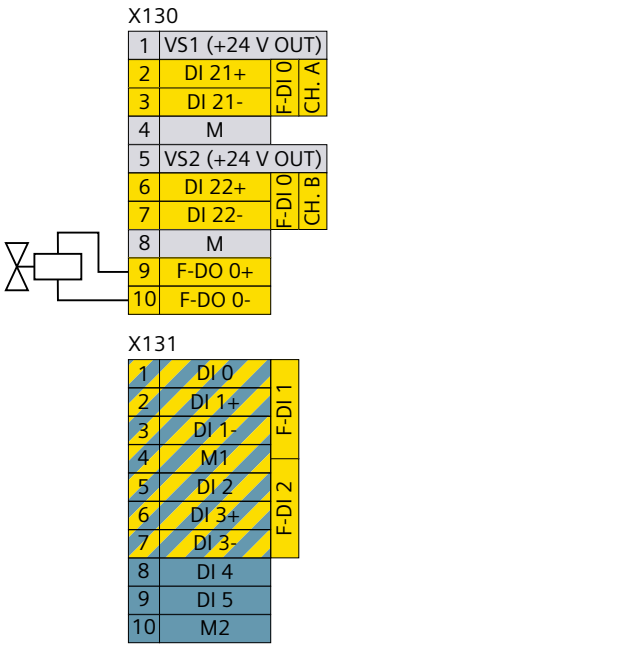


Figure 7-40 Connection of a valve with a feedback signal

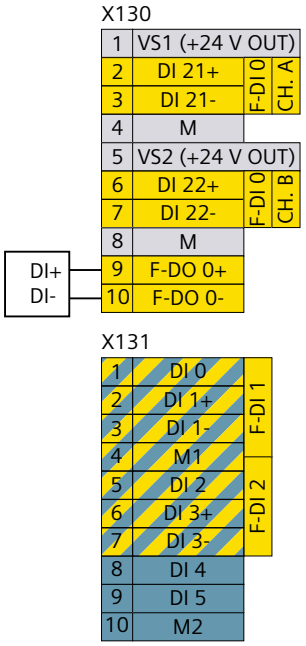


Figure 7-41 Connection of a failsafe digital input

To prevent unwanted interaction, the failsafe digital input must not perform its own self-test with dark pulses.

7.2.10 Connecting the motor holding brake

Overview

The converter controls the motor holding brake via a digital output.

Requirement

The current or voltage rating of the digital output is suitable for connecting the motor holding brake or a coupling relay.

Description

If the current or voltage rating of the digital output is not sufficient, you must control the motor holding brake via a coupling relay on the digital output.

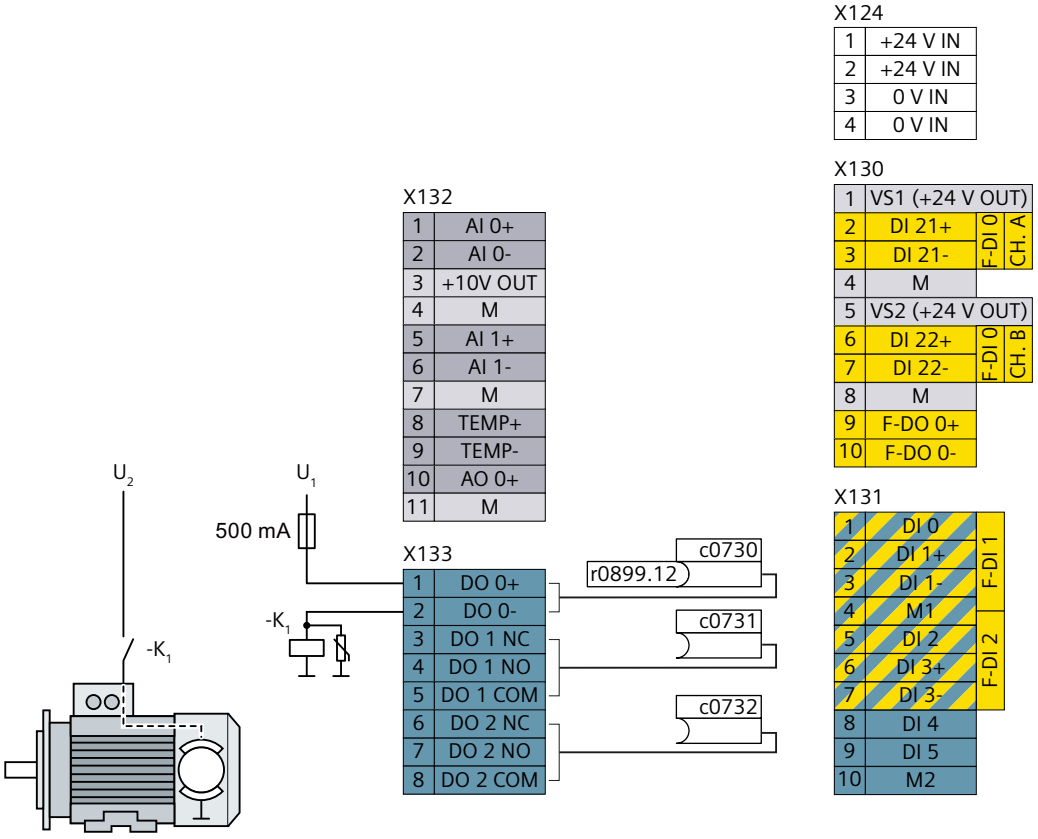
The digital output that the converter is to use to control the motor holding brake must be interconnected with the brake control signal:

- Digital output DO 0: c0730 = r0899.12
- Digital output DO 1: c0731 = r0899.12
- Digital output DO 2: c0732 = r0899.12

For inductive loads, we recommend using digital output 0. The coupling relay must be equipped with overvoltage protection.

Example

The following diagram shows an example of the connection of the motor holding brake via a coupling relay at digital output DO 0 of the converter.



U_1 Voltage supply of the coupling relay
U_2 Voltage supply of the motor holding brake
K1 Coupling relay with overvoltage protection

7.2.11 Connecting the temperature contact of the braking resistor

Requirement



⚠ WARNING

Fire caused by an unsuitable or improperly installed braking resistor

Using an unsuitable or improperly installed braking resistor can result in damage to the braking resistor, fire and formation of smoke. Fire and smoke can cause severe personal injury or property damage.

- Only use braking resistors that are approved for the converter.
- Install the braking resistor in accordance with regulations.
- Monitor the temperature sensor of the braking resistor with the converter.
- Also activate temperature monitoring in the converter.

Procedure

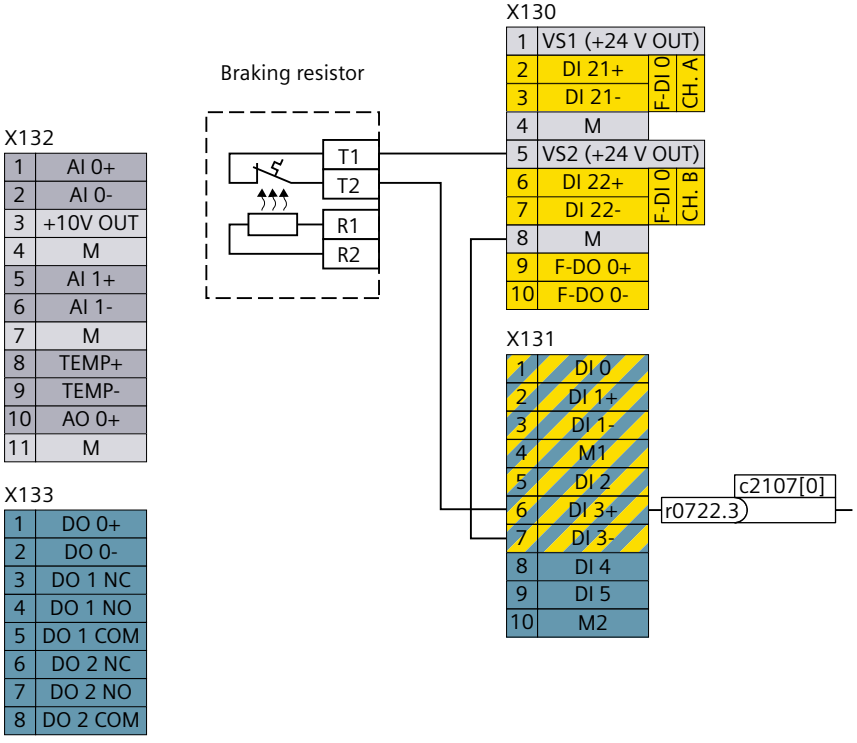
Please proceed as follows to monitor the temperature sensor of the braking resistor:

1. Connect the temperature sensor of the braking resistor to a free digital input on the converter.
2. Assign function "External fault" to the digital input that is used.

Example

Temperature sensor monitoring via digital input DI 3 of the converter:

1. Connect terminals T1 and T2 of the temperature sensor on the braking resistor to digital input DI 3.



2. Interconnect binary signal sink c2107 with signal source r0722.3.

7.2.12 Control lines for auxiliary contacts of the repair switch

Description

Both rigid and flexible cables can be connected.

1 or 2 cables can be connected to each terminal.

Table 7-40 Signal cable cross-sections that can be connected

Connection type	Cross-section in mm² (AWG)	Stripped length in mm (in)	Connection type	Tightening torque in Ncm (lbf in)
Rigid cable	0.75 ... 2.5 (14 ... 12)	8 (0.3)	Screw terminal	80 ... 100 (7 ... 8.9)
Flexible cables with end sleeves	2.5 (12)			

For converters with degree of protection IP55 and integrated maintenance switch the following voltage and current limits apply for the auxiliary contact:

- Permissible voltage:
  AC voltage: max. 260 V +10 % / -20 %
  DC voltage: max. 60 V
- Permissible current:
  Max. 2 A RMS

7.2.13 Evaluating the operating state of the maintenance switch

Overview

The higher-level control unit has information about the actual operating status of the maintenance switch.

Procedure

Proceed as follows to evaluate the operating state of the maintenance switch:

1. Connect the auxiliary contact of the maintenance switch to a free digital input on the converter.
2. To transfer the actual operating state to the higher-level control, assign a function of your choice to the digital input being used.

Result

When actuating the maintenance switch, the higher-level control receives information about the operating state of the maintenance switch.

Example

Evaluation of the auxiliary contact via digital input DI 3 of the converter:

1. Connect the terminals of the auxiliary contact to the DI 3 digital input.

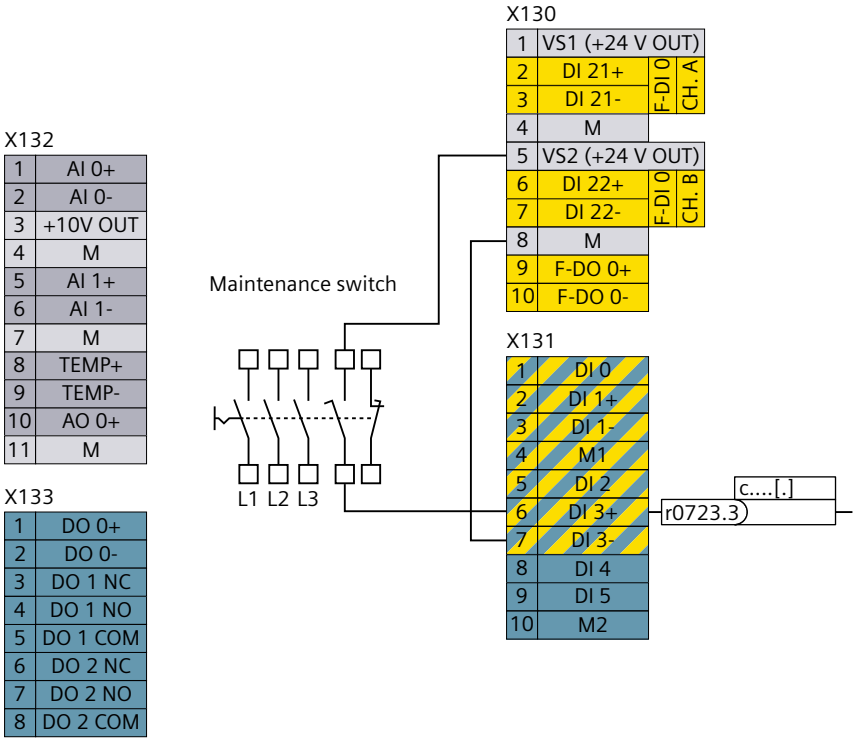


Figure 7-42 Connection, auxiliary contact of the maintenance switch at the digital input

2. Interconnect a binary signal sink of your choice to signal source r0722.3.

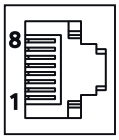
7.2.14 Communications module CM-PN, X150

Overview

Interface X150 connects the converter with fieldbuses PROFINET, EtherNet/IP or Modbus TCP.

Description

Table 7-41 Ethernet RJ45 socket X150

X150 P1 X150 P2	Pin	Signal	Explanation
	1	RX+	Receive data +
	2	RX-	Receive data -
	3	TX+	Send data +
	4	---	Not assigned
	5	---	Not assigned
	6	TX-	Send data -
	7	---	Not assigned
	8	---	Not assigned
	Shield	---	On the connector enclosure

If the connecting cable to a PROFINET or another Ethernet-based network is longer than 3 m and is located outside the power drive system, then for optical isolation we recommend a SIMATIC SCALANCE X-101-1 media converter or a comparable media converter.

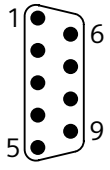
7.2.15 Communications module CM-DP, X126

Overview

Interface X126 connects the converter with the PROFIBUS fieldbus.

Description

Table 7-42 Sub-D socket X126

X126	Pin	Signal	Explanation
	1	---	Not assigned
	2	---	Not assigned
	3	RxD/TxD-P	Receive data and send data P (B)
	4	CNTR-P	Control signal
	5	DGND	Reference potential for data
	6	+5 V	Power supply
	7	---	Not assigned
	8	RxD/TxD-N	Receive data and send data N (A)
	9	---	Not assigned
	Shield	---	On the connector enclosure

7.2.16 Communications module CM-RS485, X125

Overview

Interface X125 connects the converter with the Modbus RTU fieldbus. A switch on the communications module activates the bus terminating resistor.

Description

Table 7-43 Socket X125

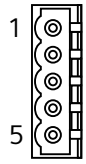
X125	Pin	Signal	Explanation
	1	DGND	Reference potential for data
	2	RS485-P	Receive data and send data P
	3	RS485-N	Receive data and send data N
	4	PE	Shield
	5	---	Not assigned

Table 7-44 Switch for bus terminating resistor

Switch position	Explanation
OFF	Bus terminating resistor is not active
ON	Bus terminating resistor is active

7.2.17 OM-SMT option module

7.2.17.1 Overview of the interfaces at option module OM-SMT

Overview image



① Internal interface (input) - X500
② Interface for PTC temperature sensor - X230
③ Internal interface (output) - X501

Figure 7-43 Option module OM-SMT

The internal interfaces of the option module connect the option module to the converter or with other option modules.

7.2.17.2 Option module OM-SMT, X230

Overview

The OM-SMT interface is designed for connecting two temperature sensors.

Precondition

⚠ CAUTION

Damage through contact with voltage sources

The OM-SMT can be damaged if terminal strip X230 of the OM-SMT comes into contact with a voltage source.

- When the converter is operational, avoid that terminal strip X230 of the OM-SMT comes into contact with a voltage source.

⚠ WARNING

Electric shock when control cables and PTC input come into contact

If you do not use the input for the overtemperature alarm and instead connect a 100-Ω resistor to terminals X230:1 and X230:2, a hazardous voltage will occur at the control inputs of the converter when the resistor comes into contact with damaged control cables. Hazardous voltages can damage the converter, and when touched, can cause injury or death due to electric shock.

- Insulate the 100 Ω resistor including its connecting cables according to IEC 61800-5-1.
- Installation work should only be carried out by qualified and authorized personnel.

⚠ WARNING

Explosion hazard due to faulty connection

If you mix up the inputs for overtemperature shutdown and overtemperature warning, the motor may overheat and cause an explosion.

- Connect the overtemperature shutdown to terminals 3 and 4.

The PTC connection for the Safe Motor Temperature (SMT) Safety Integrated Function must be protected against mechanical manipulation, e.g. by being installed in a lockable control cabinet.

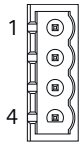
The PTC input connections must be safely electrically separated with respect to the SELV circuits.

Description

Depending on the application, one or two PTC temperature sensors are connected via a terminal.

- PTC 1 for overtemperature alarm
  PTC 1 is not relevant for Safety Integrated.
- PTC 2 for overtemperature shutdown of the motor
  The Safe Motor Temperature (SMT) Safety Integrated Function evaluates the PTC 2.

Table 7-45 PTC X230 interface

X230	Terminal	Designation	Explanation
	1	T4	Input for the overtemperature alarm +
	2	T3	Input for the overtemperature alarm -
	3	T2	Input for the overtemperature shutdown +
	4	T1	Input for the overtemperature shutdown -

If a temperature sensor is not connected at terminals X230:1 and X230:2, then the converter signals the "Overtemperature" alarm.

To avoid the "Overtemperature" alarm, connect a 100Ω resistor at terminals X230:1 and X230:2. The 100 Ω resistor is included in the scope of delivery.

Example

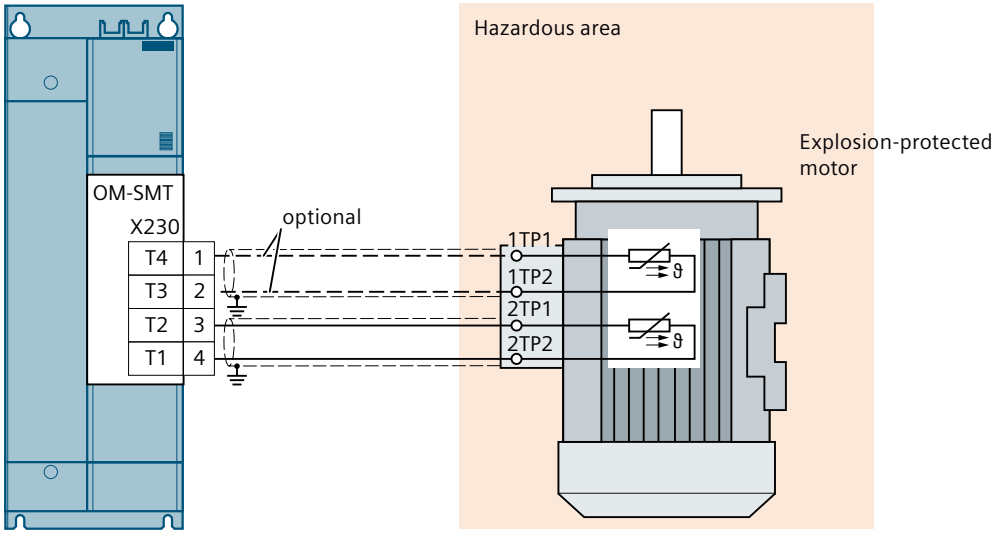


Figure 7-44 Connecting the PTC thermistor in the motor to the option module OM-SMT

7.2.18 OM-IIoT option module

7.2.18.1 Overview of the interfaces at option module OM-IIoT

Overview image



① Internal interface (input) - X500
② RJ45 socket for Ethernet connection - X128
③ Internal interface (output) - X501

Figure 7-45 Option module OM-IIoT

The internal interfaces of the option module connect the option module to the converter or with other option modules.

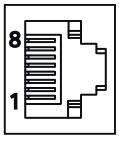
7.2.18.2 Option module OM-IIoT, X128

Overview

Digitalization interface X128 connects the converter with an Edge device.

Description

Table 7-46 Ethernet RJ45 socket X128

X128	Pin	Signal	Explanation
	1	TX+	Send data +
	2	TX-	Send data -
	3	RX+	Receive data +
	4	---	Not assigned
	5	---	Not assigned
	6	RX-	Receive data -
	7	---	Not assigned
	8	---	Not assigned
	Shield	---	On the connector enclosure

7.2.19 OM-DQ option module

7.2.19.1 Overview of the interfaces at option module OM-DQ

Overview image

The two DRIVE-CLiQ interfaces for connection to DRIVE-CLiQ-compatible components are located on the underside of option module OM-DQ.



① Internal interface (input)
② DRIVE-CLiQ interface 1 - X501
③ DRIVE-CLiQ interface 2 - X502

Figure 7-46 Option module OM-DQ

The internal interface of the option module connects the option module to the converter.

7.2.19.2 Option module OM-DQ, X501 and X502

Overview

Option module OM-DQ has two DRIVE-CLiQ interfaces.

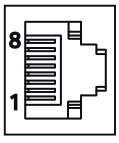
Requirement

Terminal strip X124 of the converter must be supplied with 24 V to use the 24 V supply of the DRIVE-CLiQ interface.

Description

The RJ45 sockets of the two DRIVE-CLiQ interfaces are located on the lower side of option module OM-DQ.

Table 7-47 DRIVE-CLiQ interface

X501 X502	PIN	Signal	Explanation
	1	TXP	Send data +
	2	TXN	Send data -
	3	RXP	Receive data +
	4	---	Not assigned
	5	---	Not assigned
	6	RXN	Receive data -
	7	---	Not assigned
	8	---	Not assigned
	A	+(24 V)	24 V power supply
	B	M (0 V)	Electronics ground

The blanking covers for the DRIVE-CLiQ interfaces are included in the scope of delivery.

7.2.20 OM-ENC option module



⚠ WARNING

Electric shock due to unsuitable motor temperature evaluation system

Voltage flashovers to the electronics of the converter can occur in motors without safe electrical separation of the temperature sensors in accordance with IEC 61800-5-1 when the motor develops a fault.

- Install a temperature monitoring relay 3RS1... or 3RS2...
- Evaluate the temperature monitoring relay output using a digital input of the converter, e.g. using the "External fault" function.



⚠ WARNING

Electric shock when the motor temperature sensor insulation fails

When connecting temperature sensors, which have no safe protective separation with respect to the motor power circuit, then arcing to the signal electronics can occur.

- Use motors whose temperature sensors have safe electrical separation.
- Use only connecting cables and connectors with safe electrical separation between the wires of the temperature sensor and the wires of the power circuit.

NOTICE

Damage to the option module by connecting cables under voltage (hot swapping)

Connecting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction.

- Switch off the power supply before you connect the option module to the devices.

NOTICE

Damage to the encoder due to incorrect supply voltage

The encoder supply can be parameterized to 5 V or 24 V. Incorrect parameter assignment can cause damage to the encoder.

- Select the appropriate supply voltage.

NOTICE

Damage to the motor due to incorrectly connected KTY temperature sensor

If a KTY temperature sensor is connected with incorrect polarity, it is not possible to detect when the motor overheats. Overheating can cause damage to the motor.

- Connect a KTY temperature sensor with the correct polarity.

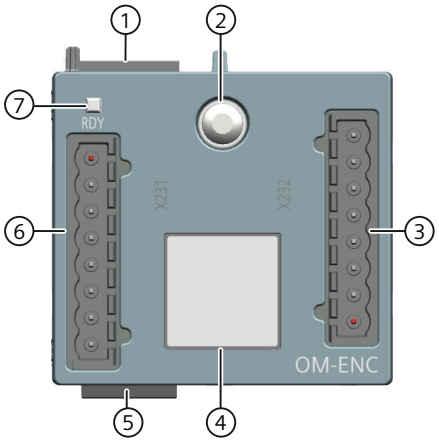
Note

To ensure EMC performance, use proper cables for connection between the option module and the devices.

- Always use shielded cables for all connections.
- Use twisted pair cables for differential signal connections.

7.2.20.1 Interface overview

Overview diagram



① Internal interface (input) - X500
② Fixing screw (M4)
③ SSI encoder/temperature sensor interface - X232
④ QR code with ID link
⑤ Internal interface (output) - X501
⑥ HTL/TTL encoder interface - X231
⑦ LED status indicator

Figure 7-47 Interface layout

The internal interfaces X500 and X501 connect the option module to the converter or other option modules for power supply and signal transmission.

7.2.20.2 Cable cross-sections

Description

Rigid as well as flexible cables can be connected.

Several cables can be connected to each terminal.

Table 7-48 Signal cable cross-sections

Conductor type	Cross-section	Stripped length	Connection type
Without end sleeve	0.2 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)	10 mm (0.4 inch)	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)		
End sleeve with plastic sleeve	0.14 mm^2 ... 2.5 mm^2 (AWG: 26 ... 14)		

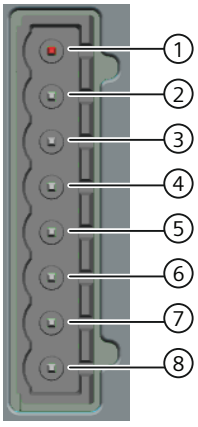
7.2.20.3 Interface description - X231

Overview

The interface X231 supplies power to the encoder and supports the transmission of HTL and TTL signals.

Description

Table 7-49 Interface X231

X231	Pin	Designation	Explanation
	①	PENC	Encoder power supply
	②	M	Encoder power supply, 0 V
	③	AP	Incremental signal, channel A
	④	AN	Inverse incremental signal, channel A
	⑤	BP	Incremental signal, channel B
	⑥	BN	Inverse incremental signal, channel B
	⑦	RP	Reference signal R
	⑧	RN	Inverse reference signal R

More information

The encoder power supply depends on the encoder type selected in the configuration. For more information about output voltage, see Chapter "AUTOHOTSPOT".

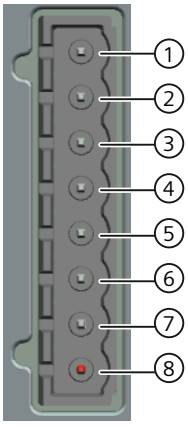
7.2.20.4 Interface description - X232

Overview

The interface X232 supports the transmission of SSI, temperature sensor, and remote sense signals.

Description

Table 7-50 Interface X232

X232	Pin	Designation	Explanation
	①	PSENSE	Encoder power supply monitoring signal from remote sense[1)]
	②	MSENSE	Encoder power supply monitoring signal from remote sense, 0 V[1)]
	③	TEMP+	Temperature sensor signal, positive
	④	TEMP-	Temperature sensor signal, negative
	⑤	SSI CLK+	SSI clock signal
	⑥	SSI CLK-	Inverse SSI clock signal
	⑦	SSI DAT+	SSI data signal
	⑧	SSI DAT-	Inverse SSI data signal

1) For 5 V TTL encoders with remote sense only

7.2.20.5 Connection examples

Connection example

Unipolar connection of an HTL encoder

For the unipolar connection of an HTL encoder, connect terminals AN, BN, and RN to pin M with jumpers.

Note

To ensure reliable signal transmission, Siemens recommends that you use bipolar connection for HTL encoders whenever feasible. Use unipolar connection only if the encoder does not support push-pull signal output.

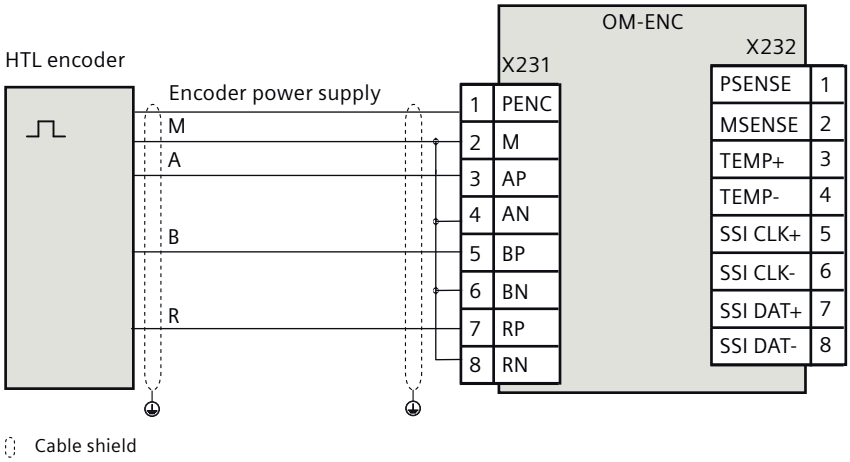


Figure 7-48 Unipolar connection of an HTL encoder, with reference signal

Bipolar connection of an HTL encoder

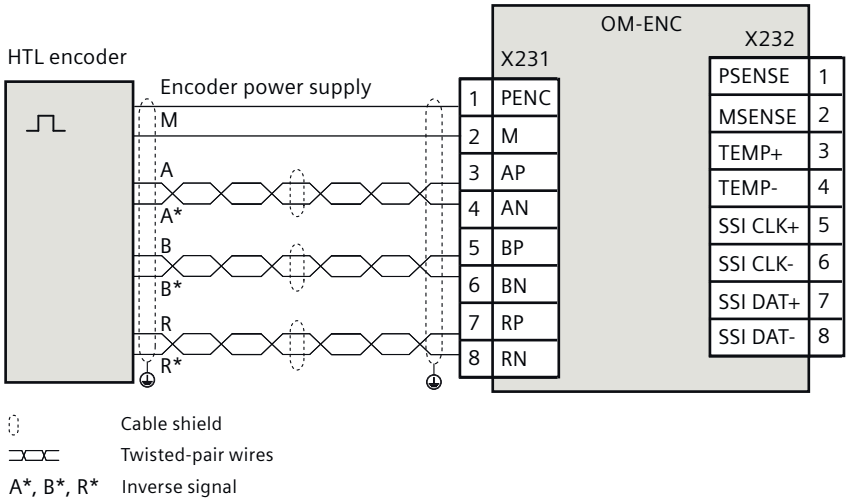


Figure 7-49 Bipolar connection of an HTL encoder, with reference signal

Connection of an SSI encoder

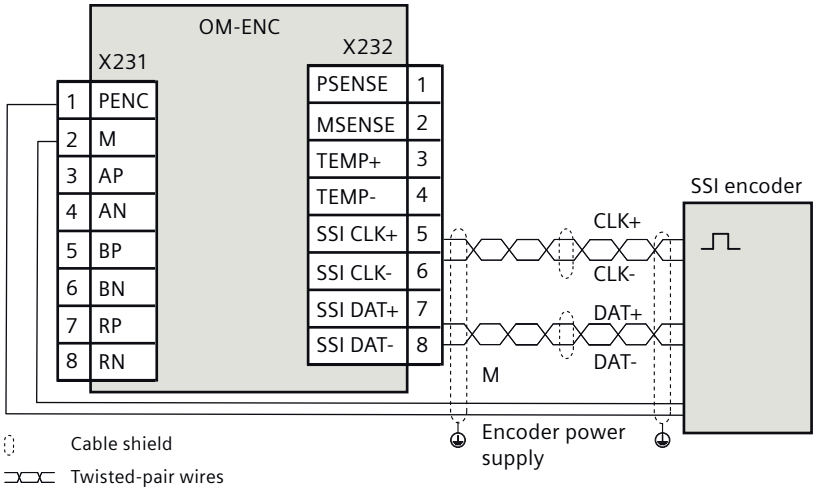


Figure 7-50 SSI encoder connection

Bipolar connection of a TTL encoder with remote sense

The OM-ENC supports the power supply monitoring of a 5 V TTL encoder via remote sense. The remote sense monitors the encoder's power supply and allows the converter to adjust the supply voltage at the option module's output, to ensure that the required 5 V DC is provided for the encoder.

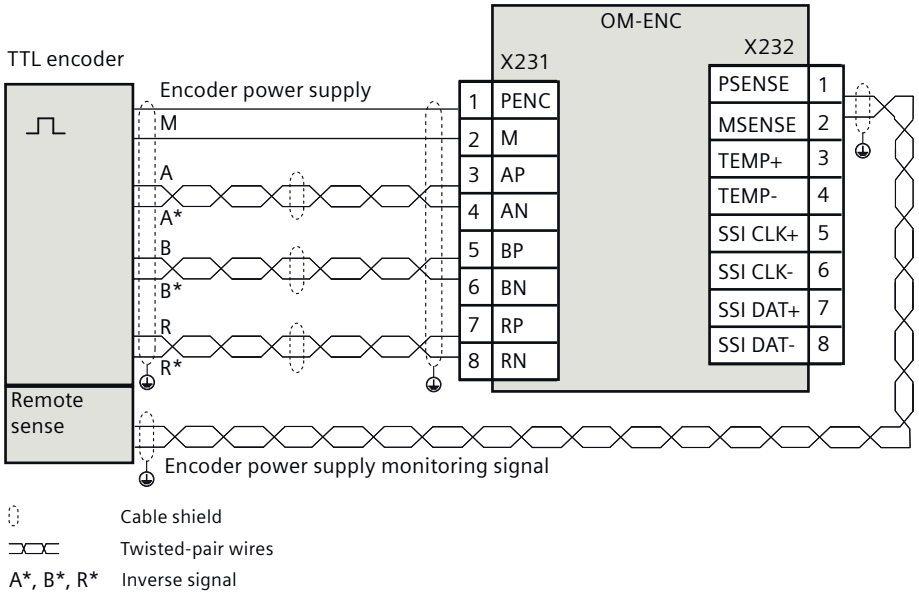


Figure 7-51 Bipolar connection of a TTL encoder, with reference signal and a remote sense

Connection of a temperature sensor

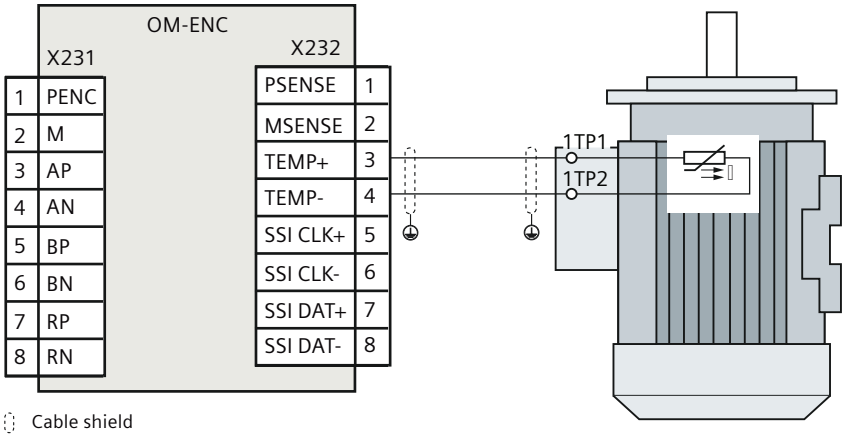
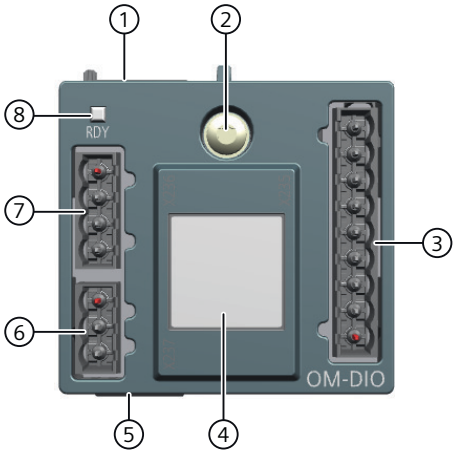


Figure 7-52 Temperature sensor connection

7.2.21 OM-DIO option module

7.2.21.1 Interface overview

Overview diagram



① Internal interface (input) - X500
② Fixing screw (M4)
③ Interface for digital inputs/outputs and external power supply - X235
④ QR code with ID link
⑤ Internal interface (output) - X501
⑥ NO/NC relay output interface - X237
⑦ NO relay output interface - X236
⑧ LED status indicator

Figure 7-53 Interface layout

The internal interfaces X500 and X501 connect the option module to the converter or other option modules for power supply and signal transmission.

7.2.21.2 Cable cross-sections

Description

Rigid as well as flexible cables can be connected.

Several cables can be connected to each terminal.

Table 7-51 Signal cable cross-sections

Conductor type	Cross-section	Stripped length	Connection type
Without end sleeve	0.2 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)	10 mm (0.4 inch)	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)		
End sleeve with plastic sleeve	0.14 mm^2 ... 2.5 mm^2 (AWG: 26 ... 14)		

7.2.21.3 Interface description - X235

Overview

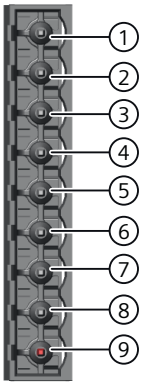
The interface X235 provides four digital outputs that can be switched over to digital inputs (DI/DO 0 ... DI/DO 3).

Requirement

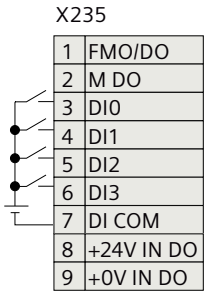
When digital outputs DO 0 ... DO 3 are used, the OM-DIO additionally requires an external 24 V power supply connected to terminal X235:8 and X235:9.

Description

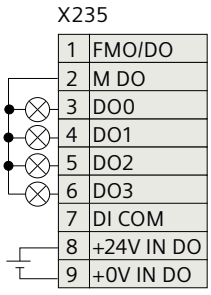
Table 7-52 OM-DIO X235 interface

X235	Pin	Designation	Explanation
	1	FMO (DO)	Reserved
	2	M DO	Reference ground for digital outputs
	3	DI/DO 0	Bidirectional digital input/output 0
	4	DI/DO 1	Bidirectional digital input/output 1
	5	DI/DO 2	Bidirectional digital input/output 2
	6	DI/DO 3	Bidirectional digital input/output 3
	7	DI COM	Common terminal for digital inputs
	8	+24V IN DO	Power supply for digital outputs, 24 V
	9	+0V IN DO	Power supply for digital outputs, 0 V

Connection example



Connecting digital inputs



Connecting digital outputs

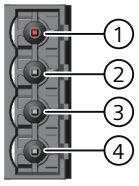
7.2.21.4 Interface description - X236

Overview

The interface X236 supports two relay outputs as NO contacts.

Description

Table 7-53 OM-DIO X236 interface

X236	Pin	Designation	Explanation
	1	DO4 NO	Digital output 4, relay output, normally open
	2	DO4 COM	Common terminal for digital output 4
	3	DO5 NO	Digital output 5, relay output, normally open
	4	DO5 COM	Common terminal for digital output 5

Connection example

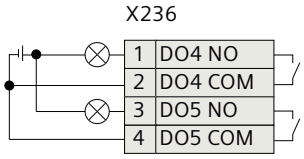


Figure 7-54 Connecting relay outputs

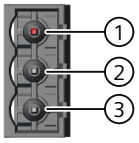
7.2.21.5 Interface description - X237

Overview

The interface X237 supports a relay output as an NC/NO contact.

Description

Table 7-54 OM-DIO X237 interface

X237	Pin	Designation	Explanation
	1	DO6 NC	Digital output 6, relay output, normally closed
	2	DO6 NO	Digital output 6, relay output, normally open
	3	DO6 COM	Common terminal for digital output 6

Connection example

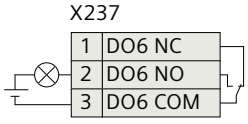


Figure 7-55 Connecting the relay output

7.2.21.6 Protective separation according to IEC 61800-5-1

Overview

Decisive Voltage Class (DVC) is the classification of the voltage range used to determine the requirements for insulation and earthing to ensure safety.

Table 7-55 Limit values of the DVC according to IEC 61800-5-1

DVC	Working voltage limits		
	Alternating voltage (rms value)	Alternating voltage (peak value)	Direct voltage (average value)
A	25 V	35.4 V	60 V
B	50 V	71 V	120 V
C	1000 V	4500 V	1500 V
D	> 1000 V	> 4500 V	> 1500 V

Requirement

The insulation concept is applicable to installation altitudes from 0 m to 2000 m (inclusive) above sea level. To use the option modules at installation altitudes above 2000 m above sea level, contact Siemens hotline.



⚠ WARNING

Electric shock due to non-compliance with the insulation concept

Connecting the option module to peripheral devices which do not conform to the specified insulation concept may cause damage to equipment. For damaged devices, hazardous voltages can be present at the enclosure or at exposed components; if touched, this can result in death or severe injury.

- Connect devices and cables to the control cable terminals only if they conform to the relevant voltage class (DVC) described in this chapter.



⚠ WARNING

Electric shock due to connecting power supplies of different DVCs on X236

When connecting the relay outputs on the X236 interface to power supplies of different DVCs at the same time, exposed components may carry a hazardous voltage that might result in serious injury or death.

- Ensure that the working voltages for the digital outputs on X236 are consistent in DVC.
- When connected to operating voltages of DVC C, the digital outputs on X236 must be powered by the same source.

Description

The relay outputs have protective separation between them according to IEC 61800-5-1. The following figure shows the insulation concept:

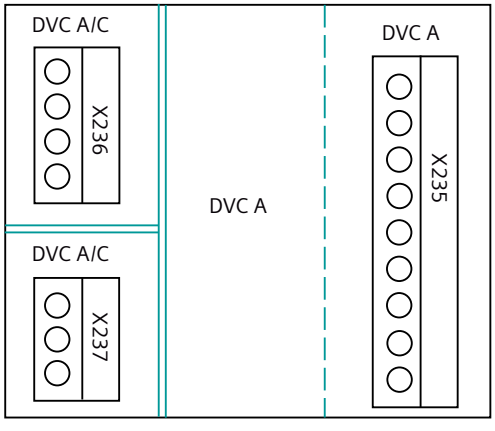


Figure 7-56 Insulation concept of the OM-DIO

The interfaces X235 supports power supplies with the following specifications:

- Overvoltage category: OVC II
- Maximum system voltage: 30 V DC

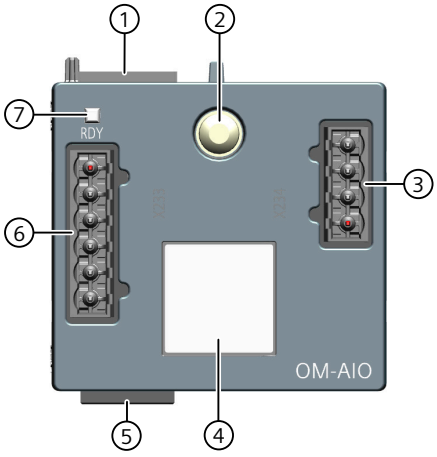
The interfaces X236 and X237 support power supplies with the following specifications:

- Overvoltage category: OVC III
- Maximum system voltage: 250 V AC or 30 V DC

7.2.22 Option Module OM-AIO

7.2.22.1 Interface overview

Overview diagram



① Internal interface (input) - X500
② Fixing screw (M4)
③ Analog output interface - X234
④ QR code with ID link
⑤ Internal interface (output) - X501
⑥ Analog input interface - X233
⑦ LED status indicator

Figure 7-57 Interface layout

The internal interfaces X500 and X501 connect the option module to the converter or other option modules for power supply and signal transmission.

7.2.22.2 Maximum permissible cable lengths

Description

Table 7-56 Maximum permissible cable lengths for the option module OM-AIO

Connection type	Interface on the option module	Maximum permissible cable length
Analog inputs AI 0 ... 2	X233: 1 ... 6	30 m for shielded cables
Analog outputs AO 0 ... 1	X234: 1 ... 4	

7.2.22.3 Cable cross-sections

Description

Both rigid and flexible cables can be connected.

Several cables can be connected to each terminal.

Table 7-57 Signal cable cross-sections

Conductor type	Cross-section	Stripped length	Connection type
Without end sleeve	0.2 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)	10 mm (0.4 inch)	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 mm^2 ... 2.5 mm^2 (AWG: 24 ... 14)		
End sleeve with plastic sleeve	0.14 mm^2 ... 2.5 mm^2 (AWG: 26 ... 14)		

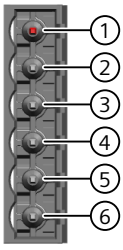
7.2.22.4 Interface description - X233

Overview

The interface X233 provides three analog inputs.

Description

Table 7-58 OM-AIO X233 interface

X233	Pin	Designation	Explanation
	1	AI0+	Analog input 0, positive
	2	AI0-	Analog input 0, negative
	3	AI1+	Analog input 1, positive
	4	AI1-	Analog input 1, negative
	5	AI2+	Analog input 2, positive
	6	AI2-	Analog input 2, negative

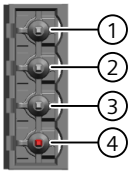
7.2.22.5 Interface description - X234

Overview

The interface X234 provides two analog outputs.

Description

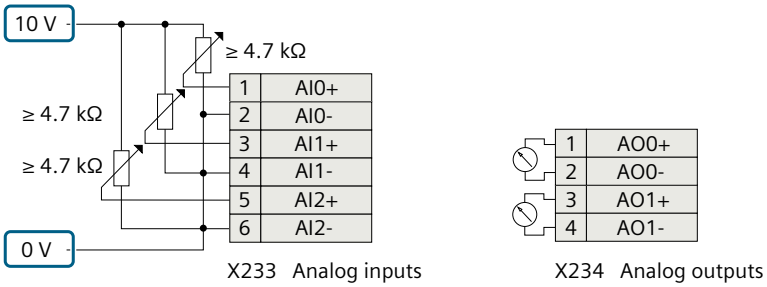
Table 7-59 OM-AIO X234 interface

X234	Pin	Designation	Explanation
	1	AO0+	Analog output 0, positive
	2	AO0-	Analog output 0, negative
	3	AO1+	Analog output 1, positive
	4	AO1-	Analog output 1, negative

7.2.22.6 Connection example

Connection example

The following figure shows the configuration of the analog inputs as voltage inputs.



Commissioning (hardware)

8

8.1 Commissioning after a long storage time

Overview

If the converter has been out of operation for too long, you must form the DC link capacitors before connecting the full line voltage to the converter.

Forming can be omitted if the line voltage is applied to the converter once a year for one hour.

Requirement

Form the DC link capacitors in the following cases:

- The converter has been non-operational for longer than one year.
- The converter is commissioned more than one year after its date of manufacture.
  The date of manufacture of the converter is coded in positions 3 - 6 of the serial number.

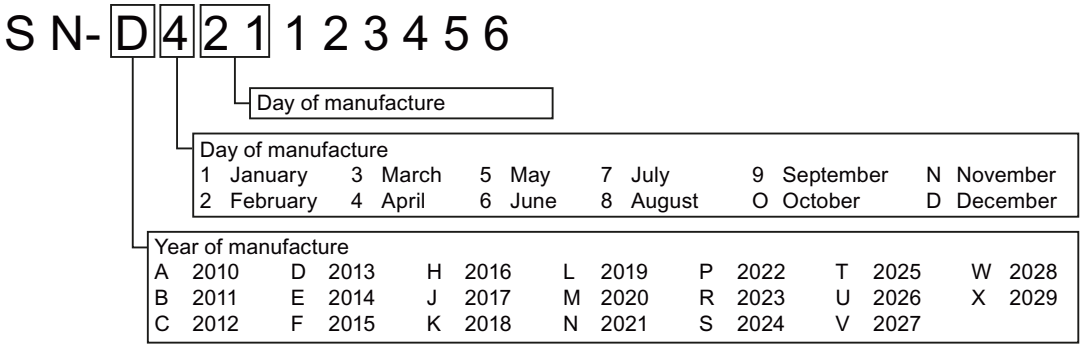


Figure 8-1 Date of manufacture in the serial number (example, April 21, 2013)

Procedure

- Form the DC link capacitors by connecting power to the converter as shown below:

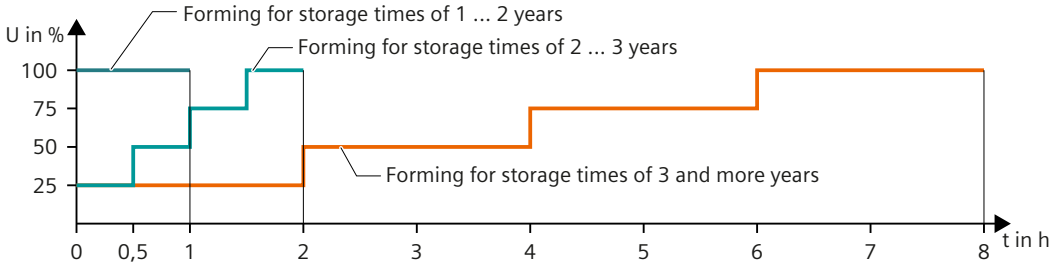


Figure 8-2 Forming the DC link capacitors

8.2 Determining the motor data

Overview

You need the data on the nameplate of the motor to commission the converter.

Requirement

You know the region of the world in which the motor is being used:

- Europe IEC: 50 Hz in kW
- North America NEMA: 60 Hz in hp or 60 Hz in kW

You know how the motor is connected:

- Star connection [Y]
- Delta connection [Δ]

NOTICE
Material damage due to incorrect motor data Entering incorrect motor data may result in damage or malfunctioning of the converter and motor. • Enter the nameplate data of the connected motor. • Check the entered data before starting commissioning.

Procedure

1. Note down the data on the motor nameplate.

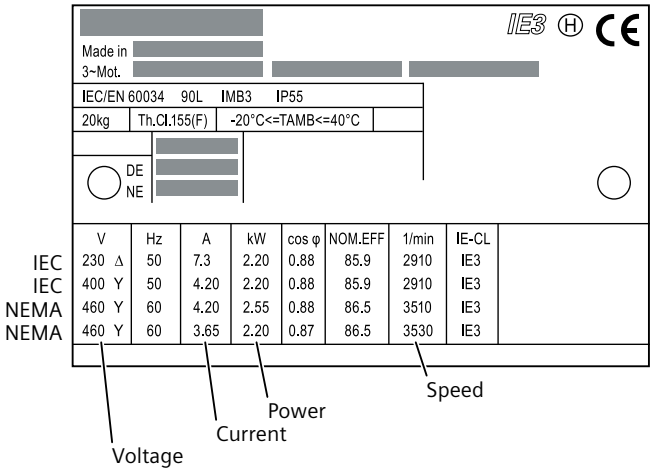


Figure 8-3 Example of a nameplate for a standard induction motor

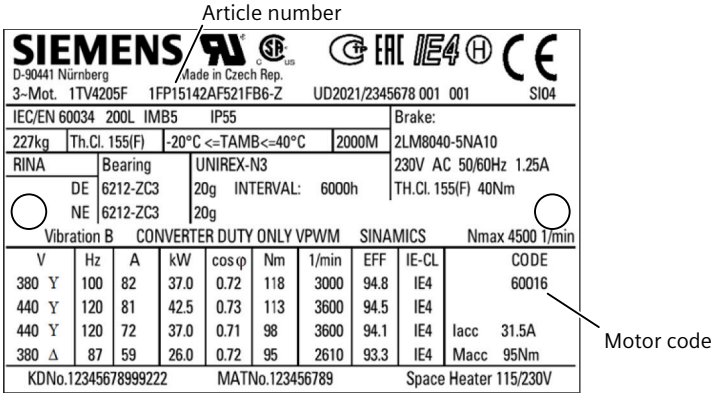


Figure 8-4 Example of a nameplate for a Siemens reluctance motor

2. If available, write down the article number and motor code on the nameplate of the Siemens motor.
   These data are required for commissioning with the web server in case the motor is not automatically identified in the web server (see Commissioning in the web server).

Commissioning (web server)

9

9.1 Functions of the web server commissioning tool

Overview

The web server commissioning tool is part of the converter.

Precondition

The web server supports the following operating units:

- Programming device, PC, notebook
- SINAMICS SDI Pro 5.5"
- SIMATIC HMI (IPC, Unified Comfort Panel)
- Mobile device, e.g. tablet or smartphone

The web server supports the following browsers:

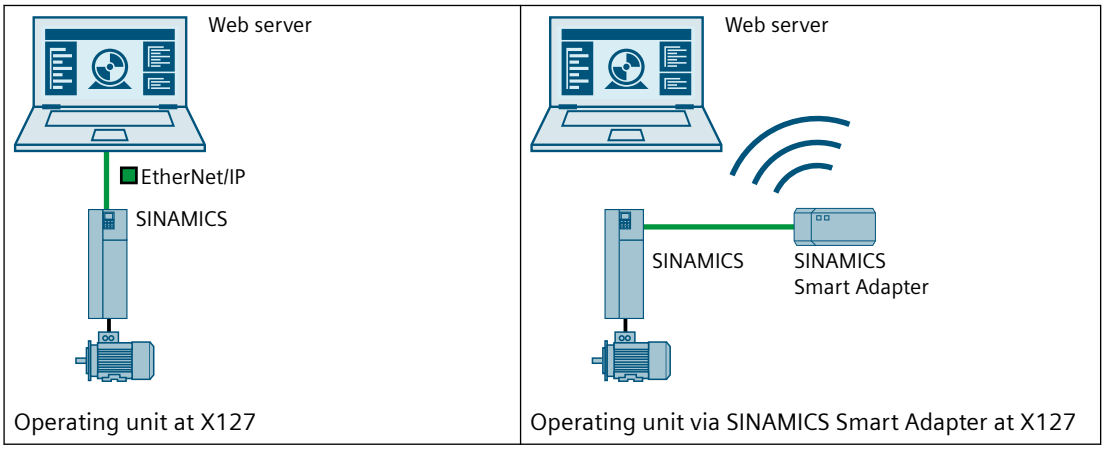
- Apple Safari
- Google Chrome
- Microsoft Edge
- Mozilla Firefox

We recommend using the most up-to-date version of the browser being used.

Description

The converter web server supports commissioning and diagnostics of the converter.

The web server accesses the converter via service interface X127 or via PROFINET interface X150.



The web server has the following functions:

- Industrial cybersecurity
  - User and rights management (UMAC)
  - Access protection for drive data
  - Wizard to support making industrial cybersecurity settings
- Commissioning
  - Configuring hardware components of the converter
  - Configuring fieldbus communications with the higher-level control
  - Wizard to provide commissioning support
  - Displaying and setting converter settings
  - Automatic controller optimization
- Diagnostics
  - Displaying faults and alarms
  - Acknowledging faults
  - Recording traces of converter signals
  - Displaying firmware versions
  - Exporting a user-defined parameter list for Startdrive
- Support
  - Information system for context-sensitive help
  - Importing product documentation into the information system
  - Creating a diagnostics report
  - Link to product information in the Internet
- Maintenance
  - Backing up drive data to the backup file
  - Restoring drive data from a backup file
  - Firmware update

More information

More information on industrial cybersecurity can be found on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/us/en/view/109995033)

9.2 Online connection to the drive

Description

The following interfaces are available for establishing an online connection to the converter:

Interface	Description of the restrictions
Service interface X127	Default settings: • IP address: 169.254.11.22 • Subnet mask: 255.255.0.0 • Data transfer via HTTPS is activated in the factory setting.
	Constraints: • Without applying additional measures, an online connection is only permissible in the control cabinet. • Additional measures are required to remotely access the drive, which prevent the following: – Misuse through sabotage – Unqualified data manipulation – Interception of confidential data
PROFINET interface X150	Installing the network in a secure protection area must prevent access to cables and open connections.

The IP addresses of the X127 service interface and the PROFINET X150 interface must be located in different subnets.

More information

More information about the supported protocols is available on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/us/en/view/109995033)

9.3 Calling the web server

Precondition

You have connected the converter to the operating unit via the service interface X127.

To access the integrated web server, you must assign PROFINET interface X150 a valid IP address via the control system.

The IP addresses of X127 and X150 must be different.

Procedure

To access the web server via service interface X127, enter the IP address of the converter into the web browser, e.g. https://169.254.11.22.

If you do not know the IP address, then at the SINAMICS SDI standard navigate to menu "Support" > "Scan IP Address".

9.4 Home page

Precondition

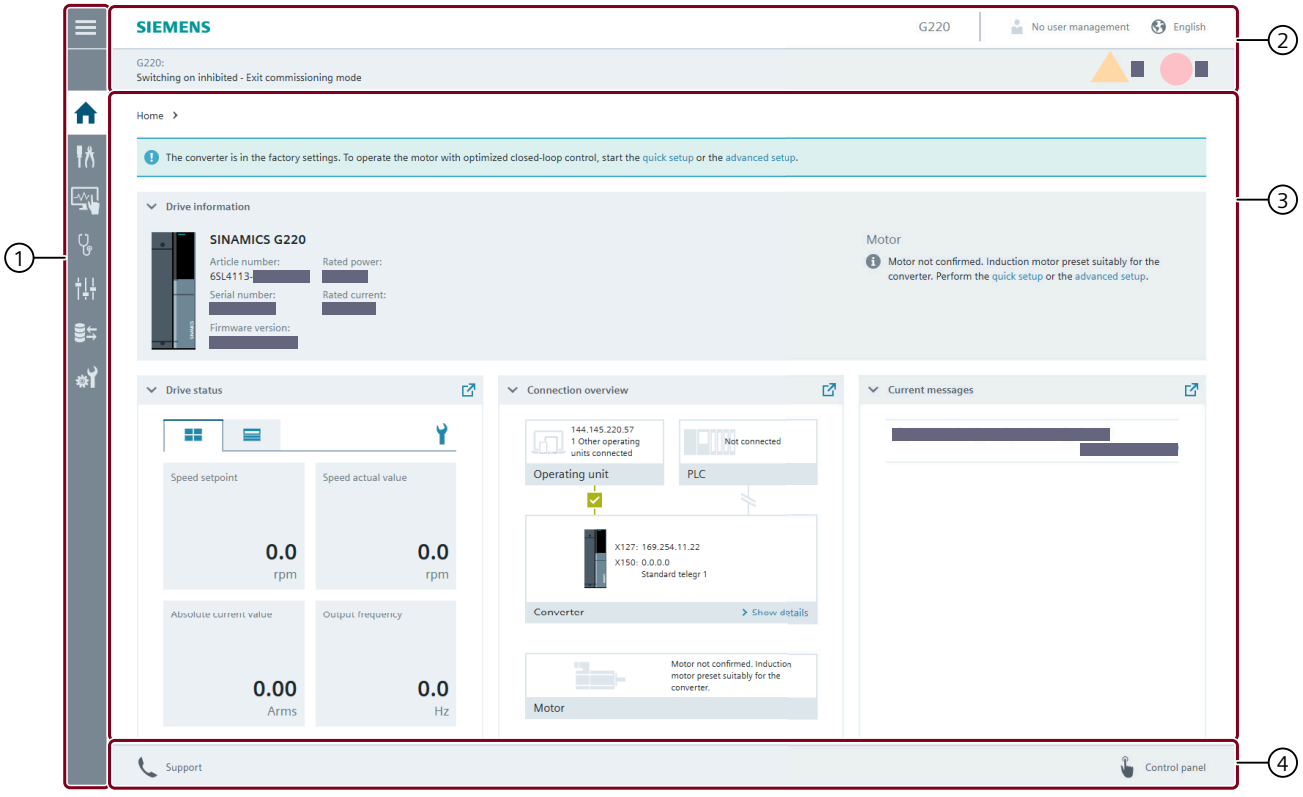
An online connection exists between the operating unit and the drive.

You have called the web server.

Description

The web server user interface can differ from the diagram below, as the web server adapts the display to the display size of the operating unit.

Information and settings not relevant for the description are covered over in the diagram.



① Navigation bar

The navigation bar provides access to converter functions and menus.

② Status bar

The status bar displays the converter product name and the converter status. Log in at the status bar and select the user interface language.

③ Main window

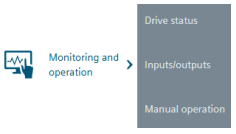
The main window provides information about converter functions and allows settings to be made.

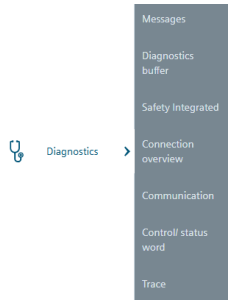
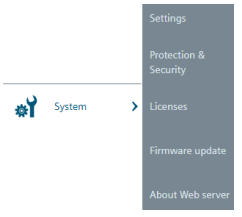
④ Action bar

When manual saving is activated in menu "System" > "Settings", then symbol is also shown in the action bar.

Figure 9-1 Home page on the web server

Icons of the navigation bar ①:

Symbol	Explanation
	Commissioning functions: • Quick commissioning • Advanced commissioning • Commissioning of the Safety Integrated Functions
	Functions for monitoring and in operation: • Drive status • The status of the inputs and outputs • Manual mode

Symbol	Explanation
	Diagnostic functions • Messages • The alarm buffer, the fault buffer and the safety message buffer • Messages of Safety Integrated Functions • Connection overview • Control word and status word • Trace
	Parameter functions: • Complete list of parameters • Complete list of signal interconnections
	Backup and restore: • Backing up drive data to the backup file • Restoring drive data from a backup file • Restoring factory settings
	System functions: • Automatic saving or manual saving • Display of standard parameters or all parameters • Settings of the service interface and fieldbus interface • Date and time • Service indicators of the internal fan • Support settings

9.5 Web server settings

Overview

The web server settings define how the converter saves any changes and which parameters the converter displays.

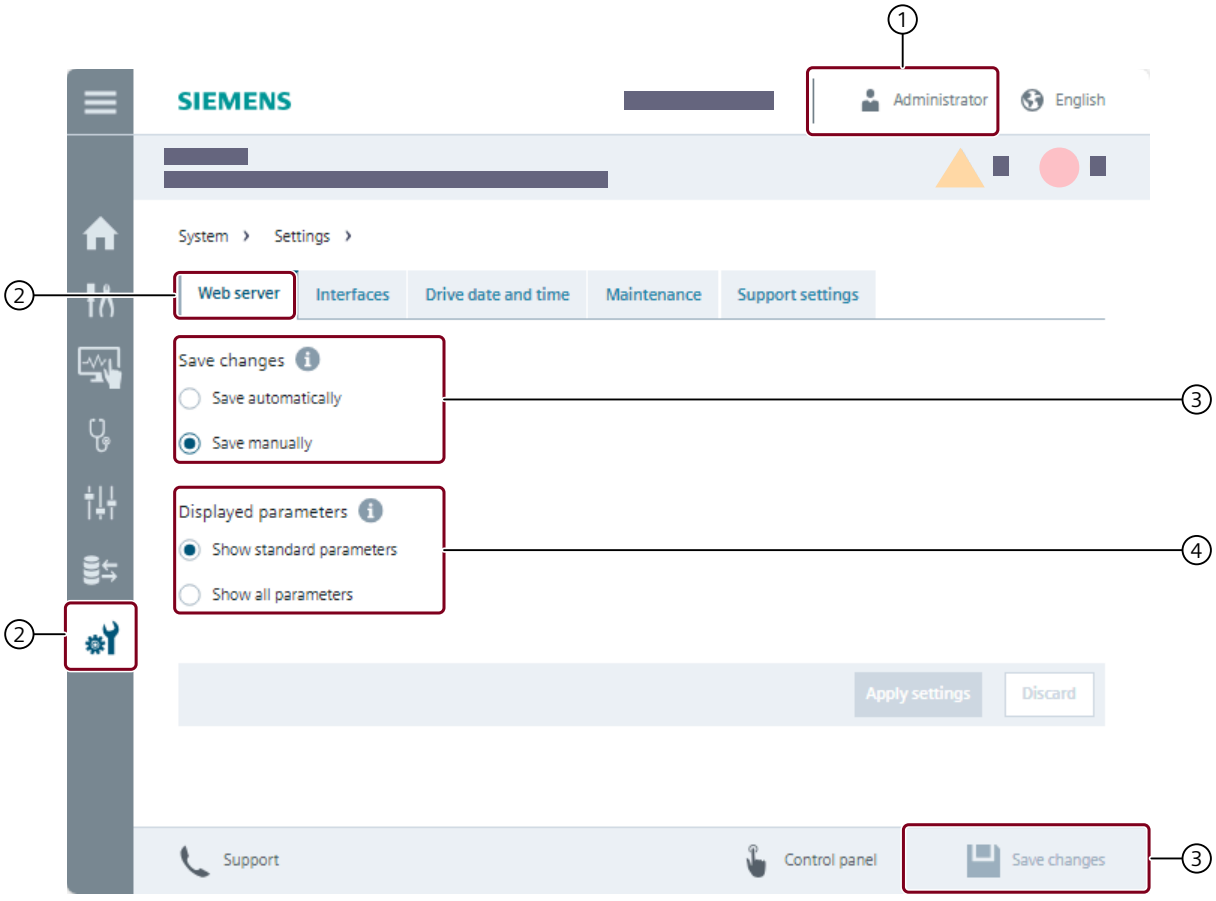
Precondition

The following rights of the user and rights management (UMAC) are enabled to edit the web server settings:

- "Edit web server configuration"
- "Edit device configuration or drive applications"

Function description

Information not relevant for the description are covered over in the diagram.



① The following is required to change the settings of the frequency converter:
- Activated user management
- User login
- The corresponding rights in the user management (UMAC)

② Navigation to the web server settings

③ The converter saves changed settings in 2 different ways:
- "Save automatically"
  The converter immediately and automatically saves any change so that it is protected against power failure.
- "Save manually"
  The converter only saves the change after selecting button "Save changes".
  The saved changes are not lost if you switch off the converter supply voltage

④ The web server displays various setting options:
- "Show standard parameters"
  The converter reduces the quantity of displayed setting options and the number of displayed firmware functions.
- "Show all parameters"
  All setting options and firmware functions are visible.

Figure 9-2 Web server settings

9.6 Quick setup

Overview

The quick setup of the web server is a wizard to make basic drive settings: Motor data, limit values and the configuration of inputs and outputs.

Precondition

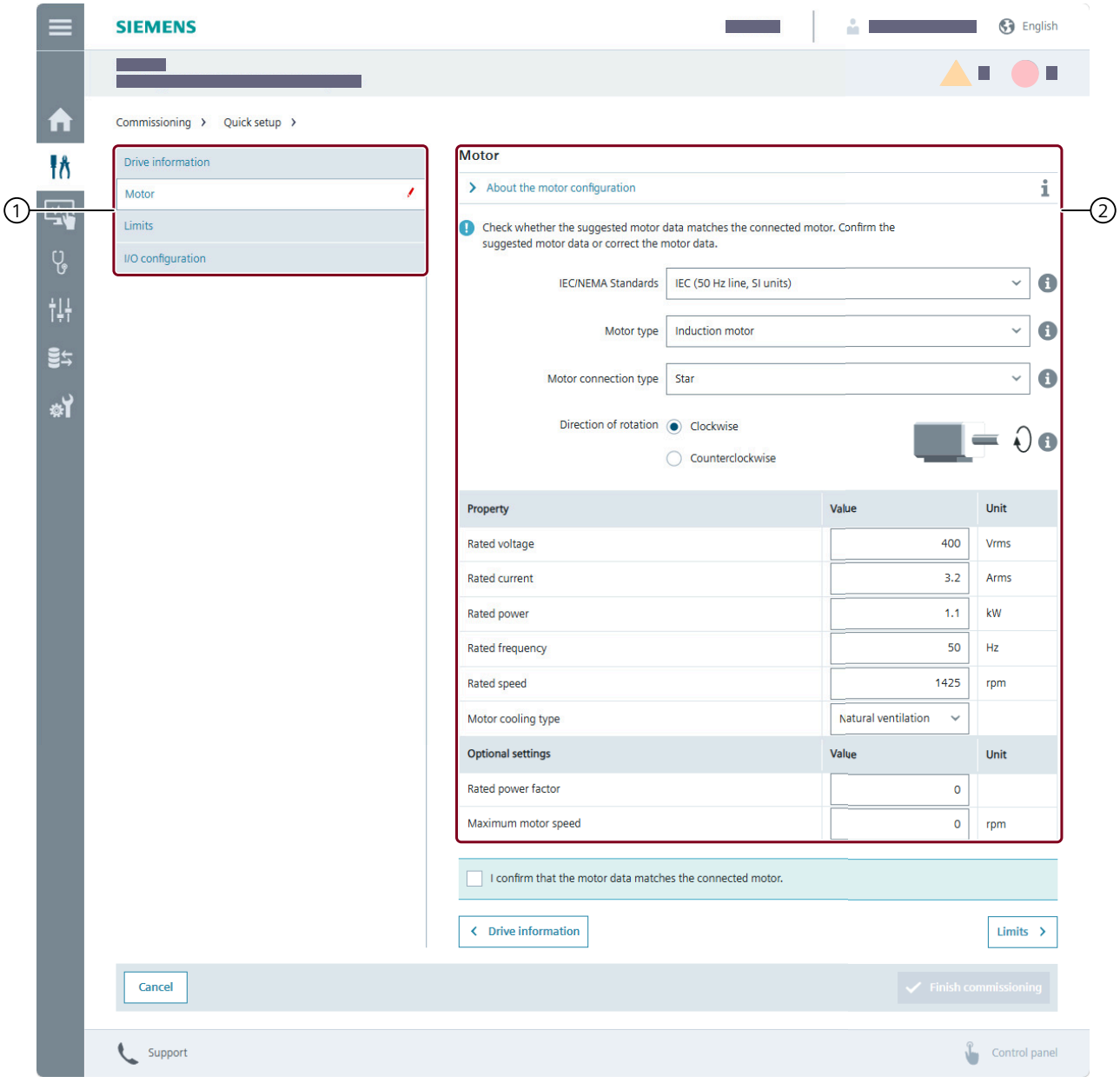
No other user controls the converter via the control panel.

No other user has started commissioning.

When UMAC is activated, then the required rights are assigned, for example, through the role "Drive Engineer and Service".

Function description

Information not relevant for the description are covered over in the diagram.



① Navigation through advanced setup
② Function views of the individual commissioning steps
All values entered are valid.
The drive has overwritten the manually changed values.
Check values.
Setting required to complete commissioning

Figure 9-3 Quick setup

The converter retentively saves the settings after commissioning has been successfully completed.

When commissioning is canceled before it has been completed, the converter rejects the settings changed since commissioning started.

9.7 Advanced setup

Overview

The advanced setup of the web server is a wizard to make basic drive settings and to set additional converter options and functions.

Precondition

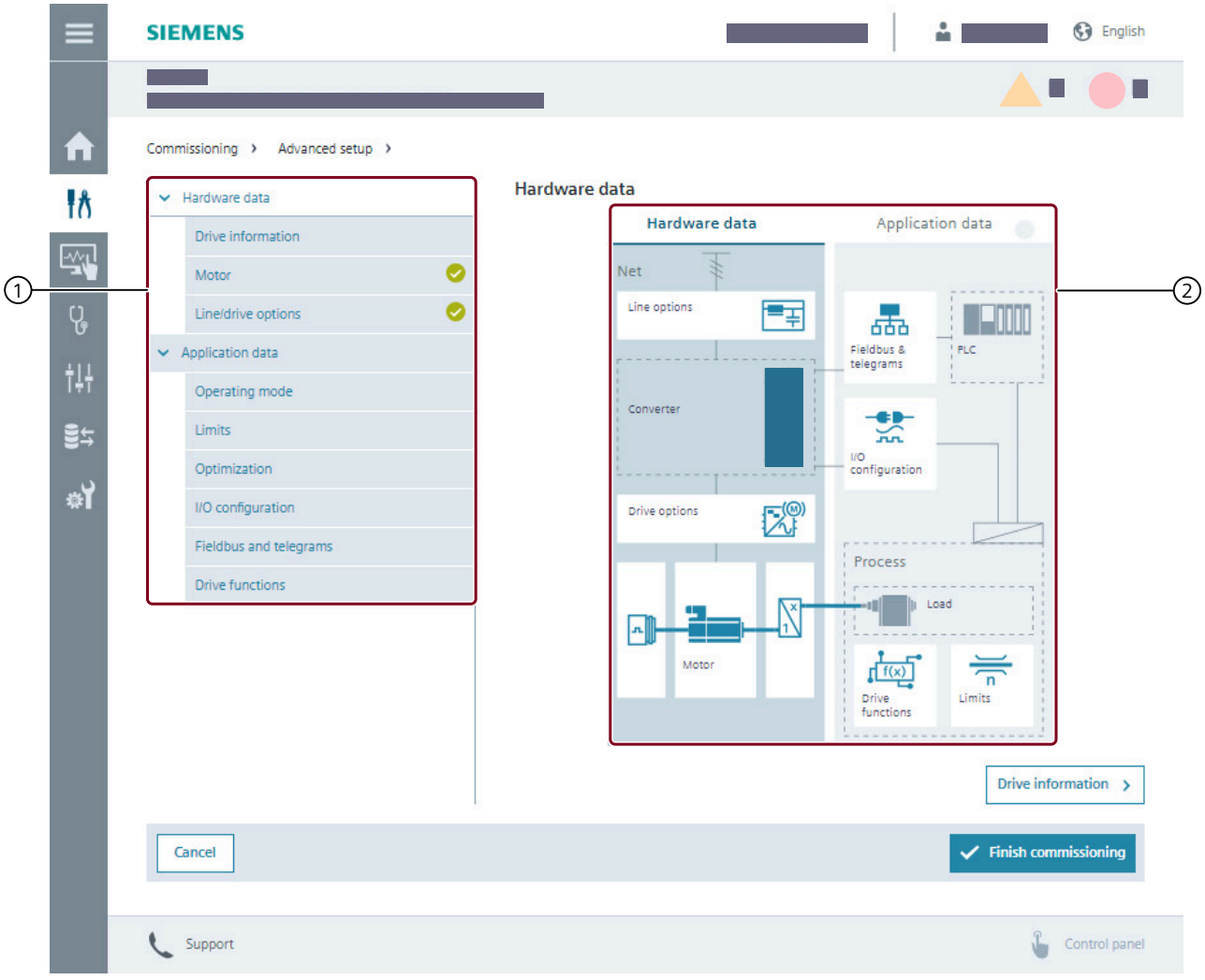
No other user controls the converter via the control panel.

No other user has started commissioning.

When UMAC is activated, then the required rights are assigned, for example, through the role "Drive Engineer and Service".

Function description

Information not relevant for the description are covered over in the diagram.



① Navigation through advanced setup
② Function views of the individual commissioning steps
All values entered are valid.
The drive has overwritten the manually changed values.
Check values.
Setting required to complete commissioning

Figure 9-4 Advanced setup

The converter retentively saves the settings after commissioning has been successfully completed.

When commissioning is canceled before it has been completed, the converter rejects the settings changed since commissioning started.

9.8 Making the product documentation available for the web server information system

Overview

For selected topics, you can use the information system of the web server to directly access the product documentation. To do this, you must make the product documentation available on a prepared memory card.

Requirement

Requirements:

- You have an empty memory card on which you can save the product documentation.
- You have connected a suitable memory card reader to your PC.

Procedure

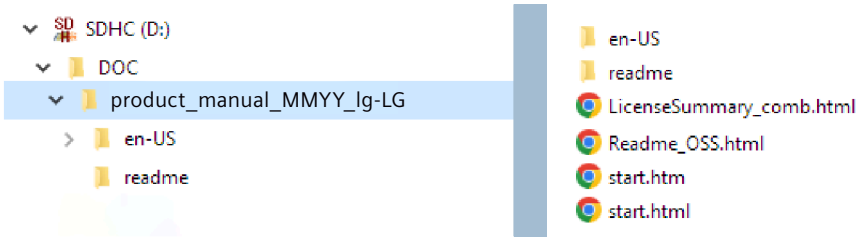
To make the project documentation available for the web server information system, proceed as follows:

1. Open the web site for the product documentation of your converter:
   SiePortal SINAMICS (https://support.industry.siemens.com/cs/ww/en/view/109807358)
2. Select the abbreviation of the converter designation to open the list of associated manuals.
3. Select the operating instructions for the converter from the list of manuals.
   ZIP archive "Multimedia document" is located under "Download".
   The multimedia document contains file "product_op_instr_MMYY_lg-LG.zip".

Explanation of file name "product_manual_MMYY_lg-LG.zip"		
	Example	**Explanation**
product	G200, G210, G210X, G220, S200, S210	Abbreviated converter name
op_instr	---	Operating Instructions
MMYY	0726	Month and year that the manual was published, e.g. July 2026
lg-LG	en-US	Language identifier, e.g. US English

4. Unzip the file to a folder with the ZIP file name, e.g. "product_op_instr_MMYY_lg-LG".
5. Insert a memory card into the SD card reader of your PC.
6. In the root directory of the memory card, create a folder called "DOC".

7. Copy the unzipped folder, e.g. "product_op_instr_MMYY_en-US", into directory "DOC" on the memory card.



8. Eject the memory card from the PC.
9. Remove the memory card from the reader.
10. Insert the memory card into the converter.

Result

You have made the product documentation in one language available for the web server information system.

For selected topics, you can access the content of the product documentation via the context-sensitive information system.

You can copy the product documentation in other languages to the memory card if there is sufficient space available on the memory card.

10 Commissioning (Startdrive)

10.1 Functions of the Startdrive commissioning tool

Overview

SINAMICS Startdrive is software to integrate SINAMICS drives into an automation environment. Startdrive is a component of the Totally Integrated Automation Portal (TIA Portal).

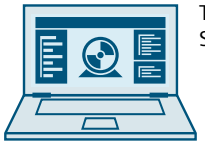
Requirement

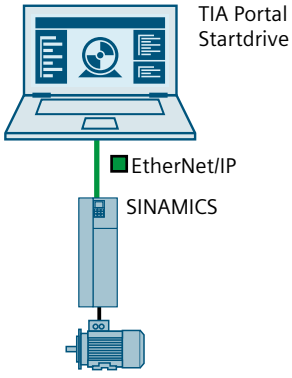
A license is required to use Startdrive Advanced functions.

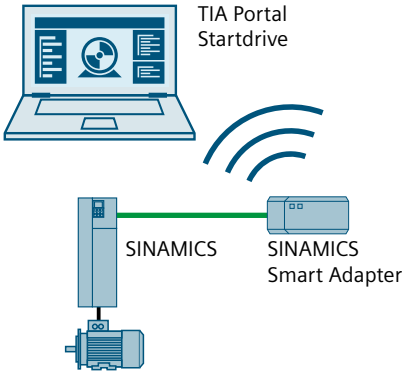
Description

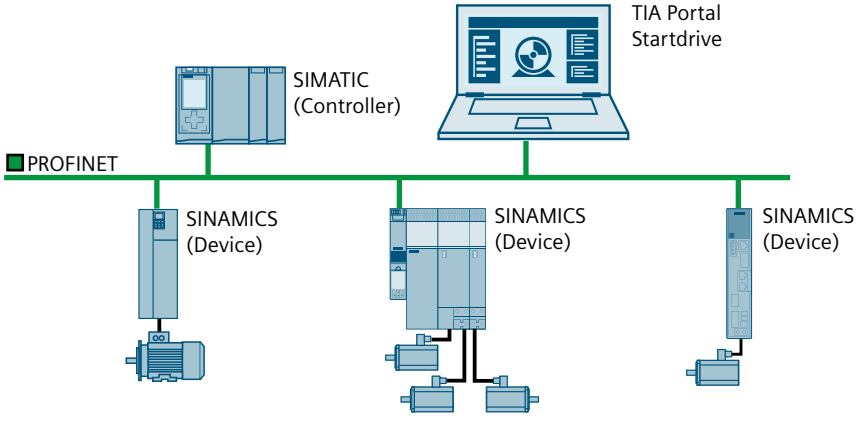
SINAMICS Startdrive is software to configure and troubleshoot SINAMICS drives.

Startdrive can be used as follows:

<table>
<tr><td>Configuring SINAMICS drives in the PC without online connection to a drive.</td><td colspan="2">

PC without online connection to a drive</td></tr>
<tr><td>Loading data to a drive or reading data from a drive via service interface X127.</td><td>

PC at X127</td><td>

PC via SINAMICS Smart Adapter at X127</td></tr>
<tr><td>Loading data to a drive or reading data from a drive via the fieldbus.</td><td colspan="2">

PC connected to the fieldbus</td></tr>
</table>

SINAMICS Startdrive is available in the Basic and Advanced variants. Startdrive Basic includes all of the essential functions for commissioning and troubleshooting drives. Startdrive Advanced contains additional functions, e.g. the Safety Integrated acceptance test.

SINAMICS Startdrive Basic has the following functions:

- Industrial cybersecurity
  - User and rights management (UMAC)
  - Access protection of the project offline data
  - Access protection of data in the drive
- Commissioning
  - Configuring hardware components of the converter
  - Configuring fieldbus communications with the higher-level control
  - Displaying and setting converter settings:
    Function view as graphic display
    Parameter view in list form
  - Automatic controller optimization
- Diagnostics
  - Displaying faults and alarms
  - Acknowledging faults
  - Recording traces of converter signals
  - Displaying firmware versions
  - Comparing the settings of various drives with one another
  - Exporting the user-defined parameter list for the web server
- Support
  - Software wizard to support making industrial cybersecurity settings
  - Software wizard to provide commissioning support
  - Online help
- Maintenance
  - Backing up drive data to the backup file
  - Restoring drive data from a backup file
  - Firmware update

Startdrive supports TIA Portal Openness. TIA Portal Openness is a programming interface (API) to automate workflows in the TIA Portal.

TIA Portal Openness has the following functions:

- Reading and setting converter parameters
- Configuring drives and drive components
- Creating a telegram configuration
- Loading configured drive data into a converter

More information

More information on TIA Portal Openness can be found on the Internet:

- API to automate engineering workflows (https://support.industry.siemens.com/cs/us/en/view/109826886)
- Openness for SINAMICS Startdrive and DCC (https://support.industry.siemens.com/cs/ww/en/view/109763491)

More information on industrial cybersecurity can be found on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/ww/en/view/109975311)

10.2 Install Startdrive commissioning tool

Overview

The installation package includes both the Basic variant as well as the Advanced variant of Startdrive.

Precondition

The latest STEP 7 version is installed on the PC.

Procedure

Installing Startdrive:

1. Download the current Startdrive version into a target directory of the PC.
   The target directory name must not contain any blanks.
2. Open the installation directory by double-clicking on file "STARTDRIVE_BASIC_ADVANCED_Vxx.iso".
   Vxx designates the Startdrive version.
3. Install Startdrive by double clicking on file "Start.exe".

More information

Download STEP 7 and Startdrive: SINAMICS Startdrive (www.siemens.com/startdrive)

10.3 Configuring a drive

Requirement

You have created a new project in Startdrive or have opened an existing project.

In the project, you have added a "new device".

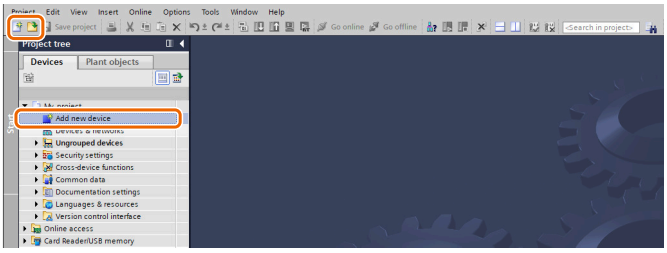


Figure 10-1 Adding a new device to a project

Description

Startdrive displays an incomplete drive configuration as follows:

- A white object in the configuration representation
- Icon ⊗ in the inspector window when selecting the corresponding object in the configuration display

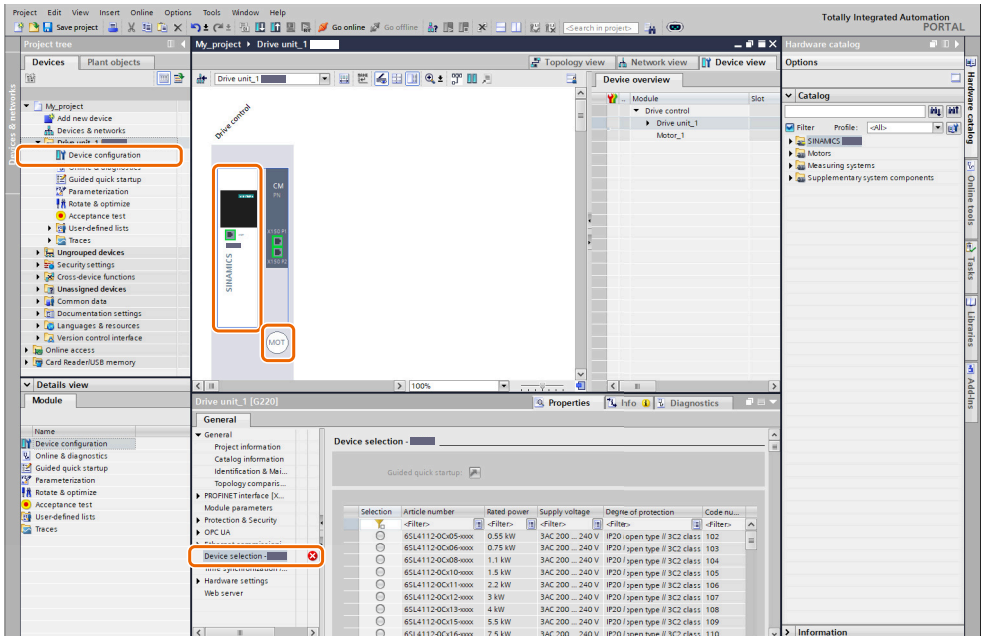


Figure 10-2 Displaying the incomplete configuration of a drive

After the drive has been completely configured, all objects in the configuration representation are colored:

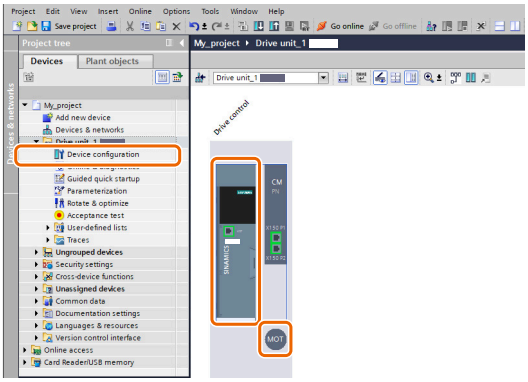


Figure 10-3 Displaying the complete configuration of a drive

10.4 Data management in the drive and on the PC

Description

A Startdrive project on the PC contains the digital image of the real SINAMICS drives.

The following options are available to create the digital image:

- You configure the drives without online connection.
- Via an online connection, Startdrive searches for accessible drives and loads the drive data into the project as digital image.

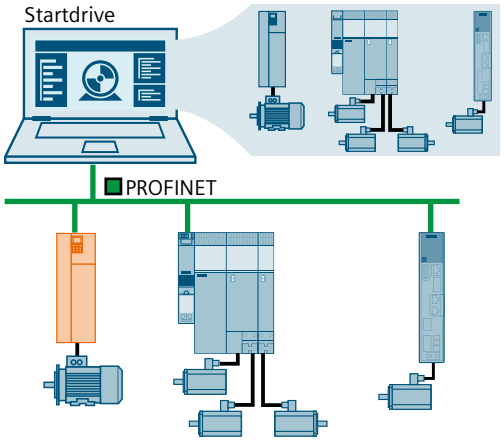
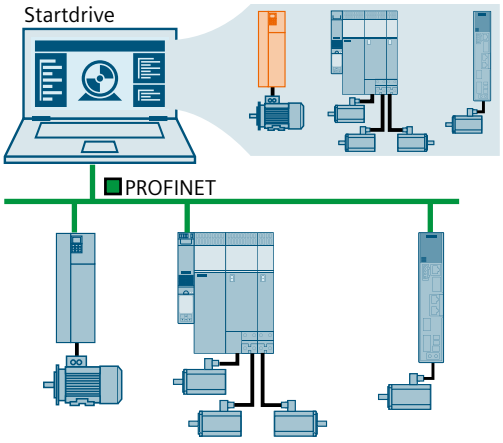
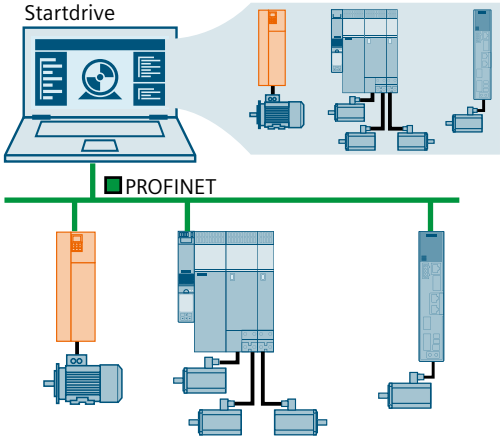
The date of the real drive and the data of the Startdrive project are not always consistent Inconsistent data has various causes:

- An operator changed the adjustable parameters of a drive at a local operator panel.
- A higher-level control changed the data of a real drive via the fieldbus.
- A service person replaced a drive.
- A configuring engineer changed the drive data in the Startdrive project.

There are 2 options to align the drive data:

- Loading data of the real drive into the Startdrive project
- Loading Startdrive project data into the real drive

Table 10-1 Aligning the drive data

	Loading data of the real drive into the Startdrive project	**Loading Startdrive project data into the real drive**
Situation	 Changed drive data of real drives	 Changed drive data in the project
Action	Loading from the device 	 Loading into the device
Result	 The drive data of the project and the real drives are identical.	

10.5 Online connection to the drive

Description

The following interfaces are available for establishing an online connection to the converter:

Interface	Description of the restrictions
Service interface X127	Default settings: • IP address: 169.254.11.22 • Subnet mask: 255.255.0.0 • Data transfer via HTTPS is activated in the factory setting.
	Constraints: • Without applying additional measures, an online connection is only permissible in the control cabinet. • Additional measures are required to remotely access the drive, which prevent the following: – Misuse through sabotage – Unqualified data manipulation – Interception of confidential data
PROFINET interface X150	Installing the network in a secure protection area must prevent access to cables and open connections.

The IP addresses of the X127 service interface and the PROFINET X150 interface must be located in different subnets.

More information

More information about the supported protocols is available on the Internet:

Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/ww/en/view/109975311)

10.6 Guided quick startup

Description

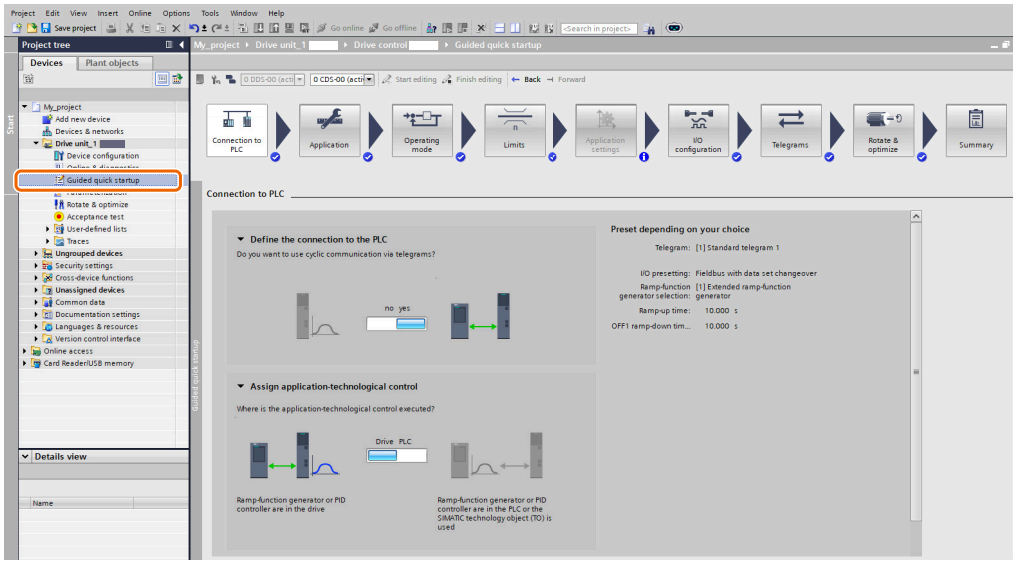


Figure 10-4 Guided quick startup

The guided quick startup supports the following drive settings:

- Communications with the higher-level control.
- Activating the technology controller or the basic positioner
- Selecting the closed-loop speed control
- Automatic optimization of the closed-loop speed control
- Speed limits
- Configuring the inputs and outputs

10.7 Simplified or extended view of the functions

Description

Startdrive offers 2 different views of the drive data setting options.

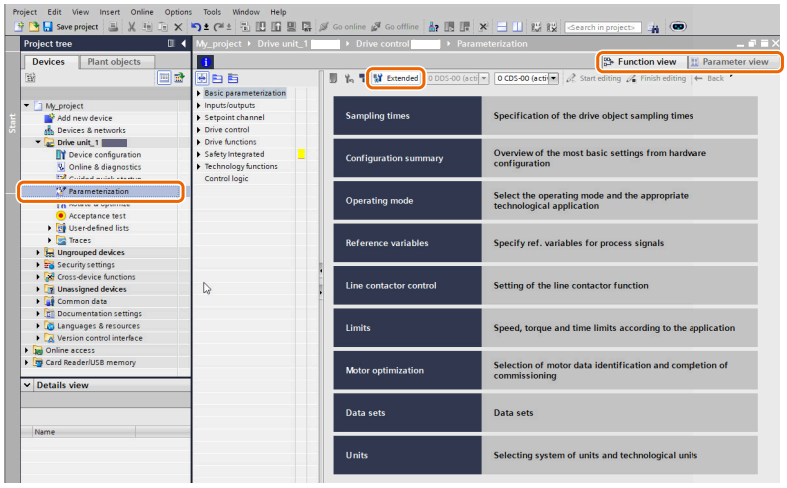


Figure 10-5 Extended view of functions and parameters

If you select "Parameterization" in the project tree, the scope of the displayed functions and parameters and the setting options can be toggled between:

- Standard Reduces the scope of functions and adjustable parameters in the function view and in the parameter view.
  Those drives parameters sufficient for standard applications are visible and adjustable.
- Extended Displays the extended functions and adjustable parameters.
  All drive parameters are visible and can be set.

10.8 Save the changed settings in the drive so they are not lost if the power fails

Overview

Startdrive saves changes to the drive data in a volatile drive memory. After transferring the changes to the drive retentive memory, drive data is also kept even when the power fails.

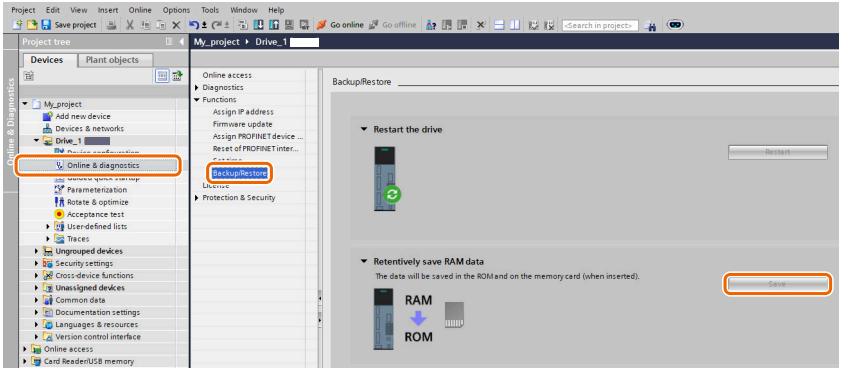
Requirement

A drive is created in the Startdrive project and you have established an online connection to the drive.

Procedure

The following options are available to save changed drive data settings so that they are protected against power failure.

- Press button  .
- Select "Online & diagnostics" > "Functions" > "Backup and restore" > "Save".



If a memory card is inserted, the drive also saves the changes on the memory card.

Series commissioning 11

11.1 Series commissioning

Overview

For series commissioning, transfer the data and settings of converter 1 to converter 2 or other converters.

Requirement

Converter 2 must comply with the following requirements:

- The rated power of converter 2 corresponds to the rated power of converter 1.
- The firmware version of converter 2 is higher than or equal to the firmware version of converter 1.
- The machines that are commissioned via series commissioning are identical in terms of the application, converter and motor.
- Converter 2 has the factory setting.

Description of function

There are two options when carrying out series commissioning of the converter:

- Series commissioning with memory card
- Series commissioning using commissioning tools

11.2 Series commissioning with memory card

Overview

"Series commissioning using a memory card" makes it possible to transfer the settings of converter 1 to converter 2 or additional converters using a memory card.

Procedure

Proceed as follows to perform series commissioning using a memory card:

1. Switch off the supply voltage of converter 1.
2. Insert a blank memory card (e.g.: 6SL5970-0AA00-0AA0) into the card slot of converter 1.
3. Switch on the supply voltage of converter 1.
4. Commission the converter.

5. Save the settings retentively at the end of commissioning.
   This means that you save the settings retentively not only in converter 1 but also to the memory card.
6. Switch off the supply voltage of converter 1.
7. Remove the memory card from converter 1.
8. Switch off the supply voltage of converter 2.
9. Insert the memory card into converter 2.
10. Switch on the supply voltage of converter 2 and wait until the RDY LED lights green.
    Converter 2 takes the settings of converter 1 from the memory card, including the following settings:
    - User management
    - Access control
    - IP configuration
    - Device name
11. Then, in converter 2, correct the IP configuration and the device name to the specific values of converter 2.
12. Switch off the supply voltage of converter 2.
13. Remove the memory card from converter 2.

Repeat steps 8 to 12 for all additional converters to which you wish to transfer these settings.

11.3 Series commissioning with a commissioning tool

Overview

For the series commissioning using a commissioning tool, transfer the settings of converter 1 using the commissioning tool to converter 2 or to additional converters.

Procedure

Proceed as follows to perform series commissioning using a commissioning tool:

1. Switch on the supply voltage of converter 1.
2. Commission the converter using your operating unit, e.g. a PC.
3. Save the settings retentively at the end of commissioning.
4. Save the drive data to a backup file.
5. Switch on the supply voltage of converter 2.
6. Restore the drive data from the backup file.
   Converter 2 takes the settings from the backup file.
   After a restart, the security settings configured in converter 1, e.g. drive password, UMAC data, become active in converter 2.

Repeat steps 5 and 6 for all additional converters to which you wish to transfer the settings of converter 1.

See also

Scanning the IP address (Page 336)

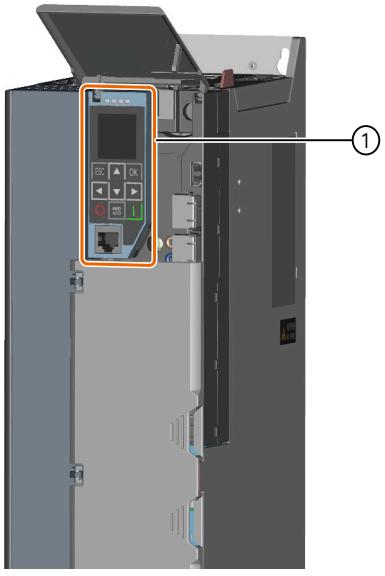
Commissioning (web server) (Page 287)

Operation and monitoring with SINAMICS SDI Standard

12

12.1 SINAMICS SDI Standard, converter in degree of protection IP20

Description



① SINAMICS SDI Standard

Figure 12-1 SINAMICS SDI Standard

SINAMICS SDI (Smart Drive Interface) Standard is located behind the converter front flap.

12.2 SINAMICS SDI Standard, converter in degree of protection IP55

Precondition

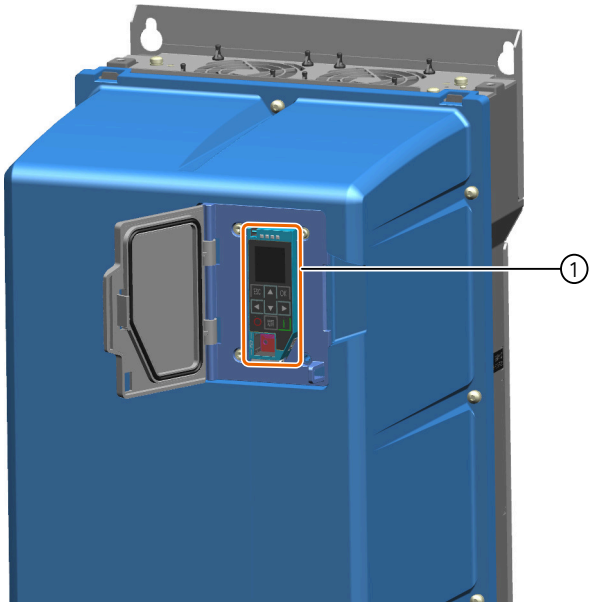
⚠ CAUTION

Burns resulting from high surface temperatures

When the converter is operational, the surface of the SINAMICS SDI Standard operator panel can reach temperatures exceeding 60 °C. Surface temperatures exceeding 60 °C can result in light burns.

- If required, wear a glove when operating the SINAMICS SDI Standard.

Description



① SINAMICS SDI Standard

Figure 12-2 SINAMICS SDI Standard

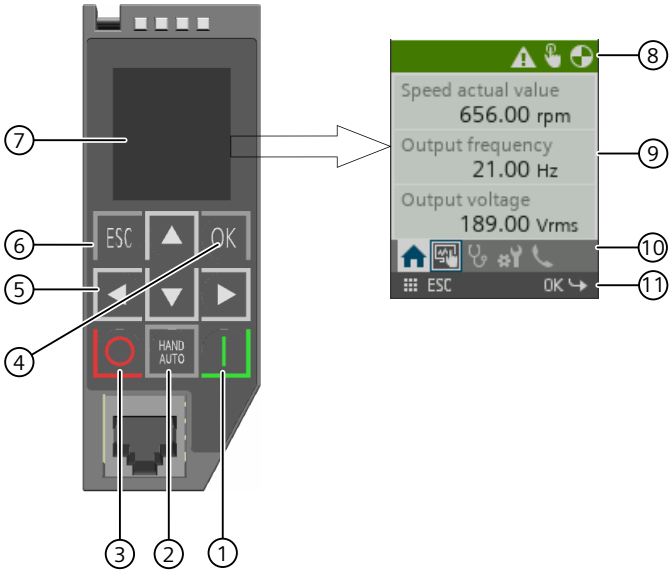
The SINAMICS SDI operator panel (Smart Drive Interface) Standard is located behind the front door of the converter.

12.3 Structure

Overview

The converter can be operated, monitored and diagnosed using the SINAMICS SDI Standard. The operator panel also supports access to the converter from mobile devices.

Description



Control keys

① ON
② MANUAL/AUTO
③ OFF
④ OK
⑤ Arrow keys
⑥ ESC

⑦ Display

Home page

⑧ Status bar
⑨ Content area
⑩ Navigation bar
⑪ Footer

Figure 12-3 SINAMICS SDI Standard

SINAMICS SDI Standard has 9 control keys.

Navigate from the start page to the various levels using the menu-based operation system. The icons on the status bar provide additional information such as the system status and controller constraints and their causes.

Functions of the control keys:

- 4 arrows
  Navigation within a level
- OK
  - Confirm selection
  - Switch to editing mode
  - Navigation to the next level down

- ESC
  - Navigation to the next level up
  - The navigation bar can be called from any level by pressing the ESC key for 2 seconds
  - Switch focus from content area to navigation bar
  - Switch focus from navigation bar to content area
- ON
  Start the motor in MANUAL mode
- OFF
  Stop the motor in MANUAL mode
- MANUAL/AUTO
  - MANUAL: Specifies SINAMICS SDI Standard as the command source
  - AUTO: Specifies an external source such as the field bus as the command source

The display is divided into the following areas:

- Status bar
  Icons provide information about the status of the converter and about alarms and faults and their causes.
  The status bar is subdivided into 2 areas: The left-hand area provides information about the converter status. The right-hand area contains details relating to converter function.
- Content area
  The content area shows the current menu with additional menu items or information.
- Navigation bar
  The navigation bar appears on the start page and at the first level of each menu item.
  Menu selection:
  - Select icon using "right" and "left" arrow keys
  - Confirm with the "OK" key
- Footer
  The footer contains the icons for possible actions. The actions are confirmed using the "ESC" key or the "OK" key.

12.4 Icons

12.4.1 Navigation bar

Description

The following table shows the navigation bar icons.

Table 12-1 Navigation bar icons

Icons	Description
	Start screen
	Operator control and monitoring
	Diagnostics
	System
	Support

12.4.2 Footer

Description

The footer icons describe possible actions, which are displayed on the screen.

Actions are confirmed by pressing the "ESC" key or the "OK" key. The key required in each case is shown next to the icon depicting the action.

Table 12-2 Footer icons

Icons	Description
	Navigate to the next level up
	Navigate to the next level down
	Closing
	Confirm
	Delete
	Edit
	Focus change to navigation bar
	Focus change to displayed navigation bar (from level 2), fast selection
ESC	Indication of the key to be used to confirm an action.
OK	

The table below shows examples of actions that have to be confirmed using the "ESC" key or the "OK" key.

Table 12-3 Examples of actions

Icons	Description
	Briefly press ESC key → focus change to navigation bar
	• Briefly press ESC key → navigate back to next level up • Press ESC for 2 s → focus change to displayed navigation bar (from level 2), fast selection
	Press "OK" key → confirm selection
	Press "OK" key → edit selection
	Press "OK" key → navigate to next level down

The icons in the footer are shown with different background colors.

Table 12-4 Footer background color

Color	Description	
gray	Standard color	
blue	Use in dialogs	
Red	Fault present Displayed in "Messages" dialog entry	Procedure • The converter has a fault. • SINAMICS SDI Standard is activated, the backlight is switched on. • Display: "Messages" dialog entry

12.4.3 Status bar

Description

The following table shows selected status bar icons.

Table 12-5 Status bar icons, converter is ready for operation

Icons	Description
	Motor running
	Manual mode, continuous operation
	Manual mode, jog mode
	Manual mode via remote access
	Commissioning

Icons	Description
	Commissioning via remote access
	Unsaved changes
	Service mode
	Alarm
	Standby Motor will enter standby shortly

The icons in the status bar are shown with different background colors. The colors indicate the converter status.

Table 12-6 Status bar background color

Color	Description	
Green	Converter is ready for operation.	Motor is running or ready for operation.
gray	Converter is not ready for operation. Cause: Missing control signals in the converter sequential control are preventing the motor from starting.	The motor is not running or cannot be started.
Red	Converter is not ready for operation. Cause: Fault present	The motor is not running or cannot be started. Exception: EOM is active and a fault occurs. In this case, the motor is running.

12.4.4 Content area

Description

The following table shows selected content area icons.

Table 12-7 Content area icons

Icons	Description
	Acknowledge all messages
	Show historical faults and alarms in the "Messages" list
	Hide historical faults and alarms in the "Messages" list
	Scan code
	Information
	Go to
	Clockwise direction of rotation
	Counterclockwise direction of rotation

Icons	Description
	Active alarm in the "Messages" list
	Historical alarm in the "Messages" list
	Active fault in the "Messages" list
	Acknowledge (historical) fault in the "Messages" list
Additional icons	Additional icons correspond to the status bar icons in the aforementioned colors. The meaning is identical.

The icons and buttons in the content area are shown with different background colors.

Table 12-8 Content area background color, buttons

Color	Description
	Deactivated function The function is not available.
	Proposed function The function is available but has not yet been selected.
	Alternative to proposed function The function is available but has not yet been selected.
	The function has been selected.
	The function is available. The border indicates that the button is selected.

12.5 Functions

12.5.1 Adapt start page

Overview

You can adapt the start page to your requirements as follows:

- Display of the view
- Display of the parameters
- Units and decimal places for the output fields

Procedure

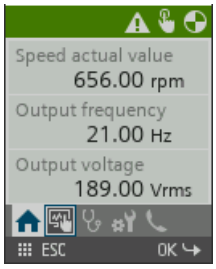


Figure 12-4 Start screen

Proceed as follows to adapt the start page:

1. In the navigation bar, navigate to the "Start screen" menu.
   Confirm the selection using the "OK" key.
   The "Edit view" dialog opens.
2. Adapt the start page to your requirements.

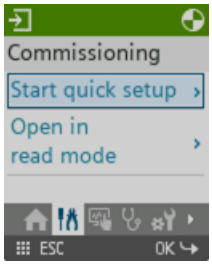
12.5.2 "Commissioning" menu

12.5.2.1 Overview

Overview

This menu allows you to commission the converter and check the settings of the converter in the quick setup.

Function description



You can perform the following tasks in this menu:

- Defining the most important properties of the drive, such as motor data, limit values, and the input and output signals
- Viewing these properties in read-only mode

The quick setup includes the following items:

Settings	Description
Drive information	This item provides information about the converter and motor being used. You can assign a specific drive name.
Motor	The motor data is entered manually. The converter only continues the commissioning process after confirmation that the motor data matches the connected motor.
Limit values	To match your particular application, you can set the converter limit values, such as the maximum speed, minimum speed and the current limit.
I/O configuration	This item allows you to select the preconfigured default settings to configure the digital and analog inputs and outputs of the converter.

12.5.2.2 Carry out quick commissioning

Overview

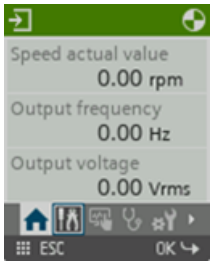
You can perform quick commissioning of the converter in just a few steps.

Preconditions

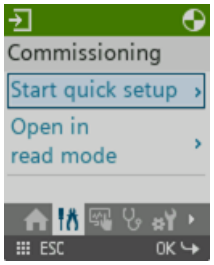
- No other user controls the converter via remote access.
- No other user has started commissioning.
- If UMAC is active, ensure that you have the right to edit drive data.

Procedure

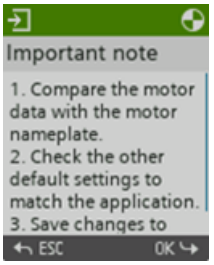
①



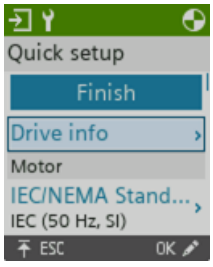
②



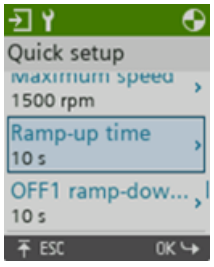
③



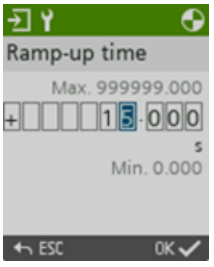
④



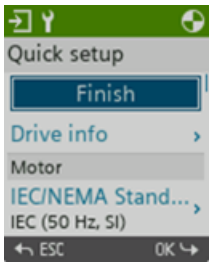
⑤



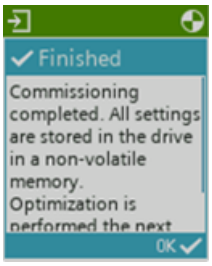
⑥



⑦



⑧



1. In the navigation bar, navigate to the "Commissioning" menu.
   Confirm your selection with OK.
2. Select the "Start quick setup" menu item.
   Confirm your selection with OK.
3. View and acknowledge the commissioning note.
   Confirm with OK.
4. Check if the settings of the converter are suitable for your application.
5. Select the items for which you want to modify the settings.
   Confirm your selection with OK.
6. Change the value using the arrow keys.
   Confirm with OK.
7. Select the "Finish" item after all desired configurations are complete.
   Confirm your selection with OK.
8. Read the note and then press OK.

12.5.2.3 Quick commissioning in the read mode

Overview

You can verify the settings of quick setup in read-only mode.

Requirement

If UMAC is active, ensure that you have the right to read drive data.

Procedure

① ② ③



Proceed as follows to view the settings of the quick setup:

1. In the navigation bar, navigate to the "Commissioning" menu.
   Confirm your selection with OK.
2. Select the "Open in read mode" menu item.
   Confirm your selection with OK.
3. View the specific items.

12.5.3 "Operation and monitoring" menu

12.5.3.1 Manually starting and stopping the motor

Overview

You manually start and stop the motor using 2 keys.

Requirement

- The conditions for starting the motor are met.
- The converter is in manual mode.

Procedure

To start or stop the motor manually, press the following keys:

- Start motor: ON key
- Stop motor: OFF key

12.5.3.2 Changing the set speed of the motor manually

Overview

You manually change the motor setpoint speed in menu "Operation and monitoring" via the following menu entries:

- "Continuous operation":
- "Jog mode"

Procedure

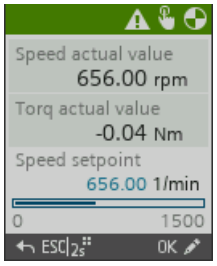


Figure 12-5 Changing the set speed of the motor

To change the set speed of the motor manually, proceed as follows:

1. Press the "MANUAL/AUTO" key.
2. Continue as under item 3

OR

1. In the navigation bar, navigate to the "Operation and monitoring" menu.
   Confirm the selection using the "OK" key.
2. Select the "Continuous operation" or "Jog mode" menu item.
   Confirm the selection using the "OK" key.
3. You have two options for changing the value of the set speed:
   - You change the value of the set speed of the motor in the bar chart using the arrow keys.
   - You enter the precise numerical value for the set speed.
     To do so, press the "OK" key.
     A dialog box to enter the value is displayed, and you change the value of the set speed.
4. Press the "ON" key to start the motor.
   - Continuous operation:
     Use the arrow keys to increase or decrease the motor speed in continuous operation.
     Press the "ON" key to enter a value.
   - Jog mode:
     The motor is rotated manually by the specified value every time the "ON" key is pressed.
     The motor rotates until the "ON" key is released again.

12.5.3.3 Change the direction of rotation of the motor shaft

Overview

You change the motor direction of rotation in menu "Operation and monitoring" > "Rotation direction".

Procedure

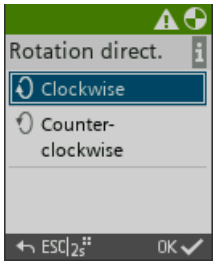


Figure 12-6 Changing the direction of rotation of the motor

Proceed as follows to change the direction of rotation of the motor:

1. In the navigation bar, navigate to the "Operation and monitoring" menu.
   Confirm the selection using the "OK" key.
2. Select the "Direction of rotation" menu item.
   Confirm the selection using the "OK" key.
3. Select the direction of rotation for the motor:
   - Right
     OR
   - Left

12.5.4 "Diagnostics" menu

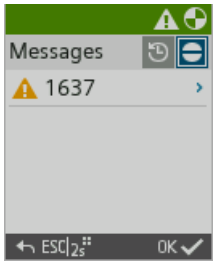
12.5.4.1 Displaying faults and alarms

Overview

Faults and alarms are listed in menu "Diagnostics" > "Messages":

- "Messages" list
  The list contains active and/or historical faults and alarms
- Description of specific faults and alarms

Procedure



Proposed function: Acknowledge messages

Alternative function: Switch display of historic messages on and off

Figure 12-7 Diagnostics menu

To display faults and alarms, proceed as follows:

1. In the navigation bar, navigate to the "Diagnostics" menu.
   Confirm the selection using the "OK" key.
   The "Diagnostics" menu opens.
2. Select the "Messages" menu item.
   Confirm the selection using the "OK" key.
   The "Messages" list is displayed.
3. To display the description of a specific fault or alarm, select the message concerned.
   Press the "OK" key.

12.5.5 "System" menu

12.5.5.1 Saving the changes in the converter

Overview

In menu "System" > menu item "Settings" >"Web server", specify whether you wish to automatically save changes in the converter.

Procedure

Proceed as follows to select or deselect whether changes are automatically saved:

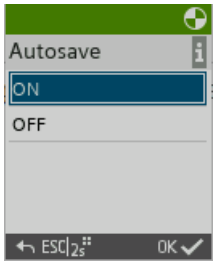


Figure 12-8 Saving changes

1. In the navigation bar, navigate to the "System" menu.
   Confirm the selection using the "OK" key.
2. Select the "Settings" menu item.
   Confirm the selection using the "OK" key.
3. Select menu item "Web server".
   Confirm the selection using the "OK" key.
4. Confirm menu item "Autosave" using the "OK" key.
5. Select one of the following menu items "Autosave"
   - On
   - Off

   Confirm the selection using the "OK" key.

12.5.5.2 Display interface information

Overview

Information about the configuration of the following interfaces is provided in menu "System" > menu item "Settings" > "Interfaces":

- X127 Service interface
  - Accessing the web server via HTTP or HTTPS
    The factory setting to access the web server is service interface X127 with HTTPS protocol. HTTP can also be activated.
  - Name of station
  - DHCP mode
  - IP address
  - Subnet mask
  - Gateway
  - MAC address
- X150 PROFINET interface
  - Accessing the web server via HTTPS
    To access the web server, PROFINET interface X150 with HTTPS protocol can also be activated.
  - Name of station
  - IP address
  - Subnet mask
  - Gateway
  - MAC address

You can find more information about the interfaces in Chapter "Online connection to the drive (Page 289)".

Procedure

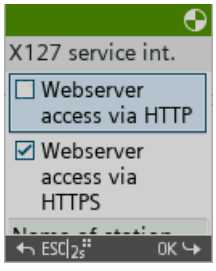


Figure 12-9 Interface information about service interface X127

To display configuration information for the interfaces, proceed as follows:

1. In the navigation bar, navigate to the "System" menu.
   Confirm the selection using the "OK" key.
2. Select the "Settings" menu item.
   Confirm the selection using the "OK" key.
3. Select the "Interfaces" menu item.
   Confirm the selection using the "OK" key.
4. Select the menu item for the required interface.
   Confirm the selection using the "OK" key.
   - The configuration information is displayed.
   - "Web server access via HTTP or HTTPS": The selection is activated/deactivated by pressing the "OK" key.

12.5.5.3 Changing the converter date and time

Overview

You change the converter date and time in menu "System" > "Settings" > "Date and time".

Various options are available for setting the date format and for adopting the date, the time and the time zone of the converter:

- Set manually
- Time zone
- Date
- Time
- Date format

Procedure

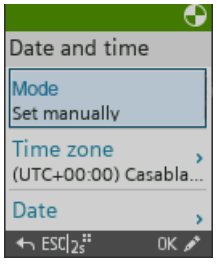


Figure 12-10 Changing the date and time

Proceed as follows to change the date and time:

1. In the navigation bar, navigate to the "System" menu.
   Confirm the selection using the "OK" key.
2. Select the "Settings" menu item.
   Confirm the selection using the "OK" key.

3. Select the "Date and time" menu item.
   Confirm the selection using the "OK" key.
4. Select the desired item to change the date/time.
   Confirm the selection using the "OK" key.
5. Change the specification.
   Confirm using the "OK" key.

12.5.5.4 Setting the display

Overview

You change the following settings in the "System" menu > "Settings" menu item > "Display":

- Lighting dur.
- Brightness

Procedure

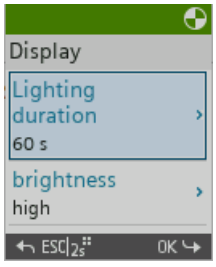


Figure 12-11 Changing the display settings

Proceed as follows to change the display settings:

1. In the navigation bar, navigate to the "System" menu.
   Confirm the selection using the "OK" key.
2. Select the "Settings" menu item.
   Confirm the selection using the "OK" key.
3. Select the "Display" menu item.
   Confirm the selection using the "OK" key.
4. Select the desired setting that you want to change.
   Confirm the selection using the "OK" key.
5. Change the specification.
   Confirm using the "OK" key.

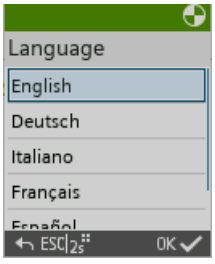
12.5.5.5 Change language

Overview

The default language for SINAMICS SDI Standard is "English".

You change the language setting in menu "System" > menu item "Settings" > "Language".

Procedure



To change the language setting, proceed as follows:

1. In the navigation bar, navigate to the "System" menu.
   Confirm the selection using the "OK" key.
   The "System" menu opens.
2. Select the "Settings" menu item.
   Confirm the selection using the "OK" key.
3. Select the "Language" menu item.
   Confirm the selection using the "OK" key.
4. Select the language required.
   Confirm the selection using the "OK" key.

12.5.6 "Support" menu

12.5.6.1 Scanning the IP address

Overview

The IP address of the converter is displayed in menu "Support" > "Scan IP address", and also available via a QR code.

You can connect to the converter web server using the IP address.

You have the following options depending on the operating unit:

- Scanning the QR code of the IP address using a mobile device
- Manually entering the IP address, e.g. at a computer, laptop

Requirement

- You have connected the mobile device to the drive via the WLAN or via a USB OTG (on-the-go) adapter.
- You have connected the computer/laptop to service interface X127 or PROFINET interface X150 via cable.

Procedure



Figure 12-12 IP address of the converter

Proceed as follows to connect to the converter web server via the QR code of the IP address:

1. In the navigation bar, navigate to the "Support" menu.
   Confirm the selection using the "OK" key.
2. Select the "Scan IP address" menu item.
   Confirm the selection using the "OK" key.
3. Press the "OK" key to access the QR code from the information window.
4. Select the interface via which the converter is connected.
   Confirm the selection using the "OK" key.
   The IP address of the converter and the corresponding QR code are displayed.
5. Scan the QR code of the IP address using your mobile device.
   A link is displayed on your mobile device.
6. Open the link.
   – The connection to the web server is established.
   – The converter web server is displayed.

12.5.6.2 Retrieving component information with a code scanner app

Overview

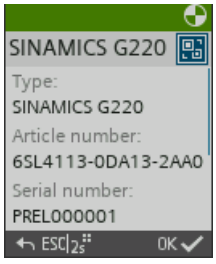
A component-specific QR code is provided in menu "Support" > "Component".

Scanning the QR code with your mobile device takes you to the converter product page on the Siemens Industry Online Support portal.

Requirement

You have installed an app for scanning QR codes on your mobile device.

Procedure





Retrieving component information

To go to the start page for the converter on the Siemens Industry Online Support portal, proceed as follows:

1. In the navigation bar, navigate to the "Support" menu.
   Confirm the selection using the "OK" key.
2. Select the "Component" menu item.
   Confirm the selection using the "OK" key.
3. Select the required component.
   Confirm the selection using the "OK" key.
   Component-specific data is displayed, for example type, Article No., serial number.
4. Confirm the default "Scan" icon using the "OK" key.
   The QR code with the previously output component information is displayed.
5. Scan the QR code with your mobile device.

You are forwarded to the start page for the converter on the Siemens Industry Online Support portal.

12.5.7 Menu "User area"

12.5.7.1 Overview

Overview

This menu provides the basic settings for managing users and passwords.

The operator panel shares the user account with the web server and Startdrive.



You can perform the following tasks in this menu:

- Logging on and off
- Viewing the currently logged-on users
- Changing the logon password

Precondition

You have activated User management & Access Control (UMAC).

Procedure

Character rules for user names and passwords

1. Make sure you use 7-bit ASCII characters on the operator panel.
   Permissible special characters are: !, ", #, $, %, &, ', (,), *, +, -, /, :, ;, <, =, >, ?, @, [, \,], ^, _, `, {, |, }, ~, ,, ., space
2. If you have created the user account on the web server or Startdrive that contains unavailable characters on the SINAMICS SDI Standard, change the user name or password via the web server or Startdrive.

More information

More information on user management can be found in "Configuration Manual Industrial Cybersecurity (https://support.industry.siemens.com/cs/us/en/view/109999221)".

12.5.7.2 Logging on to the operator panel

Overview

You can log on to the operator panel with your user name and password.

Requirement

- You have activated User management & Access Control (UMAC).
- You have a user account.

Procedure

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④ ⑤ ⑥



Proceed as follows to switch the user accounts:

1. In the navigation bar, navigate to the "User area" menu.
   Confirm your selection with OK.
2. Select the "User name" menu item.
   Confirm your selection with OK.
3. Enter the user name of the user account.
   Select ↲ and confirm with OK.
4. Select the "Password" menu item.
   Confirm your selection with OK.
5. Enter the password of the user account.
   Select ↲ and confirm with OK.
6. Select the "Logon" item.
   Confirm your selection with OK.

Functions

13

13.1 Overview of the firmware functions

Description

The converter firmware functions adapt the response of the drive system to the specific application requirements.

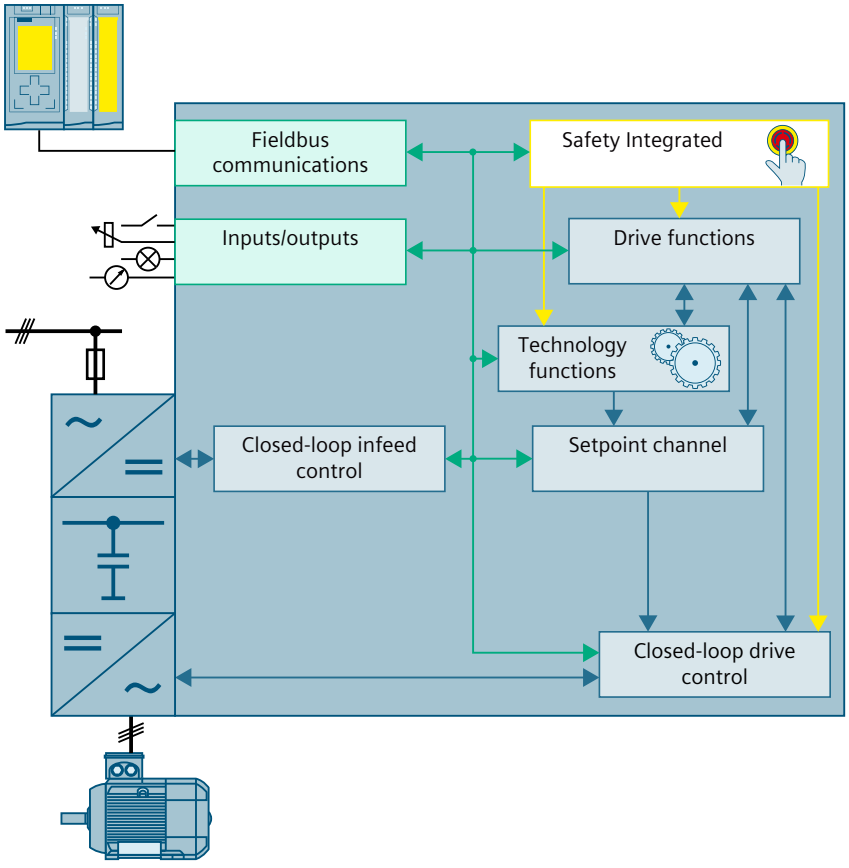


Figure 13-1 Converter firmware functions

Firmware function	Description
Fieldbus communications	The converter communicates with the higher-level control. The receive and send data can be interconnected with many converter functions.
Safety Integrated	Stop functions integrated in the converter and motion monitoring fulfill special requirements relating to fail-safety.
Inputs/outputs	The inputs and outputs of the terminal strip can be configured. The terminal strip signals can be interconnected with many converter functions.

Firmware function	Description
Drive functions	Basic functions for the application: • Sequence control when switching the motor on and off • Controlling the line contactor • Controlling the holding brake • Messages and monitoring
Technology functions	Supplementary functions. Examples: • PID technology controller • Basic positioner
Setpoint channel	The converter adapts the setpoint for the closed-loop drive control to the application. Examples: • Selection of the setpoint source, e.g. fieldbus or internal motorized potentiometer • Speed limitation • Acceleration limitation
Closed-loop infeed control	Closed-loop control of the DC link voltage and the line current for the Clean Power converter
Drive control	Depending on the selected operating mode, the converter controls the speed (open-loop control) or controls the speed and torque (closed-loop control) of the motor.

13.2 Parameters

Overview

The parameters of a converter function adapt a converter function to different applications or are used for diagnostics.

Description

The parameters are designated as follows with preceding letters:

- Adjustable parameters p adapt a converter function to different applications.
  Adjustable parameters can be read and written to.
- Display parameters r are used for diagnostics. Many display parameters are also signal sources for interconnection parameters.
  Display parameters are read-only parameters.
- Interconnection parameters c adapt a converter function to different applications.
  Interconnection parameters are signal sinks and can be interconnected with signal sources.

The parameter number follows the preceding letters. Many parameters are also indexed. The bit array is also displayed if parameters have bits that have a different significance.

p/r/cxxxx**[x...x]**	Parameter with index
p/r/cxxxx.**x...x**	Parameters with bit array
p/r/cxxxx**[x].x**	Parameter with index and bit

Example

Table 13-1 Examples of parameter numbers

Parameters	Description
p0300	Adjustable parameter 300
p1213[0...1]	Adjustable parameter 1213, indices 0 and 1
p1001[0...n]	Adjustable parameter 1001, indices 0 to n (n = configurable)
c1070[1]	Interconnection parameter 1070, index 1
p0795.4	Adjustable parameter 795, bit 4
r0020	Display parameter 20
r0052.0...15	Display parameter 52 with bit array from bit 0 (least significant bit) to bit 15 (most significant bit)
c0840[0]	Interconnection parameter 840, index 0

13.3 Signal interconnection

Overview

The converter allows input and output signals of different converter functions to be interconnected with one another. In addition to setting parameters, the ability to interconnect signals is an additional option of adapting converter functions to address the particular application.

Function description

A converter function comprises one or several subfunctions that are interconnected with one another.

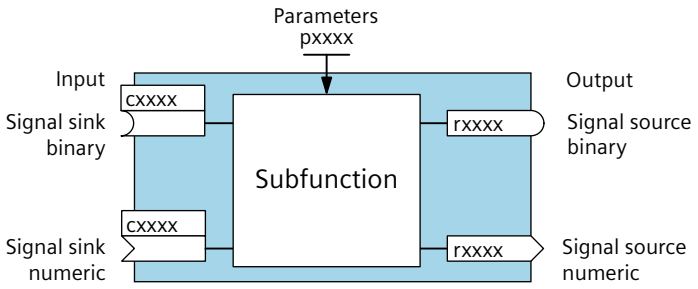


Figure 13-2 An interconnectable subfunction

Settable subfunctions can be adapted to the specific application using parameters.

In addition to setting parameters, inputs and outputs of subfunctions can be interconnected with other subfunctions.

The following signal interconnections are possible:

- Interconnecting signal sources with signal sinks:
  - Binary signal sinks and signal sources only have the value 0 or 1.
  - Numerical signal sinks and signal sources can have any values.
    We recommend that only signals with the same data format are interconnected.
    Data is lost if signal sink and signal source have different data formats. For example, when interconnecting a 16-bit word with a 32-bit double word, then the converter ignores the 16 most significant bits of the 32-bit double word.
- Interconnection of fixed values for binary or numerical signal sinks
- Interconnection of substitute values for binary and numerical signal sinks
  The converter uses the substitute value if the associated signal interconnection has become invalid.

Table 13-2 Interconnection possibilities

Icon	Name	Properties	Interconnection possibilities		
			Signal	Fixed value	Substitute value
	Binary signal sink	Can assume the value 0 or 1.	Binary signal source	X	X
	Binary signal source		Binary signal sink	-	-
	Numerical signal sink	16-bit word, 32-bit double word or floating point with 32 bit or 64 bit resolution	Numerical signal source	X	X
	Numerical signal source		Numerical signal sink	-	-

Example

Converter function "Motorized potentiometer" receives its input signals from the fieldbus and issues its output signal to the speed controller.

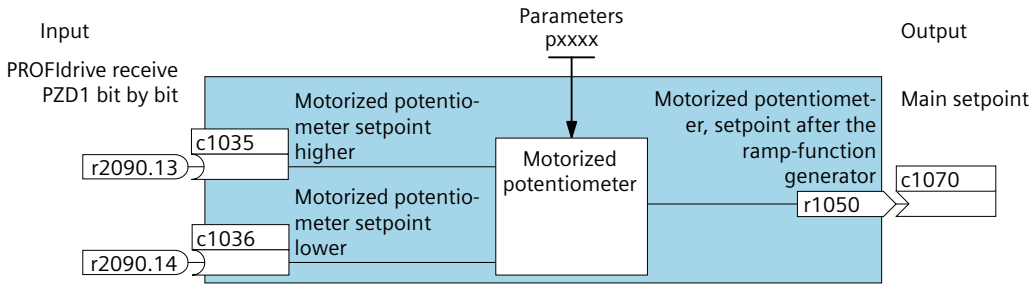


Figure 13-3 Example: Signal interconnection of the "Motorized potentiometer" converter function

The following signal interconnection is required for the example:

- Input signals of the motorized potentiometer are binary signal sinks that are interconnected with the signals from the fieldbus.
- The output signal of the motorized potentiometer is a numerical signal source that is interconnected with the main setpoint.

13.4 PROFINET and PROFIBUS communications

13.4.1 PROFINET fieldbus

Overview

The converter can be integrated into a PROFINET network.

Precondition

The converter is equipped with PROFINET interface X150.

You require the following to integrate the converter into a PROFINET network:

- Installed TIA Portal with the current Startdrive version
- For third-party controls, the GSDML file of the converter

The PN topology is configured in the controller to replace the device without removable data storage medium.

Function description

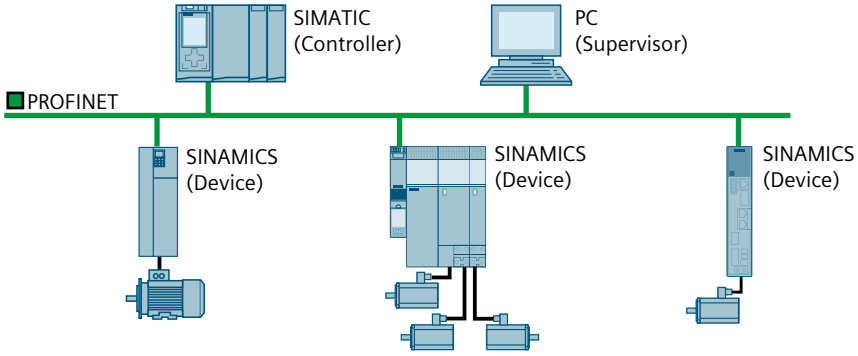


Figure 13-4 The converter in PROFINET operation (examples)

The converter supports the following functions:

- RT (Real-Time)
- IRT (Isochronous Real-Time)
- MRP (Media Redundancy Protocol): Media redundancy, with transition bump
- MRPD (Media Redundancy for Planned Duplication): Media redundancy, bumpless
- DFP (Dynamic Frame Packing): Reduce the bus cycle time by packing individual telegrams into a combined telegram
- Shared device: 2 control systems access the converter at the same time and independently
- System redundancy S2
- Diagnostic interrupts in accordance with the error classes specified in the PROFIdrive profile
- Device replacement without removable data storage medium: The replacement converter is assigned the device name from the controller, not from its memory card or from the programming device.

The converter automatically accepts a standard telegram or a manufacturer-specific telegram configured in the controller. A freely configured telegram is not automatically accepted.

More information

The GDSML file of the converter is available on the Internet:

GSDML SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109901084)

13.4.2 PROFINET protocols

Overview

The converter supports the PROFINET protocols listed in the table.

The information contained is required to set Industrial Cybersecurity measures such as the firewall for system protection.

Function description

The address parameters, the relevant communication layer, and the communication role and communication direction are specified for each protocol.

Table 13-3 PROFINET protocols

Protocol	Port number	Layer (2) Link layer (4) Transport layer	Description
DCP: Discovery and Configuration Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 8892 hex (PROFINET)	DCP detects and changes the IP suite settings of PROFINET interface X150 and service interface X127: IP address, subnet, gateway and NameOfStation. Available modes: • DCP access deactivated The PROFINET device is not visible. Communications via the DCP protocol is blocked. • Read/write DCP PROFINET device detection is activated. Changing the IP suite settings depends on interface: – X127: IP address, subnet and gateway can be changed. – X150: The IP address, subnet and gateway can be changed if there is no cyclic communications with a controller. • Only read DCP PROFINET device detection is activated; however, changes to the IP suite settings are blocked. • Only read DCP after setting up the application relationship The mode is only available for PROFINET interface X150. PROFINET device detection is activated. The IP suite settings can only be changed during commissioning. If cyclic communications is established between the PROFINET controller and the PROFINET device, then the PROFINET device responds the same as in mode "Only read DCP".
LLDP: Link Layer Discovery Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 88CC hex (PROFINET)	LLDP determines and manages neighbor relationships between PROFINET devices. LLDP uses the special multicast MAC address: 01-80-C2-00-00-0E
MRP: Media Redundancy Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 88E3 hex (PROFINET)	MRP enables the control of redundant routes through a ring topology. MRP uses the special multicast MAC address: xx-xx-xx-01-15-4E, xx-xx-xx = Organizationally Unique Identifier
PTCP Precision Transparent Clock Protocol	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 8892 hex (PROFINET)	PTCP enables the send clock synchronization and time synchronization between RJ45 ports required for IRT operation based on IEEE 1588. PTCP uses the special Multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier

Protocol	Port number	Layer (2) Link layer (4) Transport layer	Description
PROFINET IO data	Not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 8892 hex (PROFINET)	PROFINET IO data cyclically transfers process data between the PROFINET controller and PROFINET devices using telegrams.
PROFINET Context Manager	34964	(4) UDP	The PROFINET Context Manager provides an endpoint mapper in order to establish an application relationship (PROFINET AR).

13.4.3 Media redundancy

Overview

The converter supports media redundancy based on MRP (Media Redundancy Protocol). Media redundancy is a function to increase system availability through redundant communication paths.

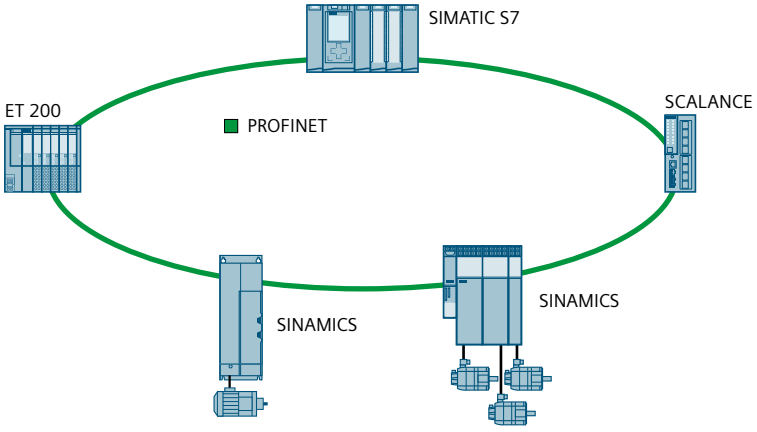
MRP can be expanded to MRPD (Media Redundancy with Planned Duplication of frames).

Requirement

The following preconditions apply regarding media redundancy:

- PROFINET as ring topology with redundancy manager
- Each device in the ring topology supports MRP or MRPD
- Maximum of 50 devices for each ring topology
- MRPD requires a suitable controller.
- MRPD requires that a topology is configured in the controller.

Function description



SIMATIC S7	PROFINET controller
ET 200	Distributed I/O
SINAMICS	Converter
SCALANCE	Redundancy manager

Figure 13-5 Example of a ring topology

Ethernet as basis for PROFINET only permits a single, unique data path from the controller to a device via a line-type topology or a star-type topology. MRP allows a line-type topology to be closed using a redundancy manager to create a ring-type topology. This means that every device can be accessed via 2 data paths.

When a device fails or if a cable is interrupted, the redundancy manager informs the device that the ring-type topology has now been switched over to a linear-type topology. The devices can be accessed again once a switchover has been made to a linear-type topology.

In the case of an interrupted cable, data transfer is only briefly interrupted (0 ... 200 ms) until the controller switches over to the redundant data path.

Under the following 2 alternative conditions, brief interruptions do not occur:

- The watchdog timer in the hardware configuration is set > 200 ms.
- Data transfer "IRT High Performance" is set.

13.4.4 Connection-oriented communication protocols

Overview

The converter supports connection-oriented communication protocols.

Function description

Table 13-4 Connection-oriented communication protocols

Protocol	Port number	Layer (2) Link layer (4) Transport layer	Description
DHCP Dynamic Host Configuration Protocol	68	(4) UDP	Is used to query an IP address. It is deactivated in the factory setting and is activated when the DHCP mode is selected.
ISO on TCP (according to RFC 1006)	102	(4) TCP	ISO on TCP (according to RFC 1006) is used for the message-oriented data exchange to a remote CPU, WinAC or products of other suppliers. Communication with engineering system, human machine interface, etc. Is active in the factory setting.
SNMP Simple network management protocol	161	(4) UDP	SNMP enables network management data to be read out and set (SNMP managed objects) by the SNMP manager.
https Secure Hypertext Transfer Protocol	443	(4) TCP	https is used for communication with the CU-internal web server via Transport Layer Security (TLS). Is active in the factory setting and can be deactivated.
Reserved	49152 ... 65535	(4) TCP (4) UDP	Dynamic port area that is used for the active connection endpoint if the application does not specify the local port number.

13.4.5 Shared device

Overview

The converter supports the PROFINET Shared Device.

PROFINET Shared Device improves network performance and allows the project to be distributed, e.g. into one standard project and one safety project.

Precondition

PROFINET Shared Device is only possible when using a safety control (F-CPU).

Function description

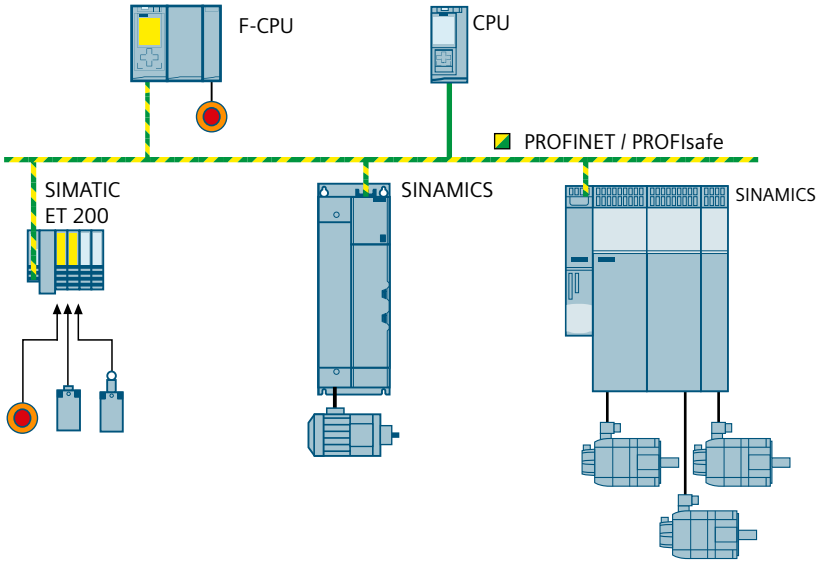


Figure 13-6 Shared device

The PROFINET "Shared Device" function allows two controls to access the same PROFINET IO device, e.g. on a SIMATIC ET 200 I/O system or on a converter. Typical applications for "Shared Device" are systems in which a standard CPU and a safety control (F-CPU) are used as separate controls:

- The safety control (F-CPU) is responsible for the Safety Integrated Functions in the converter and in the SIMATIC ET 200 I/O system.
- The standard control transfers all other signals.

Communications with both controls are independent of one another. If one of the control fails, the converter signals the failure but still communicates with the other control.

Establishing communication after the power supply voltage has been switched on:

1. The converter receives the configuration data of the automation control.
2. The converter establishes cyclic communication with the automation control.
3. The converter receives the configuration data of the F-CPU.
4. The converter establishes cyclic communication with the F-CPU.

13.4.6 System redundancy

Overview

The converter supports PROFINET system redundancy S2. The system redundancy guarantees that a system or machine continues to operate if a defect occurs or a controller is replaced.

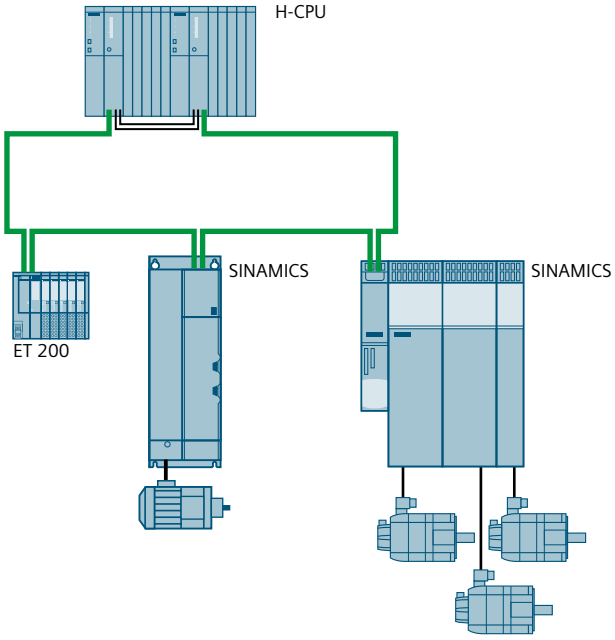
Requirement

A high-availability (fault-tolerant) control system comprising two synchronized controllers.

Restrictions:

- IRT is not supported
- Shared device and system redundancy cannot be operated simultaneously
- When configuring in the TIA Portal, the following applies to the data length for variables:
  - Maximum input data length according to GSD for variable MaxInputLength = 100 bytes.
  - Maximum output data length according to GSD for variable MaxOutputLength = 100 bytes.
  - Maximum total data length according to GSD for variable MaxDataLength = 200 bytes.

Function description



H-CPU	A high-availability (fault-tolerant) control system comprising two synchronized controllers
ET 200	Distributed I/O
SINAM-ICS	Converter

Figure 13-7 Example of PROFINET with system redundancy

The high-availability control system comprises an active and a reserve controller that continuously synchronize with one another via fiber-optic cable. If a controller fails, then the other controller automatically takes over.

The converter supports system redundancy S2:

- The converter only uses one PROFINET interface to connect with a single or redundant network (e.g. MRP).
- 2 PROFINET controllers can be assigned to the converter.

For the time that it takes to switch over from one controller to the other, the converter controls the motor with the last setpoint that was received.

13.4.7 Diagnostics with PROFINET

Overview

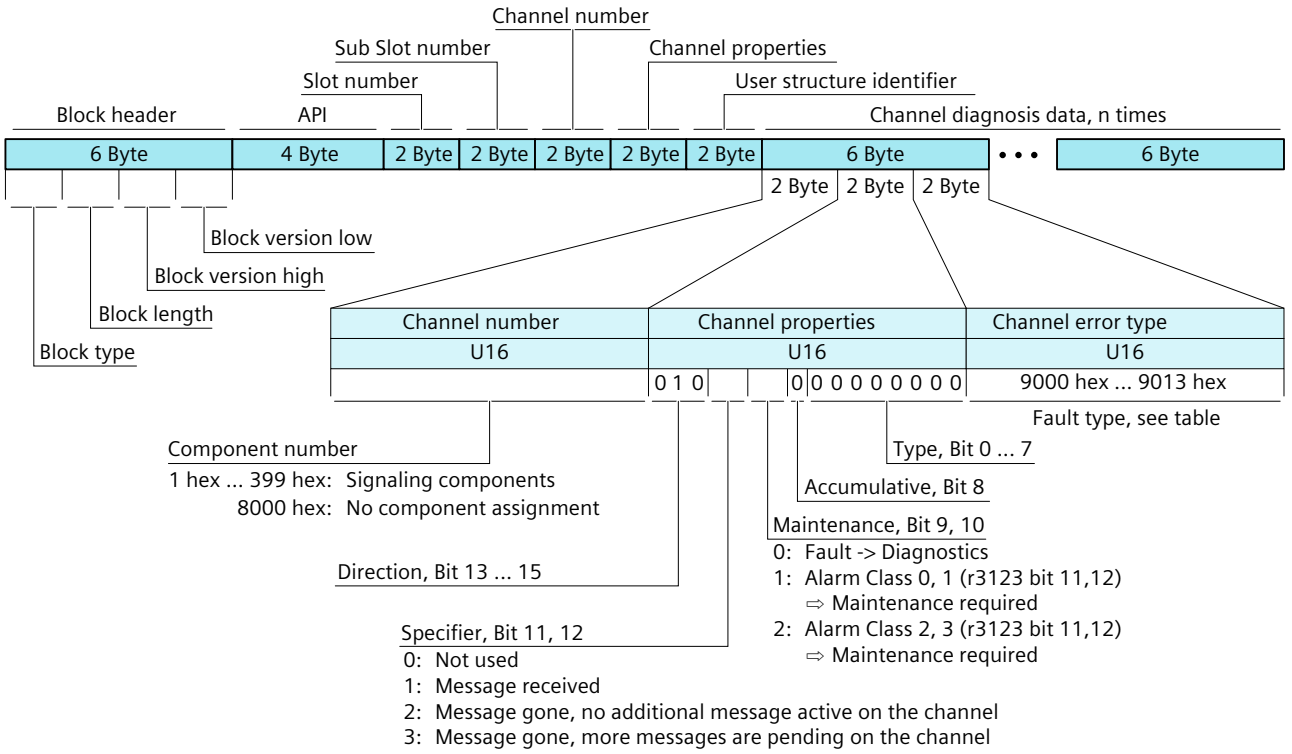
The converter provides diagnostic data according to the PROFINET standard. SINAMICS faults and alarms are mapped onto PROFIdrive fault classes, enabling them to be directly displayed on an HMI through the PROFINET controller.

Description of function

The fault and alarm messages are saved in the parameters of the converter.

The converter transfers messages in the sequence in which they occur. The converter records the time when a message occurs, and the controller generates a time stamp when it receives the message.

The faults and alarms are mapped onto PROFIdrive failure classes and sent via PROFINET channel diagnosis to the PROFINET controller.



9000 hex	Hardware/software error	900A hex	Position/speed actual value incorrect or not available
9001 hex	Network fault	900B hex	Internal (DRIVE-CLiQ) communication error
9002 hex	Supply voltage fault	900C hex	Infeed faulted
9003 hex	DC link overvoltage	900D hex	Braking chopper faulted
9004 hex	Power electronics faulted	900E hex	Line filter faulted
9005 hex	Overtemperature of the electronic components	900F hex	External measured value / signal state outside the permissible range
9006 hex	Ground fault / inter-phase short circuit	9010 hex	Application / technological function faulted
9007 hex	Motor overload	9011 hex	Error in the parameterization / configuration / commissioning procedure
9008 hex	Communication error to the higher-level control system	9012 hex	General drive fault
9009 hex	Safety monitoring channel has identified an error	9013 hex	Auxiliary unit faulted

Figure 13-8 Structure of the channel diagnostics

The diagnostic data can be accessed via the PROFINET controller by reading the record with index 0x800C on the module access of the converter.

The following rules apply:

- 1 message block (=ChannelDiagnosisData)
  if (one or several) faults of the same message class are detected at the converter
- n message blocks
  if at the converter, n faults of different message classes are detected

Parameters

The following list contains the parameters of the "Diagnostics with PROFINET" function.

Number	Name	Unit
r0947[0...63]	Fault number	-
r2122[0...63]	Alarm code	-
r3120[0...63]	Component fault	-
r3121[0...63]	Component alarm	-
r9745[0...63]	SI components	-
r60049[0...63]	SI message value	-

13.4.8 PROFIBUS DP fieldbus

Overview

The converter can be integrated into a PROFIBUS network.

Precondition

The converter is equipped with PROFIBUS interface X126.

You require the following to integrate the converter into a PROFIBUS network:

- TIA Portal with the current Startdrive version
- For third-party controls, the GSD file of the converter

The PROFIBUS address of the converter and the telegram are set using a commissioning tool.

The converter only accepts a modified PROFIBUS address after the supply voltage is switched off and switched on again.

Function description

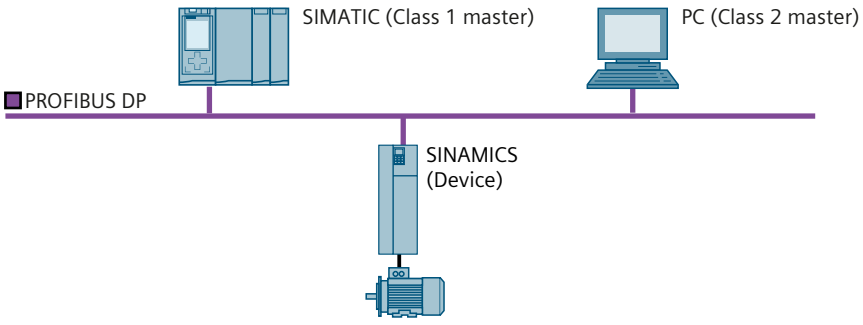


Figure 13-9 The converter in PROFIBUS DP operation (examples)

The master identifies the converter based on an individual address in the range 1 ... 125.

The converter supports the following functions:

- Cyclic communication
- Acyclic communication
- Isochronous communication
- Diagnostic interrupts in accordance with the error classes specified in the PROFIdrive profile

Parameters

The following list contains the parameters of function "PROFIBUS DP fieldbus".

Number	Name	Unit
r0918	PROFIBUS address	-
r0963	PROFIBUS baud rate	-

13.4.9 PROFIenergy

13.4.9.1 Energy-saving mode

Overview

PROFIenergy is a profile for energy management in production systems. PROFIenergy uses the PROFINET communication protocol.

Description of function

The higher-level control transfers the control commands and status queries in acyclic operation via data record 80A0 hex.

The converter supports PROFIenergy profile V1.3 and function unit class 3.

The converter supports energy-saving mode 2.

13.4.9.2 Energy-saving mode 2

Overview

The converter supports energy-saving mode 2.

Function description

The converter exhibits the following behavior when energy-saving mode 2 is active:

- Communications via PROFINET continues to run without any interruption.
- None for energy-saving relevant shutdown in the converter power unit.

- The converter does not send any diagnostic interrupts.
- p5611 defines whether the motor stops when transitioning into energy-saving mode 2.
- When transitioning into energy-saving mode 2, the converter can control or switch-off other products. To do this, binary signal source r5613 must be interconnected, e.g. with a digital output.

The converter exits hibernation mode 2 under the following conditions:

- The higher-level control goes into STOP operating state.
- The bus connection to the higher-level control is interrupted.

Parameters

The following list contains the parameters of function "Hibernation 2".

Number	Name	Unit
r5600	PROFIenergy energy-saving mode ID	-
p5611.0...2	PROFIenergy energy-saving properties general	-
r5613.0...1	PROFIenergy energy saving active/inactive	-

13.4.9.3 Setting the energy-saving mode

Overview

Various setting modes are available for the energy-saving mode.

Settings

Adjust the energy-saving mode using the information in the following table:

Table 13-5 Energy-saving mode settings

Settings	Parameters	Result
Inhibiting PROFIenergy	p5611.0 = 1	They block the reaction of the converter to PROFIenergy control commands. In this case, the converter rejects the "Start_Pause" command with 50 hex (no appropriate pause mode).
Transition to energy-saving mode	p5611.2 = 0	With p5611.2 = 0, you enable the transition to energy-saving mode from operating state S1 (switching on inhibited) or S2 (ready to switch on).
	With p5611.2 = 1	With p5611.2 = 1, you enable the transition to energy-saving mode from operating states S3 (ready for operation) and S4 (operation).
	Additional settings:	
	p5611.1 = 1	With the transition to energy-saving mode, the converter triggers an OFF1 command and enters the switching on inhibited state (S1).

13.4.9.4 Control commands for energy-saving mode

Overview

The converter switches to energy-saving mode or back to normal operation, depending on the control command.

Description of function

The following table contains the control commands for energy-saving mode.

Table 13-6 Control commands energy-saving mode

Command	Explanation
Start_Pause	Switches to energy-saving mode depending on the pause duration
Start_Pause_with_time_response	Switches to energy-saving mode depending on the pause duration and also specifies the transition times in the command response
End_Pause	Switches from energy-saving mode to normal operation Cancels switching from normal operation to energy-saving mode

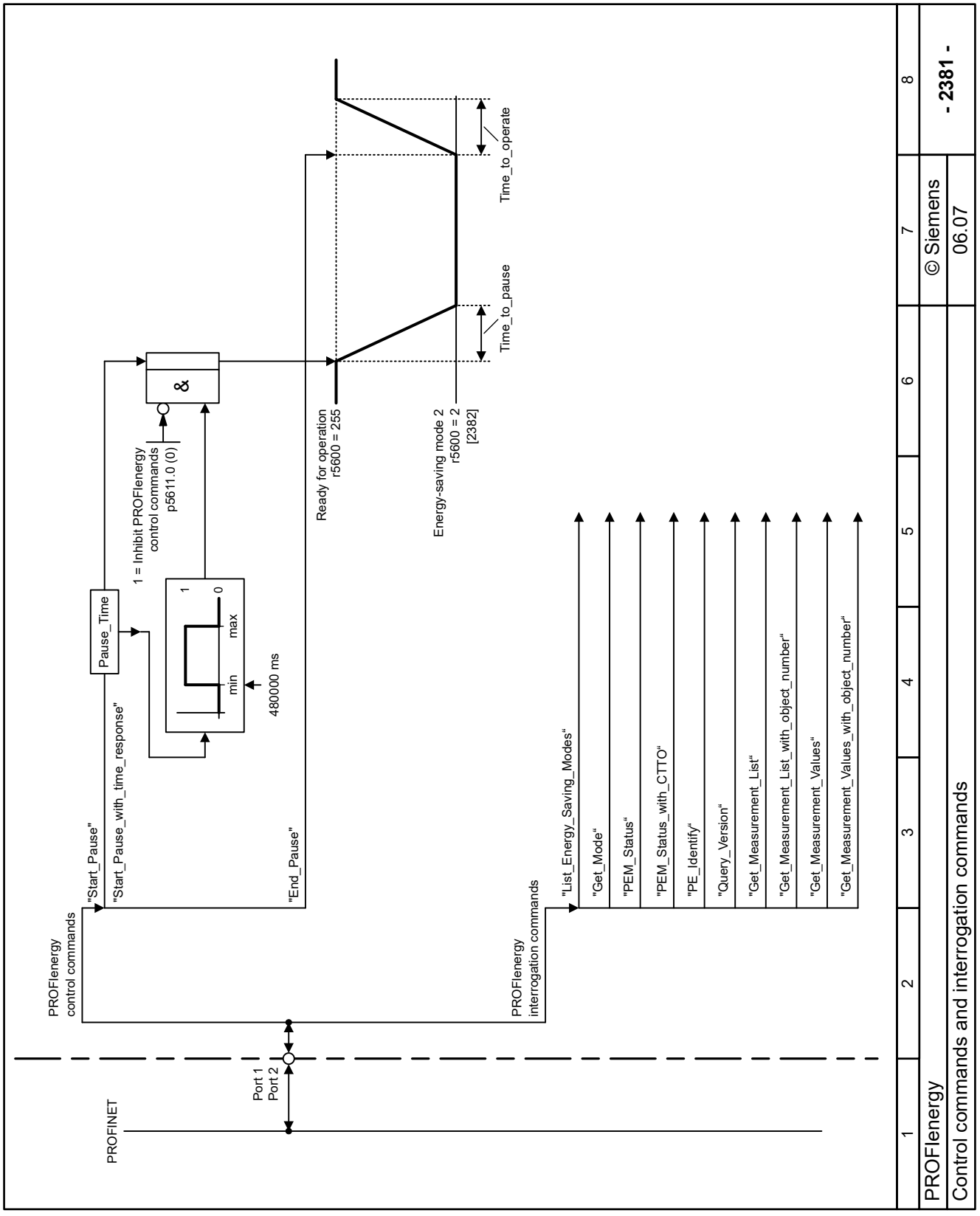


Figure 13-10 2381 - Control commands and interrogation commands

13.4.9.5 Status queries in energy-saving mode

Overview

The converter returns information about the settings and status of energy saving mode to the higher-level controller via status queries.

Description of function

The following table shows the available status queries.

Table 13-7 Status queries energy-saving mode

Command	Explanation
List_Energy_Saving_Modes	Returns all supported energy-saving modes
Get_Mode	Provides information about the selected energy-saving mode
PEM_Status	Returns the current PROFIenergy status
PEM_Status_with_CTTO	Returns the current PROFIenergy status together with the regular transition time to the operating state
PE_Identify	Returns the supported PROFIenergy commands
Query_Version	Returns the implemented PROFIenergy profile
Query_Attributes	Returns the attributes of the implemented PROFIenergy profile
Get_Measurement_List	Returns the measured value IDs that can be accessed using the "Get_Measurement_Values" command
Get_Measure-ment_List_with_object_number	Returns the measured value IDs and the associated object number that can be accessed using the "Get_Measurement_Values_with_object_number" command
Get_Measurement_Values	Returns the measured values requested via the measured value ID
Get_Measurement_Val-ues_with_object_number	Returns the measured values requested via the measured value ID and the object number. The object number corresponds to the drive object ID.

Table 13-8 Measured values

PROFIenergy					SINAMICS source parameters		Value range
Measured value		Accuracy		Unit			
ID	Name	Do-main	Class		Number	Name	
34	Active power	1	12	W	r0032	Active power smoothed	r2004
166	Power factor	1	12	1	r0038	Smoothed power factor	0 ... 1
200	Active energy im-port	2	11	Wh	r0039[1]	Energy accepted	-

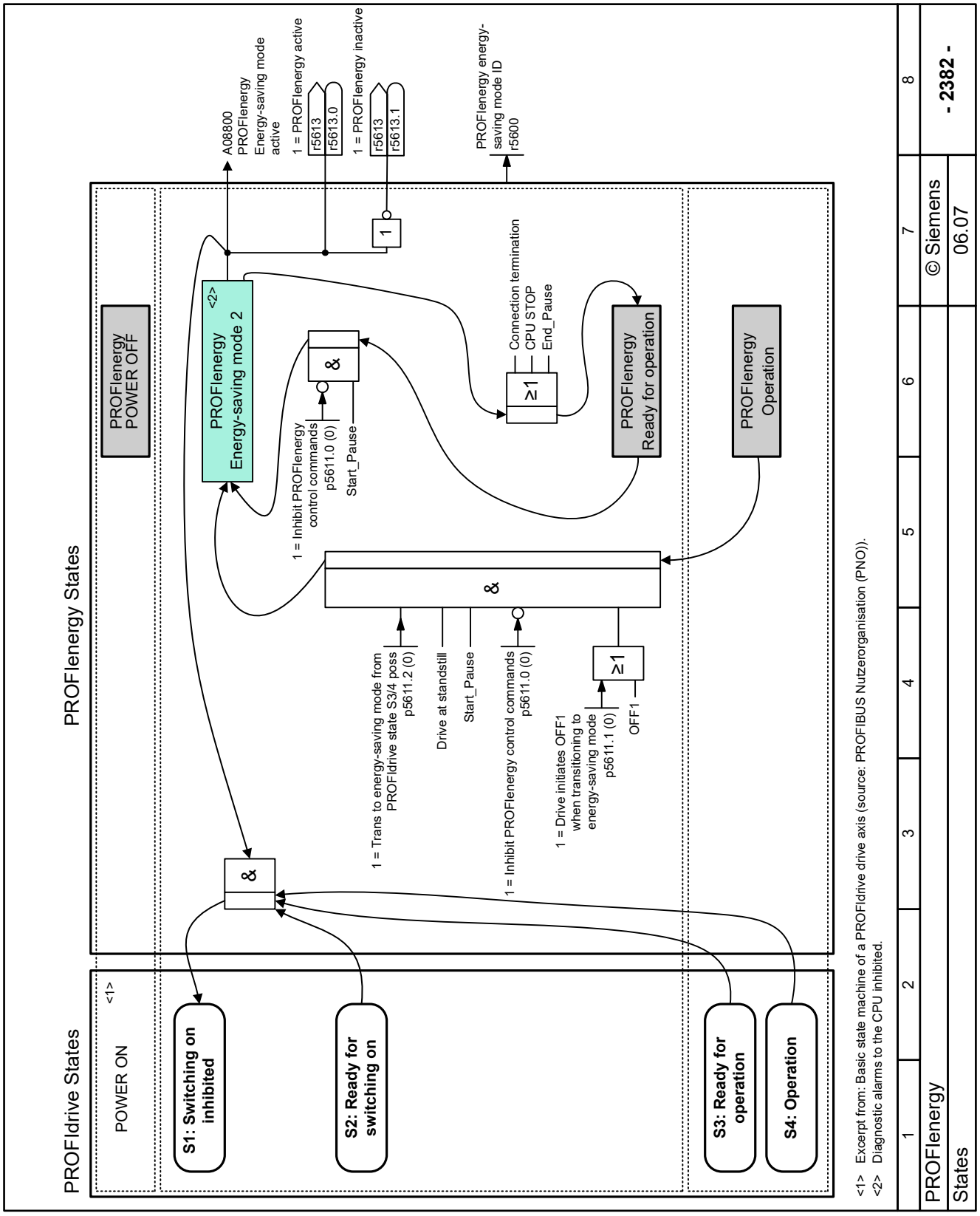


Figure 13-11 2382 - States

13.4.9.6 Error value

Overview

The converter responds to invalid PROFIenergy commands with an error value.

Function description

Table 13-9 Error value

Error value	Meaning
01 hex	Invalid ID service request
03 hex	Invalid modifier
04 hex	Invalid ID request data structure
06 hex	No energy-saving mode supported
07 hex	Response too long
08 hex	Impermissible block header
50 hex	No suitable energy saving mode on the converter for the selected pause duration
51 hex	The scheduled pause time is too short for the converter to switch to a pause mode.
52 hex	Invalid mode ID
53 hex	The converter cannot enter an energy-saving mode because it is in operation.
54 hex	Function currently not available
56 hex	No UMAC write access
57 hex	No UMAC read access

13.4.10 PROFIdrive telegrams

13.4.10.1 Telegram structure

Overview

Converter and higher-level control system exchange data via a fieldbus using telegrams.

Description of function

The converter receives data from the higher-level control cyclically and returns data to the control cyclically.

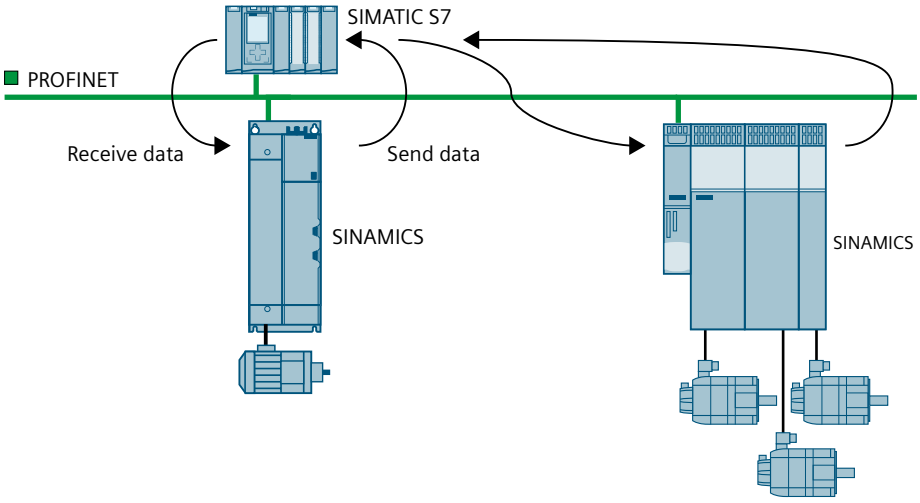


Figure 13-12 Cyclic data exchange

Converter and higher-level control system package their data in telegrams.

Specific telegrams are defined for typical applications in the PROFIdrive profile and are provided with a fixed PROFIdrive telegram number. Behind every PROFIdrive telegram number is thus a fixed composition of signals. This means that a telegram number provides an unambiguous description of the cyclic data exchange.

13.4.10.2 Receive data

Overview

The converter writes the receive data of the set telegram to signal sources designated for that purpose.

Precondition

You have activated communication via fieldbus and set a telegram.

Function description

Receive data are available in the following formats:

- "Integer16" in r2050
- "Integer32" in r2060
- "Floating-point32" in r8600
- "Floating-point64" in r8602

The converter interconnects the receive data with the signal sinks that match the selected telegram.

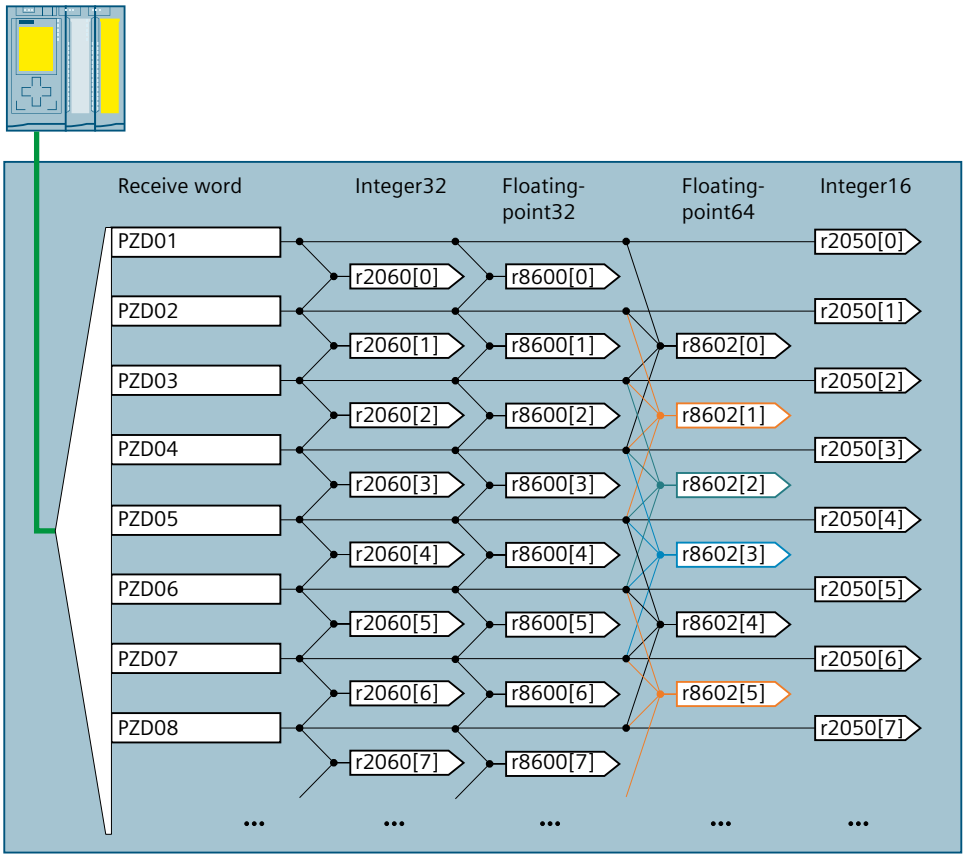
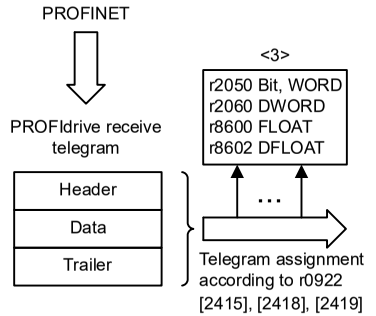


Figure 13-13 Interconnection of receive data

Parameters

The following list contains the parameters of the "Receive data" function.

Number	Name	Unit
r2050[0...31].0...15	PROFIdrive PZD receive word	-
r2060[0...30]	PROFIdrive PZD receive double word	-
r8600[0...30]	PROFIdrive PZD receive Float32	-
r8602[0...28]	PROFIdrive PZD receive Float64	-



Signal targets for PZD receive signals

Signal	Meaning	PROFIdrive Signal-No.	Interconnection parameter <1>	Function diagramm	Data type <2>	Scaling
STW1	Control word 1	1	(bit serial)	[2441] ... [2443] [2475] <4>	U16	-
STW2	Control word 2	3	(bit serial)	[2444], [2445]	U16	-
NSOLL_A	Speed setpoint A (16-bit)	5	c1060	[3030.1]	I16	4000 hex ≙ p2000
NSOLL_B	Speed setpoint B (32-bit)	7	c1060	[3030.1]	I32	4000 0000 hex ≙ p2000
G1_STW	Encoder 1 control word	9	c0480[0]	-	U16	-
G2_STW	Encoder 2 control word	13	c0480[1]	-	U16	-
SATZANW	Block selection	32	(bit serial)	[2476]	U16	-
MDI_TARPOS	MDI target position	34	c2642	[3620.1]	I32	-
MDI_VELOCITY	MDI velocity	35	c2643	[3620.1]	I32	-
MDI_ACC	MDI acceleration	36	c2644	[3620.1]	I16	4000 hex ≙ 100 %
MDI_DEC	MDI deceleration	37	c2645	[3620.1]	I16	4000 hex ≙ 100 %
MDI_MOD	MDI mode specification	38	(bit serial)	[2480]	U16	-
MDI_TARPOS_F	MDI target position	42	c2642	[3620.1]	F32	- <6>
MDI_TARPOS_D	MDI target position	43	c2642	[3620.1]	F64	- <6>
MDI_VELOCITY_F	MDI velocity	44	c2643	[3620.1]	F32	- <6>
MDI_ACC_F	MDI acceleration	45	c11560	-	F32	- <6>
MDI_DEC_F	MDI deceleration	46	c11561	-	F32	- <6>
REF_COORDINATE_F	Home position	47	c2598	[3612.4]	F32	- <6>
REF_COORDINATE_D	Home position	48	c2598	[3612.4]	F64	- <6>
FSOLL	Frequency setpoint	55	c1060	[3030.1]	I16	4000 hex ≙ p2000
MOMRED	Torque reduction	101	c1542	[6630.1]	I16	4000 hex ≙ p1544
OVERRIDE	Override in positioning mode	205	c2646	[3630.5]	I16	4000 hex ≙ 100 %
POS_STW1	Positioning control word 1	220	(bit serial)	[2463]	U16	-
POS_STW2	Positioning control word 2	222	(bit serial)	[2464]	U16	-
MDI_Mode	MDI_Mode	229	c2654	[3620.1]	U16	-
STW3 <7>	Control word 3	304	(bit serial)	[2446]	U16	-
M_LIM	Torque limit	310	c1552, c1554	[6060.1]	U16	4000 hex ≙ 100 %

<5>

<1>
When selecting a standard telegram or manufacturer-specific telegram, this interconnection parameter of the command data set CDS0 is automatically set.

<2>
Data type acc. to the PROFIdrive profile:
I16/I32 = Integer16/32,
U16/U32 = Unsigned16/32
F32/F64 = FloatingPoint32/64.

<3>
Display parameters for receive data according to [2468].

<4>
Used in telegrams 7, 9, 111, 112, 113.

<5>
Only EPOS telegrams 112, 113.

<6>
No scaling necessary. The signal contains the value with data type FloatingPoint and physical unit.

<7>
Only SIEMENS telegram 350.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2440 -
PZD receive signals interconnection						06.07	

Figure 13-14 2440 - PZD receive signals interconnection

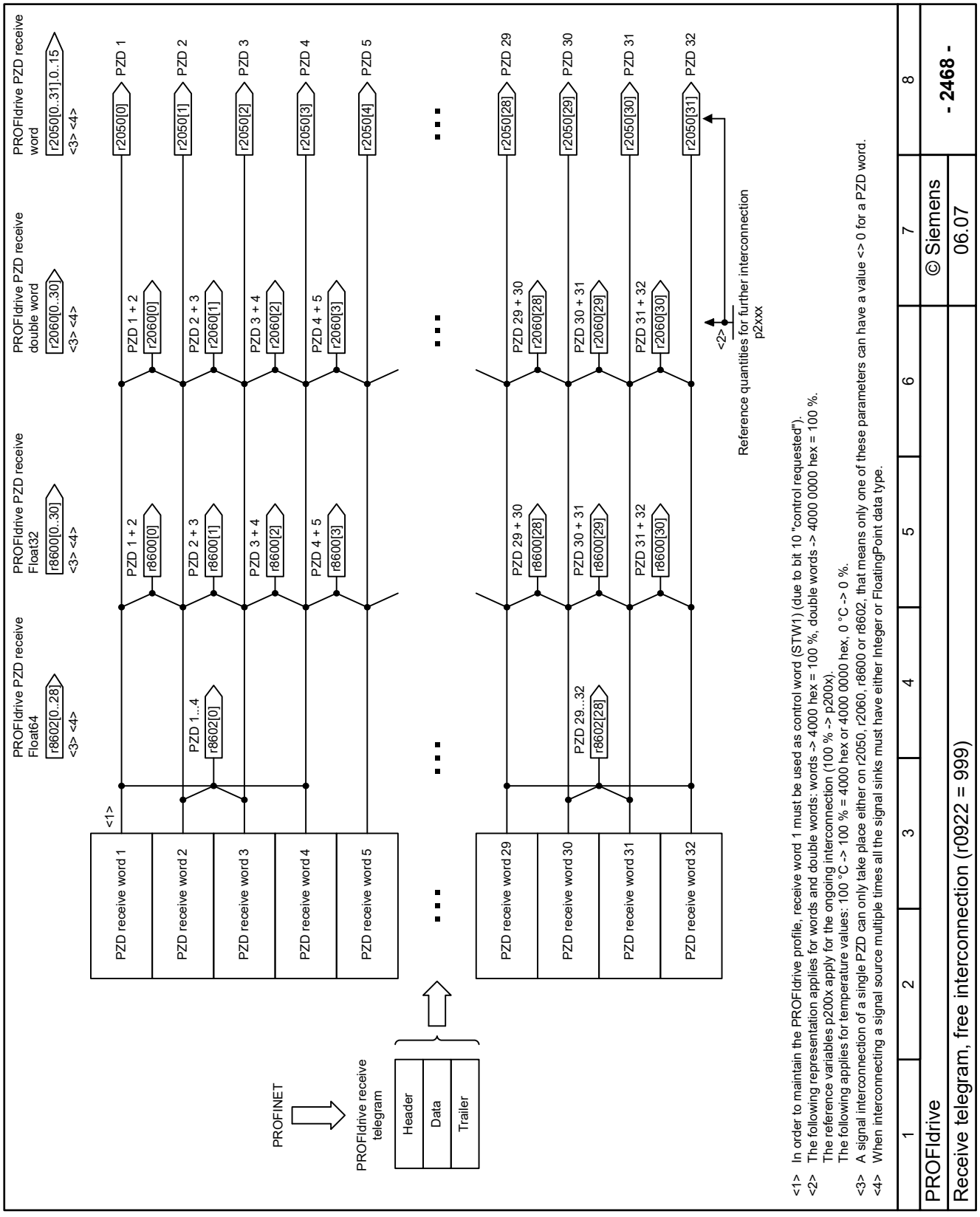


Figure 13-15 2468 - Receive telegram free interconnection

13.4.10.3 Send data

Overview

The converter receives the send data of the set telegram from signal sinks designated for that purpose.

Precondition

You have activated communication via fieldbus and set a telegram.

Function description

Send data are available in the following formats:

- "Integer16" in c2053
- "Integer32" in c2063
- "Floating-point32" in c8601
- "Floating-point64" in c8603

The converter interconnects the send data with the signal sources that match the selected telegram.

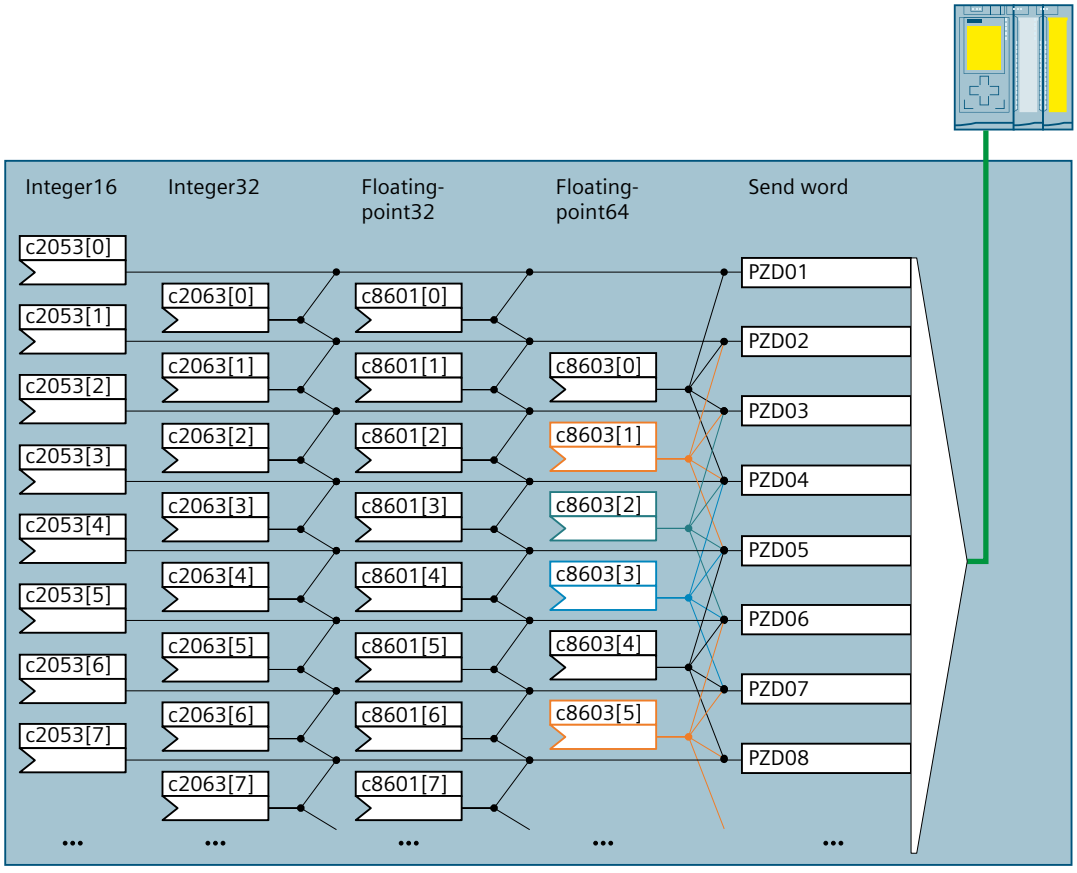


Figure 13-16 Interconnection of send data

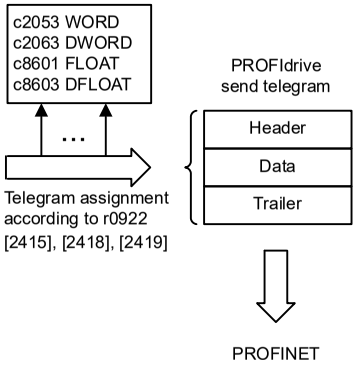
Parameters

The following list contains the parameters of the "Send data" function.

Number	Name	Unit
c2053[0...31]	PROFIdrive PZD send word	-
c2063[0...30]	PROFIdrive PZD send double word	-
c8601[0...30]	PROFIdrive PZD send Float32	-
c8603[0...28]	PROFIdrive PZD send Float64	-

Signal sources for PZD send signals

Signal	Meaning	PROFIdrive Signal-No.	<1> Interconnection parameter	Function diagramm	<2> Data type	Scaling
ZSW1	Status word 1	2	c2053[0]	[2451], [2452]	U16	-
				[2479] <3>	U16	-
ZSW2	Status word 2	4	c2053[3]	[2454]	U16	-
NIST_A	Actual speed A (16 bit)	6	r0063[0]	[4715]	I16	4000 hex ≙ p2000
NIST_B	Actual speed B (32 bit)	8	r0063[0]	[4715]	I32	4000 0000 hex ≙ p2000
G1_ZSW	Encoder 1 status word	10	r0481[0]	[4730]	U16	-
G1_XIST1	Encoder 1 position actual value 1	11	r0482[0]	[4704]	U32	-
G1_XIST2	Encoder 1 position actual value 2	12	r0483[0]	[4704]	U32	-
G2_ZSW	Encoder 2 status word	14	r0481[1]	[4730]	U16	-
G2_XIST1	Encoder 2 position actual value 1	15	r0482[1]	[4704]	U32	-
G2_XIST2	Encoder 2 position actual value 2	16	r0483[1]	[4704]	U32	-
XIST_A	Position actual value A	28	r2521[0]	[4010]	I32	-
XIST_D	Position actual value	31	r2521[0]	[4010]	F64	- <5>
AKTSATZ	Active traversing block	33	r2670	[3650]	U16	-
XIST_F	Position actual value	40	r2521[0]	[4010]	F32	- <5>
VIST_F	Velocity actual value	41	r2522[0]	[4010]	F32	- <5>
IAIST_GLATT	Absolute actual current, smoothed	51	r0068[1]	[6799]	I16	4000 hex ≙p2002
MIST_GLATT	Actual torque smoothed	53	r0080[1]	[6799]	I16	4000 hex ≙p2003
PIST_GLATT	Actual active power, smoothed	54	r0082[1]	[6799]	I16	4000 hex ≙ p2004
FIST_GLATT	Frequency actual value, smoothed	56	r0063[1]	[6799]	I16	4000 hex ≙ p2000
MELDW	Message word	102	c2053[x] <4>	[2460]	U16	-
POS_ZSW1	Positioning status word 1	221	c2053[1]	[2466]	U16	-
POS_ZSW2	Positioning status word 2	223	c2053[2]	[2467]	U16	-
FAULT_CODE	Fault code	301	r2131	[8060]	U16	-
WARN_CODE	Alarm code	303	r2132	[8065]	U16	-
ZSW3	Status word 3	305	r0053	[2456]	U16	-



<1>
When selecting a standard telegram or manufacturer-specific telegram, this interconnection parameter is automatically set.

<2>
Data type acc. to the PROFIdrive profile:
I16/I32 = Integer16/32,
U16/U32 = Unsigned16/32
F32/F64 = FloatingPoint32/64.

<3>
Used in telegrams 7, 9, 111, 112, 113.

<4>
When selecting a standard telegram or manufacturer-specific telegram, this interconnection parameter is automatically set.

<5>
No scaling necessary. The signal contains the value with data type FloatingPoint and physical unit.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2450 -
PZD send signals interconnection						06.07	

Figure 13-17 2450 - PZD send signals interconnection

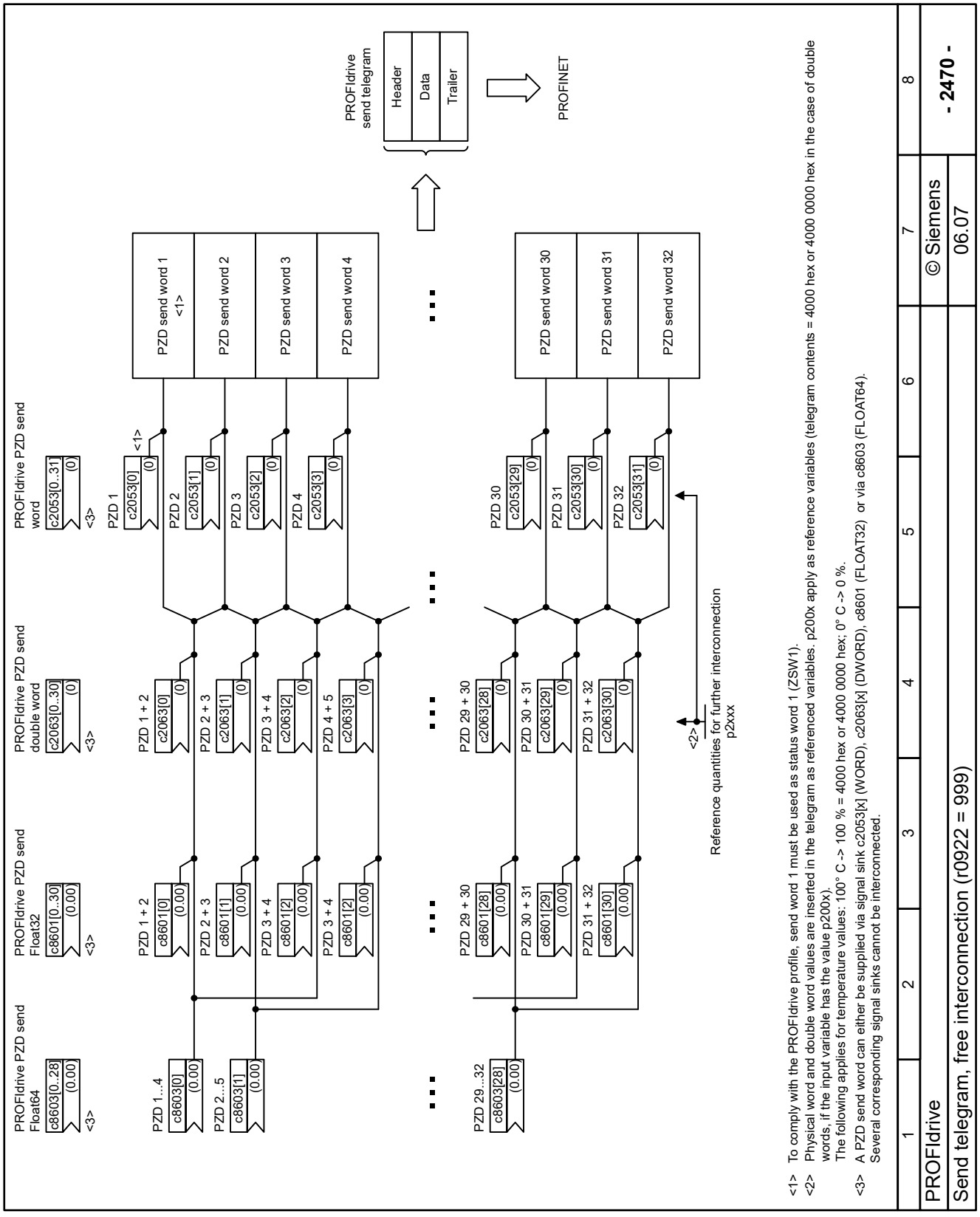


Figure 13-18 2470 - Send telegram free interconnection

13.4.10.4 Telegram 1

Function description

Process data	Telegram 1			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_A	16-bit speed setpoint	NIST_A	Speed actual value 16-bit

Parameters

The following list contains the parameters of function "Telegram 1".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm

13.4.10.5 Telegram 2

Function description

Process data	Telegram 2			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2

Parameters

The following list contains the parameters of function "Telegram 2".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm

13.4.10.6 Telegram 3

Function description

Process data	Telegram 3			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	G1_STW	Control word for encoder 1	G1_ZSW	Status word from encoder 1
PZD06	---	Not assigned	G1_XIST1	Position actual value 1 from encoder 1
PZD07	---			
PZD08	---		G1_XIST2	Position actual value 2 from encoder 1
PZD09	---			

Parameters

The following list contains the parameters of function "Telegram 3".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c0480[0...2]	Encoder control word Gn_STW	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r0482[0...2]	Encoder position actual value Gn_XIST1	-
r0483[0...2]	Encoder position actual value Gn_XIST2	-
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm

13.4.10.7 Telegram 4

Function description

Process data	Telegram 4			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	G1_STW	Control word for encoder 1	G1_ZSW	Status word from encoder 1

Process data	Telegram 4			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD06	G2_STW	Control word for encoder 2	G1_XIST1	Position actual value 1 from encoder 1
PZD07	---	Not assigned		
PZD08	---		G1_XIST2	Position actual value 2 from encoder 1
PZD09	---			
PZD10	---		G2_ZSW	Status word from encoder 2
PZD11	---		G2_XIST1	Position actual value 1 from encoder 2
PZD12	---			
PZD13	---		G2_XIST2	Position actual value 2 from encoder 2
PZD14	---			

Parameters

The following list contains the parameters of function "Telegram 4".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c0480[0...2]	Encoder control word Gn_STW	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r0482[0...2]	Encoder position actual value Gn_XIST1	-
r0483[0...2]	Encoder position actual value Gn_XIST2	-
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm

13.4.10.8 Telegram 7

Function description

Process data	Telegram 7			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	SATZANW	Selects the traversing block	AKTSATZ	Currently selected traversing block

Parameters

The following list contains the parameters of function "Telegram 7".

Number	Name	Unit
r2670.0...15	EPOS status word active traversing block	-

13.4.10.9 Telegram 9

Function description

Process data	Telegram 9			
	Control → Converter		Converter → Control	
	Signal	**Explanation**	**Signal**	**Explanation**
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	SATZANW	Selects the traversing block	AKTSATZ	Currently selected traversing block
PZD03	STW2	Control word 2	ZSW2	Status word 2
PZD04	MDI_TARPOS	Position setpoint for direct setpoint input (MDI)	XIST_A	Actual position value (32 bits)
PZD05				
PZD06	MDI_VELOCITY	MDI velocity	-	
PZD07				
PZD08	MDI_ACC	MDI accelerating torque	-	
PZD09	MDI_DEC	MDI braking torque		
PZD10	MDI_MOD	Selects the positioning mode in the case of direct setpoint input (MDI)	-	

Parameters

The following list contains the parameters of function "Telegram 9".

Number	Name	Unit
r2521[0...3]	LR position actual value	mm
r2521[0...3]	LR position actual value	°
c2642	EPOS direct setpoint input/MDI position setpoint	mm
c2642	EPOS direct setpoint input/MDI position setpoint	°
c2643	EPOS direct setpoint input/MDI velocity setpoint	mm/s
c2643	EPOS direct setpoint input/MDI velocity setpoint	°/s
c2644	EPOS direct setpoint input/MDI acceleration override	%
c2645	EPOS direct setpoint input/MDI deceleration override	%
r2670.0...15	EPOS status word active traversing block	-

13.4.10.10 Telegram 20

Function description

Process data	Telegram 20			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_A	16-bit speed setpoint	NIST_A_GLATT	Smoothed speed actual value 16 bit
PZD03	---	Not assigned	IAIST_GLATT	Smoothed current actual value
PZD04	---		MIST_GLATT	Smoothed torque actual value
PZD05	---		PIST_GLATT	Smoothed active power actual value
PZD06	---		MELD_NAMUR	Message word according to the VIK-NAMUR definition

Parameters

The following list contains the parameters of function "Telegram 20".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r0068[0...1]	Absolute current actual value	Arms
r0080[0...1]	Torque actual value	Nm
r0082[0...2]	Active power actual value (motor)	kW
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm
r3113.0...15	NAMUR message bit bar	-

13.4.10.11 Telegram 102

Function description

Process data	Telegram 102			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	MOMRED	Torque reduction	MELDW	Message word
PZD06	G1_STW	Control word for encoder 1	G1_ZSW	Status word from encoder 1

Process data	Telegram 102			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD07	---	Not assigned	G1_XIST1	Position actual value 1 from encoder 1
PZD08	---			
PZD09	---		G1_XIST2	Position actual value 2 from encoder 1
PZD10	---			

Parameters

The following list contains the parameters of function "Telegram 102".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c0480[0...2]	Encoder control word Gn_STW	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r0482[0...2]	Encoder position actual value Gn_XIST1	-
r0483[0...2]	Encoder position actual value Gn_XIST2	-
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm
c1542[0...n]	Travel to fixed stop torque reduction	%

13.4.10.12 Telegram 103

Function description

Process data	Telegram 103			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_B	32-bit speed setpoint	NIST_B	Speed actual value 32-bit
PZD03				
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	MOMRED	Torque reduction	MELDW	Message word
PZD06	G1_STW	Control word for encoder 1	G1_ZSW	Status word from encoder 1
PZD07	G2_STW	Control word for encoder 2	G1_XIST1	Position actual value 1 from encoder 1
PZD08	---	Not assigned		
PZD09	---		G1_XIST2	Position actual value 2 from encoder 1
PZD10	---			
PZD11	---		G2_ZSW	Status word from encoder 2
PZD12	---		G2_XIST1	Position actual value 1 from encoder 2
PZD13	---			
PZD14	---		G2_XIST2	Position actual value 2 from encoder 2
PZD15	---			

Parameters

The following list contains the parameters of function "Telegram 103".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
c0480[0...2]	Encoder control word Gn_STW	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r0482[0...2]	Encoder position actual value Gn_XIST1	-
r0483[0...2]	Encoder position actual value Gn_XIST2	-
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm
c1542[0...n]	Travel to fixed stop torque reduction	%

13.4.10.13 Telegram 111

Function description

Process data	Telegram 111			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	POS_STW1	Control word 1 for basic positioner	POS_ZSW1	Status word 1 for basic positioner
PZD03	POS_STW2	Control word 2 for basic positioner	POS_ZSW2	Status word 2 for basic positioner
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	OVERRIDE	Override in the positioning mode (4000 hex ≙ 100%)	MELDW	Status word for messages
PZD06	MDI_TARPOS	MDI target position	XIST_A	Position actual value in INT32
PZD07				
PZD08	MDI_VELOCITY	MDI velocity	NIST_B	Speed actual value
PZD09				
PZD10	MDI_ACC	MDI acceleration (4000 hex ≙ 100%)	FAULT_CODE	Number of the actual fault
PZD11	MDI_DEC	MDI delay (4000 hex ≙ 100%)	WARN_CODE	Number of the actual alarm
PZD12	Not assigned	-	Not assigned	-

Parameters

The following list contains the parameters of function "Telegram 111".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm

r2131	Actual fault code	-
r2132	Actual alarm code	-
r2521[0...3]	LR position actual value	mm
r2521[0...3]	LR position actual value	°
c2642	EPOS direct setpoint input/MDI position setpoint	mm
c2642	EPOS direct setpoint input/MDI position setpoint	°
c2643	EPOS direct setpoint input/MDI velocity setpoint	mm/s
c2643	EPOS direct setpoint input/MDI velocity setpoint	°/s
c2644	EPOS direct setpoint input/MDI acceleration override	%
c2645	EPOS direct setpoint input/MDI deceleration override	%
c2646	EPOS velocity override	%

13.4.10.14 Telegram 112

Function description

Process data	Telegram 112			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	POS_STW1	Control word 1 for basic positioner	POS_ZSW1	Status word 1 for basic positioner
PZD03	POS_STW2	Control word 2 for basic positioner	POS_ZSW2	Status word 2 for basic positioner
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	OVERRIDE	Override in the positioning mode (4000 hex ≙ 100%)	Reserved	---
PZD06	MDI_TARPOS_F	MDI target position	XIST_F	Position actual value
PZD07				
PZD08	MDI_VELOCITY_F	MDI velocity	VIST_F	Velocity actual value
PZD09				
PZD10	MDI_ACC_F	MDI acceleration	MELDW	Message word
PZD11			FAULT_CODE	Fault code
PZD12	MDI_DEC_F	MDI delay	WARN_CODE	Alarm code
PZD13			---	---
PZD14	Reserved	---	---	---
PZD15		---	---	---
PZD16	REF_COORDINATE	Homing position	---	---
PZD17			---	---

Parameters

The following list contains the parameters of function "Telegram 112".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r2131	Actual fault code	-
r2132	Actual alarm code	-
r2521[0...3]	LR position actual value	mm
r2521[0...3]	LR position actual value	°
c2642	EPOS direct setpoint input/MDI position setpoint	mm
c2642	EPOS direct setpoint input/MDI position setpoint	°
c2643	EPOS direct setpoint input/MDI velocity setpoint	mm/s
c2643	EPOS direct setpoint input/MDI velocity setpoint	°/s
c2644	EPOS direct setpoint input/MDI acceleration override	%
c2645	EPOS direct setpoint input/MDI deceleration override	%
c2646	EPOS velocity override	%

13.4.10.15 Telegram 113

Function description

Process data	Telegram 113			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	POS_STW1	Control word 1 for basic positioner	POS_ZSW1	Status word 1 for basic positioner
PZD03	POS_STW2	Control word 2 for basic positioner	POS_ZSW2	Status word 2 for basic positioner
PZD04	STW2	Control word 2	ZSW2	Status word 2
PZD05	OVERRIDE	Override in the positioning mode (4000 hex ≙ 100%)	Reserved	---
PZD06	MDI_TARPOS_D	MDI target position	XIST_D	Position actual value
PZD07				
PZD08				
PZD09				
PZD10	MDI_VELOCITY_F	MDI velocity	VIST_F	Velocity actual value
PZD11				
PZD12	MDI_ACC_F	MDI acceleration	MELDW	Message word
PZD13			FAULT_CODE	Fault code
PZD14	MDI_DEC_F	MDI delay	WARN_CODE	Alarm code
PZD15			---	---
PZD16	Reserved	---	---	---
PZD17			---	---

Process data	Telegram 113			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD18	REF_COORDI-NATE_D	Homing position	---	---
PZD19			---	---
PZD20			---	---
PZD21			---	---

Parameters

The following list contains the parameters of function "Telegram 113".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r2131	Actual fault code	-
r2132	Actual alarm code	-
r2521[0...3]	LR position actual value	mm
r2521[0...3]	LR position actual value	°
c2642	EPOS direct setpoint input/MDI position setpoint	mm
c2642	EPOS direct setpoint input/MDI position setpoint	°
c2643	EPOS direct setpoint input/MDI velocity setpoint	mm/s
c2643	EPOS direct setpoint input/MDI velocity setpoint	°/s
c2644	EPOS direct setpoint input/MDI acceleration override	%
c2645	EPOS direct setpoint input/MDI deceleration override	%
c2646	EPOS velocity override	%

13.4.10.16 Telegram 350

Function description

Process data	Telegram 350			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	FSOLL	16 bit frequency setpoint	FIST_GLATT	16 bit smoothed frequency actual value
PZD03	M_LIM	Torque limit value	IAIST_GLATT	Smoothed current actual value
PZD04	STW3	Control word 3	ZSW3	Status word 3

Parameters

The following list contains the parameters of function "Telegram 350".

Number	Name	Unit

r0068[0...1]	Absolute current actual value	Arms
c1503[0...n]	Torque setpoint	Nm
c1552[0...n]	Torque limit upper scaling without offset	%
c1554[0...n]	Torque limit lower scaling without offset	%

13.4.10.17 Telegram 352

Function description

Process data	Telegram 352			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	NSOLL_A	16-bit speed setpoint	NIST_A_GLATT	Smoothed speed actual value 16 bit
PZD03	...	Freely assignable	IAIST_GLATT	Smoothed current actual value
PZD04	...		MIST_GLATT	Smoothed torque actual value
PZD05	...		WARN_CODE	Alarm code
PZD06	...		FAULT_CODE	Fault code

Parameters

The following list contains the parameters of function "Telegram 352".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r0068[0...1]	Absolute current actual value	Arms
r0080[0...1]	Torque actual value	Nm
c1070[0...n]	Main setpoint	rpm
c1155[0...n]	Speed controller speed setpoint 1	rpm
r2131	Actual fault code	-
r2132	Actual alarm code	-

13.4.10.18 Telegram 700

Function description

Process data	Telegram 700			
	Control → Converter		Converter → Control "Safety Info Channel"	
	Signal	Explanation	Signal	Explanation
PZDn+1	---	Not assigned	S_ZSW1B	Status word 1B Status of the Safety Integrated Functions
PZDn+2	---		S_V_LIMIT_B	Actual limitation to the setpoint speed
PZDn+3	---			

Transfer of telegram 700 is not failsafe. A PROFIsafe telegram is required for failsafe transfer.

Parameters

The following list contains the parameters of function "Telegram 700".

Number	Name	Unit
r9733[0...2]	SI effective setpoint velocity limiting	rpm
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-

13.4.10.19 Telegram 701

Function description

Process data	Telegram 701			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZDn+1	S_STW1B	Control word of Safety Integrated Functions	S_ZSW1B	Status word of the Safety Integrated Functions
PZDn+2	S_STW3B	Control word of Safety Integrated Functions	S_ZSW2B	Status word of the Safety Integrated Functions
PZDn+3	---	Not assigned	S_V_Limit_B	Actual limitation to the setpoint speed
PZDn+4	---			
PZDn+5	---		S_ZSW3B	S_ZSW3B: Status word of the Safety Integrated Functions

Transfer of telegram 701 is not failsafe. A PROFIsafe telegram is required for fail-safe transfer.

Parameters

The following list contains the parameters of function "Telegram 701".

13.4.10.20 Telegram 750

Function description

Process data	Telegram 750			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZDn+1	M_ADD1	Acceleration compensation	M_ACT	Actual torque
PZDn+2	M_LIMIT_POS	Positive torque limit	---	Not assigned
PZDn+3	M_LIMIT_NEG	Negative torque limit	---	

Parameters

The following list contains the parameters of function "Telegram 750".

Number	Name	Unit
r0080[0...1]	Torque actual value	Nm
c1511[0...n]	Supplementary torque 1	Nm
c1522[0...n]	Torque limit upper	Nm
c1523[0...n]	Torque limit lower	Nm

13.4.10.21 Telegram 999

Function description

To comply with the PROFIdrive profile, PZD01 must be configured as control word 1 (STW1) and status word 1 (ZSW1).

Process data	Telegram 999			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	...	Freely assignable	...	Freely assignable
PZD03	...		...	
. . .				
PZD31	...		...	
PZD32	...		...	

13.4.11 Control words, status words and message word for closed-loop speed control

13.4.11.1 Control and status word 1

Overview

Control word 1 (STW1) activates the drive functions of the converter.

Status word 1 (ZSW1) signals the converter status to the higher-level control system.

Function description

Control word 1 (STW1)		
Control → Converter		
Bit	**Drive function**	**Explanation**
00	0 = OFF1	The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.
	0 → 1 = ON	The converter goes into the "Ready" state. If, in addition, bit 3 = 1, the converter switches on the motor.
01	0 = OFF2	Immediately switch off the motor and the motor then coasts down to a standstill.
	1 = No OFF2	The motor can be switched on (ON command).
02	0 = Quick stop (OFF3)	Quick stop: The motor brakes to a standstill with the OFF3 ramp-down time p1135.
	1 = No quick stop (OFF3)	The motor can be switched on (ON command).
03	0 = Inhibit operation	Immediately switch off motor (cancel pulses).
	1 = Enable operation	Switch on motor (pulses can be enabled).
04	0 = Inhibit RFG	The converter immediately sets its ramp-function generator output to 0.
	1 = Do not inhibit RFG	The ramp-function generator can be enabled.
05	0 = Stop RFG	The output of the ramp-function generator stops at the current value.
	1 = Enable RFG	The output of the ramp-function generator follows the setpoint.

Control word 1 (STW1)				
Control → Converter				
Bit	**Drive function**			**Explanation**
06	0 = Inhibit setpoint			The converter brakes the motor with the ramp-down time p1121 of the ramp-function generator.
	1 = Enable setpoint			Motor accelerates to the setpoint with the ramp-up time p1120.
07	0 → 1 = Acknowledge faults			Acknowledge fault. If the ON command is still active, the converter switches to the "switching on inhibited" state.
08	Reserved			
09	Reserved			
10	0 = No control by PLC			Converter ignores the process data from the fieldbus.
	1 = Control by PLC			Control via fieldbus, converter accepts the process data from the fieldbus.
11	1 = Direction reversal			Invert setpoint in the converter.
12	Telegrams 102, 103	All other telegrams		
	1 = Unconditionally release holding brake	Reserved		
13	Telegrams 20, 102, 103		All other telegrams	Increase the setpoint saved in the motorized potentiometer.
	Reserved		1 = MOP raise	
14	Telegrams 102, 103	Telegram 20	All other telegrams	Reduce the setpoint saved in the motorized potentiometer.
	1 = Torque control active 0 = Closed-loop speed control active	---	1 = MOP lower	
15	Reserved	CDS bit 0	Reserved	Changeover between settings for different operation interfaces (command data sets).

Status word 1 (ZSW1)		
Converter → Control		
Bit	**Status**	**Explanation**
00	1 = Ready for switching on	Power supply is switched on, electronics are initialized, pulses are inhibited.
01	1 = Ready	Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the converter switches on the motor.
02	1 = Operation enabled	Motor follows setpoint. See control word 1, bit 3.

Status word 1 (ZSW1)				
Converter → Control				
Bit	**Status**			**Explanation**
03	1 = Fault present			The converter has a fault. Acknowledge fault using STW1.7.
04	1 = OFF2 inactive			Coast down to standstill is not active.
05	1 = OFF3 inactive			Quick stop is not active.
06	1 = Switching on inhibited active			It is only possible to switch on the motor after an OFF1 followed by ON.
07	1 = Alarm active			Motor remains switched on; no acknowledgment is necessary.
08	1 = Speed deviation within the tolerance range			Setpoint/actual value deviation within the tolerance range.
09	1 = Control requested			The automation system has been requested to take over control of the converter.
10	1 = Comparison speed reached or exceeded			Speed is greater than or equal to the corresponding maximum speed.
11	Telegrams 102, 103	Telegram 20	All other telegrams	Comparison value for current or torque has been reached or exceeded.
	1 = Alarm class bit 0	1 = Current or torque limit reached	1 = Torque limit reached	
12	1 = Alarm class bit 1	---	1 = Holding brake open	Signal for opening and closing a motor holding brake.
13	Telegrams 102, 103	All other telegrams		--
	Reserved	0 = Alarm motor overtemperature		
14	1 = Torque control active	1 = Motor rotates clockwise		Converter-internal actual value > 0.
		0 = Motor rotates counter-clockwise		Converter-internal actual value < 0
15	Telegrams 102, 103	Telegram 20	All other telegrams	
	Reserved	1 = CDS display	0 = Alarm converter thermal overload	

Parameters

The following list contains the parameters of the "Control and status word 1" function.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
c0810	Command data set selection CDS bit 0	-
r0836.0...3	Command Data Set CDS selected	-
c0840[0...n]	ON / OFF (OFF1)	-
c0844[0...n]	No coast-down / coast-down (OFF2) signal 1	-
c0848[0...n]	No Quick Stop / Quick Stop (OFF3) signal 1	-
c0852[0...n]	Enable operation/inhibit operation	-
c0854[0...n]	Control by PLC/no control by PLC	-

r0899.0...13	Status word sequence control	-
c1035[0...n]	Motorized potentiometer raise setpoint	-
c1036[0...n]	Motorized potentiometer lower setpoint	-
c1113[0...n]	Setpoint inversion	-
c1140[0...n]	Enable ramp-function generator/inhibit ramp-function generator	-
c1141[0...n]	Continue ramp-function generator/ freeze ramp-function generator	-
c1142[0...n]	Enable setpoint/inhibit setpoint	-
r1407.0...31	Status word speed controller	-
c2103[0...n]	1st acknowledge faults	-
r2135.6...15	Status word faults/alarms 2	-
r2139.0...15	Status word faults/alarms 1	-
r2197.0...13	Status word monitoring 1	-
r2199.0...11	Status word monitoring 3	-

Signal targets for STW1 in Interface Mode 3 (VIK-NAMUR) <1>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
STW1.0	↑ = ON (pulses can be enabled) 0 = OFF1 (braking with ramp-function generator, then pulse suppression & ready for switching on)	c0840[0] = r2050[0].0	[2501.2]	[2610]
STW1.1	1 = No OFF2 (enable is possible) 0 = OFF2 (immediate pulse suppression and switching on inhibited)	c0844[0] = r2050[0].1	[2501.2]	[2610]
STW1.2	1 = No OFF3 (enable is possible) 0 = OFF3 (braking with the OFF3 ramp p1135, then pulse suppression and switching on inhibited)	c0848[0] = r2050[0].2	[2501.2]	[2610]
STW1.3	1 = Enable operation (pulses can be enabled) 0 = Inhibit operation (suppress pulses)	c0852[0] = r2050[0].3	[2501.2]	[2610]
STW1.4	1 = Ramp-function generator enable 0 = Inhibit ramp-function generator (set the ramp-function generator output to zero)	c1140[0] = r2050[0].4	[2501.2]	[3060], [3070], [3080]
STW1.5	1 = Continue ramp-function generator 0 = Freezes the ramp-function generator	c1141[0] = r2050[0].5	[2501.2]	[3060], [3070]
STW1.6	1 = Setpoint enable 0 = Inhibits the setpoint (the ramp-function generator input is set to zero)	c1142[0] = r2050[0].6	[2501.2]	[3060], [3070], [3080]
STW1.7	↑ = 1st acknowledge faults	c2103[0] = r2050[0].7	[2512.1]	[8060]
STW1.8	Reserved	-	-	-
STW1.9	Reserved	-	-	-
STW1.10	1 = Control via PLC <2>	c0854[0] = r2050[0].10	[2501.2]	[2501]
STW1.11	1 = Direction reversal <3>	c1113[0] = r2050[0].11	[2505.2]	[3040]
STW1.12	Reserved	-	-	-
STW1.13	Reserved	-	-	-
STW1.14	Reserved	-	-	-
STW1.15	1 = CDS bit 0	c0810 = r2050[0].15	-	[8560]

<1> Used in telegram 20.
<2> Bit 10 in STW1 must be set to ensure that the drive accepts the process data.
<3> The direction reversal can be locked (see p1110 and p1111).

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2441 -
STW1 control word interconnection in Interface Mode 3 (VIK/NAMUR)						06.07	

Figure 13-19 2441 – STW1 control word interconnection in Interface Mode 3 (VIK/NAMUR)

Signal targets for STW1 in Interface Mode 1 <1>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
STW1.0	⤒= ON (pulses can be enabled) 0 = OFF1 (braking with ramp-function generator, then pulse suppression & ready for switching on)	c0840[0] = r2050[0].0	[2501.2]	[2610]
STW1.1	1 = No OFF2 (enable is possible) 0 = OFF2 (immediate pulse suppression and switching on inhibited)	c0844[0] = r2050[0].1	[2501.2]	[2610]
STW1.2	1 = No OFF3 (enable is possible) 0 = OFF3 (braking with the OFF3 ramp p1135, then pulse suppression and switching on inhibited)	c0848[0] = r2050[0].2	[2501.2]	[2610]
STW1.3	1 = Enable operation (pulses can be enabled) 0 = Inhibit operation (suppress pulses)	c0852[0] = r2050[0].3	[2501.2]	[2610]
STW1.4	1 = Ramp-function generator enable 0 = Inhibit ramp-function generator (set the ramp-function generator output to zero)	c1140[0] = r2050[0].4	[2501.2]	[3060], [3070], [3080]
STW1.5	1 = Continue ramp-function generator 0 = Freezes the ramp-function generator	c1141[0] = r2050[0].5	[2501.2]	[3060], [3070]
STW1.6	1 = Setpoint enable 0 = Inhibits the setpoint (the ramp-function generator input is set to zero)	c1142[0] = r2050[0].6	[2501.2]	[3060], [3070], [3080]
STW1.7	⤒ = 1st acknowledge faults	c2103[0] = r2050[0].7	[2512.1]	[8060]
STW1.8	Reserved	-	-	-
STW1.9	Reserved	-	-	-
STW1.10	1 = Control via PLC <2>	c0854[0] = r2050[0].10	[2501.2]	[2501]
STW1.11	1 = Direction reversal <3>	c1113[0] = r2050[0].11	[2505.2]	[3040]
STW1.12	Reserved	-	-	-
STW1.13	1 = Motorized potentiometer raise	c1035[0] = r2050[0].13	[2505.2]	[3020]
STW1.14	1 = Motorized potentiometer lower	c1036[0] = r2050[0].14	[2505.2]	[3020]
STW1.15	Reserved	-	-	-

<1> Used in telegram 1, 2, 3, 4, 350, 352.
<2> Bit 10 in STW1 must be set to ensure that the drive accepts the process data.
<3> The direction reversal can be locked (see p1110 and p1111).

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2442 -
STW1 control word interconnection in Interface Mode 1						06.07	

Figure 13-20 2442 - control word interconnection via Interface Mode 1

Signal targets for STW1 in Interface Mode 2 <1>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
STW1.0	↑ = ON (pulses can be enabled) 0 = OFF1 (braking with ramp-function generator, then pulse suppression & ready for switching on)	c0840[0] = r2050[0].0	[2501.2]	[2610]
STW1.1	1 = No OFF2 (enable is possible) 0 = OFF2 (immediate pulse suppression and switching on inhibited)	c0844[0] = r2050[0].1	[2501.2]	[2610]
STW1.2	1 = No OFF3 (enable is possible) 0 = OFF3 (braking with the OFF3 ramp p1135, then pulse suppression and switching on inhibited)	c0848[0] = r2050[0].2	[2501.2]	[2610]
STW1.3	1 = Enable operation (pulses can be enabled) 0 = Inhibit operation (suppress pulses)	c0852[0] = r2050[0].3	[2501.2]	[2610]
STW1.4	1 = Ramp-function generator enable 0 = Inhibit ramp-function generator (set the ramp-function generator output to zero)	c1140[0] = r2050[0].4	[2501.2]	[3060], [3070], [3080]
STW1.5	1 = Continue ramp-function generator 0 = Freezes the ramp-function generator	c1141[0] = r2050[0].5	[2501.2]	[3060], [3070]
STW1.6	1 = Setpoint enable 0 = Inhibits the setpoint (the ramp-function generator input is set to zero)	c1142[0] = r2050[0].6	[2501.2]	[3060], [3070], [3080]
STW1.7	↑ = 1st acknowledge faults	c2103[0] = r2050[0].7	[2512.1]	[8060]
STW1.8	Reserved	-	-	-
STW1.9	Reserved	-	-	-
STW1.10	1 = Control via PLC <2>	c0854[0] = r2050[0].10	[2501.2]	[2501]
STW1.11	1 = Ramp-function generator active	c2148[0] = r2050[0].11	-	[8011]
STW1.12	1 = Unconditionally open the holding brake	c0855[0] = r2050[0].12	[2501.2]	[2701]
STW1.13	Reserved	-	-	-
STW1.14	1 = Closed-loop torque control active 0 = Closed-loop speed control active	c1501[0] = r2050[0].14	[2520.2]	[6060]
STW1.15	Reserved	-	-	-

<1> Used in telegram 102, 103.
<2> Bit 10 in STW1 must be set to ensure that the drive accepts the process data.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2443 -
STW1 control word interconnection in Interface Mode 2						06.07	

Figure 13-21 2443 – STW1 control word interconnection in Interface Mode 2

Signal sources for ZSW1 in Interface Mode 3 (VIK-NAMUR) <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal status word	[Function diagram] signal target
ZSW1.0	1 = Ready for switching on	c2053[0].0 = r0899.0	[2503.7]	[2610]
ZSW1.1	1 = Ready for operation (DC link loaded, pulses inhibited)	c2053[0].1 = r0899.1	[2503.7]	[2610]
ZSW1.2	1 = Operation enabled (drive follows n_set)	c2053[0].2 = r0899.2	[2503.7]	[2610]
ZSW1.3	1 = Fault present	c2053[0].3 = r2139.3	[2548.7]	[8060]
ZSW1.4	1 = No coast down active (OFF2 inactive)	c2053[0].4 = r0899.4	[2503.7]	[2610]
ZSW1.5	1 = No Quick stop active (OFF3 inactive)	c2053[0].5 = r0899.5	[2503.7]	[2610]
ZSW1.6	1 = Switching on inhibited active	c2053[0].6 = r0899.6	[2503.7]	[2610]
ZSW1.7	1 = Alarm present	c2053[0].7 = r2139.7	[2548.7]	[8065]
ZSW1.8	1 = Speed setpoint - actual value deviation within tolerance t_off	c2053[0].8 = r2197.7	[2534.7]	[8011]
ZSW1.9	1 = Control requested <3>	c2053[0].9 = r0899.9	[2503.7]	[2503]
ZSW1.10	1 = f or n comparison value reached/exceeded	c2053[0].10 = r2199.1	[2537.7]	[8010]
ZSW1.11	1 = I, M, or P limit not reached <4>	c2053[0].11 = r0056.13	[2510.7]	-
ZSW1.12	Reserved	-	-	-
ZSW1.13	1 = No motor overtemperature alarm <4>	c2053[0].13 = r2135.14	[2549.7]	[8016]
ZSW1.14	1 = Motor rotates forwards (n_act ≥ 0) 0 = Motor rotates backwards (n_act < 0)	c2053[0].14 = r2197.3	[2534.7]	[8011]
ZSW1.15	1 = Command Data Set CDS selected, CDS selection bit 0	c2053[0].15 = r0836.0	-	-

<1> Used in telegram 20.
<2> The ZSW1 is generated using c2053[0].0...15.
<3> The drive is ready to accept data.
<4> Inverted

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2451 -
ZSW1 status word interconnection in Interface Mode 3 (VIK-NAMUR)						06.07	

Figure 13-22 2451 – ZSW1 status word interconnection in Interface Mode 3 (VIK/NAMUR)

Signal sources for ZSW1 in Interface Mode 1 <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal status word	[Function diagram] signal target
ZSW1.0	1 = Ready for switching on	c2053[0].0 = r0899.0	[2503.7]	[2610]
ZSW1.1	1 = Ready for operation (DC link loaded, pulses inhibited)	c2053[0].1 = r0899.1	[2503.7]	[2610]
ZSW1.2	1 = Operation enabled (drive follows n_set)	c2053[0].2 = r0899.2	[2503.7]	[2610]
ZSW1.3	1 = Fault present	c2053[0].3 = r2139.3	[2548.7]	[8060]
ZSW1.4	1 = No coast down active (OFF2 inactive)	c2053[0].4 = r0899.4	[2503.7]	[2610]
ZSW1.5	1 = No Quick stop active (OFF3 inactive)	c2053[0].5 = r0899.5	[2503.7]	[2610]
ZSW1.6	1 = Switching on inhibited active	c2053[0].6 = r0899.6	[2503.7]	[2610]
ZSW1.7	1 = Alarm present	c2053[0].7 = r2139.7	[2548.7]	[8065]
ZSW1.8	1 = Speed setpoint - actual value deviation within tolerance t_off	c2053[0].8 = r2197.7	[2534.7]	[8011]
ZSW1.9	1 = Control requested <3>	c2053[0].9 = r0899.9	[2503.7]	[2503]
ZSW1.10	1 = f or n comparison value reached/exceeded	c2053[0].10 = r2199.1	[2537.7]	[8010]
ZSW1.11	1 = I, M, or P limit not reached <4>	c2053[0].11 = r1407.7	[2522.7]	-
ZSW1.12	1 = Open holding brake	c2053[0].12 = r0899.12	[2503.7]	[2701]
ZSW1.13	1 = No motor overtemperature alarm <4>	c2053[0].13 = r2135.14	[2549.7]	[8016]
ZSW1.14	1 = Motor rotates forwards (n_act ≥ 0) 0 = Motor rotates backwards (n_act < 0)	c2053[0].14 = r2197.3	[2534.7]	[8011]
ZSW1.15	1 = No alarm, thermal overload, power unit <4>	c2053[0].15 = r2135.15	[2549.7]	[8021]

<1> Used in telegram 1, 2, 3, 4, 350, 352.
<2> The ZSW1 is generated using c2053[0].0...15.
<3> The drive is ready to accept data.
<4> Inverted

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2452 -
ZSW1 status word interconnection in Interface Mode 1						06.07	

Figure 13-23 2452 – ZSW1 status word interconnection in Interface Mode 1

Signal sources for ZSW1 in Interface Mode 2 <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal status word	[Function diagram] signal target
ZSW1.0	1 = Ready for switching on	c2053[0].0 = r0899.0	[2503.7]	[2610]
ZSW1.1	1 = Ready for operation (DC link loaded, pulses inhibited)	c2053[0].1 = r0899.1	[2503.7]	[2610]
ZSW1.2	1 = Operation enabled (drive follows n_set)	c2053[0].2 = r0899.2	[2503.7]	[2610]
ZSW1.3	1 = Fault present	c2053[0].3 = r2139.3	[2548.7]	[8060]
ZSW1.4	1 = No coast down active (OFF2 inactive)	c2053[0].4 = r0899.4	[2503.7]	[2610]
ZSW1.5	1 = No Quick stop active (OFF3 inactive)	c2053[0].5 = r0899.5	[2503.7]	[2610]
ZSW1.6	1 = Switching on inhibited active	c2053[0].6 = r0899.6	[2503.7]	[2610]
ZSW1.7	1 = Alarm present	c2053[0].7 = r2139.7	[2548.7]	[8065]
ZSW1.8	1 = Speed setpoint - actual value deviation within tolerance t_off	c2053[0].8 = r2197.7	[2534.7]	[8011]
ZSW1.9	1 = Control requested <3>	c2053[0].9 = r0899.9	[2503.7]	[2503]
ZSW1.10	1 = f or n comparison value reached/exceeded	c2053[0].10 = r2199.1	[2537.7]	[8010]
ZSW1.11	1 = Alarm class bit 0	c2053[0].11 = r2139.11	[2548.7]	-
ZSW1.12	1 = Alarm class bit 1	c2053[0].12 = r2139.12	[2548.7]	-
ZSW1.13	Reserved	-	-	-
ZSW1.14	1 = Closed-loop torque control active	c2053[0].14 = r1407.2	[2522.7]	-
ZSW1.15	Reserved	-	-	-

<1> Used in telegram 102, 103.
<2> The ZSW1 is generated using c2053[0].0...15.
<3> The drive is ready to accept data.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2453 -
ZSW1 status word interconnection in Interface Mode 2						06.07	

Figure 13-24 2453 – ZSW1 status word interconnection in Interface Mode 2

13.4.11.2 Control and status word 2

Overview

Control word 2 (STW2) activates the drive functions of the converter.

Status word 2 (ZSW2) signals the converter status to the higher-level control system.

Function description

Control word 2 (STW2)		
Control → Converter		
Bit	**Drive function**	
00	1 = Drive data set selection DDS bit 0	
01	1 = Drive data set selection DDS bit 1	
02	1 = Drive data set selection DDS bit 2	
03	Telegrams 2, 3, 4, 9, 111, 112 and 113	Telegrams 102 and 103
	1 = Drive data set selection DDS bit 3	Reserved
04, 05	Reserved	
06	Telegrams 2, 3, 4, 9, 111, 112 and 113	Telegrams 102 and 103
	Reserved	1 = Integrator disable speed controller
07	Reserved	
08	1 = Travel to fixed stop	
09	Telegrams 2, 3, 4, 9, 111, 112 and 113	Telegrams 102 and 103
	Reserved	1 = Drive data set selection DDS bit 3
10	Reserved	
11	Positive edge = motor changeover feedback	
12	Controller sign-of-life bit 0	
13	Controller sign-of-life bit 1	
14	Controller sign-of-life bit 2	
15	Controller sign-of-life bit 3	

Status word 2 (ZSW2)		
Converter → Control		
Bit	**Status**	
00	1 = Drive data set DDS effective bit 0	
01	1 = Drive data set DDS effective bit 1	
02	1 = Drive data set DDS effective bit 2	
03	Telegrams 2, 3, 4, 9, 111, 112 and 113	Telegrams 102 and 103
	1 = Drive data set DDS effective bit 3	Reserved
04	Reserved	1 = Ramp-function generator inactive
05	1 = Alarm class bit 0	1 = Open holding brake
06	1 = Alarm class bit 1	1 = Integrator disable speed controller

Status word 2 (ZSW2)		
Converter → Control		
Bit	**Status**	
07	Reserved	
08	1 = Travel to fixed stop active	
09	Telegrams 2, 3, 4, 9, 111, 112 and 113	Telegrams 102 and 103
	Reserved	1 = Drive data set DDS effective bit 3
10	1 = Pulses enabled	Reserved
11	1 = Motor changeover active	
12	Device sign-of-life bit 0	
13	Device sign-of-life bit 1	
14	Device sign-of-life bit 2	
15	Device sign-of-life bit 3	

Parameters

The following list contains the parameters of the "Control and status word 2" function.

Number	Name	Unit
r0051.0...3	Drive Data Set DDS effective	-
c0820[0...n]	Drive Data Set selection DDS bit 0	-
c0821[0...n]	Drive Data Set selection DDS bit 1	-
c0822[0...n]	Drive Data Set selection DDS bit 2	-
c0823[0...n]	Drive Data Set selection DDS bit 3	-
c0828[0...n]	Motor changeover feedback signal	-
r0835.0...10	Data set changeover status word	-
r0899.0...13	Status word sequence control	-
r1199.0...8	Ramp-function generator status word	-
r1406.4...15	Control word speed controller	-
c1477[0...n]	Speed controller set integrator value	-
c1545[0...n]	Activates travel to a fixed stop	-
c2045	PN isochronous controller sign-of-life	-
r2050[0...31].0...15	PROFIdrive PZD receive word	-
r2139.0...15	Status word faults/alarms 1	-

Signal targets for STW2 in Interface Mode 1 and Positioning mode <2> <1>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
STW2.0	Drive Data Set selection DDS bit 0	c0820[0] = r2050[3].0	-	[8565]
STW2.1	Drive Data Set selection DDS bit 1	c0821[0] = r2050[3].1	-	[8565]
STW2.2	Drive Data Set selection DDS bit 2	c0822[0] = r2050[3].2	-	[8565]
STW2.3	Drive Data Set selection DDS bit 3	c0823[0] = r2050[3].3	-	[8565]
STW2.4	Reserved	-	-	-
STW2.5	Reserved	-	-	-
STW2.6	Reserved	-	-	-
STW2.7	Reserved	-	-	-
STW2.8	1 = Traverse to fixed endstop active <3>	c1545[0] = r2050[3].8	[2520.2]	[8015]
STW2.9	Reserved	-	-	-
STW2.10	Reserved	-	-	-
STW2.11	= Motor changeover feedback signal	c0828[0] = r2050[3].11	-	-
STW2.12	Controller sign-of-life, bit 0	c2045 = r2050[3]	-	-
STW2.13	Controller sign-of-life, bit 1			
STW2.14	Controller sign-of-life, bit 2			
STW2.15	Controller sign-of-life, bit 3			

<1> Used in telegram 2, 3, 4, 9, 111, 112, 113.
<2> For telegram 9: interconnection with r2050[2].x
<3> Not for telegram 9, 111, 112, 113.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2444 -
STW2 control word interconnection in Interface Mode 1 and Positioning mode						06.07	

Figure 13-25 2444 – STW2 control word interconnection in Interface Mode 1 and positioning mode

Signal targets for STW2 in Interface Mode 2 <1>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
STW2.0	Drive Data Set selection DDS bit 0	c0820[0] = r2050[3].0	-	[8565]
STW2.1	Drive Data Set selection DDS bit 1	c0821[0] = r2050[3].1	-	[8565]
STW2.2	Drive Data Set selection DDS bit 2	c0822[0] = r2050[3].2	-	[8565]
STW2.3	Reserved	-	-	-
STW2.4	Reserved	-	-	-
STW2.5	Reserved	-	-	-
STW2.6	1 = Integrator inhibit, speed controller	c1477[0] = r2050[3].6	[2520.2]	[6040]
STW2.7	Reserved	-	-	-
STW2.8	1 = Traverse to fixed endstop active	c1545[0] = r2050[3].8	[2520.2]	[8015]
STW2.9	1 = Drive Data Set, DDS effective bit 3	c0823[0] = r2050[3].9	-	[8565]
STW2.10	Reserved	-	-	-
STW2.11	⍋ = Motor changeover feedback signal	c0828[0] = r2050[3].11	-	-
STW2.12	Controller sign-of-life, bit 0	r2045 = r2050[3]	-	-
STW2.13	Controller sign-of-life, bit 1			
STW2.14	Controller sign-of-life, bit 2			
STW2.15	Controller sign-of-life, bit 3			

<1> Used in telegram 102, 103.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2445 -
STW2 control word interconnection in Interface Mode 2						06.07	

Figure 13-26 2445 – STW2 control word interconnection in Interface Mode 2

Signal sources for ZSW2 in Interface Mode 1 and Positioning mode <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal status word	[Function diagram] signal target
ZSW2.0	1 = Drive Data Set, DDS effective bit 0	c2053[3].0 = r0051.0	-	[8565]
ZSW2.1	1 = Drive Data Set, DDS effective bit 1	c2053[3].1 = r0051.1	-	[8565]
ZSW2.2	1 = Drive Data Set, DDS effective bit 2	c2053[3].2 = r0051.2	-	[8565]
ZSW2.3	1 = Drive Data Set, DDS effective bit 3	c2053[3].3 = r0051.3	-	[8565]
ZSW2.4	Reserved	-	-	-
ZSW2.5	1 = Alarm class bit 0	c2053[3].5 = r2139.11	[2548.7]	[8065]
ZSW2.6	1 = Alarm class bit 1	c2053[3].6 = r2139.12	[2548.7]	[8065]
ZSW2.7	Reserved	-	-	-
ZSW2.8	1 = Travel to fixed stop active <3>	c2053[3].8 = r1406.8	[2520.7]	-
ZSW2.9	Reserved	-	-	-
ZSW2.10	1 = Pulses enabled	c2053[3].10 = r0899.11	[2503.7]	[2610]
ZSW2.11	1 = Motor changeover active	c2053[3].11 = r0835.0	-	[8575]
ZSW2.12	Follower sign-of-life, bit 0 <3> <4>	Implicitly interconnected	-	-
ZSW2.13	Follower sign-of-life, bit 1 <3> <4>			
ZSW2.14	Follower sign-of-life, bit 2 <3> <4>			
ZSW2.15	Follower sign-of-life, bit 3 <3> <4>			

<1> Used in telegram 2, 3, 4, 9, 111, 112, 113.
<2> The ZSW2 is generated using c2053[3].0...15.
<3> Not for U/f control.
<4> These signals are automatically interconnected for clock-cycle synchronous operation.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2454 -
ZSW2 status word interconnection in Interface Mode 1 and Positioning mode						06.07	

Figure 13-27 2454 – ZSW2 status word interconnection in Interface Mode 1 and positioning mode

Signal sources for ZSW2 in Interface Mode 2 <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal status word	[Function diagram] signal target
ZSW2.0	1 = Drive Data Set, DDS effective bit 0	c2053[3].0 = r0051.0	-	[8565]
ZSW2.1	1 = Drive Data Set, DDS effective bit 1	c2053[3].1 = r0051.1	-	[8565]
ZSW2.2	1 = Drive Data Set, DDS effective bit 2	c2053[3].2 = r0051.2	-	[8565]
ZSW2.3	Reserved	-	-	-
ZSW2.4	1 = Ramp-function generator inactive <3>	c2053[3].4 = r0053.9	[2511.7]	-
ZSW2.5	1 = Open the holding brake	c2053[3].5 = r0899.12	-	[2701]
ZSW2.6	1 = Integrator inhibit, speed controller	c2053[3].6 = r2050[3].6	-	[2445]
ZSW2.7	Reserved	-	-	-
ZSW2.8	1 = Travel to fixed stop active	c2053[3].8 = r1406.8	[2520.7]	-
ZSW2.9	1 = Drive Data Set, DDS effective bit 3	c2053[3].9 = r0051.3	-	[8565]
ZSW2.10	Reserved	-	-	-
ZSW2.11	1 = Motor changeover active	c2053[3].11 = r0835.0	-	[8575]
ZSW2.12	Follower sign-of-life, bit 0 <4> <5>	Implicitly interconnected	-	-
ZSW2.13	Follower sign-of-life, bit 1 <4> <5>			
ZSW2.14	Follower sign-of-life, bit 2 <4> <5>			
ZSW2.15	Follower sign-of-life, bit 3 <4> <5>			

<1> Used in telegram 102, 103.
<2> The ZSW2 is generated using c2053[3].0...15.
<3> Inverted
<4> Not for U/f control.
<5> These signals are automatically interconnected for clock-cycle synchronous operation.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2455 -
ZSW2 status word interconnection in Interface Mode 2						06.07	

Figure 13-28 2455 – ZSW2 status word interconnection in Interface Mode 2

13.4.11.3 Control and status word 3

Overview

Control word 3 (STW3) activates the converter drive functions.

Status word 3 (ZSW3) signals the status of the converter to the higher-level control.

Function description

Table 13-10 Control word 3 (STW3)

Bit	Drive function	Explanation
0	1 = Fixed setpoint bit 0	Selects 1 ... 16 different fixed setpoints.
1	1 = Fixed setpoint bit 1	
2	1 = Fixed setpoint bit 2	
3	1 = Fixed setpoint bit 3	
4	1 = DDS selection bit 0	Changeover between settings for different motors (drive data sets).
5	1 = DDS selection bit 1	
6	Reserved	
7	Reserved	
8	1 = Technology controller enable	--
9	1 = DC braking enable	--
10	Reserved	
11	1 = Droop enable	Enable or inhibit droop of the speed controller.
12	1 = Torque control active 0 = Speed control active	Changes over the control mode for speed control.
13	1 = No external fault 1 0 = External fault 1 is active	--
14	Reserved	
15	1 = CDS bit 1	Changeover between settings for different operation interfaces (command data sets).

[1] If you switch from telegram 350 to another telegram, the converter sets all interconnections r1020, ... to "0". Exception: r2106 = 1.

Table 13-11 Status word 3 (ZSW3)

Bit	Status	Explanation
0	1 = DC braking active	--
1	1 = |n_act | > p1226	Absolute value of actual speed > standstill detection
2	1 = |n_act | > p1080	Absolute value of actual speed > minimum speed
3	1 = i_act ≧ p2170	Actual current ≥ current threshold

Bit	Status	Explanation
4	1 = |n_act | > p2155	Absolute value of actual speed > speed threshold 2
5	1 = |n_act | ≦ p2155	Absolute value of actual speed < speed threshold 2
6	1 = |n_act | ≧ r1119	Speed setpoint reached
7	1 = DC link voltage ≦ p2172	Actual DC link voltage ≦ threshold
8	1 = DC link voltage > p2172	Actual DC link voltage > threshold
9	1 = Ramp-up or ramp-down completed	Ramp-function generator is not active
10	1 = Technology controller output at lower limit	Technology controller output ≦ p2292
11	1 = Technology controller output at upper limit	Technology controller output > p2291
12 ... 15	Reserved	

Parameters

The following list contains the parameters of the "Control and status word 3" function.

Number	Name	Unit
r0053.0...11	Status word 2	-
c0811	Command data set selection CDS bit 1	-
c0820[0...n]	Drive Data Set selection DDS bit 0	-
c0821[0...n]	Drive Data Set selection DDS bit 1	-
c1020[0...n]	Fixed speed setpoint selection bit 0	-
c1021[0...n]	Fixed speed setpoint selection bit 1	-
c1022[0...n]	Fixed speed setpoint selection bit 2	-
c1023[0...n]	Fixed speed setpoint selection bit 3	-
c1230[0...n]	DC braking/armature short circuit activation	-
c1492[0...n]	Droop enable	-
c1501[0...n]	Change over between closed-loop speed/torque control	-
c2106[0...n]	External fault 1	-
c2200[0...n]	Technology controller enable	-

13.4.11.4 Message word

Overview

The message word (MELDW) signals the converter status to the higher-level control system.

Description of function

Message word (MELDW)		
Converter → Control		
Bit	**Status**	**Explanation**
00	0 = Ramp-function generator active	The motor is presently accelerating or braking.
	1 = Ramp-up/ramp-down completed	Speed setpoint and actual speed are the same.
01	1 = Torque utilization [%] < torque threshold value 2 (p2194)	---
02	1 = |n_actt| < speed threshold value 3 (p2161)	---
03	1 = |n_act| speed threshold value 2 (p2155)	---
04	1 = Vdc_min controller active	---
05	Variable signaling function 1 output signal	---
06	1 = No motor overtemperature alarm	The motor temperature is within the permissible range.
07	1 = No alarm power unit thermal overload	The converter temperature is within the permissible range.
08	1 = Speed setpoint - actual value deviation within tolerance t_on	Speed setpoint and actual speed are within the permissible tolerance p2163.
09, 10	Reserved	
11	1 = Controller enable	The speed controller is enabled.
12	1 = Drive ready	The converter is ready to start.
13	1 = pulses enabled	The motor is switched on.
14	Variable signaling function 2 output signal	---
15	Variable signaling function 3 output signal	---

Parameters

The following list contains the parameters of function "Message word".

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
r0899.0...13	Status word sequence control	-
r2135.6...15	Status word faults/alarms 2	-
r2197.0...13	Status word monitoring 1	-
r2199.0...11	Status word monitoring 3	-
r3294.0...6	Variable signaling function output signal	-

Signal sources for MELDW <1>

Signal	Meaning	Interconnection parameter <3>	[Function diagram] internal status word	[Function diagram] signal target
MELDW.0	1 = Ramp-up/ramp-down completed	c2053[x].0 = r2199.5	[2537.7]	[8011]
MELDW.1	1 = Torque utilization < torque threshold value 2 (p2194)	c2053[x].1 = r2199.11	[2537.7]	[8012]
MELDW.2	1 = |n_act| < speed threshold value 3 (p2161)	c2053[x].2 = r2199.0	[2537.7]	[8010]
MELDW.3	1 = |n_act| ≤ speed threshold value 2 (p2155)	c2053[x].3 = r2197.1	[2534.7]	[8010]
MELDW.4	1 = Vdc_min controller active	c2053[x].4 = r0056.15	[2526.7]	[6220], [6320]
MELDW.5	Variable signaling function 1 output signal	c2053[x].5 = r3294.0	-	[8024]
MELDW.6	1 = No motor overtemperature alarm <2>	c2053[x].6 = r2135.14	[2549.7]	[8016]
MELDW.7	1 = No alarm, thermal overload, power unit <2>	c2053[x].7 = r2135.15	[2549.7]	[8021]
MELDW.8	1 = Speed setpoint - actual value deviation within tolerance t_on	c2053[x].8 = r2199.4	[2537.7]	[8011]
MELDW.9	Reserved	-	-	-
MELDW.10	Reserved	-	-	-
MELDW.11	1 = Controller enable	c2053[x].11 = r0899.8	[2503.7]	[2610]
MELDW.12	1 = Drive ready	c2053[x].12 = r0899.7	[2503.7]	[2610]
MELDW.13	1 = Pulses enabled	c2053[x].13 = r0899.11	[2503.7]	[2610]
MELDW.14	Variable signaling function 2 output signal	c2053[x].14 = r3294.1	-	[8024]
MELDW.15	Variable signaling function 3 output signal	c2053[x].15 = r3294.2	-	[8024]

<1> Used in telegram 102, 103, 111, 112, 113.
<2> Inverted
<3> When selecting a standard telegram or manufacturer-specific telegram, this interconnection parameter is automatically set.

1	2	3	4	5	6	7	8
PROFIdrive						© Siemens	- 2460 -
MELDW status word interconnection						06.07	

Figure 13-29 2460 - MELDW status word interconnection

13.4.11.5 NAMUR message word

Overview

The NAMUR message word signals the converter status to the higher-level control system.

Description of function

NAMUR message word (MELD_NAMUR)	
Converter → Control	
Bit	**Meaning**
00	1 = Converter control unit fault
01	1 = Line supply fault: Phase failure or inadmissible voltage
02	1 = DC link overvoltage
03	1 = Power unit fault, e.g. overcurrent or overtemperature
04	1 = Converter overtemperature
05	1 = Ground fault/inter-phase short-circuit in the motor cable or motor
06	1 = Motor overload
07	1 = Communication error with the higher-level control system
08	1 = Error in a safety monitoring channel
09	1 = Actual position value or actual speed value incorrect or not available
10	1 = Converter-internal communication error
11	1 = Line system fault
12 ... 14	Reserved
15	1 = Other fault

Parameters

The following list contains parameters of function "NAMUR message word".

Number	Name	Unit
r3113.0...15	NAMUR message bit bar	-

13.4.11.6 Control and status word encoder

Overview

The encoder control word (Gx_STW) and the encoder status word (Gx_ZSW) have identical structures for each encoder. Gx designates the number of the encoder, e.g. G1_STW and G1_ZSW are assigned to encoder 1.

Control word and encoder status word allow the higher-level control to directly access the functions and status of the encoder.

Direct access to the encoder is necessary, if the higher-level control performs the closed-loop position control for the drive.

Function description

Control word encoder (Gx_STW)			
Control → Converter			
Bit	**Function**	**Explanation**	
00		Bit 7 = 0	Bit 7 = 1
	Function 1	1 = Search for reference cam 1 with positive start direction	1 = Request passive homing to the rising edge of reference cam 1
01	Function 2	1 = Search for reference cam 1 with negative start direction	1 = Request passive homing to the falling edge of reference cam 1
02	Function 3	1 = Search for reference cam 2 with positive start direction	1 = Request passive homing to the rising edge of reference cam 2
03	Function 4	1 = Search for reference cam 2 with negative start direction	1 = Request passive homing to the falling edge of reference cam 2
04	Command bit 0	1 = Activate requested function using bit 0 ... 3	
05	Command bit 1	1 = Read requested value using bit 0 ... 3	
06	Command bit 2	Reserved	
07	Mode	1 = Passive homing 0 = Search for reference cam	
08 ... 12	Reserved	---	
13	Absolute value cyclically	1 = Request for the cyclic transfer of the actual position value in Gx_XIST2	
14	Park	1 = Request to park the encoder	
15	Acknowledge	0 → 1 = Acknowledge encoder fault	

Status word encoder (Gx_ZSW)			
Converter → Control			
Bit	**Status**	**Explanation**	
00		Bit 7 = 0	Bit 7 = 1
	Function 1	1 = Search for reference cam 1 is active	1 = Passive homing to the rising edge of reference cam 1 is active
01	Function 2	1 = Search for reference cam 1 is active	1 = Passive homing to the falling edge of reference cam 1 is active
02	Function 3	1 = Search for reference cam 2 is active	1 = Passive homing to the rising edge of reference cam 2 is active
03	Function 4	1 = Search for reference cam 2 is active	1 = Passive homing to the falling edge of reference cam 2 is active

Status word encoder (Gx_ZSW)			
Converter → Control			
Bit	**Status**	**Explanation**	
04	Status value 1	1 = Actual position value is at reference cam 1	1 = Passive homing to the rising edge of reference cam 1 has been completed
05	Status value 2	1 = Actual position value is at reference cam 1	1 = Passive homing to the falling edge of reference cam 1 has been completed
06	Status value 3	1 = Actual position value is at reference cam 2	1 = Passive homing to the rising edge of reference cam 2 has been completed
07	Status value 4	1 = Actual position value is at reference cam 2	1 = Passive homing to the falling edge of reference cam 2 has been completed
08	Reference cam 1	1 = Reference cam 1 supplies a high signal 0 = Reference cam 1 supplies a low signal	
09	Reference cam 2	1 = Reference cam 2 supplies a high signal 0 = Reference cam 2 supplies a low signal	
10	Reserved	---	
11	Acknowledge	1 = Acknowledge encoder fault is active	
12	Reserved	---	
13	Absolute value cyclically	1 = The actual position value is in Gx_XIST2.	
14	Park	1 = The encoder is parked	
15	Fault	1 = The encoder indicates its current fault in r0483	

Parameters

The following list contains the parameters of the "Control and status word encoder" function.

Number	Name	Unit
c0480[0...2]	Encoder control word Gn_STW	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r2050[0...31].0...15	PROFIdrive PZD receive word	-

13.4.11.7 Actual position value of the encoder

Overview

In the factory setting, the converter transfers the actual position value of the encoder to the higher-level control with 11-bit fine resolution.

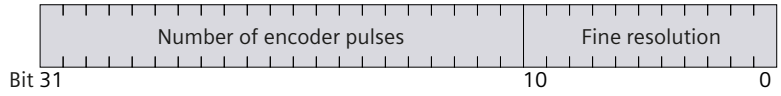
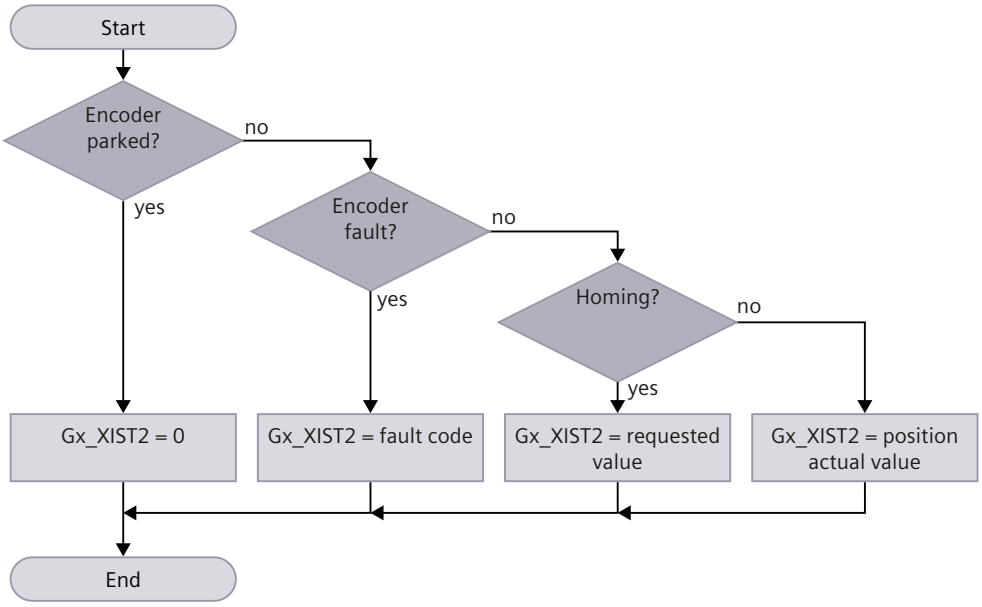


Figure 13-30 Encoder resolution

Description of function

After switch-on of the supply voltage of the converter, the transferred encoder signal = 0.

The converter transfers different values to the higher-level control system in G1_XIST2 and G2_XIST2:



Encoder x parked	Gx_ZSW.14 = 1
Fault encoder x	Gx_ZSW.15 = 1
Reference encoder x	Gx_ZSW.4 = 1 or Gx_ZSW.5 = 1 or Gx_ZSW.6 = 1 or Gx_ZSW.7 = 1

Figure 13-31 G1_XIST2 and G2_XIST2

The converter transfers position values in the same format (encoder pulse number and fine resolution) as G1_XIST1 and G2_XIST1.

Table 13-12 Error code

No.	Explanation	Possible cause
1	Encoder fault	One or more encoder faults pending. Observe the converter message.
2	Zero-mark monitoring	---
3	Encoder parking canceled	Parking was already requested.
4	Active homing canceled	• Encoder has no zero mark (homing mark). • Homing mark 2, 3 or 4 was requested. • A switch was made to passive homing during active homing. • Command "Read value x" requested during homing mark search. • Inconsistent position measured value when using distance-coded homing marks

No.	Explanation	Possible cause
5	Fetch reference value canceled	• More than four values were requested. • No value requested. • Requested value is not available.
6	Passive homing interrupted	• Reference cam has not been configured • A switch was made to active homing during passive homing. • During passive homing, the request "Read value x" was received.
7	Fetch measured value canceled	• More than one value was requested. • No value requested. • Requested value is not available. • Encoder is parked.
8	Actual position value transfer canceled	• No absolute encoder available. • Alarm bit set in the absolute value protocol.
3841	Encoder does not support the function	---

13.4.12 Control words, status words and message word for basic positioner

13.4.12.1 Control and status word 1

Requirement

Function "Basic positioner" is active.

Function description

Control word 1 (STW1)		
Control → Converter		
Bit	**Drive function**	**Explanation**
0	0 = OFF1	The motor brakes with the ramp-down time p1121 of the ramp-function generator. The converter switches off the motor at standstill.
	0 → 1 = ON	The converter goes into the "Ready" state. If, in addition, bit 3 = 1, the converter switches on the motor.
1	0 = OFF2	Immediately switch off the motor and the motor then coasts down to a standstill.
	1 = No OFF2	The motor can be switched on (ON command).
2	0 = Quick stop (OFF3)	Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.
	1 = No quick stop (OFF3)	The motor can be switched on (ON command).

Control word 1 (STW1)		
Control → Converter		
Bit	**Drive function**	**Explanation**
3	0 = Inhibit operation	Immediately switch off motor (cancel pulses).
	1 = Enable operation	Switch on motor (pulses can be enabled).
4	0 = Reject traversing job	Axis brakes down to standstill with the maximum deceleration. Converter rejects the actual traversing block.
	1 = Do not reject traversing task	Axis can be started or travel to set position.
5	0 = Intermediate stop	Axis brakes down to standstill with the specified deceleration override. Converter remains in the actual traversing block.
	1 = No intermediate stop	Axis can be started or continue to travel to the set position.
6	0 → 1: Activate traversing job	The converter starts axis travel to the set position.
	0 → 1: Setpoint transfer MDI	
7	0 → 1: = Acknowledge faults	Acknowledge fault in the converter. If the ON command is still active, the converter switches to the "switching on inhibited" state.
8	1 = jogging bit 0	Jog 1
9	1 = jogging bit 1	Jog 2
10	0 = No control by PLC	Converter ignores the process data from the fieldbus.
	1 = Control by PLC	Control via fieldbus, converter accepts the process data from the fieldbus.
11	0 = Stop homing	---
	1 = Start homing	The converter does not start referencing.
12	Reserved	
13	0 → 1: External block change	The axis goes to the next traversing block.
14, 15	Reserved	

Status word 1 (ZSW1)		
Converter → Control		
Bit	**Drive function**	**Explanation**
0	1 = Ready for switching on	Power supply is switched on, electronics are initialized, pulses are inhibited.
1	1 = Ready	Motor is switched on (ON command = 1); no fault is active. With the command "Enable operation" (STW1.3), the converter switches on the motor.
2	1 = Operation enabled	Motor follows setpoint. See control word 1, bit 3.
3	1 = Fault present	The converter has a fault. Acknowledge fault using STW1.7.
4	1 = OFF2 inactive	Coast down to standstill is not active.
5	1 = OFF3 inactive	Quick stop is not active.
6	1 = Switching on inhibited active	It is only possible to switch on the motor after an OFF1 command and an additional ON command.
7	1 = Alarm active	Motor remains switched on; no acknowledgment is necessary.

Status word 1 (ZSW1)			
Converter → Control			
Bit	**Drive function**		**Explanation**
8	1 = Following error in tolerance		The actual difference between the actual position and the position setpoint is within the permissible tolerance p2546.
9	1 = Control requested		The automation system has been requested to take over control of the converter.
10	1 = Target position reached		The axis has reached the target position.
11	1 = Home position set		The axis is homed.
12	0 → 1 = Acknowledgment, traversing block active		
13	1 = Setpoint is stationary		
14	Telegram 7, 9	Telegrams 111 112	
	Reserved	1 = Axis accelerates	
15	Telegram 7, 9	Telegrams 111 112	
	Reserved	1 = Axis brakes	

Parameters

The following list contains the parameters of function "Positioning control word 1 and positioning status word 1".

Number	Name	Unit
c2625	EPOS traversing block selection bit 0	-
c2626	EPOS traversing block selection bit 1	-
c2627	EPOS traversing block selection bit 2	-
c2628	EPOS traversing block selection bit 3	-
c2629	EPOS traversing block selection bit 4	-
c2630	EPOS traversing block selection bit 5	-
c2647	EPOS direct setpoint input/MDI selection	-
c2648	EPOS direct setpoint input/MDI positioning type	-
c2649	EPOS direct setpoint input/MDI transfer type selection	-
c2651	EPOS direct setpoint input/MDI direction selection, positive	-
c2652	EPOS direct setpoint input/MDI direction selection negative	-
c2653	EPOS direct setpoint input/MDI setting-up selection	-
r2670.0...15	EPOS status word active traversing block	-
r2684.0...15	EPOS status word 2	-

13.4.12.2 Control and status word 2

Requirement

Function "Basic positioner" is active.

Control word 2 and status word 2 are available in telegrams 9, 111, 112 and 113.

Control word 2 (STW2)

Control word 2 (STW2)	
Control → Converter	
Bit	**Drive function**
0	Reserved
1	Reserved
2...6	Reserved
7	Reserved
8	Reserved
9...11	Reserved
12	1 = controller sign-of-life bit 0
13	1 = controller sign-of-life bit 1
14	1 = controller sign-of-life bit 3
15	1 = controller sign-of-life bit 4

Status word 2 (ZSW2)	
Converter → Control	
Bit	**Drive function**
0	1 = Drive data set DDS effective bit 0
1	1 = Drive data set DDS effective bit 1
2...4	Reserved
5	1 = Alarm class bit 0
6	1 = Alarm class bit 1
7	Reserved
8	1 = Travel to fixed stop active
9	Reserved
10	1 = pulses activated
11	Reserved
12	Device sign-of-life bit 0
13	Device sign-of-life bit 1
14	Device sign-of-life bit 2
15	Device sign-of-life bit 3

Parameters

The following list contains the parameters of function "Positioning control word 2 and positioning status word 2".

Number	Name	Unit
c2511[0...3]	LR measuring probe evaluation edge	-
c2568	EPOS hardware limit switch activation	-
c2582	EPOS software limit switch activation	-
c2591	EPOS jogging incremental	-

c2596	EPOS set home position	-
c2597	EPOS homing type selection	-
c2604	EPOS active homing start direction	-
c2612[0...1]	EPOS active homing reference cam	-
c2655[0...1]	EPOS select tracking mode	-
r2683.0...14	EPOS status word 1	-

13.4.12.3 Control and status word 1 for the positioner

Requirement

Function "Basic positioner" is active.

Function description

Positioning control word 1 (POS_STW1)		
Control system → Converter		
Bit	**Drive function**	**Explanation**
0	Traversing block selection, bit 0	Selecting the traversing block
1	Traversing block selection, bit 1	
2	Traversing block selection, bit 2	
3	Traversing block selection, bit 3	
4	Traversing block selection, bit 4	
5	Traversing block selection, bit 5	
6	Reserved	---
7	Unconditionally open holding brake	The converter opens a connected holding brake
8	0 = Relative positioning is selected	The converter interprets the set position as the set position relative to the starting position.
	1 = Absolute positioning is selected	The converter interprets the set position as absolute set position relative to machine zero point.
9	01 = Absolute positioning for rotary axis in the positive direction	Selection of the positioning type for a rotary axis.
10	10 = Absolute positioning for rotary axes in negative direction	
	00, 11 = Absolute positioning for a rotary axis through the shortest distance	
11	Reserved	---
12	1 = Continuous acceptance	The converter accepts position setpoint changes immediately.
	0 = MDI block change with control word 1, bit 6	The converter accepts a changed position setpoint with the signal change 0 → 1 of control word 1, bit 6.
13	Reserved	---

Positioning control word 1 (POS_STW1)		
Control system → Converter		
Bit	**Drive function**	**Explanation**
14	1 = Select Set up	Toggling the axis operating mode between "Set up" and "Positioning".
	0 = Select positioning	
15	1 = Activate MDI	The converter receives its position setpoint from an external control.
	0 = Deactivate MDI	

Positioning status word 1 (POS_ZSW1)		
Converter → Control system		
Bit	**Drive function**	**Explanation**
0	Active traversing block bit 0 (2^0)	Number of the currently selected traversing block.
1	Active traversing block bit 1 (2^1)	
2	Active traversing block bit 2 (2^2)	
3	Active traversing block bit 3 (2^3)	
4	Active traversing block bit 4 (2^4)	
5	Active traversing block bit 5 (2^5)	
6	Reserved	---
7	Open holding brake	The converter opens the holding brake
8	1 = STOP cam minus active	The axis is currently located at a STOP cam.
9	1 = STOP cam plus active	
10	1 = Jogging active	The converter is in the jogging mode.
11	1 = Home position approach active	The converter is presently executing a home position approach.
12	1 = Flying homing active	The converter homes when passing the reference cam.
13	1 = Traversing block active	The converter receives its position setpoint from a traversing block.
14	1 = Set up active	The axis is in the "Set up" operating mode.
15	1 = MDI active	The converter receives its position setpoint from an external control.
	0 = MDI inactive	

Parameters

The following list contains the parameters of function "Control and status word 1 for basic positioner".

Number	Name	Unit
c0840[0...n]	ON / OFF (OFF1)	-
c0844[0...n]	No coast-down / coast-down (OFF2) signal 1	-
c0848[0...n]	No Quick Stop / Quick Stop (OFF3) signal 1	-
c0852[0...n]	Enable operation/inhibit operation	-
c0854[0...n]	Control by PLC/no control by PLC	-
c2103[0...n]	1st acknowledge faults	-

c2589	EPOS jog 1	-
c2590	EPOS jog 2	-
c2595	EPOS homing start	-
c2631	EPOS activate traversing task (0 -> 1)	-
c2633	EPOS external block change (0 -> 1)	-
c2640	EPOS intermediate stop (0 signal)	-
c2641	EPOS reject traversing task (0 signal)	-
c2650	EPOS direct setpoint input/MDI setpoint acceptance edge	-

13.4.12.4 Control and status word 2 for the positioner

Requirement

Function "Basic positioner" is active.

Function description

Positioning control word 2 (POS_STW2)		
Control system → Converter		
Bit	**Drive function**	**Explanation**
0	1 = Activate follow-up mode	The converter continuously corrects the position setpoint to follow the position actual value.
1	1 = Set home position	The converter accepts the home position coordinate in its position actual value and setpoint.
2	1 = Reference cam active	The axis is currently located at the reference cam.
3	1 = encoder adjustment	The absolute encoder is adjusted
4	Reserved	---
5	1 = Incremental jogging active	If the jogging command is active, the converter positions the axis by the specified traversing path in a positive or negative direction.
	0 = Jogging velocity active	If the jogging command is active, the converter positions the axis with the jog velocity in the direction of the beginning or end of the traversing range.
6	Reserved	---
7		
8	1 = Selects homing using flying homing	Select the homing type.
	0 = Selects homing via the home position approach	
9	1 = Starts home position approach in the negative direction	Select the start direction for automatic homing.
	0 = Starts home position approach in the positive direction	
10	1 = Selects probe 2	Edge of the probe input, with which the converter references its actual position value.
	0 = Selects probe 1	

Positioning control word 2 (POS_STW2)		
Control system → Converter		
Bit	**Drive function**	**Explanation**
11	1 = Probe falling edge	Select the edge of the probe input, with which the converter references its actual position value.
	0 = Probe, rising edge	
12	Reserved	---
13		
14	1 = Software limit switch active	The converter evaluates its software limit switch.
15	1 = STOP cams active	Converter evaluates the stop cams.

Positioning status word 2 (POS_ZSW2)				
Converter → Control system				
Bit	**Drive function**		**Explanation**	
0	1 = Follow-up mode active		The converter is in the follow-up mode.	
1	1 = Velocity limiting is active		The converter limits the velocity of the axis.	
2	Telegram 111	Telegrams 112 and 113	Telegram 111	Telegrams 112 and 113
	1 = Setpoint is stationary	1 = Position setpoint reached	During a positioning operation, the setpoint no longer changes.	The closed-loop position control has reached the target position.
3	1 = Print index outside outer window		The discrepancy between the actual position and the home position was greater than permitted during flying homing.	
4	1 = Axis traverses forwards		The axis traverses in the positive direction.	
	0 = Axis is stationary or traverses backwards		---	
5	1 = Axis traverses backwards		The axis traverses in the negative direction.	
	0 = Axis is stationary or traverses forwards		---	
6	1 = Software limit switch, minus actuated		The axis is outside the permitted traversing range.	
7	1 = Software limit switch, plus actuated			
8	1 = Position actual value ≤ cam switching position 1		Feedback of the cam sequencer in the converter.	
	0 = Cam switching position 1 passed			
9	1 = Position actual value ≤ cam switching position 2			
	0 = Cam switching position 2 passed			
10	1 = Direct output 1 active		The converter sets these signals in the actual traversing block.	
11	1 = Direct output 2 active			
12	1 = Fixed stop reached		The axis is at the fixed stop	
13	1 = Fixed stop clamping torque reached		The axis is at the fixed stop and has reached the clamping torque.	
14	1 = Travel to fixed stop active		The converter moves the axis to a fixed stop.	

Positioning status word 2 (POS_ZSW2)		
Converter → Control system		
Bit	**Drive function**	**Explanation**
15	1 = Traversing command active	Feedback signal indicating as to whether the converter is currently moving the axis.
	0 = Axis stationary	

Parameters

The following list contains the parameters of function "Control and status word 2 for basic positioner".

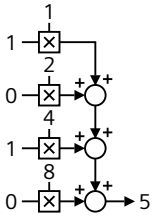
Number	Name	Unit
r0899.0...13	Status word sequence control	-
r2139.0...15	Status word faults/alarms 1	-
r2683.0...14	EPOS status word 1	-
r2684.0...15	EPOS status word 2	-

13.4.12.5 Control word block selection

Requirement

Function "Basic positioner" is active.

Function description

Control word block selection			
Control → Converter			
Bit	**Drive function**	**Explanation**	
0	Traversing block selection, bit 0	Example for selecting traversing block number 5:	
1	Traversing block selection, bit 1		
2	Traversing block selection, bit 2		
3	Traversing block selection, bit 3		
4	Traversing block selection, bit 4		
5	Traversing block selection, bit 5		
6...14	Reserved		
15	0 = Deactivate MDI	Switching over traversing blocks to direct setpoint input.	
	1 = Activate MDI		

Actual traversing block		
Converter → Control		
Bit	**Drive function**	**Explanation**
0	Actual traversing block, bit 0	---
1	Actual traversing block, bit 1	
2	Actual traversing block, bit 2	
3	Actual traversing block, bit 3	
4	Actual traversing block, bit 4	
5	Actual traversing block, bit 5	
6...14	Reserved	
15	0 = MDI active	---
	1 = MDI not active	

13.4.12.6 Control word MDI mode

Requirement

Function "Basic positioner" is active.

Function description

Selecting the MDI mode			
Control system → Converter			
Bit	**Meaning**		**Remarks**
0	0 = Relative positioning is selected		The converter interprets the set position as the set position relative to the starting position.
	1 = Absolute positioning is selected		The converter interprets the set position as absolute set position relative to machine zero point.
1		01 = Absolute positioning for rotary axis in the positive direction	Selection of the positioning type for a rotary axis.
2		10 = Absolute positioning for rotary axes in negative direction	
		00, 11 = Absolute positioning for a rotary axis through the shortest distance	
3...15	Reserved		

13.4.13 Control word and status words for Safety Info Channel

13.4.13.1 Safety Control Channel control word 1B

Function description

Safety control word 1B (S_STW1B)	
Failsafe control → Converter	
Bit	**Meaning**
00 ... 11	Reserved
12	Enable transition time p9569
13 ... 15	Reserved

Parameters

The following list contains the parameters of function "Safety Info Channel control word 1B".

Number	Name	Unit
c10250	SI Safety Control Channel control word S_STW1B	-
r10251.12...13	SI Safety Control Channel control word S_STW1B diagnostics	-

13.4.13.2 Safety Info Channel status word 1B

Overview

The converter signals the status of the Safety Integrated Functions to the higher-level control using Safety Info Channel status word 1B (S_ZSW1B).

Function description

Safety Info Channel status word 1B (S_ZSW1B)	
Converter → Control	
Bit	**Safety status**
00	STO active
01	SS1 active
02	SS2 active
03	SOS active
04	SLS active
05	SOS selected
06	SLS selected
07	Internal event
08	SLA selected
09	Select SLS Bit 0

Safety Info Channel status word 1B (S_ZSW1B)	
Converter → Control	
Bit	**Safety status**
10	Select SLS Bit 1
11	Reserved
12	SDI positive selected
13	SDI negative selected
14	Reserved
15	Safety message active

Parameters

The following list contains the parameters of the "Safety Info Channel status word 1B" function.

Number	Name	Unit
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-

13.4.13.3 Safety Info Channel status word 2B

Overview

The converter signals the status of the Safety Integrated Functions to the higher-level control using Safety Info Channel status word 2B (S_ZSW2B).

Function description

Safety Info Channel status word 2B (S_ZSW2B)	
Converter → Control	
Bit	**Safety status**
00	Reserved
01	Reserved
02	Reserved
03	SS1E selected
04	Reserved
05	Reserved
06	Reserved
07	Reserved
08	SDI positive selected
09	SDI negative selected
10	Reserved
11	Reserved
12	Reserved
13	Reserved

Safety Info Channel status word 2B (S_ZSW2B)	
Converter → Control	
Bit	**Safety status**
14	Reserved
15	Reserved

Parameters

The following list contains the parameters of the "Safety Info Channel status word 2B" function.

Number	Name	Unit
r9743.3...9	SI Safety Information Channel status word S_ZSW2B	-

13.4.13.4 Transferring SIC status word 2B to the control

Overview

A freely configurable telegram is required to transfer the Safety Info Channel status word 2B to the higher-level control.

Description of function

In the factory setting, status word 2B in the Safety Info Channel is not contained in any telegram. To transfer Safety Info Channel status word 2B to a higher-level control, the binary signal source r9743 must be interconnected with the process data send word of a freely configurable telegram, e.g. c2053[x] = r9743.

13.4.13.5 Safety Info Channel status word 3B

Overview

The converter signals the status of the Safety Integrated Functions to the higher-level control using Safety Info Channel status word 3B (S_ZSW3B).

Function description

Safety Info Channel status word 3B (S_ZSW3B)	
Converter → Control	
Bit	**Safety status**
00 ... 10	Reserved
11	SS2E selected
12 ... 14	Reserved
15	Acceptance test mode selected

Parameters

The following list contains the parameters of the "Safety Info Channel status word 3B" function.

Number	Name	Unit
r10234.11...15	SI Safety Information Channel status word S_ZSW3B	-

13.4.13.6 Transferring SIC status word 3B to the control

Overview

A freely configurable telegram is required to transfer the Safety Info Channel status word 3B to the higher-level control.

Description of function

In the factory setting, status word 3B in the Safety Info Channel is not contained in any telegram. To transfer Safety Info Channel status word 3B to a higher-level control, the binary signal source r10234 must be interconnected with the process data send word of a freely configurable telegram, e.g. c2053[x] = r10234.

13.4.14 Acyclic PROFIdrive communication

13.4.14.1 Acyclic communication via PROFINET

Description of function

The converter supports acyclic communication via B02E hex and B02F hex for PROFINET.

The maximum data length per job is 240 bytes.

13.4.14.2 Acyclic communication via PROFIBUS

Function description

For PROFIBUS the converter supports acyclic communication via data set 47.

The maximum data length per job is 240 bytes.

13.4.14.3 Reading parameter values

Overview

To read a parameter value, the higher-level control sends a read job to the converter. After receiving the read job, the converter sends its response to the higher-level control.

Description of function

Values in italics in the following tables mean that these values must be adapted to the specific request.

Table 13-13 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**01 hex**: Read job	0
	01 hex (drive object)	**Number of parameters (m)**	2
Address, parameter 1	**Attribute** *10 hex:* Parameter value *20 hex:* Parameter description	**Number of the indices** *00 hex ... EA hex* (For parameters without index: 00 hex)	4
	Parameter number *0001 hex ... FFFE hex*		6
	Number of the 1st index *0000 hex ... FFFE hex* (for parameters without index: 0000 hex)		8
	...		...
Address, parameter 2	...		...
...	...		...
Address, parameter m	...		...

Table 13-14 Converter response to a read job

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a read job)	**01 hex**: Converter has executed the read job. **81 hex**: Converter was not able to completely execute the read job.	0
	01 hex (ID of drive objects, for G120 always = 01 hex)	**=Number of parameters (m)** (identical to the read job)	2

Data block	Byte n	Bytes n + 1	n
Values, parameter 1	**Format** *02 hex*: Integer8 *03 hex*: Integer16 *04 hex*: Integer32 *05 hex*: Unsigned8 *06 hex*: Unsigned16 *07 hex*: Unsigned32 *08 hex*: FloatingPoint *0A hex*: OctetString *0D hex*: TimeDifference *34 hex*: TimeOfDay without date indication *35 hex*: TimeDifference with date indication *36 hex*: TimeDifference without date indication *41 hex*: Byte *42 hex*: Word *43 hex*: Double word *44 hex*: Error	**Number of index values** or - for a negative response - **number of error values**	4
	Value of the 1st index or - in case of negative response - **error value 1**		6
	...		...
Values, parameter 2	...		
...	...		
Values, parameter m	...		

13.4.14.4 Changing parameter values

Overview

To change a parameter value, the higher-level control sends a change request to the converter. After receiving the change request, the converter changes the parameter value and sends its response to the higher-level control.

Function description

Values in italics in the following tables mean that these values must be adapted to the specific request.

Table 13-15 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	Drive object *01 hex ... FF hex* for drive systems with several drive axes, e.g. SINAMICS S220 *01 hex ... FF hex* for converters with 1 drive axis, e.g. SINAMICS S210 or SINAMICS G2.0	**Number of parameters (m)** *01 hex ... 27 hex*	2

Data block	Byte n	Bytes n + 1	n
Address, parameter 1	**10 hex**: Value of the parameter	**Number of indices** *00 hex ... EA hex* (00 hex and 01 hex are equivalents)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0000 hex ... FFFE hex*		8
	...		...
Address, parameter 2	...		
...	...		...
Address, parameter m	...		
Values, parameter 1	**Format** *02 hex:* Integer 8 *03 hex:* Integer 16 *04 hex:* Integer 32 *05 hex:* Unsigned 8 *06 hex:* Unsigned 16 *07 hex:* Unsigned 32 *08 hex:* Floating Point *0A hex:* Octet String *0D hex:* Time Difference *34 hex*: TimeOfDay without date indication *35 hex*: TimeDifference with date indication *36 hex*: TimeDifference without date indication *41 hex:* Byte *42 hex:* Word *43 hex:* Double word	**Number of index values** *00 hex ... EA hex*	
	Value of the 1st index		
	...		
Values, parameter 2	...		
...	...		
Values, parameter m	...		

Table 13-16 Response, if the converter has executed the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**02 hex** (change request successful)	0
	Drive object	**Number of parameters** (identical to a change request)	2

Table 13-17 Response if the converter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex:** (Converter was not able to completely execute the write request)	0
	Drive object	**Number of parameters** (identical to a change request)	2

Data block	Byte n	Bytes n + 1	n
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex 01 hex or 02 hex	4
	Only for "Error" - **error value 1**		6
	Only for "Error" - **error value 2** Error value 2 is either zero, or it contains the number of the first index where the error occurred.		8
Values, parameter 2	...		
...	...		...
Values, parameter m	...		

13.4.14.5 Error value 1 for read and change requests

Overview

If the converter receives an erroneous request to read or change parameter values, then the response from the converter will contain one or two error values. Error value 1 provides information about the type of faulty request.

Function description

Table 13-18 Error value 1

Error value 1	Meaning
00 hex	Illegal parameter number (access to a parameter that does not exist)
01 hex	Parameter value cannot be changed (change request for a parameter value that cannot be changed)
02 hex	Lower or upper value limit exceeded (change request with a value outside the value limits)
03 hex	Incorrect subindex (access to a parameter index that does not exist)
04 hex	No array (access with a subindex to non-indexed parameters)
05 hex	Incorrect data type (change request with a value that does not match the data type of the parameter)
06 hex	Setting not permitted, only resetting (change request with a value not equal to 0 without permission)
07 hex	Descriptive element cannot be changed (change request to a descriptive element that cannot be changed)
09 hex	Description data not available (access to a description that does not exist, parameter value is available)
0B hex	No master control (change request but with no master control)
0F hex	Text array does not exist (although the parameter value is available, the request is made to a text array that does not exist)
11 hex	Request cannot be executed due to the operating state (access is not possible for temporary reasons that are not specified)
14 hex	Inadmissible value (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
15 hex	Response too long (the length of the actual response exceeds the maximum transfer length)
16 hex	Illegal parameter address (illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)

Error value 1	Meaning
17 hex	Illegal format (change request for an illegal or unsupported format)
18 hex	Number of values not consistent (number of values of the parameter data to not match the number of elements in the parameter address)
19 hex	Drive object does not exist (access to a drive object that does not exist)
20 hex	Parameter text cannot be changed
21 hex	Service is not supported (illegal or not support request ID).
6B hex	A change request for a controller that has been enabled is not possible. (The converter rejects the change request because the motor is switched on. Observe the "Can be changed" parameter attribute in the parameter list.)
6C hex	Unknown unit.
6E hex	Change request is only possible in the "Motor commissioning" state.
6F hex	Change request is only possible in the "Power unit commissioning" state.
70 hex	Change request is only possible in the "Quick commissioning" ("Basic commissioning") state.
71 hex	Change request is only possible if the converter is in the "ready" state.
72 hex	Change request is only possible for a parameter reset (restore factory settings).
73 hex	Change request is only possible in the "Safety Integrated commissioning" state.
74 hex	Change request is only possible in the "Commissioning the technological application/units" state
75 hex	Change request is only possible in a commissioning state.
76 hex	Change request is not possible for internal reasons.
77 hex	Change request is not possible during download.
81 hex	Change request is not possible during download.
82 hex	Accepting the master control is inhibited.
83 hex	Desired interconnection is not possible (signal source does not supply float value, but the signal sink requires float)
84 hex	Converter does not accept a change request (the converter is busy with internal calculations)
85 hex	No access methods defined.
86 hex	Write access only during commissioning of the data records (the operating status of the converter prevents a parameter change)
87 hex	Know-how protection active: access inhibited
88 hex	Write access only in the commissioning state Safety Integrated device
89 hex	Access blocked due to missing UMAC function right
C8 hex	Change request below the currently valid limit (change request for a value that lies within the "absolute" limits, but is below the currently valid lower limit)
C9 hex	Change request above the currently valid limit (example: a parameter value is too large for the converter power)
CC hex	Change request not permitted (change is not permitted as the access code is not available)
CD hex	Converter temporarily does not accept a change request (example: the converter is currently storing drive data in its internal memory)

13.4.15 Field Device Integration (FDI)

Overview

The converter supports the standardized "Field Device" Integration (FDI) via PROFINET.

Precondition

The data set protocol of fieldbus interface X150 is configured using a commissioning tool, e.g. in the web server via "System" → "Protection and Security".

Description

Using data sets DS102 and DS103, the converter exchanges commands and configuration data with the higher-level control.

13.4.16 Data set communication with DS102 and DS103

13.4.16.1 Overview of the data set communication

Overview

Using data sets 102 and 103, the higher-level control system reads and writes converter data and controls converter functions.

Function description

A communication job via data sets DS102 and DS103 comprises 2 or 3 parts:

- → Start
  Data set DS102 defines which data or which converter function the higher-level control system requests.
- → Data
  The converter transfers the requested configuration data in data set DS103.
  Data set DS103 is not required when selecting a converter function.
- → End
  The converter concludes the communication job using data set DS102.

The configuration data as well as the converter functions are marked by an object number. The object number is part of data set DS102.

Generally, additional input and output data are required for converter functions.

The following table shows the structure of data set DS102.

Table 13-19 Data set DS102

Content	Format	Value	Description
ID protocol	U8	34 hex	Constant value
Version	U8	1 hex	Starts with "1"
Reference ID	U8	1 hex ... FF hex	The reference ID remains unchanged during the communication job → Start → Data → End.

Content	Format	Value	Description
Type of message	U8	1 hex REQUEST 2 hex RESPONSE	---
Length of the secure session ID	U16	0	Only for REQUEST Value is always = 0
Service	U8	20 hex start upload 21 hex end upload 22 hex start uncompressed upload 23 hex stop uncompressed upload 30 hex start download 31 hex end download 40 hex select converter function 80 hex data	---
Object class	U8	1 hex configuration data 2 hex converter function	Configuration data Data, which completely describe a certain converter configuration
			Converter function Controlling converter functions, e.g. restoring factory setting or trace control
Drive object	U16	1 ... FF hex	*Relevant* for drive systems with several drive axes, e.g. SINAMICS S220 1 hex for converters with 1 drive axis, e.g. SINAMICS S210 or SINAMICS G2.0
Object number	U16	See the following chapter on "Converter function" and "Configuration data"	Selecting configuration data or a converter function
Reserved	U16	0 hex	---
Data or fault	U8	1 hex no data 2 hex data via DS102 3 hex data via DS103 80 hex error	---
Reserved	U8	0 hex	---
Data length or error length	U32		Optional For a data transfer the data length is here. For a fault, the fault structure starts here.
Direct data	U8		Optional

13.4.16.2 Select converter functions via data set DS102

Overview

The converter provides a series of converter functions via data set communications with DS102.

Function description

The following table lists the available converter functions.

Table 13-20 Converter functions

Converter function	Explanation	Format	Input data	Output data	Object number
Cancel commissioning	Cancel commissioning and reject all changes that were made since commissioning was started.	U32	Drive object	---	1
Acknowledge fault	The converter acknowledges all faults whose cause has been resolved.	U8	Drive object	---	2
Copy command data set CDS	Transfer the settings of the source command data set into the target command data set.	U32	Drive object	---	3
		U8	CDS source	---	
		U8	CDS target	---	
Calculating closed-loop drive control data	Method to calculate the drive closed-loop control data: 0: No calculation 1: Complete calculation: 2: Calculating equivalent circuit diagram parameters 3: Calculate all control parameters; corresponds to calculation method = 4 plus additional parameters 4: Calculating current controller, speed controller and flux controller parameters 5: Calculating technological limits and threshold values 11: Exit complete calculation for all drive data sets and quick commissioning	U32	Drive object	---	4
		I16	Calculation method	Calculation status	
		U16	Drive data set DDS	---	
Checking closed-loop drive control data	Check: 0: No check 1: Check for the selected drive data set 11: Check for all drive data sets	U32	Drive object	---	5
		I16	Check	Check status	
		U16	Drive data set DDS	---	

Converter function	Explanation	Format	Input data	Output data	Object number
Activating the "Commissioning" mode in the drive	Store actual settings and activate commissioning. Type of commissioning: -1: Actual status of the drive commissioning 0: Commissioning deactivated without calculating the motor and closed-loop control parameters 1: Quick commissioning with data sets and sampling times 9: Configuring drive objects and available functions 10: Quick commissioning without data sets and sampling times 95: Safety Integrated commissioning	U32	Drive object	---	7
		I16	Type of commissioning	Commissioning status	
Read signal interconnection	Read the data of the selected interconnection from the signal source and signal sink.	U8	Input type	Input type	8
			Input data type	Input data type	
			---	Output type	
				Output data type	
		U8[2]	Reserve input	Reserve input	
			---	Reserve output	
		U8[8]	Input address	Input address	
			---	Output address	
			---	Substitute value	
		U32	---	Quality	
Start commissioning	Save the actual settings and start commissioning.	U32	Drive object	---	9
Reset energy consumption display	---	U32	Drive object	---	10
Reset service indicator for fan	Reset the wear calculation in the converter for the main fan or the auxiliary fan	U8	ID of the fan	---	11
			PDS	---	
		U32	Drive object	---	
Finish commissioning	Save the settings and exit commissioning.	U32	Drive object	---	12
Restore factory settings	Restoring the factory settings of the drive.	---	---	---	13

Converter function	Explanation	Format	Input data	Output data	Object number
Setting the date and time of the real-time clock	Example: Date March 3, 2027, time 4:05:6 Year: EB hex 02 00 00 Month 02 00 00 00 Day: 03 00 00 00 Hour: 04 00 00 00 Minute: 05 00 00 00 Second: 06 00 00 00	U16	Year	---	14
			Month	---	
			Tag	---	
			Hour	---	
			Minute	---	
			Second	---	
Save all parameters	Accept settings from the volatile memory into the non-volatile memory.	---	---	---	15
Interconnecting signals	Interconnect signal source and signal sink with one another	U8	Signal sink type	---	16
		U8[2]	Reserved		
		U8	Data type of the signal sink		
		U8[8]	Parameter number of the signal sink		
		U8	Signal source type		
		U8[2]	Reserved		
		U8	Data type of the signal source		
		U8[8]	Parameter number of the signal source		
		U8[8]	Substitute value of the signal source		
Topology comparison result	---	U16	COMPID	84 byte data structure	17
Starting recording in the trace	---	U32	HANDLE	---	18
Stopping recording in the trace	---	U32	HANDLE	---	19
Loading firmware versions	The converter function supplies the path name of the file. The "Upload" service is required to load the file itself.	U32	MODE	Pathname of the file	20
Converter restart	Restart the converter firmware.	U8	---	Restart successful	21
Loading information about a signal interconnection	The converter function supplies the path name of the file. The "Upload" service is required to load the file itself.	U16	Drive object	Pathname of the file	22
		U16	Parameter number		
		U16	Parameter index		
		U16	Parameter bit		

Example

The higher-level control should acknowledge a converter fault.

→ Start: The higher-level control sends the request to the converter via DS102.

Table 13-21 → Start: Request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Length of the secure session ID = 0	
Word 3	Service: Execute command = 40 hex	Object class: Command = 2
Word 4	Drive object = 1	
Word 5	Object number = 2: Acknowledge fault	
Word 6	Reserved = 0	
Word 7	Data channel = 2	Reserved = 0
Word 8	Data length = 4	
Word 9	Drive object	
Word 10	Drive object	

→ End: Via DS102, the converter signals to the higher-level control system that the acknowledgment was executed.

Table 13-22 → End: Converter response to the request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Service: Execute command = 40 hex	Object class: Command = 2
Word 3	Drive object = 1	
Word 4	Object number = 2: Acknowledge fault	
Word 5	Reserved = 0	
Word 6	Data channel = 2	Reserved = 0
Word 7	Data length = 0	

Example

The higher-level control system activates quick commissioning in the drive.

→ Start: The higher-level control sends the request to the converter via DS102.

Table 13-23 → Start: Request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Length of the secure session ID = 0	
Word 3	Service: Execute command = 40 hex	Object class: Command = 2

	Least significant byte	Most significant byte
Word 4	Drive object = 1	
Word 5	Object number = 7: Activating the "Commissioning" mode in the drive	
Word 6	Reserved = 0	
Word 7	Data channel = 2	Reserved = 0
Word 8	Data length = 6	
Word 9	Drive object	
Word 10	Drive object	
Word 11	Type of commissioning = 1: Quick commissioning with data sets and sampling times	

→ End: Via DS102, the converter signals to the higher-level control system that the command was executed.

Table 13-24 → End: Converter response to the request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Service: Execute command = 40 hex	Object class: Command = 2
Word 3	Drive object = 1	
Word 4	Object number = 7: Activating the "Commissioning" mode in the drive	
Word 5	Reserved = 0	
Word 6	Data channel = 2	Reserved = 0
Word 7	Data length = 2	
Word 8	Commissioning status: Completed	

13.4.16.3 Transfer configuration data via DS102 and DS103

Overview

The converter provides a series of configuration data via data set communications with DS102 and DS103.

Function description

The following table shows the available configuration data.

Table 13-25 Configuration data

Data	Object number
Actual signal interconnection of the drive	1
Actual hardware topology	2
Global communications data, e.g. PROFINET protocols used	3
PROFIdrive telegrams of the drive	4
Real-time clock	6

Data	Object number
Predefined I/O configuration	7
Fieldbus interface data, e.g. IP address or subnet mask.	8
PROFIBUS data, e.g. PROFIBUS address	9

Example

The higher-level control requests data of the signal interconnections of the converter. The quantity of data to be transferred requires data set DS103.

→ Start: The higher-level control sends the request to the converter via DS102.

Table 13-26 → Start: Request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Length of the secure session ID = 0	
Word 3	Service = 20 hex: Start upload	Object class: Configuration = 1
Word 4	Drive object = 1	
Word 5	Object number: Signal interconnection = 1	
Word 6	Reserved = 0	
Word 7	Data channel = 3	Reserved = 0

→ Start: The converter mirrors the request from the higher-level control system via DS102.

Table 13-27 → Start: Converter response to the request of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Service = 20 hex: Start upload	Object class: Configuration = 1
Word 3	Drive object = 1	
Word 4	Reserved = 0	
Word 5	Data channel = 3	Reserved = 0
Word 6	Data length = 77,777	

→ Data: For the requested data, the converter defines the length of the data block and calculates the number of data blocks required:

- Total data length = 77 777 words
- Length of the data block: 900 words
- Number of data blocks = 87 (86 data blocks with 900 words and 1 data block with 377 words)
- Length of the last data block = 377 words

→ Data: The converter sends the requested data in several data blocks via DS103:

Table 13-28 → Data: the converter sends the requested data in the 1st data block

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Reference ID = 88 hex
Word 1	Service = 80 hex: Data	Additional data follow = 1
Word 2	Number of the data block = 1	
Word 3	Length of the data block = 900	
Word 4	Data	Data
Word ...	Data	Data

Table 13-29 → Data: the converter sends the requested data in the nth data block

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Reference ID = 88 hex
Word 1	Service = 80 hex: Data	Additional data follow = 1
Word 2	Number of the data block = n, n = 2 ... 86	
Word 3	Length of the data block = 900	
Word 4	Data	Data
Word ...	Data	Data

Table 13-30 → Data: the converter sends the requested data in the last data block

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Reference ID = 88 hex
Word 1	Service = 80 hex: Data	Additional data follow = 0
Word 2	Number of the data block = 87	
Word 3	Length of the data block = 377	
Word 4	Data	Data
Word ...	Data	Data

→ End: The higher-level control system signals the converter once data transfer has been completed and whether data transfer functioned correctly.

Table 13-31 → End: Feedback signal of the higher-level control system

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Length of the secure session ID = 0	
Word 3	Service = 21 hex: Terminate upload	Object class: Configuration = 1
Word 4	Drive object = 1	
Word 5	Object number: Signal interconnection = 1	

	Least significant byte	Most significant byte
Word 6	Reserved = 0	
Word 7	Data channel = 1	Reserved = 0

→ End: If a data transfer error has occurred, then the higher-level control system signals the converter once data transfer has been completed and whether data transfer functioned correctly.

Table 13-32 → End: Feedback signal of the higher-level control system for a data transfer error

	Least significant byte	Most significant byte
Word 0	Log ID = 34 hex	Version = 1
Word 1	Reference ID = 88 hex	Type of message: REQUEST = 1 hex
Word 2	Length of the secure session ID = 0	
Word 3	Service = 21 hex: Terminate upload	Object class: Configuration = 1
Word 4	Drive object = 1	
Word 5	Object number: Signal interconnection = 1	
Word 6	Reserved = 0	
Word 7	Data channel = 80 hex	Reserved = 0
Word 8	Fault class	Fault code
Word 9	Fault information 1	
Word 10	Fault information 2	

13.4.16.4 Fault class and fault code

Overview

For a data transfer error, data set DS102 contains the error diagnostics in a structured form.

Function description

Table 13-33 Fault diagnostics in data set DS102

	Least significant byte	Most significant byte
Word 1	Fault class	Fault code
Word 2	Fault information 1	
Word 3	Fault information 2	

For a command fault, the two words "Fault information 1" and "Fault information 2" contain the full diagnostics in the U32 format.

Table 13-34 Fault class and fault code

Fault class	Meaning	Fault code	Meaning
1	Internal error	1	Fatal fault
		2	No CCI session available

Fault class	Meaning	Fault code	Meaning
2	Syntax error	1	ID protocol
		2	Version
		3	Message type
		4	Secure session ID too long
		5	Service type
		6	Object class
		7	Data or fault-specific
		8	Data length
		9	Drive object
3	Error in the sequence	1	Incorrect request at → Start
		2	Request of the communication part "→ end" without previous request of the communication part "→ start"
		3	Missing data
		4	Incomplete data
4	Error when selecting the converter function or the configuration data	1	Converter function not supported
		2	Configuration data not supported
		3	Configuration and data are inconsistent
		4	No access due to missing UMAC rights
5	Incorrect converter function	1	Details are provided in the fault information
6	Error in the DS103	1	Incorrect protocol ID
		2	Incorrect reference ID
		3	Incorrect service
		4	DS103 expected, but is missing
		5	DS103 available, but not expected
		6	DS103 reading and writing do not match
		7	More data than expected
		8	Fewer data than expected

13.4.17 Identification & Maintenance (I&M) data

Overview

I&M data are identification and maintenance data that are stored in a product. The higher-level controller has access to the I&M data of all products on the fieldbus.

Using the I&M data, the plant operator can identify and label products and specify maintenance measures.

The converter supports the identification and maintenance (I&M) data listed in the table.

Function description

Table 13-35 I&M data

I&M data	Format	Explanation	Example for the content
I&M0	u8[64] PROFIBUS u8[54] PROFINET	Converter-specific data, read only	See below
I&M1	Visible String [32]	Plant/system identifier	"ak12-ne.bo2=fu1"
	Visible String [22]	Location identifier	"sc2+or45"
I&M2	Visible String [16]	Date	"2013-01-21 16:15"
I&M3	Visible String [54]	Any comment or remark	-
I&M4	Octet string [54]	Check signature to track changes for Safety Integrated.	Values of r9781[0] and r9782[0]

When requested, the converter transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7 or TIA Portal.

Table 13-36 I&M0

Designation	Format	Example for the content
MANUFACTURER_ID	u16	42d hex (=Siemens)
ORDER_ID	Visible String [20]	"6SL3246-0BA22-1FA0"
SERIAL_NUMBER	Visible String [16]	"T-R32015957"
HARDWARE_REVISION	u16	0001 hex
SOFTWARE_REVISION	char, u8[3]	"V" 06.02.00
REVISION_COUNTER	u16	0000 hex
PROFILE_ID	u16	3A00 hex
PROFILE_SPECIFIC_TYPE	u16	0000 hex
IM_VERSION	u8[2]	01.02
IM_SUPPORTED	bit[16]	001E hex

13.5 Modbus communications

13.5.1 Modbus TCP fieldbus

Overview

Modbus TCP is a fieldbus standard used by the converter to communicate with a higher-level control system.

Precondition

Requirements:

- Converter with Ethernet interface X150
- Following selection of Modbus TCP in the commissioning tool, the power supply must be switched off and then switched on again or a hardware reset must be performed via p0972.

Function description

The Modbus protocol, which is based on a client-server architecture, transfers data as TCP/IP packets.

The converter supports the connection to a maximum of 3 clients.

TCP port 502 is reserved for Modbus TCP.

The client accesses converter process data and parameters via registers:

- Process data: Registers 40100 - 40119
- Drive data: Registers 40300 - 40522
- Parameter via data set DS47: Registers 40601 - 40722

Modbus TCP provides a basic Ethernet functionality:

- Commissioning access
- DCP, for example for setting the IP address
- SNMP for identification

13.5.2 Register

Overview

The Modbus protocol contains register and bit numbers for addressing memory. The registers are assigned in converter control words, condition words and parameters of the converter.

Function description

A Modbus register comprises 16 bits. The values of the converter display parameters (r parameters) cannot always be represented with 16 bits. In these particular cases, the maximum value that can be represented is displayed.

- Unsigned: 65535
- Signed min: -32768
- Signed max: 32767

Table 13-37 Control parameters with up to ten process data items[1)]

Register	Description	Access[2)]	Unit	Scaling	Value range	Parameters
40100	Control word (see function diagram 2442)	R/W	-	1	-	r2050[0]
40101	Main setpoint	R/W	-	1	-	r2050[1]
40102	Control word 3	R/W	-	1	-	r2050[2]
40103	Control word 4	R/W	-	1	-	r2050[3]
40104	Process data item 5	R/W	-	1	-	r2050[4]
40105	Process data item 6	R/W	-	1	-	r2050[5]
40106	Process data item 7	R/W	-	1	-	r2050[6]
40107	Process data item 8	R/W	-	1	-	r2050[7]
40108	Process data item 9	R/W	-	1	-	r2050[8]
40109	Process data item 10	R/W	-	1	-	r2050[9]

1) We recommend using registers 40150 ... 40169. Registers 40100 ... 40109 are compatible with converters that have firmware < V6.1.

2) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-38 Control parameters with more than ten process data items[1)]

Register	Description	Access[2)]	Unit	Scaling	Value range	Parameters
40150	Control word (see function diagram 2442)	R/W	-	1	-	r2050[0]
40151	Main setpoint	R/W	-	1	-	r2050[1]
40152	Control word 3	R/W	-	1	-	r2050[2]
40153	Control word 4	R/W	-	1	-	r2050[3]
40154	Process data item 5	R/W	-	1	-	r2050[4]
40155	Process data item 6	R/W	-	1	-	r2050[5]
40156	Process data item 7	R/W	-	1	-	r2050[6]
40157	Process data item 8	R/W	-	1	-	r2050[7]
40158	Process data item 9	R/W	-	1	-	r2050[8]
40159	Process data item 10	R/W	-	1	-	r2050[9]
40160	Process data item 11	R/W	-	1	-	r2050[10]
40161	Process data item 12	R/W	-	1	-	r2050[11]
40162	Process data item 13	R/W	-	1	-	r2050[12]
40163	Process data item 14	R/W	-	1	-	r2050[13]
40164	Process data item 15	R/W	-	1	-	r2050[14]
40165	Process data item 16	R/W	-	1	-	r2050[15]
40166	Process data item 17	R/W	-	1	-	r2050[16]
40167	Process data item 18	R/W	-	1	-	r2050[17]
40168	Process data item 19	R/W	-	1	-	r2050[18]
40169	Process data item 20	R/W	-	1	-	r2050[19]

1) Registers 40150 ... 40159 are identical to registers 40100 ... 40109.

2) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-39 Status data

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40110	Condition word (see function diagram 2452)	R	-	1	-	c2053[0]
40111	Main actual value	R	-	1	-	c2053[1]
40112	Process data item 3	R	-	1	-	c2053[2]
40113	Process data item 4	R	-	1	-	c2053[3]
40114	Process data item 5	R	-	1	-	c2053[4]
40115	Process data item 6	R	-	1	-	c2053[5]
40116	Process data item 7	R	-	1	-	c2053[6]
40117	Process data item 8	R	-	1	-	c2053[7]
40118	Process data item 9	R	-	1	-	c2053[8]
40119	Process data item 10	R	-	1	-	c2053[9]
40120	Process data item 11	R	-	1	-	c2053[10]
40121	Process data item 12	R	-	1	-	c2053[11]
40122	Process data item 13	R	-	1	-	c2053[12]
40123	Process data item 14	R	-	1	-	c2053[13]
40124	Process data item 15	R	-	1	-	c2053[14]
40125	Process data item 16	R	-	1	-	c2053[15]
40126	Process data item 17	R	-	1	-	c2053[16]
40127	Process data item 18	R	-	1	-	c2053[17]
40128	Process data item 19	R	-	1	-	c2053[18]
40129	Process data item 20	R	-	1	-	c2053[19]

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-40 Inputs and outputs

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40200	Digital output DO 0	R/W	-	-	-	r0747.0, c0730[2)]
40201	Digital output DO 1	R/W	-	-	-	r0747.1, c0731[2)]
40202	Digital output DO 2	R/W	-	-	-	r0747.2, c0732[2)]
40240	Digital input DI 0	R	-	-	-	r0722.0
40241	Digital input DI 1	R	-	-	-	r0722.1
40242	Digital input DI 2	R	-	-	-	r0722.2
40243	Digital input DI 3	R	-	-	-	r0722.3
40244	Digital input DI 4	R	-	-	-	r0722.4
40245	Digital input DI 5	R	-	-	-	r0722.5
40251	Digital input DI 11	R	-	-	-	r0722.11
40252	Digital input DI 12	R	-	-	-	r0722.12

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40260	Value of analog input 0	R	%	100	-100.0 ... 100.0	r0755[0]
40523	Analog output AO 0	R/W	%	100	-100.0 ... 100.0	r0772[0], c0771[0]

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

2) If the signal source for a digital output is interconnected with a signal sink, the converter will not write the value.

Table 13-41 Drive data

Register	Description	Access[1)]	Unit	Scaling	ON/OFF text or Value range	Parameters
40300	Power unit code number	R	-	1	0 ... 65535	r0200
40301	Converter firmware	R	-	1	0 ... 65535	r0964[2]
40302	Converter firmware	R	-	1	0 ... 65535	r0964[6]
40320	Rated power of the converter	R	kW	100	0 ... 655.35	r0206
40321	Current limit	R/W	A	10	0.0 ... 6553.5	p0640
40322	Acceleration time	R/W	s	100	10.00 ... 655.35	p1120
40323	Ramp-down time	R/W	s	100	10.00 ... 655.35	p1121
40324	Reference speed	R/W	RPM	1	6 ... 65535	p2000
40340	Speed setpoint	R	RPM	1	-32768 ... 32767	r0020
40341	Actual speed value	R	RPM	1	-32768 ... 32767	r0021
40342	Output frequency	R	Hz	100	- 327.68 ... 327.67	r0024
40343	Output voltage	R	V	1	0 ... 65535	r0025
40344	DC link voltage	R	V	1	0 ... 65535	r0026
40345	Current actual value	R	A	100	0 ... 655.35	r0027
40346	Actual torque value	R	Nm	100	0 ... 655.35	r0031
40347	Actual active power	R	kW	100	0 ... 655.35	r0032
40349	Master control	R	-	1	HAND | AUTO	r0807

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-42 Faults and alarms

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40400	Fault number, index 0	R	-	1	0 ... 65535	r0947 [0]
40401	Fault number, index 1	R	-	1	0 ... 65535	r0947 [1]
40402	Fault number, index 2	R	-	1	0 ... 65535	r0947 [2]
40403	Fault number, index 3	R	-	1	0 ... 65535	r0947 [3]
40404	Fault number, index 4	R	-	1	0 ... 65535	r0947 [4]
40405	Fault number, index 5	R	-	1	0 ... 65535	r0947 [5]
40406	Fault number, index 6	R	-	1	0 ... 65535	r0947 [6]
40407	Fault number, index 7	R	-	1	0 ... 65535	r0947 [7]
40408	Alarm number	R	-	1	0 ... 65535	r2122 [0]

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40409	Actual alarm code	R	-	1	0 ... 65535	r2132
40420	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[0]
40421	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[1]
40422	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[2]
40423	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[3]
40424	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[4]
40425	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[5]
40426	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[6]
40427	Safety Integrated alarm number	R	-	1	0 ... 65535	r60047[7]
40499	PRM ERROR code	R	-	1	0 ... 255	-

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-43 Technology controller

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40500	Technology controller enable	R/W	-	1	0 ... 1	c2200, r2349.0
40501	Technology controller MOP	R/W	%	100	-200.0 ... 200.0	p2240
40510	Time constant for actual value filters of the technology controller	R/W	-	100	0.00 ... 60.0	p2265
40511	Scaling factor for actual value of the technology controller	R/W	%	100	0.00 ... 500.00	p2269
40512	Proportional gain of the technology controller	R/W	-	1000	0.000 ... 65.535	p2280
40513	Integral time of the technology controller	R/W	s	1	0 ... 60	p2285
40514	Time constant D-component of the technology controller	R/W	-	1	0 ... 60	p2274
40515	Max. limit of technology controller	R/W	%	100	-200.0 ... 200.0	p2291
40516	Min. limit technology controller	R/W	%	100	-200.0 ... 200.0	p2292
40520	Effective setpoint acc. to internal technology controller MOP ramp-function generator	R	%	100	-100.0 ... 100.0	r2250
40521	Actual value of technology controller after filter	R	%	100	-100.0 ... 100.0	r2266
40522	Output signal technology controller	R	%	100	-100.0 ... 100.0	r2294

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 13-44 Parameter access via DS47

Register	Description	Access[1)]	Unit	Scaling	Value range	Data / parameter
40601	DS47 Control	R/W	-	-	-	-
40602	DS47 header	R/W	-	-	-	-
40603	DS47 data 1	R/W	-	-	-	-

Register	Description	Access[1)]	Unit	Scaling	Value range	Data / parameter
...	...	...	-	-	-	-
40722	DS47 data 120	R/W	-	-	-	-

1) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

13.5.3 Application data unit

Overview

The controller communicates with the converter via the application data unit.

Description of function

Application Data Unit (ADU)					
Modbus Application Header				Protocol Data Unit (PDU)	
Transaction ID	Protocol ID	Length	Unit ID	FCode	Data
2 Bytes	2 Bytes	2 Bytes	1 Byte	1 Byte	0 ... 252 Bytes

Figure 13-32 Design of the application data unit

The application data unit (ADU) comprises the following elements:

- The Modbus application header is a 7-byte header.
  The "Unit ID" byte has no significance for Modbus TCP.
- The protocol data unit (PDU) comprises the following components:
  - The function code (FCode) indicates whether the controller is writing data to the converter or reading data from the converter.
  - The data (Data) depends on the FCode and can contain information such as the registers or parameter numbers and parameter values.

13.5.4 Registers read with function code FC 03

Overview

Function code FC 03 enables read access for the controller to one or more converter registers.

Description of function

The structure of the protocol data unit (PDU) in the case of read access using function code FC 03 is as follows:

- Byte 7: FCode 03
- Byte 8 and Byte 9: Register
- Byte 10 and Byte 11: Number of registers the controller is reading

Example

Table 13-45 Structure of a read request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	00 h	8	"High" register (40110)
	6D h	9	"Low" register
	00 h	10	Number of "High" registers (two registers: 40110; 40111)
	02 h	11	Number of "Low" registers

The converter responds with the content of the register requested (bytes 8 ... 11).

Table 13-46 Response of the converter to a valid read request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	04 h	8	Number of bytes (four bytes are returned)
	11 h	9	Data from the first register, "High"
	22 h	10	Data from the first register, "Low"
	33 h	11	Data from the second register, "High"
	44 h	12	Data from the second register, "Low"

Table 13-47 Response of the converter to an invalid read request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	83 h	7	Highest bit = 1 and function code
	01 h ... 04 h	8	Error code

13.5.5 Registers write with function code FC 06

Overview

Function code FC 06 enables write access for the controller to precisely one converter register.

Description of function

The structure of the protocol data unit (PDU) in the case of write access using function code FC 06 is as follows:

- Byte 7: FCode 06
- Byte 8 and Byte 9: Register
- Byte 10 and Byte 11: Value to be written to the register

Example

Table 13-48 Structure of a write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	06 h	7	Function code
	00 h	8	"High" register (40100)
	63 h	9	"Low" register
	55 h	10	"High" register data
	66 h	11	"Low" register data

The converter responds with the register (bytes 8 and 9) and the value (bytes 10 and 11) that the controller has written to the register.

Table 13-49 Response of the converter to a valid write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	06 h	7	Function code
	00 h	8	"High" register
	63 h	9	"Low" register
	55 h	10	"High" register data
	66 h	11	"Low" register data

Table 13-50 Response of the converter to an invalid write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	86 h	7	Highest bit = 1 and function code
	01 h ... 04 h	8	Error code

13.5.6 Registers write with function code FC 16

Overview

Function code FC 16 enables write access for the controller to multiple converter registers. Function code FC 16 is suitable in particular for writing the control parameters using registers 40150 et seq.

Requirement

The registers accessed by the controller must be consecutive with no gaps.

Description of function

The structure of the protocol data unit (PDU) in the case of write access using function code FC 16 is as follows:

- Byte 7: FCode 16
- Byte 8 and Byte 9: Register
- Byte 10 and Byte 11: Number of registers to which controller is writing
- Byte 12: Number of bytes the controller is writing
- Byte 13 and following bytes: Data the controller is writing

Example

The following example describes writing to registers 40150 ... 40154.

Table 13-51 Structure of a write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	10 h	7	Function code
	0095 h	8, 9	Register (40150)
	0005 h	10, 11	Number of registers to be written to (five registers)
	0A h	12	Number of data bytes (five registers of two bytes each = ten bytes)
	047E h	13,14	40150: Control word
	1000 h	15,16	40151: Main setpoint
	0000 h	17,18	40152: Process data item 3
	0000 h	19,20	40153: Process data item 4
	0815 h	21,22	40154: Process data item 5

Table 13-52 Response of the converter to a valid write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	10 h	7	Function code
	0095 h	8, 9	Register (40150)
	0005 h	10, 11	Number of registers to be written to (five registers)

Table 13-53 Response of the converter to an invalid write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	90 h	7	Highest bit = 1 and function code
	01 h ... 04 h	8	Error code

13.5.7 Communication via DS 47

Overview

Communication via DS 47 is possible using registers 40601 ... 40722.

Function description

The controller accesses the converter parameters using registers 40601 ... 40722:

- Write access with function code FC 16
- Read access with function code FC 03

Register 40601 controls communication via DS47. 40602 contains the function code and the number of user data items following. Registers 40603 ... 40722 contain the user data.

Value in the register				Explanation
40601	40602		40603 ... 40722	
0	47	...	...	Write values for acyclic access
1	47	Request length [byte]	Request data	Activate acyclic access

Value in the register				Explanation
40601	40602		40603 ... 40722	
2	47	Response length [byte]	Response data	Response for a successful request
2	47	0	Error code [1] 1 hex: Invalid length 2 hex: Action not permitted in current converter state 3 hex: Invalid function code (FC ≠ 2F hex) 4 hex: Response has still not been issued 5 hex: General system fault	Response to an erroneous request

[1] The error code is described in the PROFIdrive profile.

The structure of the protocol data unit (PDU) in the case of write or read access is as follows:

- Byte 7: Write FCode 16; read FCode 03
- Byte 8 and Byte 9: Register 40601
- Byte 10 and Byte 11: Number of registers the controller is reading or writing
- Byte 12: Number of bytes the controller is reading or writing
- Byte 13 and following bytes: Data in accordance with DS47 of the PROFIdrive profile

Example

The following example describes reading parameter r0002.

Procedure for reading the parameter value of r0002:

1. The controller sends a "Read parameter value" parameter request to the converter.
2. The controller sends a read request to the converter.
3. The converter responds to the read request with the parameter response.

Table 13-54 Write parameter request: Read parameter value of r0002

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	10 h	7	Function code
	0258 h	8, 9	Register (40601)
	0007 h	10, 11	Number of registers to be read (40601 ... 40607)
	0E h	12	Number of data bytes (seven registers of two bytes each = 14 bytes)
	0001 h	13,14	40601: DS47 Control = 1 (activate request)
	2F0A h	15,16	40602: Function code 2F h (47), request length 10 bytes (0A h)
	8001 h	17,18	40603: Request reference = 80 h, request identifier = 1 h
	0101 h	19,20	40604: DO-ID = 1, number of parameters = 1
	1001 h	21,22	40605: Attribute, number of elements = 1
	0002 h	23,24	40606: Parameter number = 2
	0000 h	23,24	40607: Subindex = 0

Table 13-55 Read parameter response: Read parameter value of r0002

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0258 h	8, 9	Register (40601)
	0007 h	10, 11	Number of registers to be read (40601 ... 40607)

Table 13-56 Response of the converter to a valid read request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0E h	8	Number of bytes (the converter returns 14 bytes)
	0002 h	9, 10	40601: DS47 Control = 2 (the converter has executed the request)
	2F08 h	11, 12	40602: Function code 2F h (47), response length 8 bytes
	8001 h	13, 14	40603: Request reference mirrored = 80 h, response identifier = 1 (read parameter)
	0101 h	15, 16	40604: Drive object = 1, number of parameters = 1
	0301 h	17, 18	40605: Format, number of elements = 1
	001F h	19, 20	40606: Parameter value = 1F h (31)

Table 13-57 Response if read request has still not been completed

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0E h	8	Number of data bytes following (14 bytes ≙ 7 registers)
	0001 h	9, 10	40601: Control value 1 = the converter is currently processing the request
	2F00 h	11, 12	40602: Function code 2F h (47), response length 0 (error)
	0004 h	13, 14	40603: Fault code 0004 (the converter has still not responded)

Example

The following example describes writing parameter p1121.

Procedure for writing the parameter value of p1121:

1. The controller sends a "write parameter value" parameter request to the converter.
2. The controller sends a write request to the converter.
3. The converter responds to the write request.

Table 13-58 Write parameter request: Write parameter value of p1121

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	10 h	7	Function code
	0258 h	8, 9	Register (40601)
	000A h	10, 11	Number of registers to be written (40601 ... 40610)
	14 h	12	Number of data bytes (ten registers of two bytes each = 20 bytes)
	0001 h	13,14	40601: DS47 Control = 1 (activate request)
	2F10 h	15,16	40602: Function code 2F h (47), request length 10 bytes (0A h)
	8002 h	17,18	40603: Request reference = 80 h, request identifier = 2 h (write parameter)
	0101 h	19,20	40604: DO-ID = 1, number of parameters = 1
	1001 h	21,22	40605: Attribute, number of elements = 1
	0461 h	23,24	40606: Parameter number = 1121
	0000 h	25, 26	40607: Subindex = 0
	0801 h	27, 28	40608: Format + number of values
	4142 h	29, 30	40609: Parameter value
	6666 h	31, 32	40610: Parameter value

Table 13-59 Read parameter response: Write parameter value of p1121

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0258 h	8, 9	Register (40601)
	0007 h	10, 11	Number of registers to be read (40601 ... 40607)

Table 13-60 Response of the converter to a valid write request

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0E h	8	Number of bytes (0E h: 14 bytes ≙ 7 registers)
	0002 h	9, 10	40601: DS47 Control = 2 (the converter has executed the request)
	2F04 h	11, 12	40602: Function code 2F h (47), response length 4 bytes
	8002 h	13, 14	40603: Request reference mirrored = 80 h, response identifier = 2 (write parameter)
	0101 h	15, 16	40604: Drive object = 1, number of parameters = 1

Table 13-61 Response if write request has still not been completed

	Value	Byte	Description
Modbus Application Header	-	0 ... 6	-
Protocol Data Unit	03 h	7	Function code
	0E h	8	Number of bytes (0E h: 14 bytes ≙ 7 registers)
	0001 h	9, 10	40601: Control value 1 = the converter is currently processing the request
	2F00 h	11, 12	40602: Function code 2F h (47), response length 0 (error)
	0004 h	13, 14	40603: The converter has still not responded

13.5.8 Response to an invalid write or read access attempt

Overview

The converter signals an erroneous read or write access attempt to the controller with an error code.

Description of function

If the converter detects a logical error in an access attempt, it responds with the following two bytes in the protocol data unit:

- Byte 1: Highest bit in function code = 1
- Byte 2: Error code

Table 13-62 Overview of the error codes

Error code	Name	Possible error causes
01	Invalid function code	• The controller has sent a function code that is not supported by the converter. • The current UMAC settings do not contain any write or read permissions.
02	Invalid register	• The controller is attempting to access an invalid register. • The range defined by the starting register and the number of registers contains one or more invalid registers.
03	Invalid data value	The controller is addressing more than 125 registers.
04	General error	• Write access to a "Read only" register • Write access to a reserved register

13.5.9 Modbus RTU fieldbus

Overview

Modbus RTU is a fieldbus standard used by the converter to communicate with a higher-level control system.

Precondition

Requirements:

- Converter with RS485 interface X125
- After selecting Modbus RTU in the commissioning tool, the power supply must be switched off and then switched on again or a hardware reset must be performed using p0972.

Function description

The Modbus protocol, which is based on a client-server architecture, transfers data in the binary format.

The converter supports a connection to precisely 1 master.

The client identifies the converter based on an individual address in the range 1 ... 247.

The client accesses converter process data and parameters via registers:

- Process data: Registers 40100 - 40119
- Drive data: Registers 40300 - 40522
- Parameter via data set DS47: Registers 40601 - 40722

13.6 Ethernet/IP communication

13.6.1 Ethernet/IP fieldbus

Overview

The Ethernet Industrial Protocol (Ethernet/IP) is an open standard for industrial networks used by the converter to communicate with a higher-level control system.

Requirement

Converter with Ethernet interface X150.

Following selection of EtherNet/IP in the commissioning tool, the power supply must be switched off and then switched on again or a hardware reset must be performed via p0972.

Description of function

Ethernet/IP, which uses the Common Industrial Protocol (CIP), transfers data as TCP/IP packets.

Ethernet/IP is used to transmit cyclic I/O data and acyclic parameter data.

The higher-level control system accesses converter process data and parameters via Ethernet/IP objects:

- Cyclic communication of process data with "assembly objects"
- Acyclic communication for writing and reading converter parameters with "class objects"

Ethernet/IP always provides a basic Ethernet functionality:

- Commissioning access
- DCP, for example for setting the IP address
- SNMP for identification

13.6.2 Ethernet protocols

Overview

The converter supports the Ethernet protocols listed in the table.

The information contained is required to set security measures such as the firewall to protect the system.

Description of function

The address parameters, the relevant communication layer, and the communication role and communication direction are specified for each protocol.

Table 13-63 EtherNet/IP protocols

Protocol	Port number	Layer (2) Link layer (4) Transport layer	Description
Implicit messaging	2222	(4) UDP	Used for the exchange of process data Is inactive in the factory setting. Is activated when selecting EtherNet/IP.
Explicit messaging	44818	(4) TCP (4) UDP	Used for reading and writing parameter values Is inactive in the factory setting. Is activated when selecting EtherNet/IP.

13.6.3 Supported objects

Overview

The higher-level control system accesses converter process data and parameters via EtherNet/IP objects.

Description of function

Table 13-64 EtherNet/IP objects

Class		Name	Required object	SINAMICS object
1 hex	1	Identity object	x	-
4 hex	4	Assembly object [1)]	x	-
6 hex	6	Connection management object	x	-
47 hex	71	Device Level Ring (DLR) object	x	-
48 hex	72	Quality of service (QoS) object	x	-
F5 hex	245	TCP/IP interfacing object [2)]	x	-
F6 hex	246	Ethernet link object [2)]	x	-
109 hex	265	LLDP management object	x	-
10A hex	266	LLDP data table object	x	-
32C hex	812	Siemens drive object	-	x

Class		Name	Required object	SINAMICS object
32D hex	813	Siemens motor object	-	x
401 hex	1025	Parameter object	-	x

1) The assembly object is assigned a cycle in the control system.

2) Part of the EtherNet/IP system management

13.6.4 Cyclic communication

13.6.4.1 Generic I/O module

Overview

A generic I/O module provides cyclic communication between controller and converter.

Description of function

The following are required for cyclic communication between controller and converter:

- The controller has a generic I/O module with all network parameters created: IP address, subnet mask, standard gateway, station names.
- The converter has been configured with the same network parameters as the controller using a commissioning tool.
- The number of process data items has been configured in the controller's generic module to match the telegram selected in the converter:
  - Input 101 = sum of all converter send data
  - Output 102 = sum of all converter receive data
  - Configuration 1 = 0 and configuration 103 = 0

The converter supports 4 ms as the minimum value for RPI (Requested Packet Interval).

More information

An application example for the integration of the converter into a Rockwell control system can be found on the Internet:

Application example (https://support.industry.siemens.com/cs/ww/en/view/109824950)

The application description is also valid for the converter described in this manual.

13.6.4.2 "Assembly object" class

Overview

The "assembly object" enables cyclical communication between controller and converter.

Description of function

The "assembly object" has object class 04 hex.

Table 13-65 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported service: Get attribute single

Table 13-66 Instance attributes

Attribute ID	Service[1)]	Type	Name	Value/explanation
3	get	Array of UINT8	Assembly	1 byte field

1) Supported service: Get attribute single

13.6.5 Acyclic communication

13.6.5.1 "Identity object" class

Overview

The "identity object" enables the controller to access selected converter data.

Function description

The "identity object" has object class 01 h.

Table 13-67 Class attributes

Attribute ID	Service [1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported service: Get attribute single, get attribute all

Table 13-68 Instance attributes

Attribute ID	Service [1)]	Type	Name	Value/explanation
1	get	UINT16	Vendor ID	1251
2	get	UINT16	Device: Siemens Product	0C hex
3	get	UINT16	Product code	9000 (G220)
4	get	UINT16	Revision	-
5	get	UINT16	Status	See the following table
6	get	UINT32	Serial number	Bits 0 ... 19: consecutive number; bits 20 ... 23: production identifier bits 24 ... 27: month of manufacture (0 = Jan, B = Dec) bits 28 ... 31: year of manufacture (0 = 2002)
7	get	Short String	Product name	Max. length 32 bytes

1) Supported services: Get attribute single, get attribute all

Table 13-69 Explanation of attribute ID 5 of the previous table

Byte	Bit	Name	Description
1	0	Assignment	0: Converter is not assigned to a controller 1: Converter is assigned to a controller
	1	-	Reserved
	2	Configuration	0: Ethernet/IP basic settings 1: modified Ethernet/IP settings
	3	-	Reserved
	4 ... 7	Extended device status	0: Self-test or status not known 1: Firmware update active 2: At least one I/O connection with error 3: No I/O connections 4: Incorrect configuration in the ROM 5: Fatal fault 6: At least one I/O connection is active 7: All I/O connections in the quiescent state 8 ... 15: Reserved
2	8 ... 11	-	not used
	12 ... 15	-	Reserved

13.6.5.2 "Connection management object" class

Overview

The "connection management object" enables communication diagnostics.

Description of function

The "connection management object" has object class 06 hex.

Table 13-70 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute single, get attribute all

Table 13-71 Instance attributes

Attribute ID	Service[1)]	Type	Name	Value/explanation
1	get	UINT16	Open Requests	Counters
2	get	UINT16	Open Format Rejects	Counters
3	get	UINT16	Open Resource Rejects	Counters

Attribute ID	Service[1)]	Type	Name	Value/explanation
4	get	UINT16	Open Other Rejects	Counters
5	get	UINT16	Close Requests	Counters
6	get	UINT16	Close Format Rejects	Counters
7	get	UINT16	Close Other Rejects	Counters
8	get	UINT16	Timeouts	Number of bus errors

1) Supported services: Get attribute single, get attribute all

13.6.5.3 "Device Level Ring object" class

Overview

The "Device Level Ring object" provides the interface for configuration and status information of an Ethernet ring topology.

Description of function

The "Device Level Ring object" has object class 47 hex.

Table 13-72 Class attributes

Attribute ID	Service 1)	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute all, get attribute single

Table 13-73 Instance attributes

Attribute ID	Service 1)	Type	Name	Value/explanation
1	get	UINT8	Network topology	0: Linear topology 1: Ring topology
2	get	UINT8	Network status	0: Normal 1: Ring fault 2: Unexpected loop detected 3: Partial network fault 4: Rapid fault/restore cycle

Attribute ID	Service [1]	Type	Name	Value/explanation
10	get	STRUCT of:	Active supervisor address	
		UINT32	Supervisor IP address	0: No IP address configured for drive
		ARRAY of 6 UINT8	Supervisor MAC address	
12	get	DWORD	Capability flags	

[1] Supported services: Get attribute all, get attribute single

13.6.5.4 "Quality-of-service object" class

Overview

The "Quality-of-service object" controls data traffic with different relative priority or other delivery flags.

Description of function

The "Quality-of-service object" has object class 48 hex.

The "Quality-of-service object" supports no class attributes.

Table 13-74 Instance attributes

Attribute ID	Service[1]	Type	Name	Value/explanation
4	get, set	UINT8	DSCP Urgent	Factory setting: Priority 55
5	get, set	UINT8	DSCP Scheduled	Factory setting: Priority 47
6	get, set	UINT8	DSCP High	Factory setting: Priority 43
7	get, set	UINT8	DSCP Low	Factory setting: Priority 31
8	get, set	UINT8	DSCP Explicit	Factory setting: Priority 27

[1] Supported services: Get attribute single, set attribute single

13.6.5.5 "TCP/IP interfacing object" class

Overview

The "TCP/IP interfacing object" class enables configuration of the Ethernet interface.

Description of function

The "TCP/IP interfacing object" has object class F5 hex.

Table 13-75 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute all, get attribute single

Table 13-76 Instance attributes

Attribute ID	Service[1)]	Type	Name	Value/explanation
1	get	UINT32	Status	Fixed value: 1 hex 1: Configuration acknowledged, by DHCP or saved values
2	get	UINT32	Configuration Capability	Fixed value: 94 hex 4 hex: DHCP supported, 10 hex: Configuration can be adjusted, 80 hex: ACD-capable
3	get, set	UINT32	Configuration Control	1 hex: Saved values 3 hex: DHCP
4	get	UINT16	Physical Link	Path Size (in WORDs); fixed value: 2 hex
		UINT8		Path (20 hex, F6 hex, 24 hex, 05 hex, where 5 hex is the number of instances of F6 hex: 4 physical ports plus an internal port).
5	get, set	STRING	Interface Configuration	r61000 Name of Station
		UINT32		r61001 IP address
6	get, set	UINT16	Host Name	Host Name Length
		STRING		-
10	get, set	UINT8	Select ACD	local OM flash: 0: Disabled, 1: Enabled
11	get, set	UINT8	Last Conflict Detected	local OM flash ACD Activity
		UINT8		local OM flash Remote MAC
		UINT8		local OM flash ARP PDU

1) Supported services: Get attribute all, get attribute single, set attribute single

13.6.5.6 "Ethernet link object" class

Overview

The "Ethernet link object" enables communication diagnostics.

Description of function

The "Ethernet link object" has object class F6 hex.

Table 13-77 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute all, get attribute single

Table 13-78 Instance attributes

Attribute ID	Service[1)]	Type	Name	Value/explanation
1	get	UINT32	Interface Speed	0: link down, 10: 10 Mbps, 100: 100 Mbps
2	get	DWORD	Interface Flags	Bit 1: Link-Status Bit 2: Duplex Mode (0: Half duplex, 1 duplex) Bit 3 ... 5: Automatic state identification Bit 6: Reset required Bit 7: Local hardware fault (0 = ok)
3	get	ARRAY	Physical Address	Ethernet MAC address

Attribute ID	Service[1)]	Type	Name	Value/explanation
4	get, get_and_clear	Struct of	Interface Counters	Optional, required if the "Media Counters Attribute" is implemented.
		UINT32	In Octets	Received octets
		UINT32	In Ucast Packets	Received Unicast packets
		UINT32	In NUcast Packets	Received non-Unicast packets
		UINT32	In Discards	Incoming packets, not processed
		UINT32	In Errors	Incoming packets with errors
		UINT32	In Unknown Protos	Incoming packets with unknown protocol
		UINT32	Out Octets	Sent octets
		UINT32	Out Ucast Packets	Sent Unicast packets
		UINT32	Out NUcast packets	Sent non-Unicast packets
		UINT32	Out Discards	Outgoing packets, not processed
		UINT32	Out Errors	Outgoing packets, with errors
5	get, get_and_clear	Struct of	Media Counters	Media-specific counters
		UINT32	Alignment Errors	Structure received, which does not match the number of octets
		UINT32	FCS Errors	Structure received, which does not pass the FCS check
		UINT32	Single Collisions	Structure successfully transmitted, precisely one collision
		UINT32	Multiple Collisions	Structure successfully transmitted, multiple collisions
		UINT32	SQE Test Errors	Number of SQE errors
		UINT32	Deferred Transmissions	First transmission attempt delayed
		UINT32	Late Collisions	Number of collisions that occurred delayed by 512 bit timers to the request
		UINT32	Excessive Collisions	Transmission unsuccessful as a result of intensive collisions
		UINT32	MAC Transmit Errors	Transmission unsuccessful as a result of an internal MAC sublayer transmission error.
		UINT32	Carrier Sense Errors	Number of errors when attempting to send a request frame, where the transmission condition was lost or was not assigned
		UINT32	Frame Too Long	Structure too large
		UINT32	MAC Receive Errors	Transmission unsuccessful as a result of an internal MAC sublayer receive error.
6	get, set	Struct of	Interface Control	-
		UINT16	Control Bits	-
		UINT16	Forced Interface Speed	-

Attribute ID	Service[1)]	Type	Name	Value/explanation
10	get	String	Interface_Label	Interface-Label
11	get	-	Interface Capability	Bit 0: Manual Setting Bit 1: Auto-negotiate Bit 2: Auto-MDIX Bit 3: Manual Speed/Duplex Bits 4 – 31: Reserved Rest: Speed/Duplex options

1) Supported services: Get attribute all, get attribute single, set attribute single, get_and_clear

13.6.5.7 "LLDP management object" class

Overview

The "LLDP management object" contains administration information for the LLDP protocol.

Function description

The "LLDP management object" has object class 109 hex.

Table 13-79 Class attributes

Attribute ID	Service [1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute all, get attribute single

Table 13-80 Instance attributes

Attribute ID	Service [1)]	Type	Name	Value/explanation
1	get, set	Structure of:	LLDP Enable	
		UINT16	Array Length	Number of bits in "LLDP Enable Array"
		ARRAY of BYTE	LLDP Enable Array	Enables the generation of LLDP frames, both globally and by port, and the processing of received LLDP frames globally.

Attribute ID	Service [1]	Type	Name	Value/explanation
2	get, set	UINT16	msgTxInterval	0: Reserved 1...3600: Message transfer interval for LLDP frames 3601...65535: Reserved
3	get, set	UINT8	msgTxHold	0: Reserved 1...100: Multiplier for transfer of LLDP frames 101-255: Reserved
4	get	WORD	LLDP Datastore	Bits: 0: LLDP data table object 1: SNMP1 2: NETCONF YANG 3...15: Reserved
5	get	UINT32	Last Change	Time of last change to an entry in the local LLDP database

[1] Supported services: Get attribute all, get attribute single, set attribute single

13.6.5.8 "LLDP data table object" class

Overview

The "LLDP data table object" contains a record of all neighboring active products implementing LLDP.

Function description

The "LLDP data table object" has object class 10A hex.

Table 13-81 Class attributes

Attribute ID	Service [1]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

[1] Supported services: Get attribute all, get attribute single

Table 13-82 Instance attributes

Attribute ID	Service [1)]	Type	Name	Value/explanation
1	get	UINT16	Ethernet Link Instance Number	0: Unknown 1...65535: Number of the Ethernet link instance
2	get	ETH_MAC_ADDR	MAC address	The neighboring MAC address received from the CIP MAC address, the chassis ID or the port IDTLV
3	get	SHORT_STRING	Interface Label	The neighboring interface label received from the CIP interface label, chassis ID or Port ID TLV
4	get	UINT16	Time to Live	Number of seconds for which the adjacency information is to be considered valid.
5	get	Structure of:	System Capabilities TLV	Bitmaps of the capabilities that define the principal functions of the neighboring system
		WORD	System Capabilities	Functions of the neighboring product according to the firmware currently installed
		Array of WORD	Enabled Capabilities	Functions currently activated on the neighboring product
6	get	Structure of:	IPv4 Management Addresses	The IPv4 management addresses of the neighboring product
		UINT8	Management Address Count	The number of management addresses implemented
		ARRAY of UINT32	Management Address	IPv4 management addresses of the neighboring product
7	get	Structure of:	CIP Identification	CIP identification TLV of the neighboring product, where applicable.
		UINT16	Vendor ID	
		UINT16	Device Type	
		UINT16	Product Code	
		BYTE	Major Revision	
		UINT8	Minor Revision	
		UINT32	CIP Serial Number	

Attribute ID	Service [1]	Type	Name	Value/explanation
8	get	Structure of:	Additional Ethernet Capabilities	TLV for Ethernet preemption support from the neighboring product
		BOOL	Preemption Support	0: Not supported 1: Supported
		BOOL	Preemption Status	0: Not enabled 1: Enabled
		BOOL	Preemption Active	0: Not active 1: Active
		UINT8	Additional Fragment Size	0: 64 octets 1: 128 octets 2: 192 octets 3: 256 octets 4: 55 = Reserved
9	get	UINT32	Last Change	Time of last change to an attribute in this instance

[1] Supported services: Get attribute all, get attribute single

13.6.5.9 "Siemens drive object" class

Overview

The "Siemens drive object" class enables access for the controller to selected converter parameters.

Description of function

"Siemens drive object" has object class 32C h.

Table 13-83 Class attributes

Attribute ID	Service[1]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

[1] Supported service: Get attribute single, get attribute all

Table 13-84 Instance attributes

Attribute ID	Service[1)]	Type	Name	Value/explanation
3 ... 18	get	WORD	STW1	c2050[0] control word 1 (STW1) Bit-by-bit access: Attribute ID 3 = STW1.0 Attribute ID18 = STW1.15
19	get	REAL	Main setpoint	c1060[0] main setpoint
20 ... 35	get	WORD	ZSW1	c2053[0] status word 1 (ZSW1) Bit-by-bit access: Attribute ID 20 = ZSW1.0 Attribute ID 35 = ZSW1.15
36	get	REAL	Actual Speed	r0063 actual speed value
37	get, set	REAL	Ramp Up Time	p1120[0] ramp-function generator ramp-up time
38	get, set	REAL	Ramp Down Time	p1121[0] ramp-function generator ramp-down time
39	get, set	REAL	Current Limit	p0640[0] current limit
40	get, set	REAL	Speed MAX Limit	p1082[0] maximum speed
41	get, set	REAL	Speed MIN Limit	p1080[0] minimum speed
42	get, set	REAL	OFF3 Ramp Down Time	p1135[0] OFF3 ramp-down time
43	get, set	BOOL	PID Enable	c2200[0] technology controller enable
44	get, set	REAL	PID Filter Time Constant	p2265 technology controller actual value filter time constant
45	get, set	REAL	PID D Gain	p2274 technology controller differentiation time constant
46	get, set	REAL	PID P Gain	p2280 technology controller proportional gain
47	get, set	REAL	PID I Gain	P2285 technology controller integral action time
48	get, set	REAL	PID Up Limit	p2291 technology controller maximum limiting
49	get, set	REAL	PID Down Limit	p2292 technology controller minimum limiting
50	get	REAL	Speed setpoint	r0020 speed setpoint
51	get	REAL	Output Frequency	r0024 output frequency
52	get	REAL	Output Voltage	r0025 output voltage
53	get	REAL	DC Link Voltage	r0026[0] DC link voltage
54	get	REAL	Actual Current	r0027 actual current value
55	get	REAL	Actual Torque	r0031 torque actual value
56	get	REAL	Output power	r0032 actual active power value
57	get	REAL	Motor Temperature	r0035[0] motor temperature
58	get	REAL	Power Unit Temperature	r0037[0] power unit temperature
59	get	REAL	Energy kWh	r0039 energy indicator
60	get	UINT8	CDS Eff (Local Mode)	r0050 active command data set

Attribute ID	Service[1)]	Type	Name	Value/explanation
61	get	WORD	Status Word 2	r2053[3] PROFIdrive PZD send word
62	get	WORD	Control Word 1	r0898 control word sequence control
63	get	REAL	Motor Speed (Encoder)	r0061 speed actual value
64	get	UINT32	Digital Inputs	r0722 digital inputs status
65	get	UINT32	Digital Outputs	r0747 digital outputs status
66	get	REAL	Analog Input 1	r0752[0] analog input 1
67	get	REAL	Analog Input 2	r0752[1] analog input 2
68	get	REAL	Analog Output 1	r0774[0] analog output
70	get	UINT16	Fault Code 1	r0947[0] fault number 1
71	get	UINT16	Fault Code 2	r0947[1] fault number 2
72	get	UINT16	Fault Code 3	r0947[2] fault number 3
73	get	UINT16	Fault Code 4	r0947[3] fault number 4
74	get	UINT16	Fault Code 5	r0947[4] fault number 5
75	get	UINT16	Fault Code 6	r0947[5] fault number 6
76	get	UINT16	Fault Code 7	r0947[6] fault number 7
77	get	UINT16	Fault Code 8	r0947[7] fault number 8
78	get	REAL	Pulse Frequency	r1801 actual pulse frequency
79	get	UINT16	Alarm Code 1	r2122[0] alarm code
80	get	UINT16	Alarm Code 2	r2122[1] alarm code
81	get	UINT16	Alarm Code 3	r2122[2] alarm code
82	get	UINT16	Alarm Code 4	r2122[3] alarm code
83	get	REAL	PID setpoint Output	r2260 technology controller setpoint after the ramp-function generator
84	get	REAL	PID Feedback	r2266 technology controller actual value after the filter
85	get	REAL	PID Output	r2294 technology controller output signal

1) Supported services: Get attribute single, set attribute single

13.6.5.10 "Siemens motor object" class

Overview

The "Siemens motor object" class enables read access for the controller to the motor data.

Description of function

The "Siemens motor object" has object class 32D h.

Table 13-85 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported service: Get attribute single, get attribute all

Table 13-86 Instance attributes

Attribute ID	Service	Type	Name	Value/explanation
3	get	INT16	Motor Type	p0300 motor type
6	get	REAL	Rated Current	p0305 rated motor current
7	get	REAL	Rated Voltage	p0304 rated motor voltage
8	get	REAL	Rated Power	p0307 rated motor power
9	get	REAL	Rated Frequency	p0310 rated motor frequency
10	get	REAL	Rated Temperature	p0605 threshold and temperature value for monitoring the motor temperature
11	get	REAL	Max Speed	p0322 maximum motor speed
12	get	UINT16	Pole pair number	p0314 motor pole pair number
13	get	REAL	Torque Constant	p0316 motor torque constant
14	get	REAL	Inertia	p0341 motor moment of inertia
15	get	REAL	Base Speed	p0311 rated motor speed
19	get	REAL	Cos Phi	p0308 rated motor power factor

1) Supported services: Get attribute single

13.6.5.11 "Parameter object" class

Overview

The "Parameter object" class enables write and read access for the controller to all converter parameters.

Description of function

The "Parameter object" has object class 401 h.

Table 13-87 Class attributes

Attribute ID	Service[1)]	Type	Name
1	get	UINT16	Revision
2	get	UINT16	Maximum instance
3	get	UINT16	Number of instances

1) Supported services: Get attribute all, get attribute single

Example

In the following example, the controller reads the value of parameter r2050[10].

"Get attribute single" service with the following values:

- Class = 401 h
- Instance = 2050 = 802 h ≙ parameter number
- Attribute = 10 = A h ≙ index 10

Example

In the following example, the controller writes value = 500 to parameter p1520[0].

"Set attribute single" service with the following values:

- Class = 401 h
- Instance = 1520 = 5F0 hex ≙ parameter number
- Attribute = 0 = 0 h ≙ index 0
- Data = 500.0 (value)

13.7 Communication with edge device

13.7.1 Communication with the edge device

Overview

The converter transmits freely configurable signals with an adjustable transfer rate to the edge device.

Precondition

The option module OM-IIoT is mounted and configured in the converter.

Function description

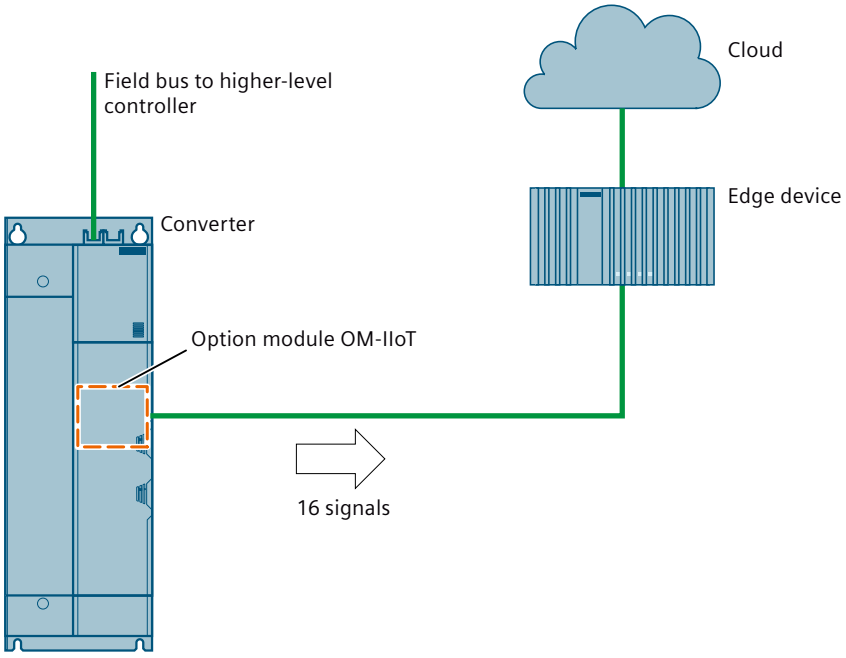


Figure 13-33 Signal transmission from the converter to the edge device

The converter transmits 16 signals cyclically to the edge device.

The signal interconnection with the numerical signal sink c4441[0 ... 15] defines which signals the converter transmits to the edge device.

The sampling time p4448 defines the time intervals of the signal values.

Table 13-88 Sampling time

Value of p4448	Sampling time
< 375 µs	250 µs
375 µs ... < 750 µs	500 µs
750 µs ... < 1.5 ms	1 ms
1.5 ms ... < 3 ms	2 ms
≥ 3 ms	4 ms

Parameters

The following list contains the parameters for the "Communication with edge device" function.

Number	Name	Unit
c4441[0...15]	IIoT signals	-
r4446.0...17	IIoT status	-

p4447.0	IIoT configuration	-
p4448	IIoT sampling time cyclic signal transfer	µs

13.7.2 Configure communication with the converter in the edge device

Overview

An appropriate configuration is required in both devices for communications between the edge device and option module OM-IIoT.

Requirement

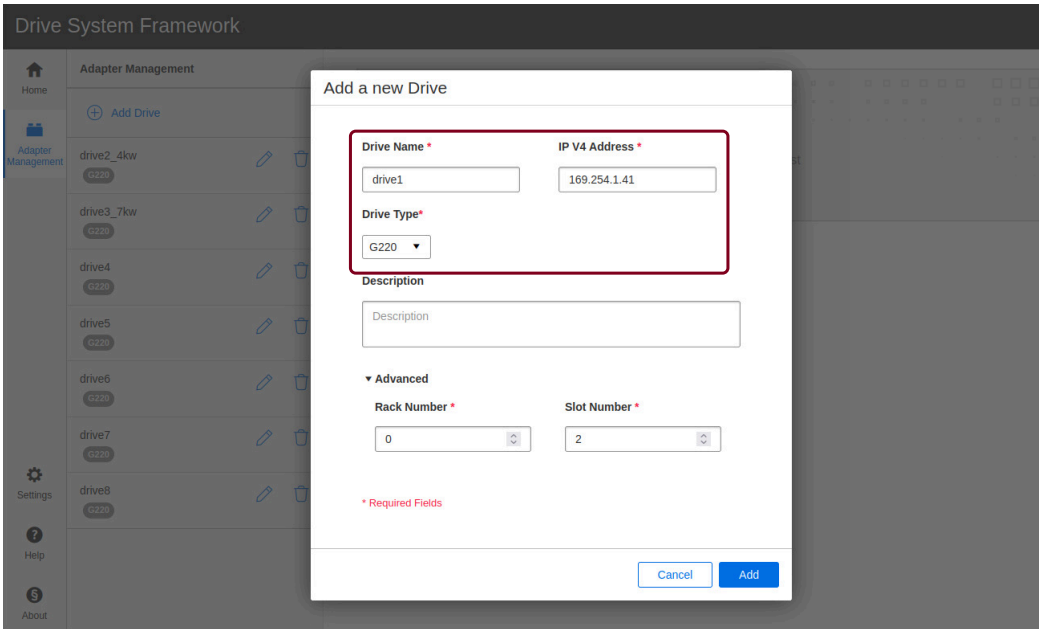
The procedure includes as example the "Drive System Framework" app that runs in the edge device.

Procedure

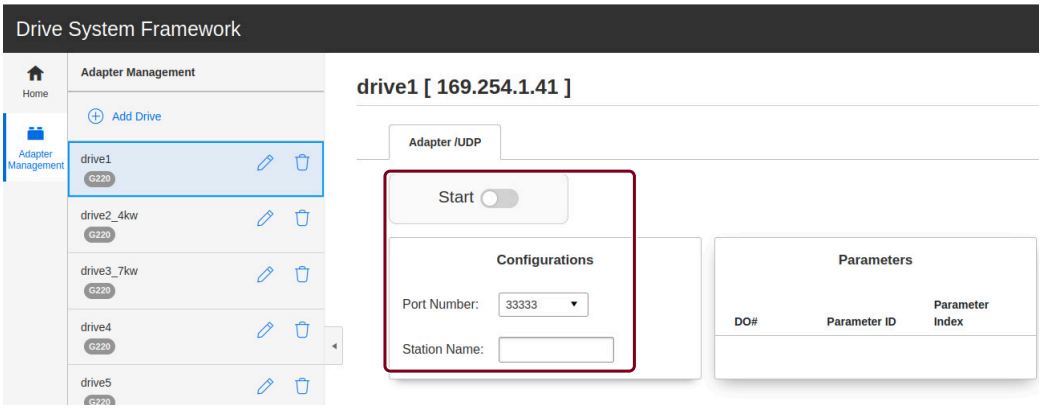
Proceed as follows to establish communications between the edge device and OM-IIoT:

1. Configure the OM-IIoT in the drive commissioning tool:
   - "Name of Station" of the OM-IIoT
     Only lower case letters and numbers are permissible: a, b, c, ... z, 0, 1, ... 9.
   - IP address of the OM-IIoT
   - IP address of the edge device
   - UDP port of the edge device
     Permissible values: 33333 ... 33340
2. Create a new drive in the "Drive System Framework".

3. Configure the edge device in the "Drive System Framework" to match the configuration of the commissioning tool:
   - Name of the drive
   - IP address of the OM-IIoT
   - Product name



4. Set the port number and the station name.
   The settings must correspond to the corresponding settings in the commissioning tool.
   If several OM-IIoTs are connected to the same edge device, then each OM-IIot must have a unique port number.



5. Activate the "Start" button to start communications.

13.8 OPC UA communication

13.8.1 License for OPC UA

Description

Function "OPC UA" requires license "H80 - SINAMICS OPC UA Single Extended".

You activate license "H80 - SINAMICS OPC UA Single Extended" with one of the following options:

- Memory card with license as Z option
  The memory card can be ordered with preinstalled license.
- Allocate a license to an existing Siemens memory card
  Use the "Web License Manager" to assign a purchased license to a particular memory card and create a new license file for the memory card.

13.8.2 Properties of OPC UA

Overview

The converter supports the OPC Unified Architecture (OPC UA) protocol as server.

Requirement

The OPC UA server in the converter is configured using the Startdrive commissioning tool.

The following user-defined data are populated in Startdrive:

- OPC UA application URI
- OPC UA application name

Function description

OPC UA is based on open technologies and standards. This is the reason that the OPC UA server in the converter permits interoperable data exchange between products from the same manufacturer as well as across various manufacturers.

The OPC UA server in the converter is accessible via opc.tcp://<IP address of X150>:<port>, e.g. opc.tcp://192.168.0.31:4840.

A client connects with the OPC UA server of the converter either as participant of a PROFINET network or via a point-to-point connection.

OPC UA permits data exchange via TCP/IP in parallel to real-time communications.

The converter supports the following OPC UA specifications:

- OPC 10000-100, Device Model
- OPC UA Powertrain Information Model 40400-1 for Asset Management corresponding to the conformance unit "Powertrain Asset Identification"
- OPC UA SINAMICS Functional Model for Process Data

The converter exchanges data with all OPC UA clients via OPC UA. Examples of OPC UA clients:

- Control systems
- HMI
- Digitalization applications
- PC-based OPC UA clients

The converter provides the following data:

- Hardware version
- Firmware version
- Measured values for process data acquisition, e.g. for quality or energy management or condition monitoring
- Converter topology

An OPC UA client reads the converter data. To guarantee secure data transfer, OPC UA provides the following read access mechanisms to:

- Secure the integrity and confidentiality protection of the transferred data
- Connect to the user and access management of the converter (UMAC)

The OPC UA server supports encrypted communication with security guidelines that can be set. When activating security guidelines or when changing the URI application (Uniform Resource Identifier), after the supply voltage has been switched on, the OPC UA server generates a new certificate. Generating the certificate can the delay the OPC UA server start by up to 90 seconds.

More information

More information on the OPC UA server of the converter can be found on the Internet:

SINAMICS OPC UA server (https://support.industry.siemens.com/cs/ww/en/view/109990876)

An overview of the articles and links on the topic of OPC UA is available in the Internet:

OPC UA topic page (https://support.industry.siemens.com/cs/ww/en/view/109770435)

13.9 Inputs/outputs

13.9.1 Default settings of inputs and outputs

13.9.1.1 Default setting "Conveyor technology with 4 fixed setpoints"

Overview

In order to avoid having to successively change terminal by terminal, multiple terminals can be set jointly with one operating unit.

With the I/O preset "Conveyor systems with 4 fixed setpoints", the converter is prepared for a typical conveyor technology application.

Requirement

The preset can only be changed using the Startdrive commissioning tool or the web server.

The converter only accepts the default setting if one of the following configurations is set for the fieldbus telegram:

- Configurable telegram 999
- No telegram

Description

Different fixed speed setpoints can be selected via 4 digital inputs.

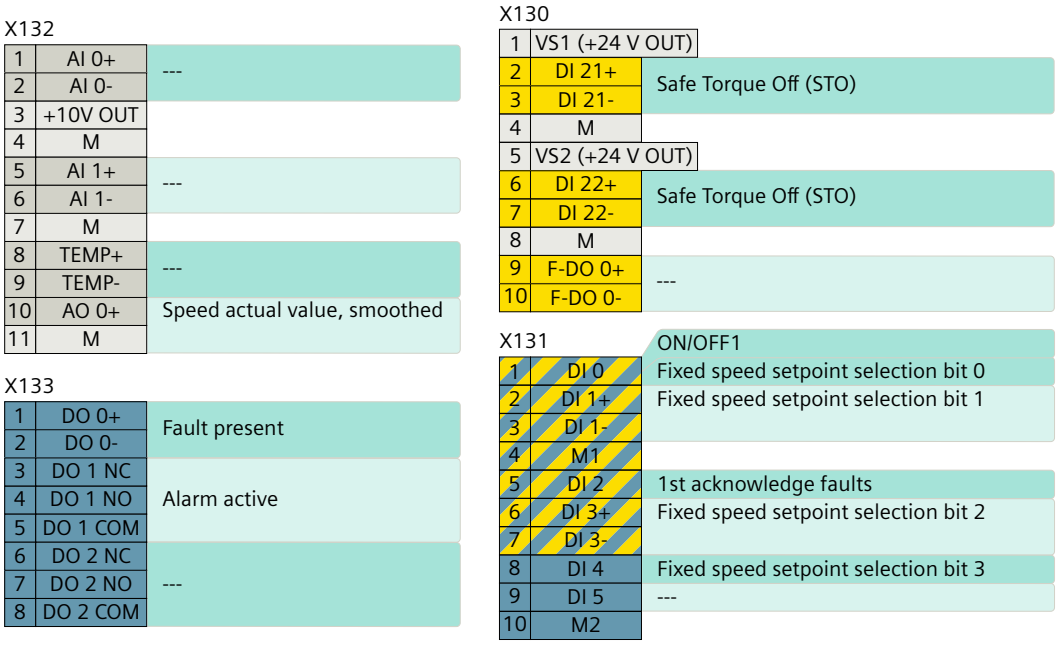


Figure 13-34 I/O preset "Conveyor systems with 4 fixed setpoints"

Table 13-89 Signal interconnection of the inputs and outputs

Input	Signal interconnection	Output	Signal interconnection
DI 0	c0840[0] = r0722.0 c1020[0] = r0722.0	DO 0 DO 1	c0730 = r0052.2 c0731 = r0052.7
DI 1	c1021[0] = r0722.1	AO 0	c0771[0] = r0021
DI 2	c2103[0] = r0722.2		
DI 3	c1022[0] = r0722.3		
DI 4	c1023[0] = r0722.4		

In the factory setting, the fixed speed setpoints are preset with the value 0.

To ensure that the motor rotates after selecting a fixed speed setpoint, the fixed speed setpoints must be set accordingly.

Parameters

The following list contains the parameters of the "I/O presetting Conveyor systems with 4 fixed setpoints" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0730	Signal for terminal DO 0	-
c0731	Signal for terminal DO 1	-
c0771[0]	Analog output signal	%
c0810	Command data set selection CDS bit 0	-

c0840[0...n]	ON / OFF (OFF1)	-
p1001[0...n]	Fixed speed setpoint 1	rpm
p1002[0...n]	Fixed speed setpoint 2	rpm
p1003[0...n]	Fixed speed setpoint 3	rpm
p1004[0...n]	Fixed speed setpoint 4	rpm
p1016	Fixed speed setpoint select mode	-
c1020[0...n]	Fixed speed setpoint selection bit 0	-
c1021[0...n]	Fixed speed setpoint selection bit 1	-
c1022[0...n]	Fixed speed setpoint selection bit 2	-
c1023[0...n]	Fixed speed setpoint selection bit 3	-
r1024	Fixed speed setpoint effective	rpm
c1070[0...n]	Main setpoint	rpm
c2103[0...n]	1st acknowledge faults	-

13.9.1.2 Default setting "Standard I/O with analog setpoint"

Overview

In order to avoid having to successively change terminal by terminal, multiple terminals can be set jointly with one operating unit.

With the I/O preset "Standard I/O with analog setpoint", the converter is prepared for operation without fieldbus with an analog setpoint.

Requirement

The preset can only be changed using the Startdrive commissioning tool or the web server.

The converter only accepts the default setting if one of the following configurations is set for the fieldbus telegram:

- Configurable telegram 999
- No telegram

Description

The converter receives its main setpoint via analog input AI 0 and the command to start and stop the motor via digital input DI 0.

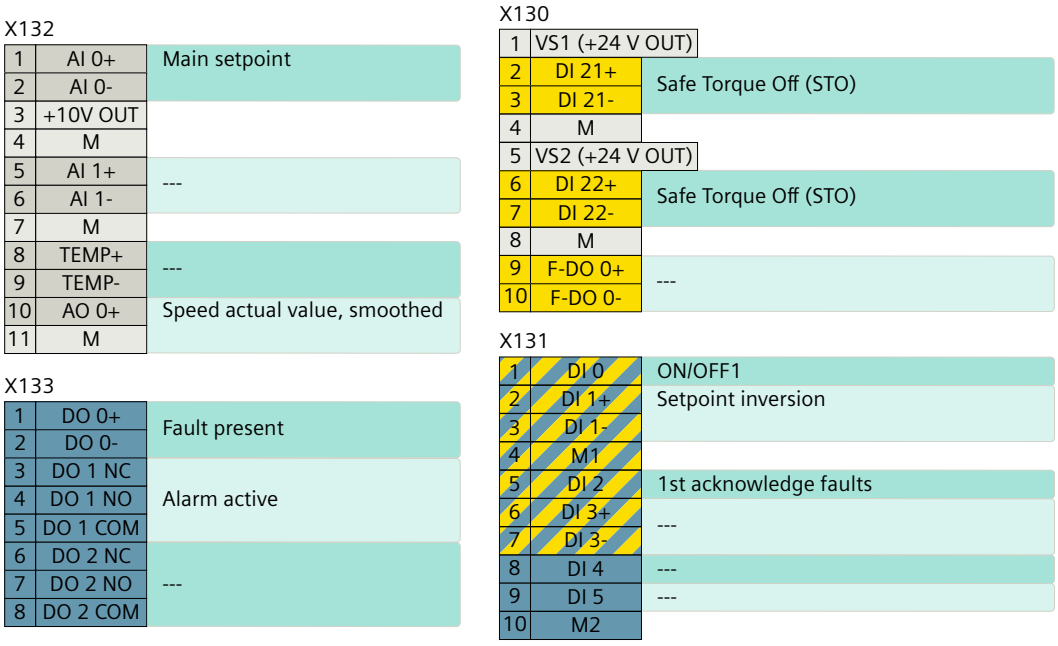


Figure 13-35 I/O preset "Standard I/O with analog setpoint"

Table 13-90 Signal interconnection of the inputs and outputs

Input	Signal interconnection	Output	Signal interconnection
DI 0 DI 1 DI 2	c0840[0] = r0722.0 c1113[0] = r0722.1 c2103[0] = r0722.2	DO 0 DO 1	c0730 = r0052.2 c0731 = r0052.7
AI 0	c1070[0] = r0755[0]	AO 0	c0771[0] = r0021

Parameters

The following list contains the parameters of function "I/O presetting Standard I/O with analog setpoint".

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0730	Signal for terminal DO 0	-
c0731	Signal for terminal DO 1	-
r0755[0...1]	Analog inputs, actual value in percent	%
c0771[0]	Analog output signal	%
c0840[0...n]	ON / OFF (OFF1)	-
c1070[0...n]	Main setpoint	rpm
c1113[0...n]	Setpoint inversion	-
c2103[0...n]	1st acknowledge faults	-

13.9.1.3 Default setting "Fieldbus with data set switchover"

Overview

In order to avoid having to successively change terminal by terminal, multiple terminals can be set jointly with one operating unit.

With the I/O preset "Fieldbus with data set switchover", the converter is prepared for operation on the fieldbus.

Requirement

The preset can only be changed using the Startdrive commissioning tool or the web server.

The preset is only useful if a fieldbus telegram has been configured.

Description

The I/O preset "Fieldbus with data set switchover" is the factory setting of the converter with PROFINET interface.

The converter obtains its signals via the fieldbus. With 1 signal at digital input DI 3, the motor can be traversed via the digital inputs DI 0 and DI 1.

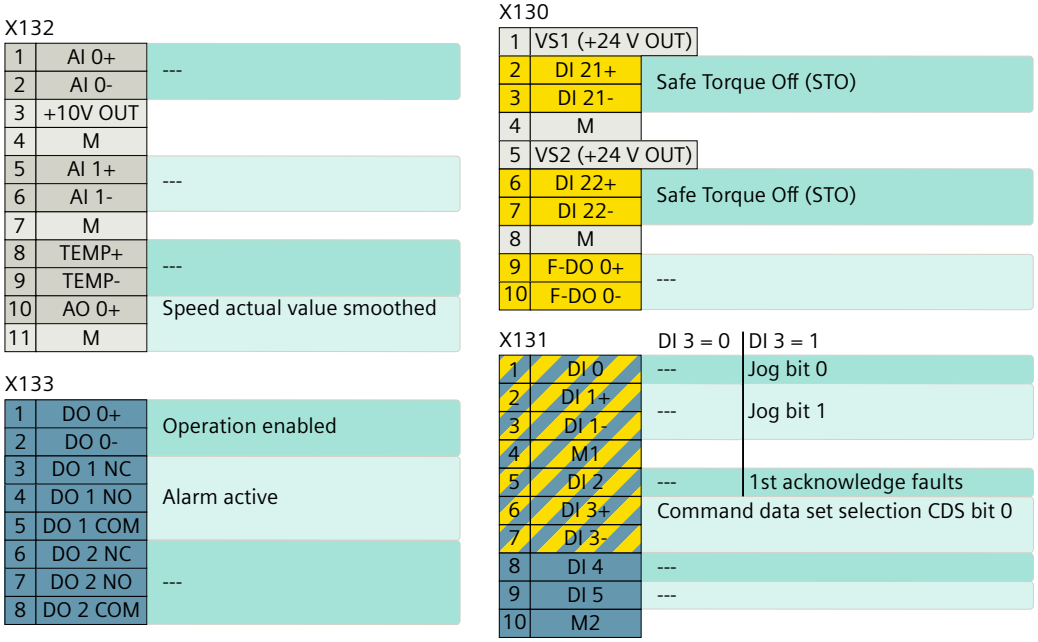


Figure 13-36 I/O preset "Fieldbus with data set switchover"

Table 13-91 Signal interconnection of the inputs and outputs

Input	Signal interconnection	Output	Signal interconnection
DI 0	c1055[1] = r0722.0	DO 0	c0730 = r0052.3
DI 1	c1056[1] = r0722.1	DO 1	c0731 = r0052.7
DI 2	c2103[1] = r0722.2	AO 0	c0771[0] = r0021
DI 3	c0810[0] = r0722.3		

Parameters

The following list contains the parameters of function "I/O presetting Fieldbus with data set switchover".

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0730	Signal for terminal DO 0	-
c0731	Signal for terminal DO 1	-
c0771[0]	Analog output signal	%
c0810	Command data set selection CDS bit 0	-
c1055[0...n]	Jog 1 signal	-
c1056[0...n]	Jog 2 signal	-
c2103[0...n]	1st acknowledge faults	-

13.9.1.4 Deleting default settings

Overview

With the I/O default setting "Delete I/O configuration", the converter deletes the signal interconnections of its inputs and outputs.

Precondition

The preset can only be changed using the Startdrive commissioning tool or the web server.

Description

The signal interconnection of the inputs is deleted.

The digital outputs are interconnected with a 0 signal.

The analog outputs are interconnected with value 0.

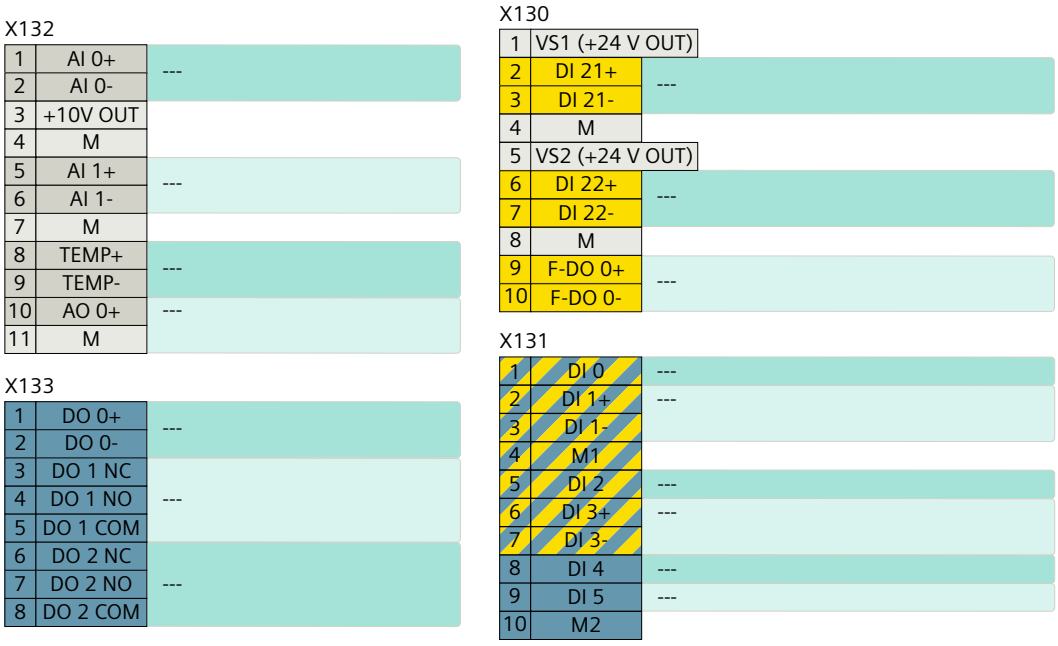


Figure 13-37 I/O configuration is deleted

Table 13-92 Signal interconnection of the inputs and outputs

Input	Signal interconnection	Output	Signal interconnection
DI, AI	---	DO 0 DO 1 DO 2	c0730 = 0 c0731 = 0 c0731 = 0
		AO 0	c0771[0] = 0

13.9.2 Analog input

Overview

An analog input can either evaluate a voltage or a current signal. Based on an adjustable characteristic, the converter converts the voltage or current signal into an internal percentage value. A signal interconnection defines the function of the analog input.

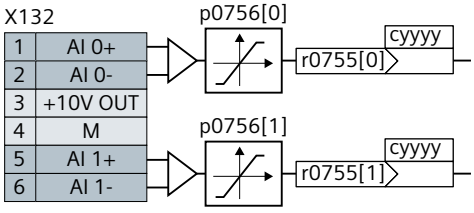


Figure 13-38 Type and function of an analog input

Function description

Analog inputs have the following properties:

- Type
  The analog input can be operated as a current input or voltage input.
  Parameter p0756[x] defines the analog input type.
  The converter offers the following settings:

AI 0			
Unipolar voltage input	0 V ... +10 V	p0756[0] =	0
Unipolar voltage input monitored	+2 V ... +10 V		1
Unipolar current input	0 mA ... +20 mA		2
Unipolar current input monitored	+4 mA ... +20 mA		3
Bipolar voltage input	-10 V ... +10 V		4
AI 1			
Unipolar voltage input	0 V ... +10 V	p0756[1] =	0
Unipolar voltage input monitored	+2 V ... +10 V		1
Unipolar current input	0 mA ... +20 mA		2
Unipolar current input monitored	+4 mA ... +20 mA		3
Bipolar voltage input	-10 V ... +10 V		4

- Scaling
  The converter converts the current or voltage at the analog input into a percentage value using a characteristic.
  If the analog input type is changed with parameter p0756, the converter chooses the appropriate scaling of the analog input independently.
  The two points (p0757, p0758) and (p0759, p0760) define the linear scaling characteristic.
  Parameters p0757 ... p0760 are assigned to an analog input by their index, e.g. parameters p0757[0] ... p0760[0] belong to analog input 0.

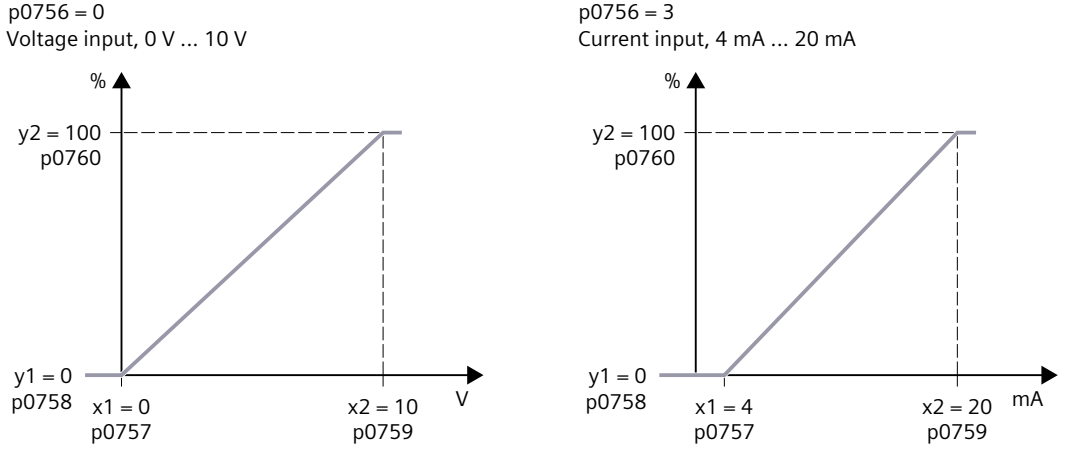


Figure 13-39 Scaling for analog input

- Function
  The interconnection of the numerical signal source r0755 with a numerical signal sink determines the function of the analog input.
  Parameter r0755 is assigned to the particular analog input via its index, e.g. parameter r0755[0] is assigned to analog input 0.
  Typical examples for numerical signal sinks:

Parameter	Description
c1070	Main setpoint
c1075	Supplementary setp
c2253	Technology controller setpoint 1
c2264	Technology controller actual value

- Offset
  Parameter p0763 determines the offset for the analog input.
- Smoothing
  Parameter p0753 causes a smoothing of the input signal using a PT1 filter. This allows strong fluctuations or short-term peaks to be suppressed.
- Noise suppression
  Analog values are always subject to noise. Parameter p0768 determines the value of the noise suppression for the input signal.
- Wire-break monitoring
  Parameters p0761 and p0762 define the behavior of wire break monitoring.
- Absolute value generation
  Parameter p0766 represents the amount of the scaled input value.
- Inversion
  Binary signal sink c0767 inverts the analog input signal.
- Enable
  Binary signal sink c0769 enables the analog input.
- Simulation mode
  Parameters p0797 and p0798 simulate the analog input signal.
- Deadband
  Deadband p0764 suppresses unwanted signals below an adjustable threshold. This prevents the converter from reacting to electromagnetic interference at speed setpoints close to 0.

Parameters

The following list contains the parameters of the "Analog inputs" function.

Number	Name	Unit
p0753[0...1]	Analog inputs smoothing time constant	ms
r0755[0...1]	Analog inputs, actual value in percent	%
p0756[0...1]	Analog inputs type	-
p0757[0...1]	Analog inputs characteristic value x1	-
p0758[0...1]	Analog inputs characteristic value y1	%
p0759[0...1]	Analog inputs characteristic value x2	-

p0760[0...1]	Analog inputs characteristic value y2	%
p0761[0...1]	Analog inputs wire break monitoring, response threshold	-
p0762[0...1]	Analog inputs wire-break monitoring delay time	ms
p0763[0...1]	Analog inputs offset	-
p0764[0...1]	Analog inputs deadband	-
p0766[0...1]	Analog inputs activate absolute value generation	-
c0767[0...1]	Analog inputs inversion	-
p0768[0...1]	Analog inputs noise suppression window	%
c0769[0...1]	Analog inputs enable	-

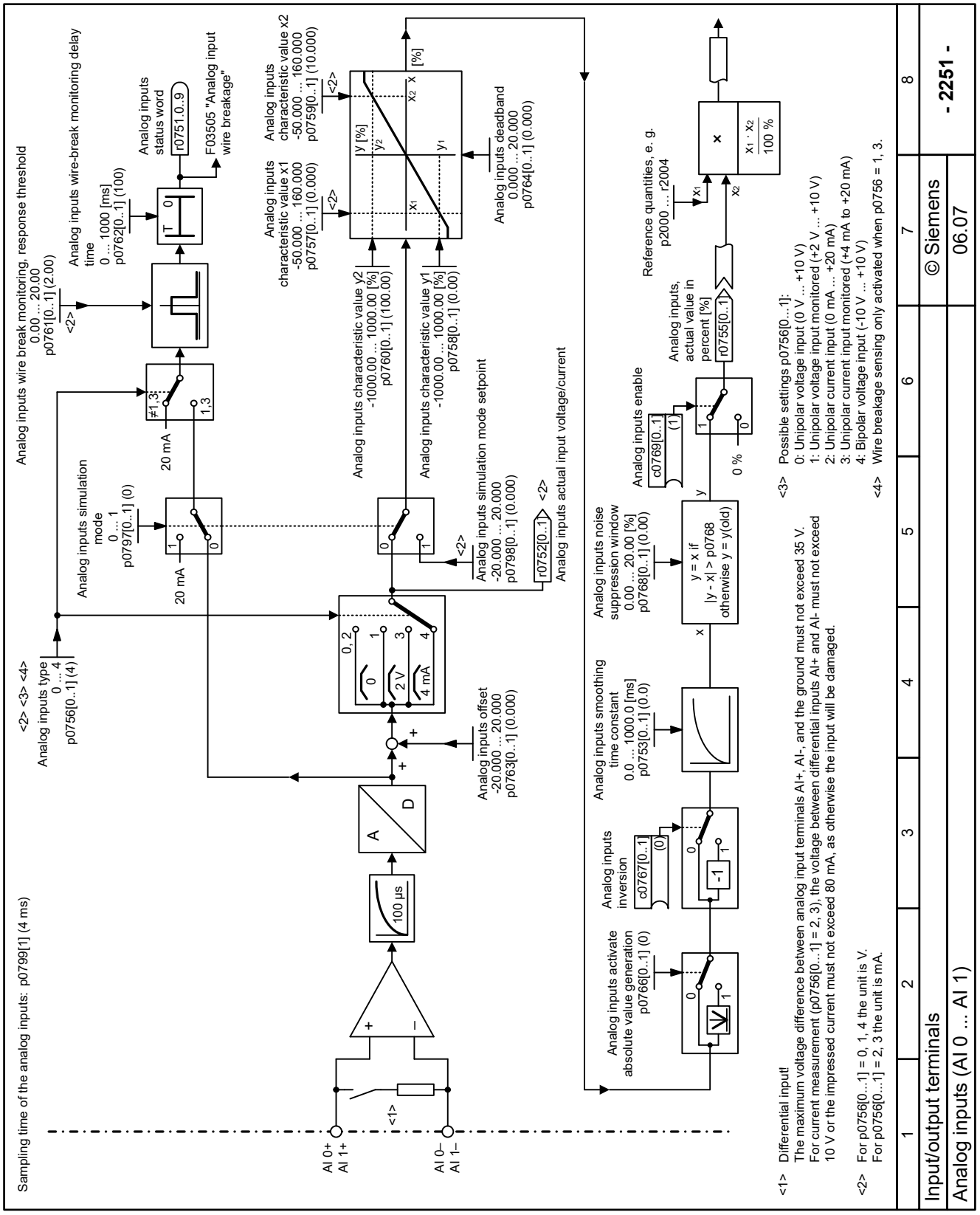


Figure 13-40 2251 - Analog inputs 0 ... 1 (AI 0 ... AI 1)

13.9.3 Analog output

Overview

An analog output can either output a voltage or a current signal. A signal interconnection defines the function of the analog output. Based on an adjustable characteristic, the converter converts an internal percentage value into a voltage or current signal.

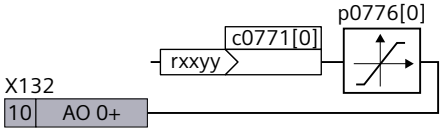


Figure 13-41 Function of an analog output

Function description

The analog output has the following properties:

- Type
  To adapt the analog output to the external control system, the analog output can be operated as a current output or voltage output. Parameter p0776 defines the analog output type.

AO 0			
Unipolar current output	0 mA ... +20 mA	p0776[0] =	0
Unipolar voltage output	0 V ... +10 V		1
Unipolar current output monitored	+4 mA ... +20 mA		2

- Function
  The interconnection of numerical signal sink c0771 with a numerical signal source defines the function of an analog output.
  Typical examples for numerical signal sources:

Parameter	Description
r0021	Actual speed smoothed
r0025	Output voltage smoothed
r0026	DC link voltage smoothed
r0027	Absolute actual current smoothed
r0063	Speed actual value

- Smoothing
  Parameter p0773 effects a smoothing of the output signal using a PT1 filter. This allows strong fluctuations or short-term peaks to be suppressed.
- Absolute value generation
  Parameter p0775 represents the amount of the output value.
- Inversion of the analog output signal
  Binary signal sink c0782 inverts the analog output signal.

- Offset
  Parameter p0783 determines the offset for the analog output.
- Scaling
  The converter uses a scaling characteristic to convert the value range -100% ... 100% of the internal signal to the voltage range 0 V ... 10 V or current range 4 mA ... 20 mA, whichever is suitable. The two points (x1, y1) and (x2, y2) define the scaling characteristic.

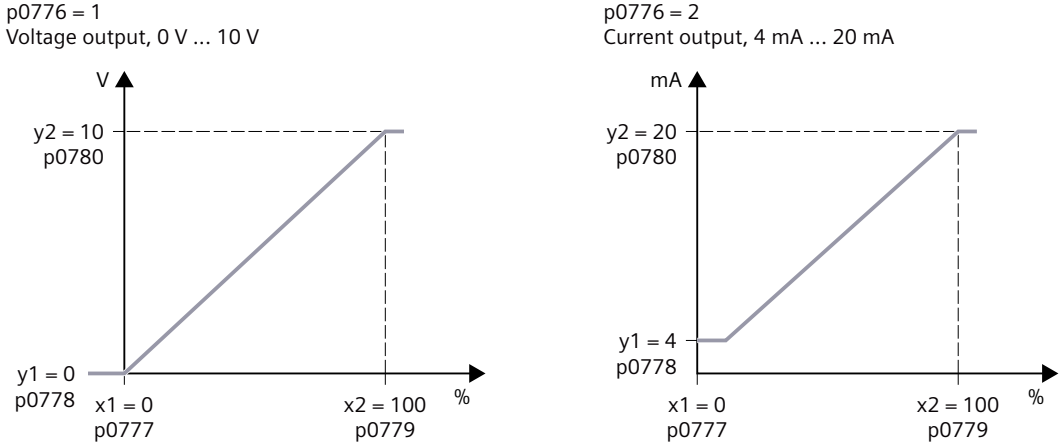


Figure 13-42 Scaling of the analog output

Parameters

The following list contains the parameters of the "Analog outputs" function.

Number	Name	Unit
c0771[0]	Analog output signal	%
r0772[0]	Analog output actual output value referred	%
p0773[0]	Analog output smoothing time constant	ms
r0774[0]	Analog output actual output voltage/current	-
p0775[0]	Analog output, activate absolute value generation	-
p0776[0]	Analog output type	-
p0777[0]	Analog output characteristic value x1	%
p0778[0]	Analog output characteristic value y1	-
p0779[0]	Analog output characteristic value x2	%
p0780[0]	Analog output characteristic value y2	-
c0782[0]	Analog output inversion	-
p0783[0]	Analog output offset	-

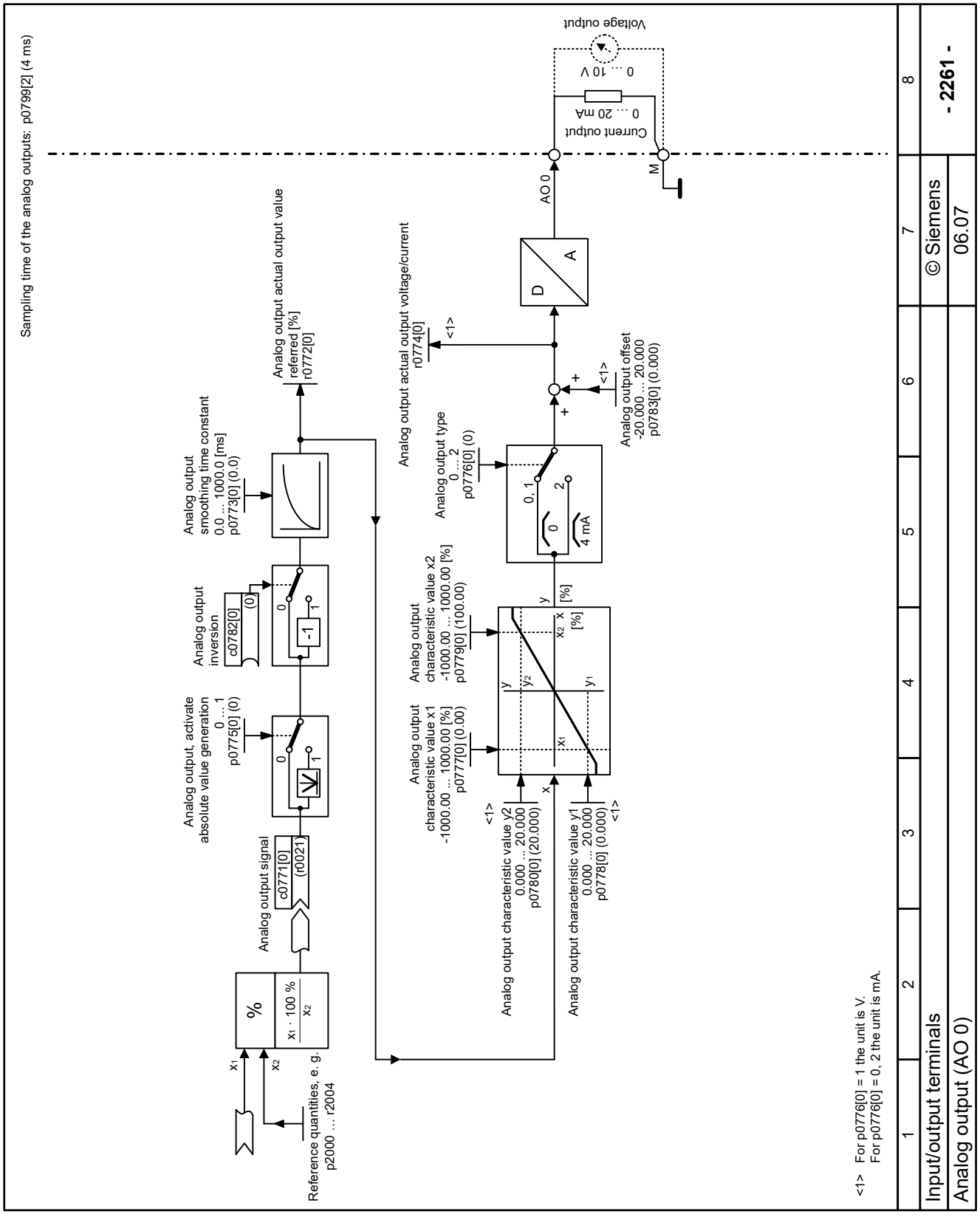


Figure 13-43 2261 – Analog outputs 0 ... 1 (AO 0 ... AO 1)

13.9.4 Digital inputs

Overview

A signal interconnection defines the function of the digital input.

Requirement

When using an analog input as digital input, the analog input must be set as voltage input.

Description of function

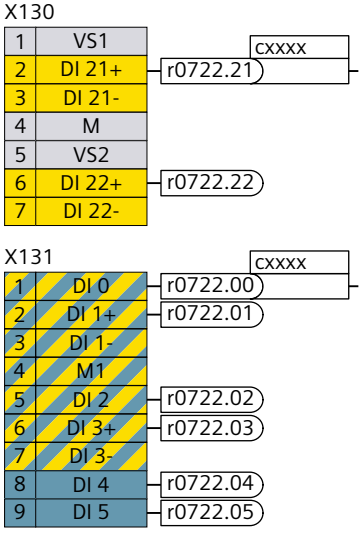


Figure 13-44 Binary signal sources of the digital inputs

A binary signal source r0722[x] is assigned to each digital input.

The inverted input signal is available in the binary signal source r0723[x].

If the number of digital inputs is not sufficient, the analog inputs can also be used as digital inputs.

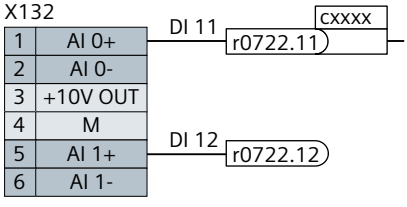


Figure 13-45 Analog inputs as digital inputs

Parameters

The following list contains the parameters of function "Digital inputs".

Number	Name	Unit
r0722.0...22	Digital inputs status	-
r0723.0...22	Digital inputs status inverted	-
p0724	Digital inputs debounce time	ms

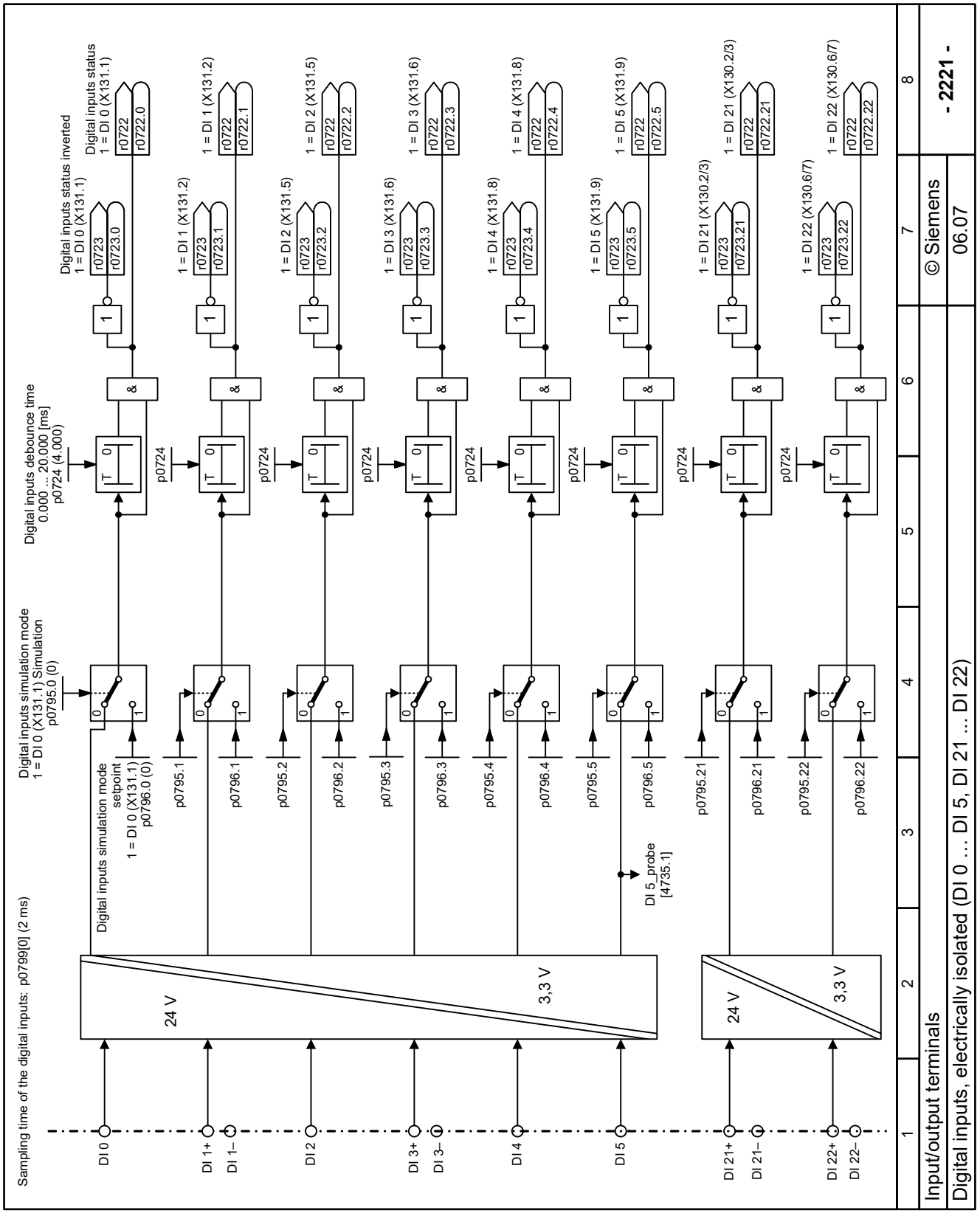


Figure 13-46 2221 – Digital inputs electrically isolated (DI 0 ... DI 5, DI 21 ... DI 22)

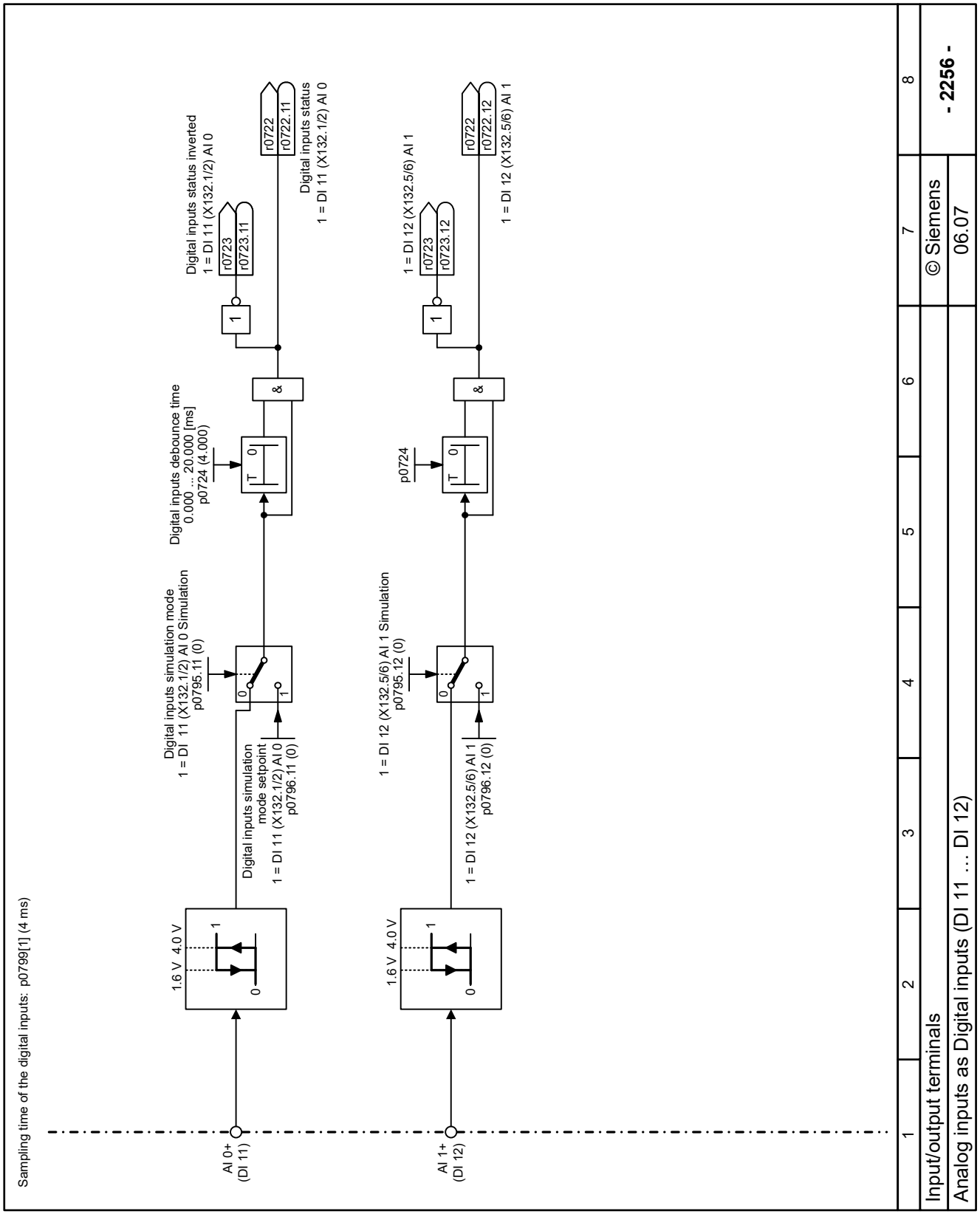


Figure 13-47 2256 - Analog inputs as digital inputs (DI 11 ... DI 12)

13.9.5 Digital outputs

Overview

A digital output reports signal states of the converter to the outside, e.g. a fault or an alarm. The function of a digital output is adjustable.

Description of function

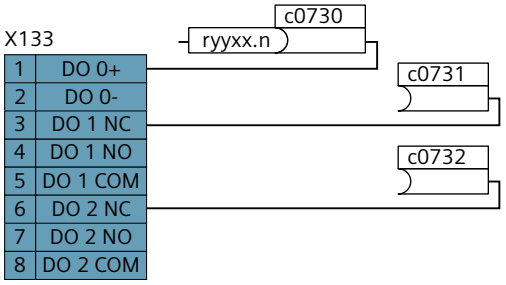


Figure 13-48 Binary signal sinks of the digital outputs

A binary signal sink r073x is assigned to each digital output.

The interconnection of the binary signal sink with a binary signal source determines the function of the digital output.

Parameter p0748 inverts the signal of the digital output.

Parameters

The following list contains the parameters of function "Digital outputs".

Number	Name	Unit
r0729.0...2	Digital outputs access authority	-
c0730	Signal for terminal DO 0	-
c0731	Signal for terminal DO 1	-
c0732	Signal for terminal DO 2	-
r0747.0...2	Digital outputs status	-
p0748.0...2	Invert digital outputs	-

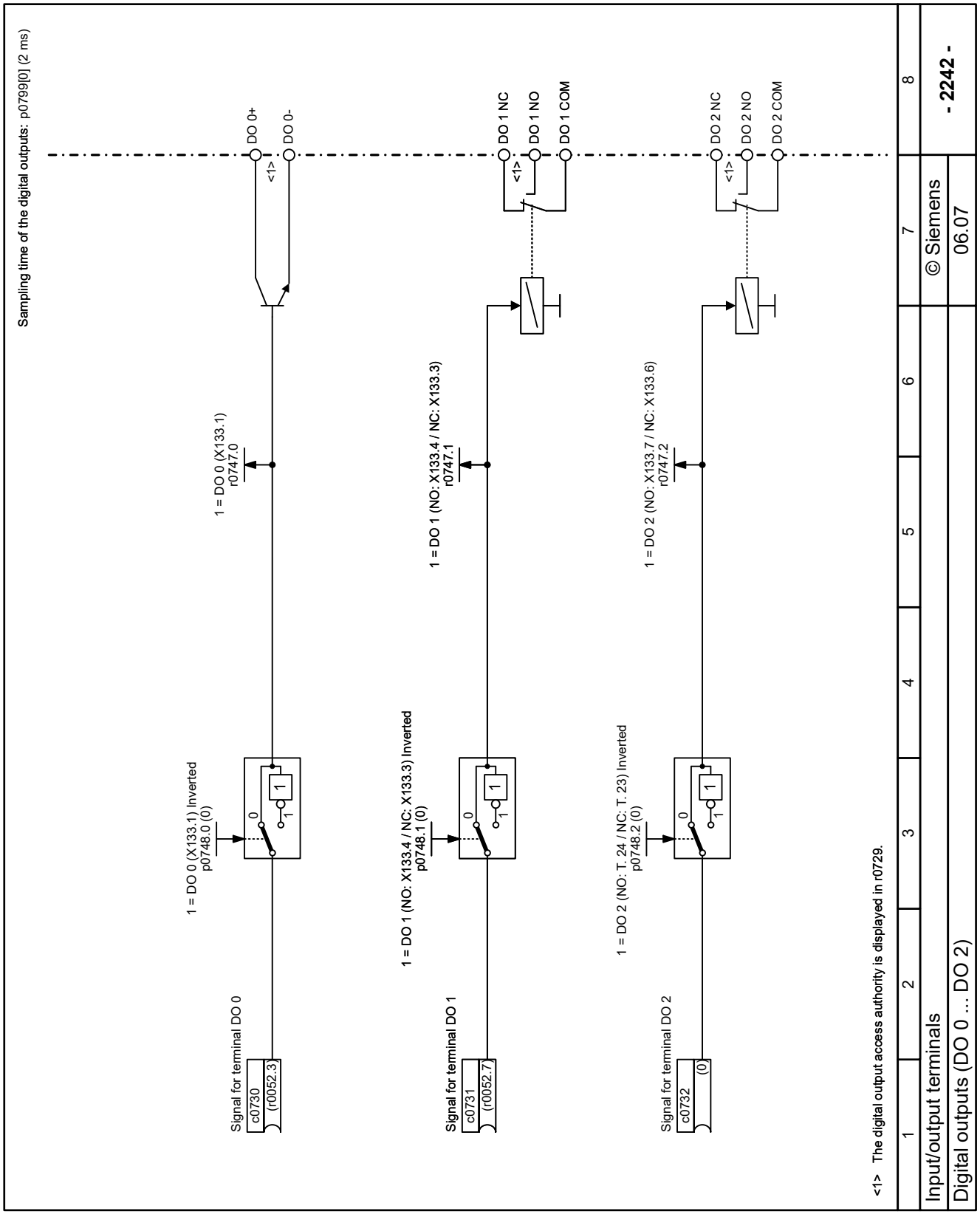


Figure 13-49 2242 - Digital outputs (DO0 ... DO2)

13.10 Clean Power closed-loop infeed control

13.10.1 Function of the Clean Power infeed

Overview

The Clean Power infeed permits operation at the rated operating point with very low line harmonic distortion with sinusoidal line currents ($\cos \phi \approx 1$). The amplitude of the DC link voltage is essentially independent of line voltage fluctuations.

Requirement

The converter has an active Clean Power infeed. In this case, the converter is called "G2X0 Clean Power".

Function description

The converter controls the DC link voltage to an adjustable setpoint p3510.

After commissioning, the converter adapts the DC link voltage setpoint to the device supply voltage:

- p3510 = device supply voltage p0210 · 1.5

Setpoint p3510 is set within the following limits:

- Upper limit
  - Maximum DC link voltage p0280
  - Device supply voltage p0210 · 1.60
- Lower limit
  - Device supply voltage p0210 · 1.48

For technical reasons, the DC link voltage is always higher than the rectified value of the line voltage. As a consequence, the actual setpoint r0088 of the DC link voltage can be higher than the setpoint p3510 that has been set.

In the factory setting, the converter controls the Clean Power infeed with the necessary signals. A change of control or additional control signals are not necessary.

Operating display r13002 provides information about the operating status of the infeed.

The Clean Power infeed may only be controlled independently of the converter for diagnostic purposes, e.g. to investigate problems involving precharging.

Parameters

The following list includes the parameters of the "Clean Power infeed" function.

Number	Name	Unit

p0210	Device supply voltage	Vrms
p0280	DC link voltage maximum steady-state	V
p3510	Infeed DC link voltage setpoint	V
r13002	Infeed operating display	-
r13024	Infeed line frequency smoothed	Hz
r13025	Infeed input voltage smoothed	Vrms
r13027	Infeed absolute current actual value smoothed	Arms
r13029	Infeed reactive current actual value smoothed	Arms
r13030	Infeed current actual value smoothed	Arms
r13032	Infeed active power actual value smoothed	kW
r13036	Infeed power unit overload I2t	%
r13037[0...10]	Infeed power unit temperatures	°C
r13038	Infeed power factor smoothed	-
r13046.0...26	Infeed missing enable signals	-
r13066[0...1]	Infeed line frequency	Hz
r13067[0...1]	Infeed absolute current value permissible	Arms
r13068[0...1]	Absolute current actual value	Arms
r13069[0...8]	Infeed phase current actual value	A
r13070	Infeed DC link voltage actual value	V
r13072[0...4]	Infeed input voltage	Vrms
r13074	Infeed modulation depth	%
r13075	Infeed reactive current setpoint	Arms
r13076	Infeed reactive current actual value	Arms
r13077	Infeed active current setpoint	Arms
r13078	Infeed active current actual value	Arms
r13082[0...1]	Infeed active power actual value	kW
r13088	Infeed DC link voltage setpoint	V
r13089[0...5]	Infeed phase voltage actual value	V
r13094	Infeed transformation angle	°
r13192.0...26	Infeed firmware properties 1	-
r13193.5...31	Infeed firmware properties 2	-
r13200[0...n]	Infeed power unit current code number	-
p13201[0...n]	Infeed power unit code number	-
r13204[0...n].0...25	Infeed power unit hardware properties	-
r13206[0...1]	Infeed power unit rated power	kW
r13207[0...1]	Infeed power unit rated current	Arms
r13208	Infeed rated power unit line voltage	Vrms
r13209[0...1]	Infeed power unit maximum current	Arms
r13257[0...29]	Infeed power unit individual temperatures	°C
p13287[0...1]	Infeed ground fault monitoring shutdown threshold	%
r13801[0...2]	Infeed actual pulse frequency	kHz
r13802	Infeed modulator mode	-
r13807[0...9]	Infeed DC link voltage to calculate the modulation depth	V
p13810.0...11	Infeed modulator configuration	-
r13838.0...31	Gating unit status words 1 and 2	-
r13839.0...31	Gating unit control words 1 and 2	-
c13840[0...n]	Infeed ON/OFF (OFF1)	-
c13844[0...n]	Infeed no coast-down / coast-down (OFF2) signal source 1	-
c13845[0...n]	Infeed no coast-down / coast-down (OFF2) signal source 2	-

c13852[0...n]	Enable infeed operation/inhibit infeed operation	-
c13854[0...n]	Infeed control by PLC/no control by PLC	-
r13863.0...2	Infeed drive coupling status word/control word	-
p13870	Voltage setpoint filter modulator type	-
r13898.0...10	Infeed control word sequence control	-
r13899.0...13	Infeed status word sequence control	-

13.10.2 Control and status signals

Overview

In the factory setting, the control and status signals of the Clean Power infeed are interconnected with the appropriate converter signals.

Requirement

The converter has an active Clean Power infeed.

⚠ WARNING

Unexpected response as the control has been changed

Unexpected malfunctions can occur if you change the signal interconnections to control the Clean Power infeed (r13840...r13854) with respect to the factory setting. For example, the infeed can remain active although the closed-loop motor control has been shut down after a fault.

Malfunctions can result in death or serious injury.

- Only directly control the Clean Power infeed for diagnostic purposes.
- Avoid malfunctions by applying suitable measures, for example additional shutdown paths.

Description of function

Table 13-93 Control signals of the Clean Power infeed

Signal name	Binary signal sink	Display parameters
ON/OFF1	c13840 ON/OFF1	r13898.0
OFF2	c13844 1st OFF2 and c13845 2nd OFF2	r13898.1
Enable operation	c13852 Enable operation	r13898.3
Acknowledge faults (complete device)	c2103 1st acknowledge faults or c2104 2nd acknowledge faults	---
Control by PLC	c13854 Infeed control by PLC	r13898.10

Table 13-94 Status signals of the Clean Power infeed

Signal name	Display parameters
Ready for switching on	r13899.0
Ready for operation	r13899.1
Operation enabled	r13899.2
Fault present	r13899.3
No OFF2 active	r13899.4
Switching on inhibited	r13899.6
Alarm active (converter)	r13899.7
Switch-on operation active	r13899.8
Control requested	r13899.9
Precharging completed	r13899.11
Line contactor closed	r13899.12

13.10.3 Active phase failure detection

Overview

The active phase failure detection detects high-ohmic line supply phase failures.

The active phase failure detection also detects line supply phase failures in no-load operation or when operating with low loads.

Description of function

The active phase failure detection is activated in the factory setting:

- p3640.1 = 1

If the set signaling threshold for phase asymmetry p3647[1] is exceeded, the converter outputs Alarm A06208 and sets parameter r3405.2 = 1 (phase failure detected).

If it is necessary to stop the motor in a controlled fashion, and therefore shutting down the Clean Power infeed is to be avoided, the function to limit the controller output voltage p3640.2 = 1 can also be activated.

Parameter p3647[0...2] changes the response of the active phase failure detection as follows:

- Index 0: Threshold limit
- Index 1: Signaling threshold
- Index 2: Smoothing time

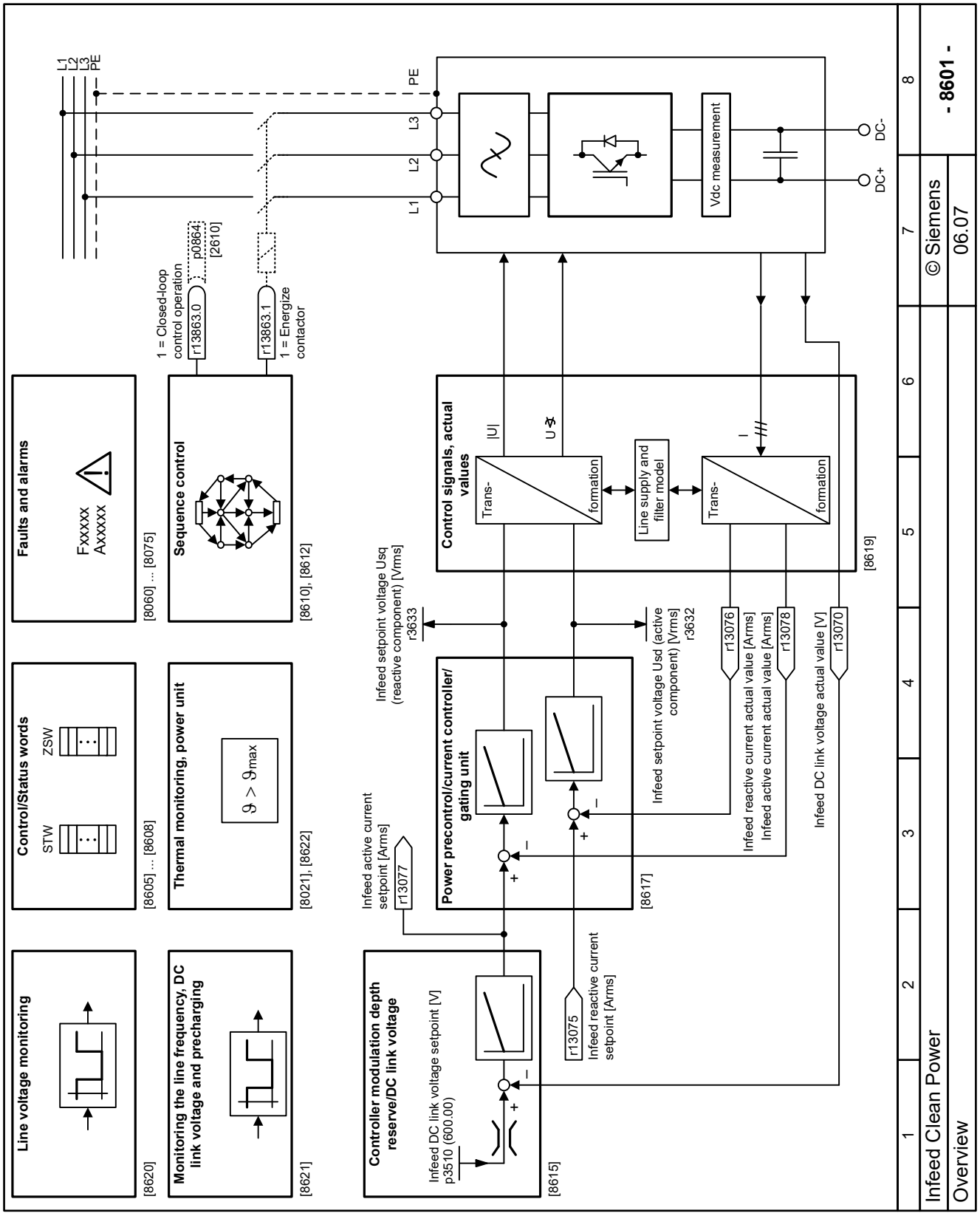


Figure 13-50 8601 – Overview

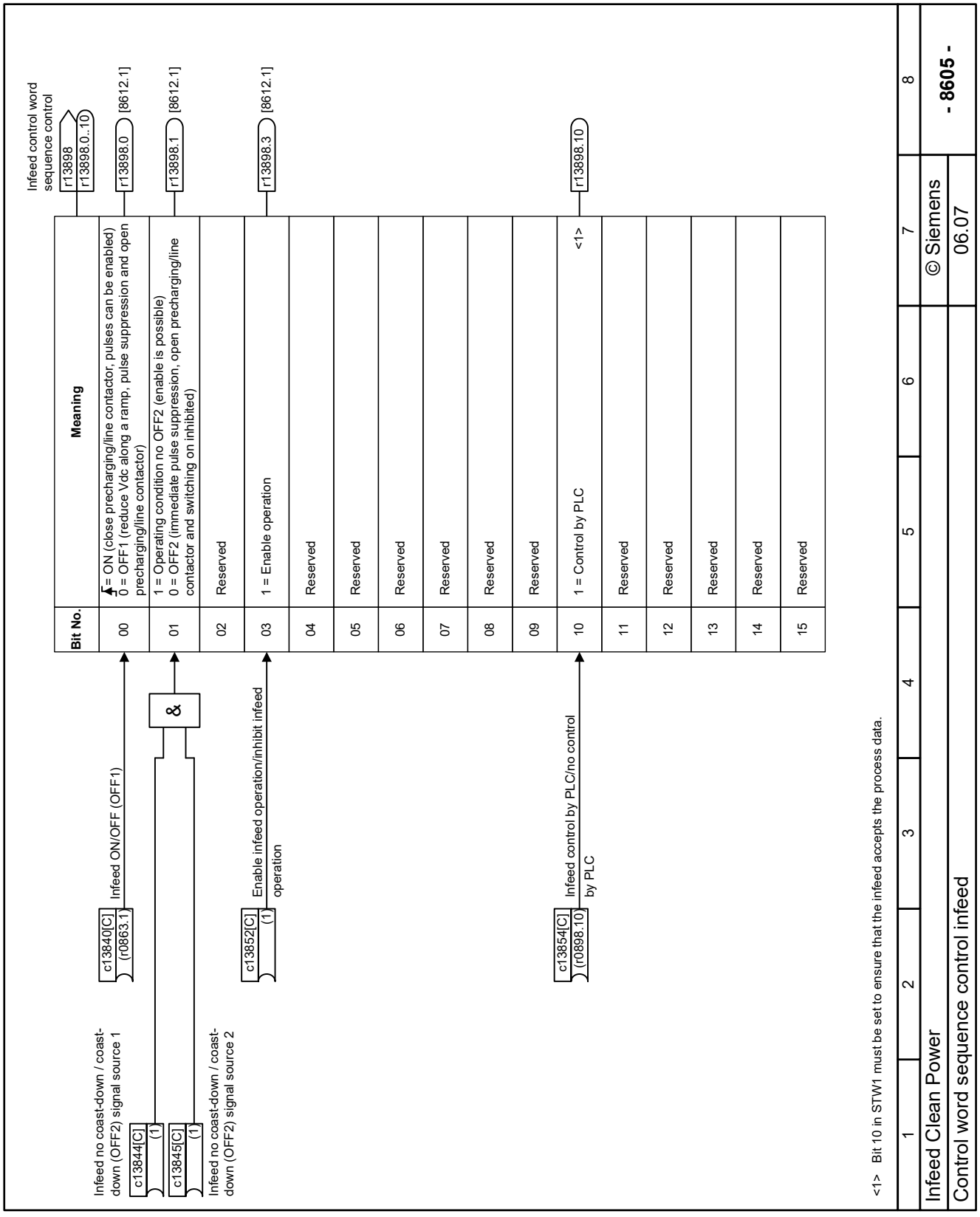


Figure 13-51 8605 – Control word sequence control infeed

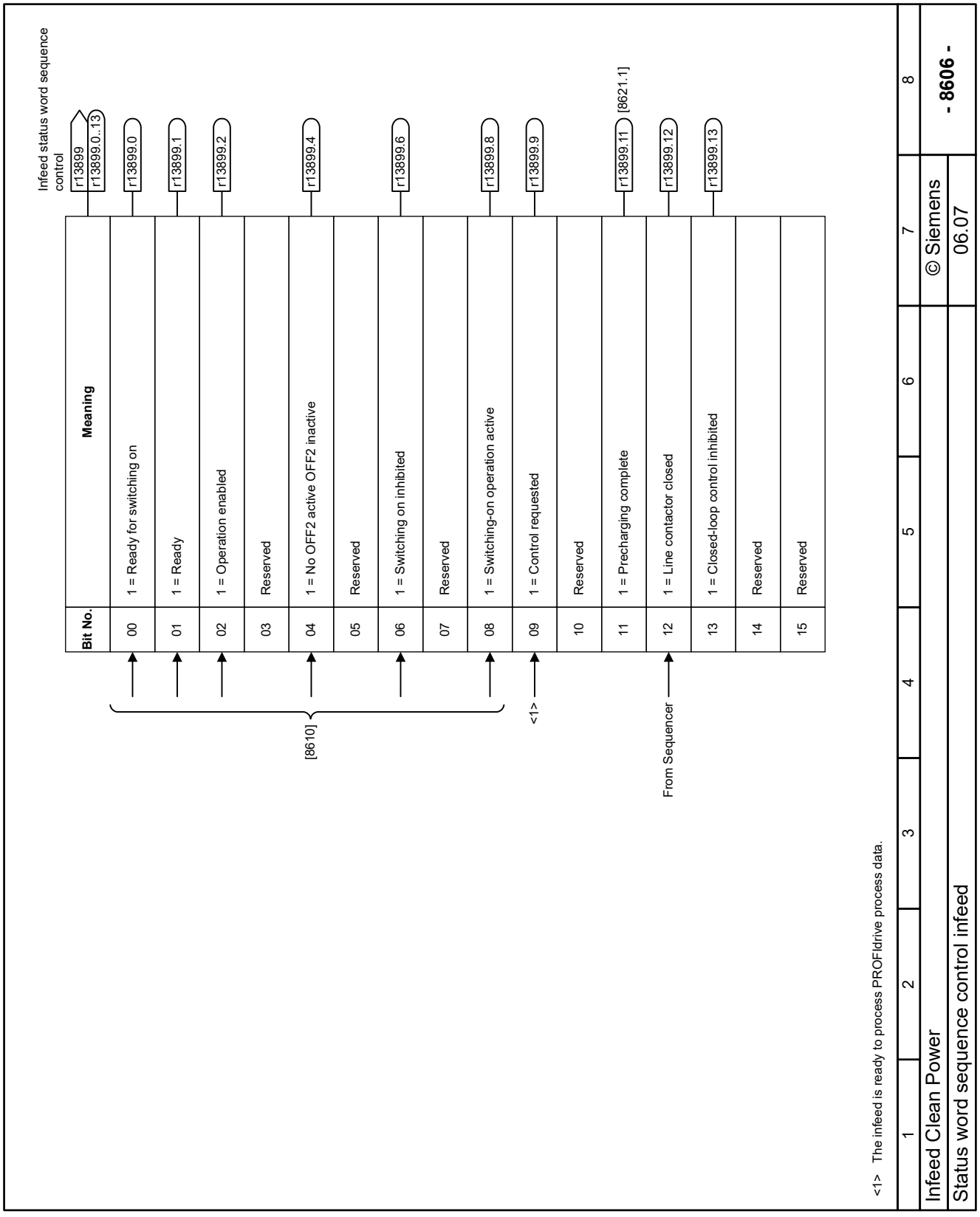


Figure 13-52 8606 – Status word sequence control infeed

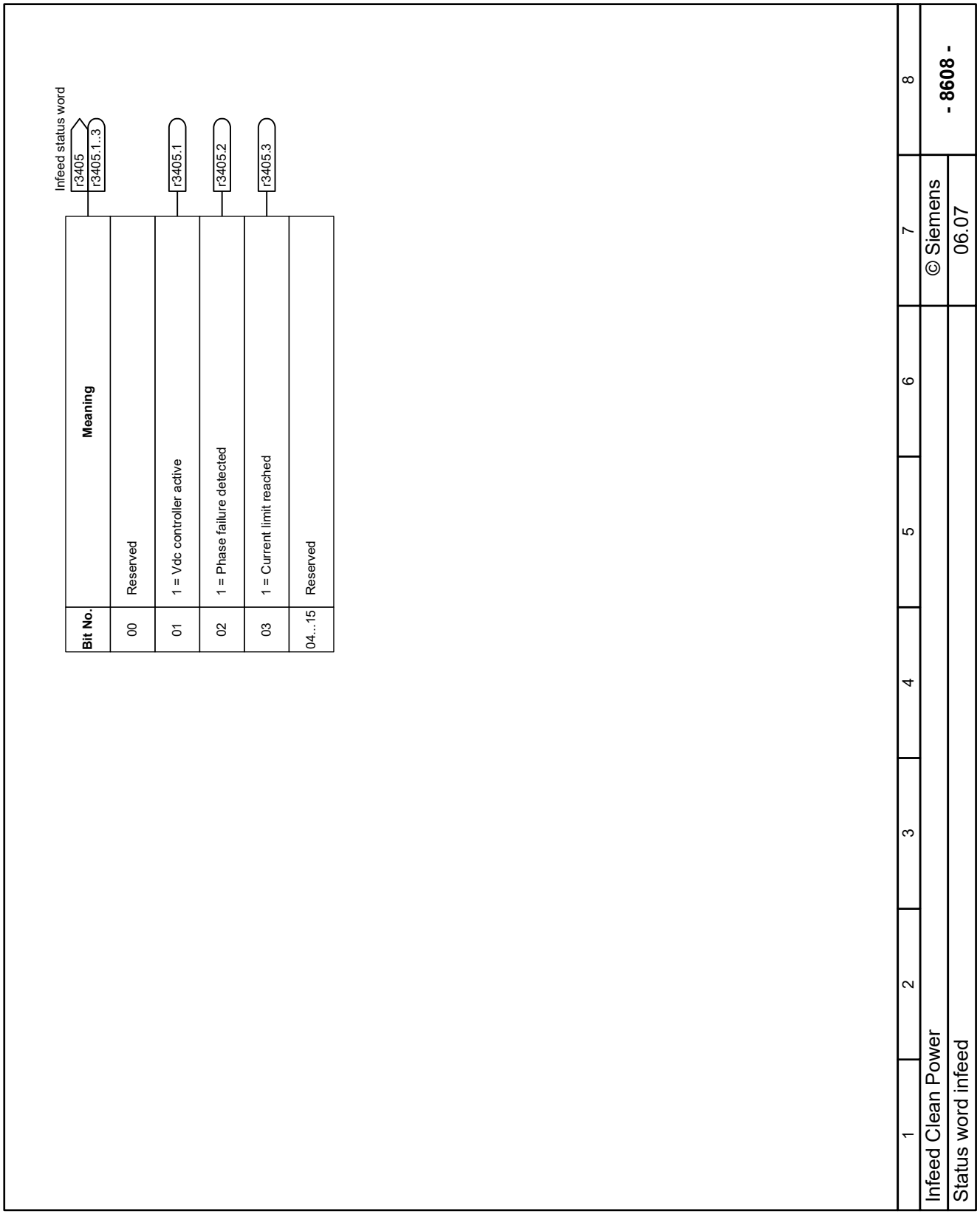


Figure 13-53 8608 – Status word infeed

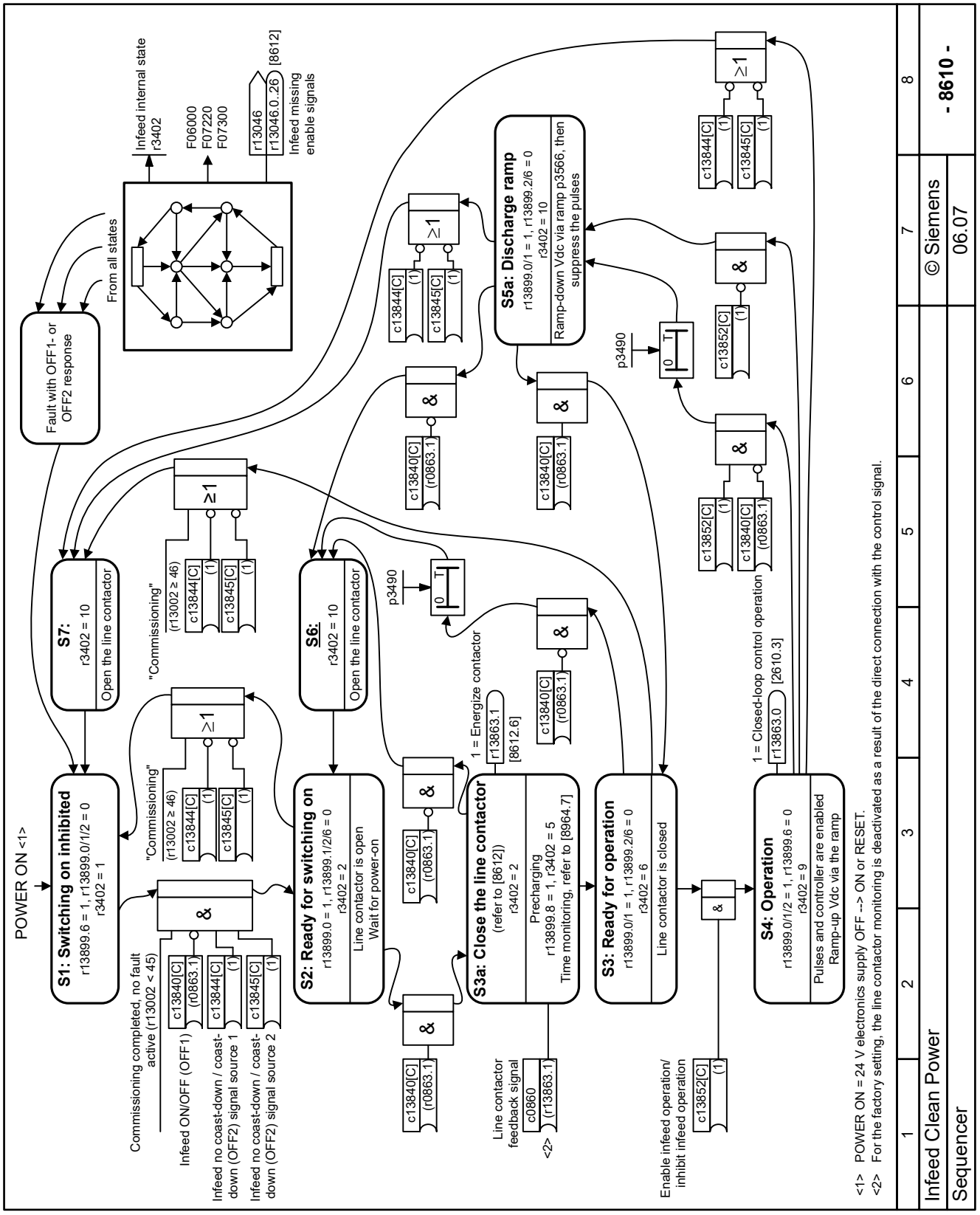


Figure 13-54 8610 – Sequencer

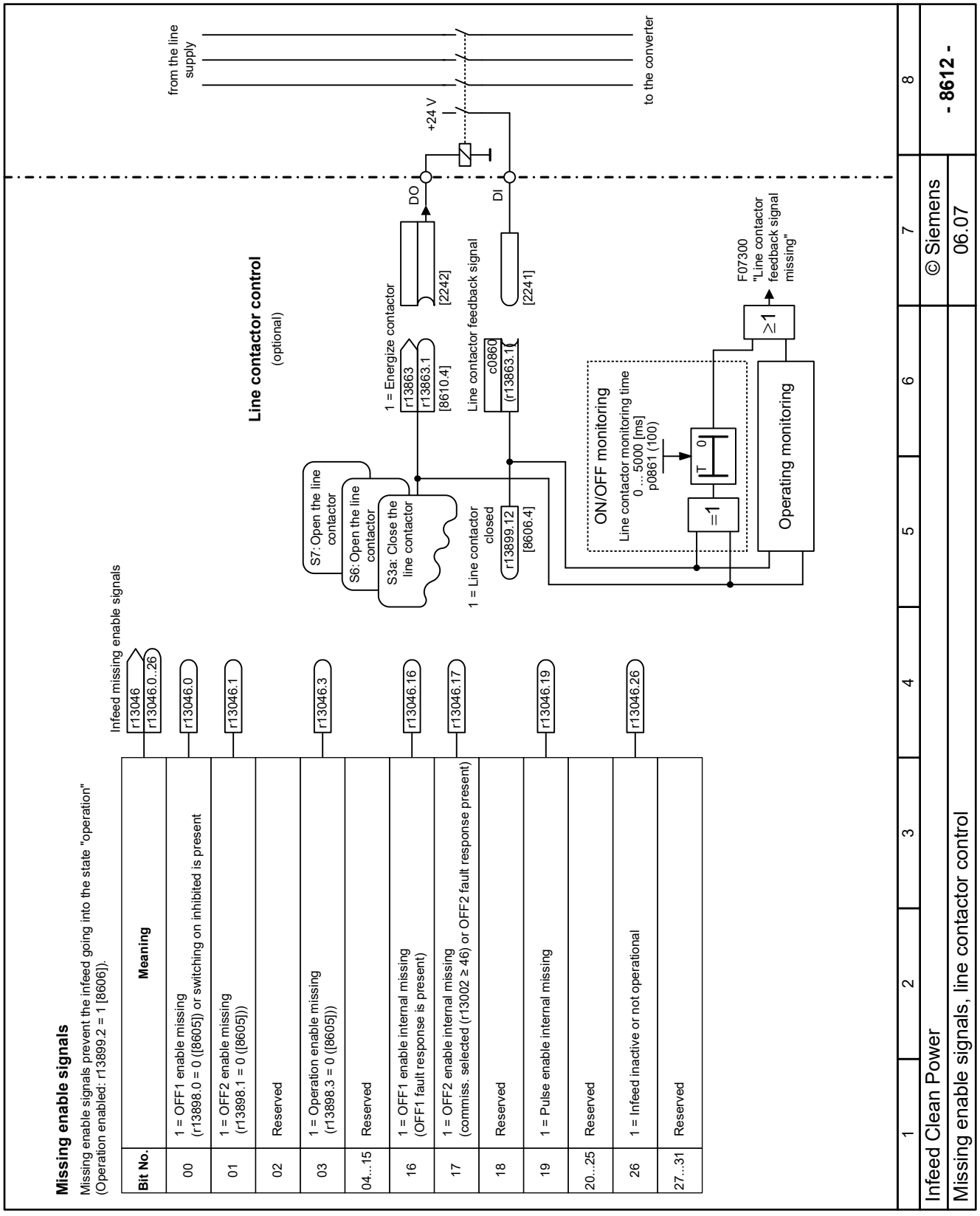


Figure 13-55 8612 – Missing enables, line contactor control

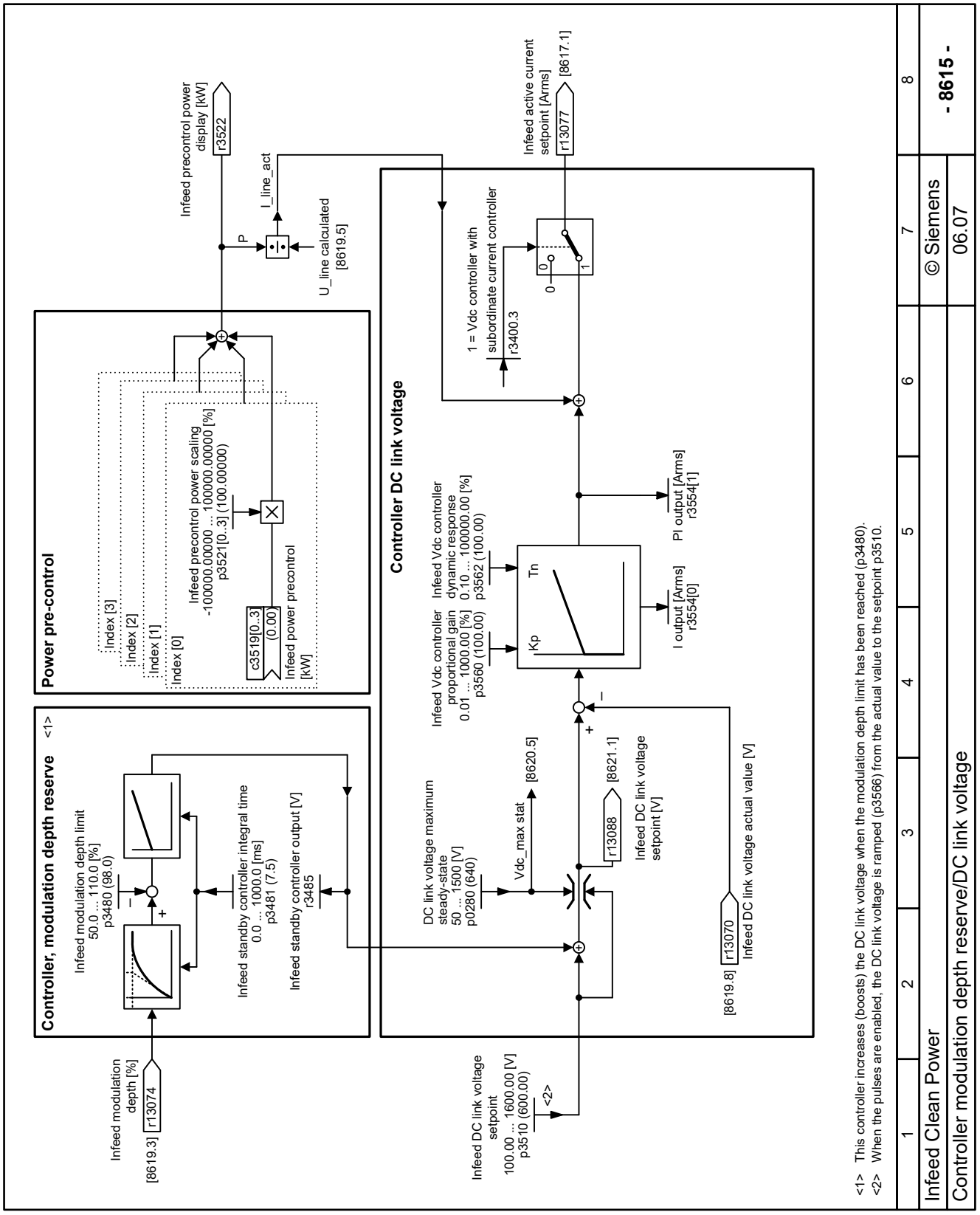


Figure 13-56 8615 – Controller modulation depth reserve/DC link voltage

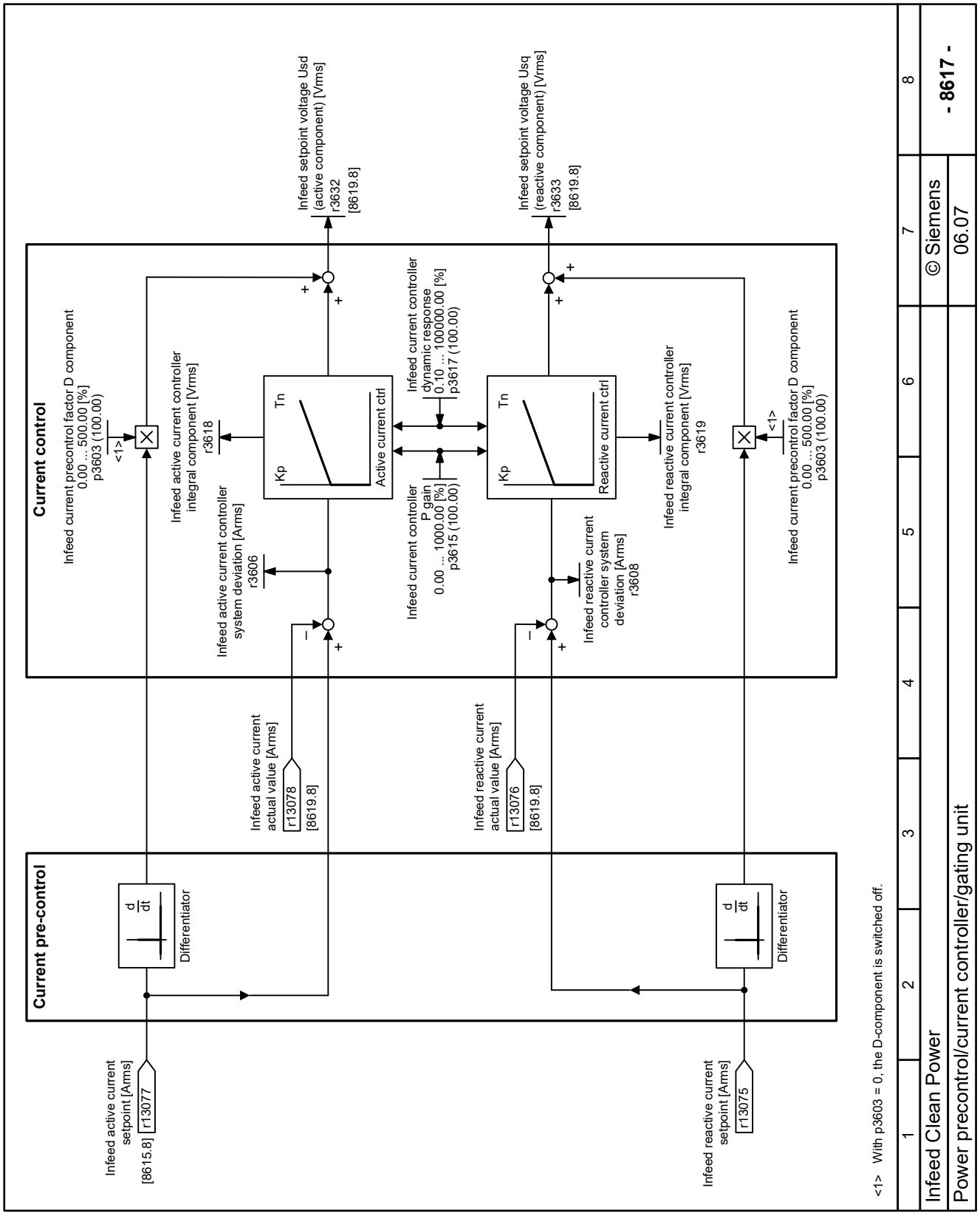


Figure 13-57 8617 – Current precontrol/current controller/gating unit

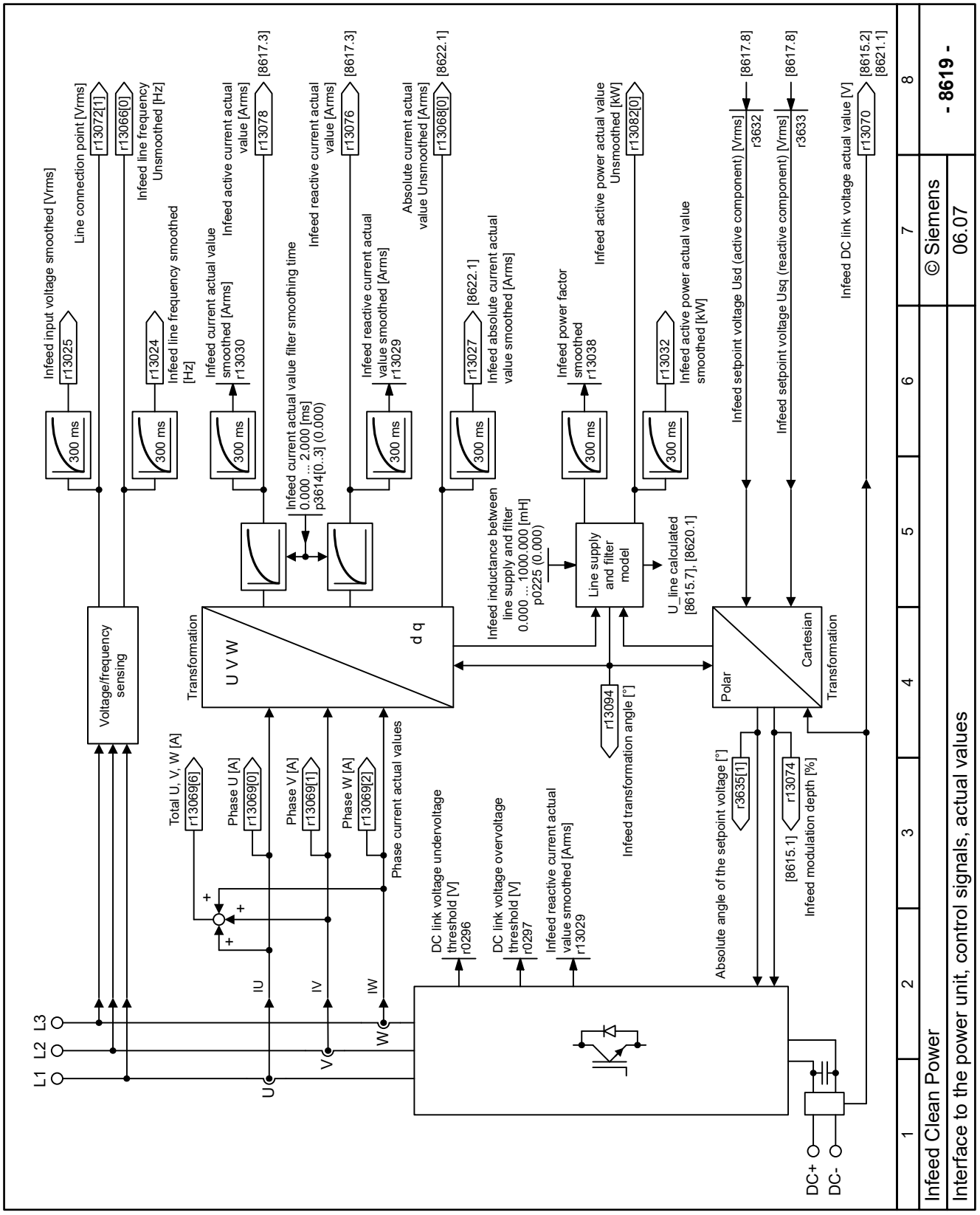


Figure 13-58 8619 – Interface to the power unit, control signals, actual values

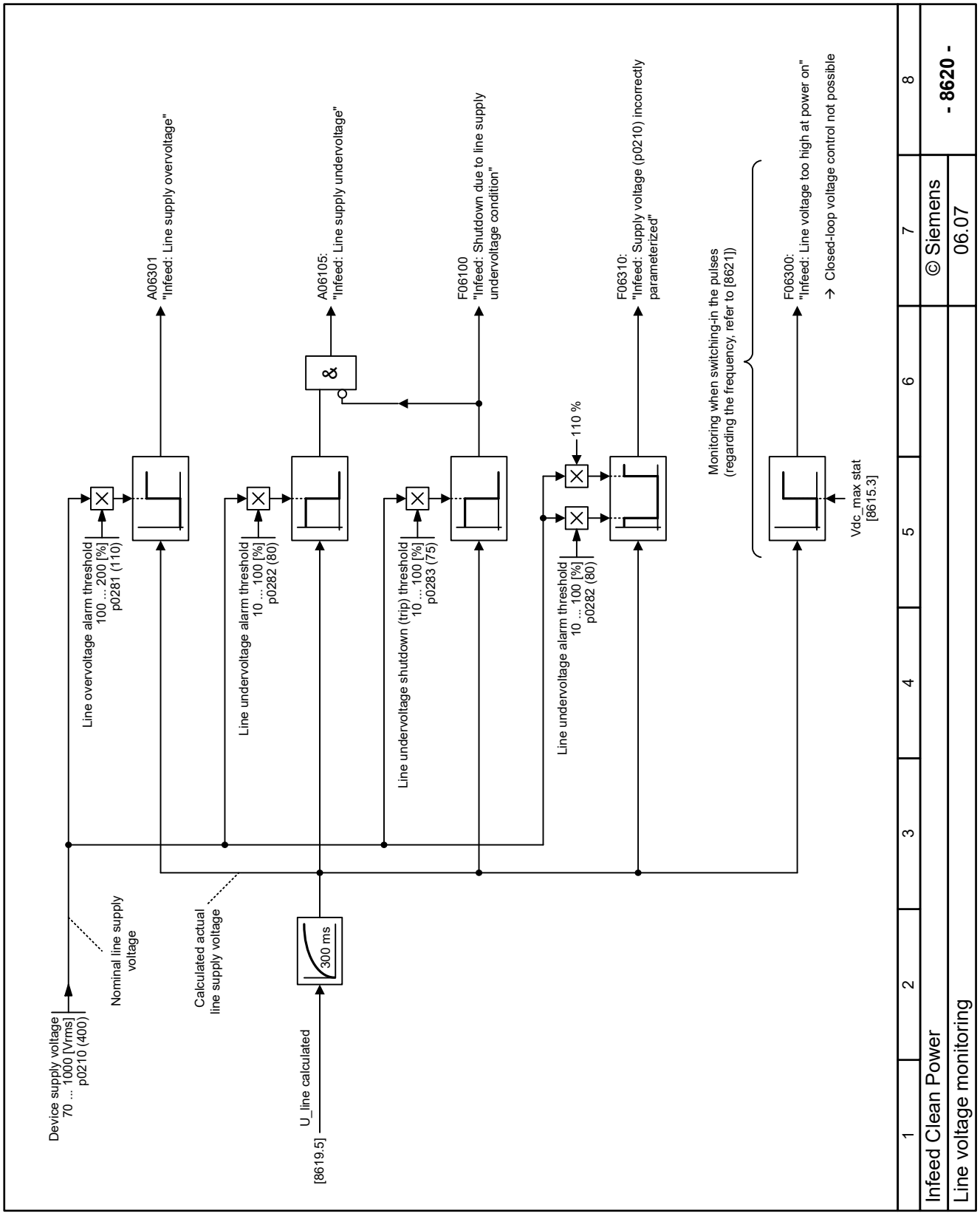


Figure 13-59 8620 – Line voltage monitoring

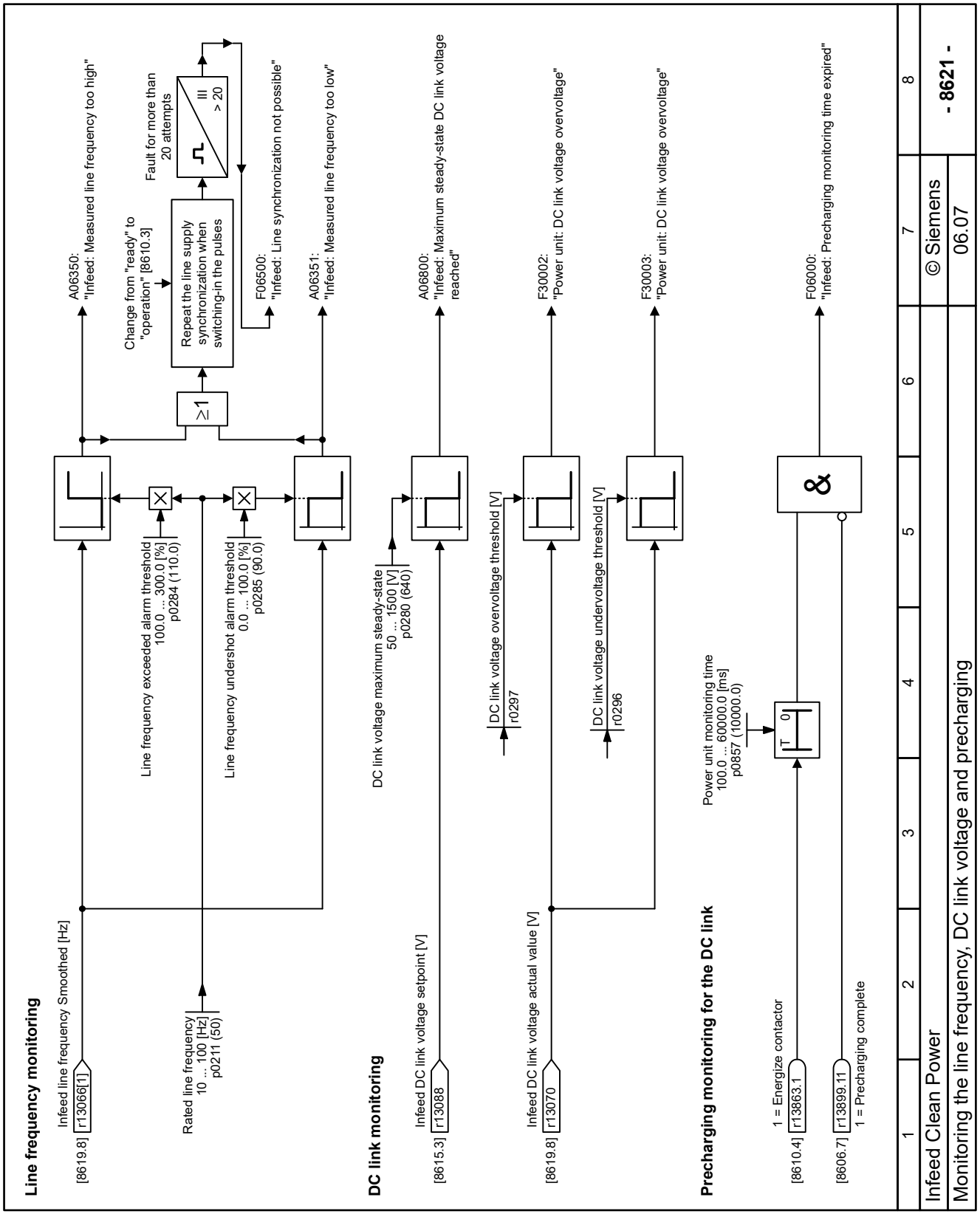


Figure 13-60 8621 – Monitoring line frequency, DC link voltage and precharging

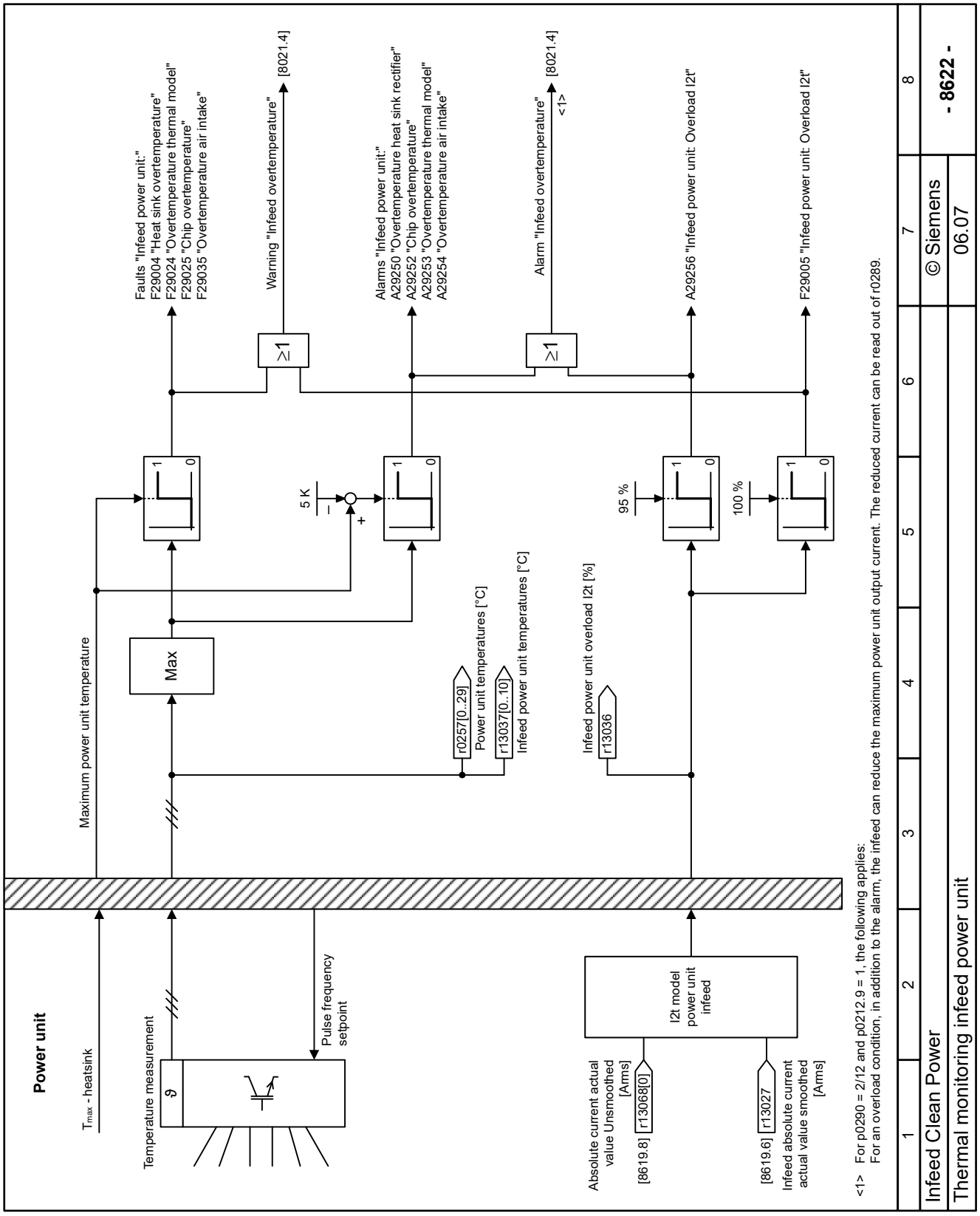


Figure 13-61 8622 – Thermal monitoring power unit infeed

13.11 Setpoint channel

13.11.1 Main setpoint

Overview

The main setpoint specifies the speed of the motor.

Function description

The converter receives its main setpoint via one of the following setpoint sources:

- Fieldbus interface of the converter
- Converter analog input
- Motorized potentiometer emulated in the converter
- Fixed setpoints stored in the converter
- Measuring probe: The converter converts a sequence of pulse signals at the digital input to an analog value.

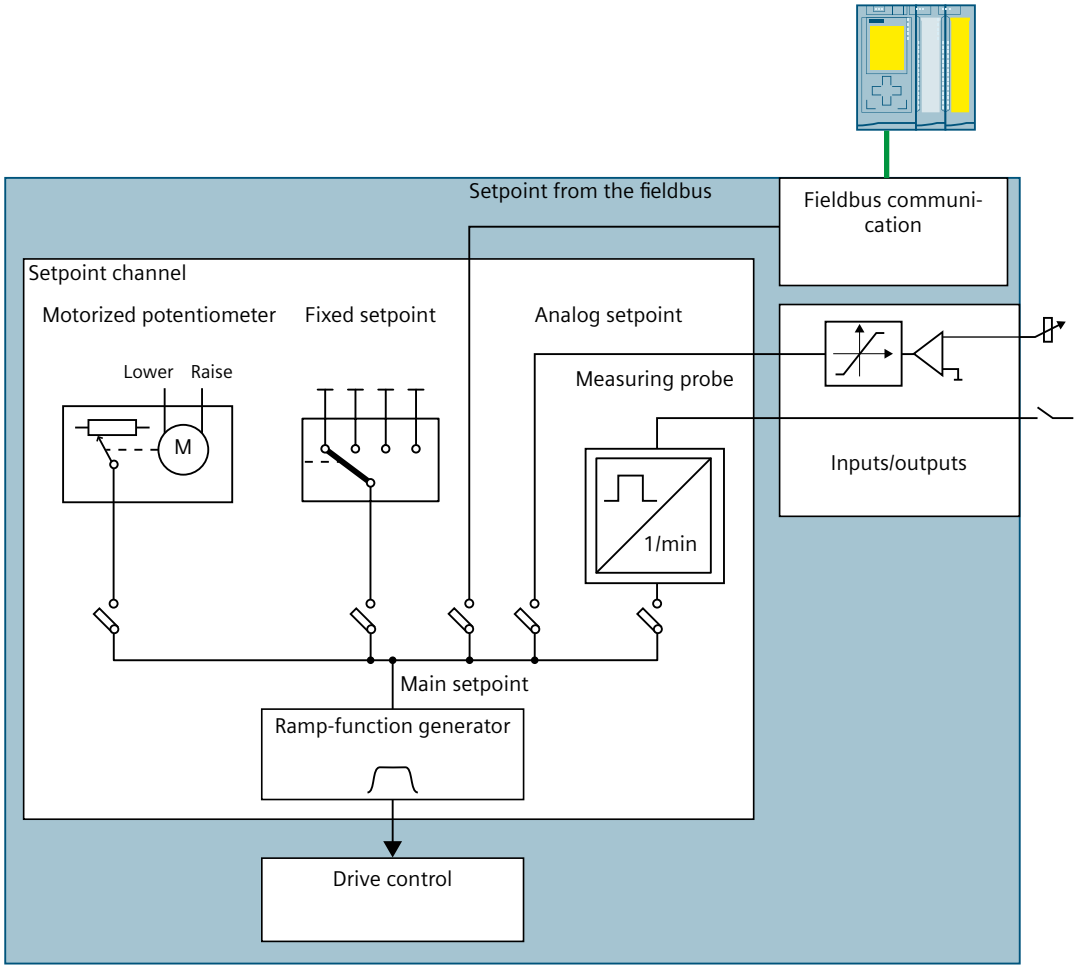


Figure 13-62 Setpoint sources of the converter

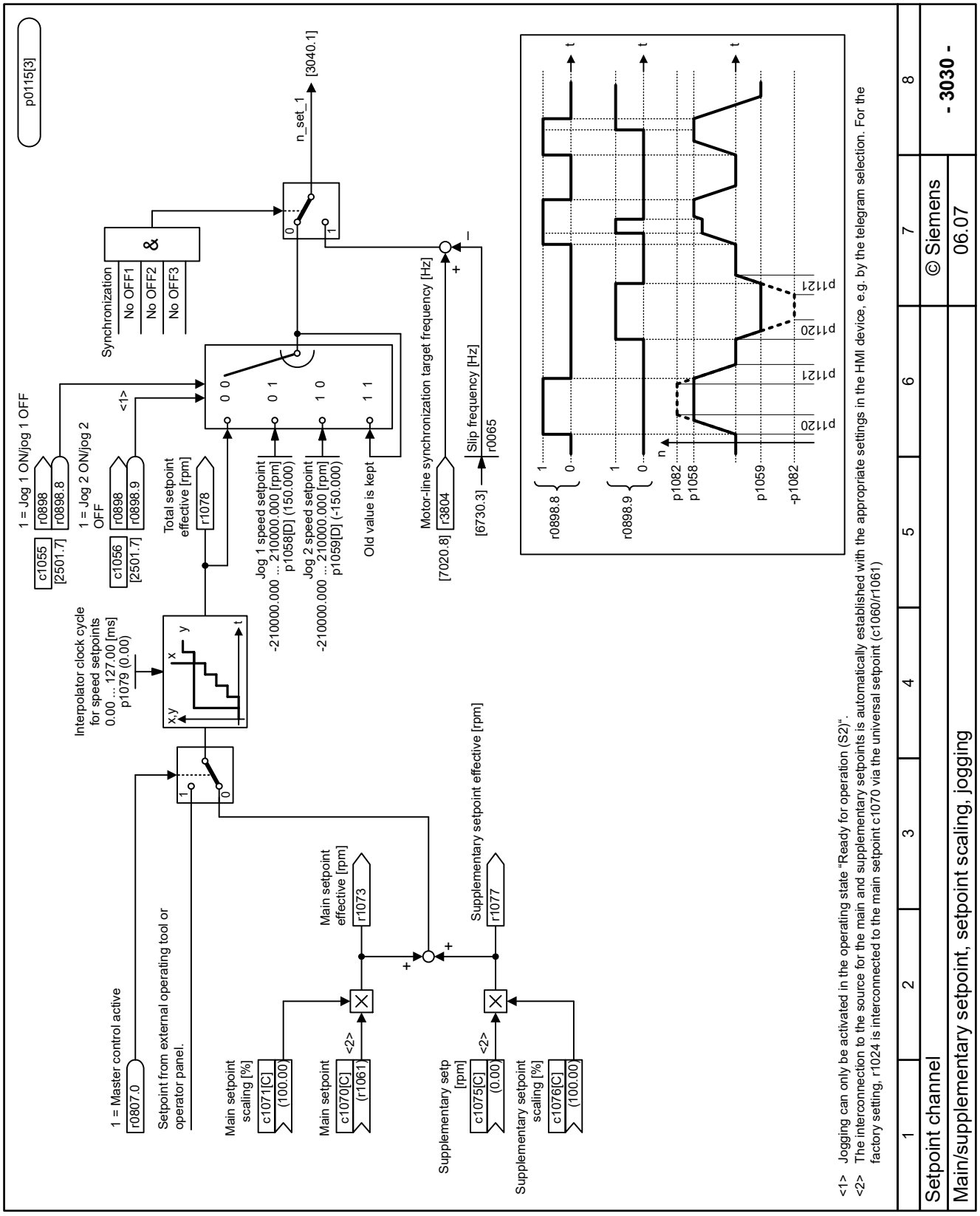


Figure 13-63 3030 - Main/supplementary setpoint, setpoint scaling, jogging

13.11.2 Motorized potentiometer

Overview

The "Motorized potentiometer" function emulates an electromechanical potentiometer.

Function description

The motorized potentiometer is a possible setpoint source for the main setpoint or the supplementary setpoint.

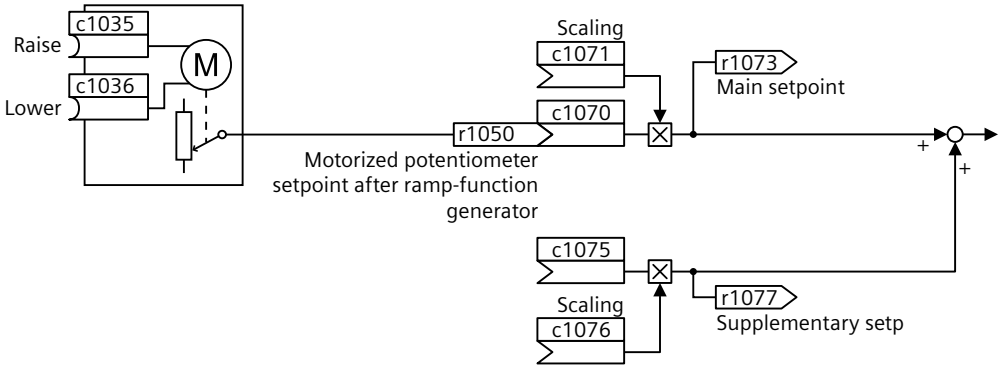


Figure 13-64 The motorized potentiometer as setpoint source

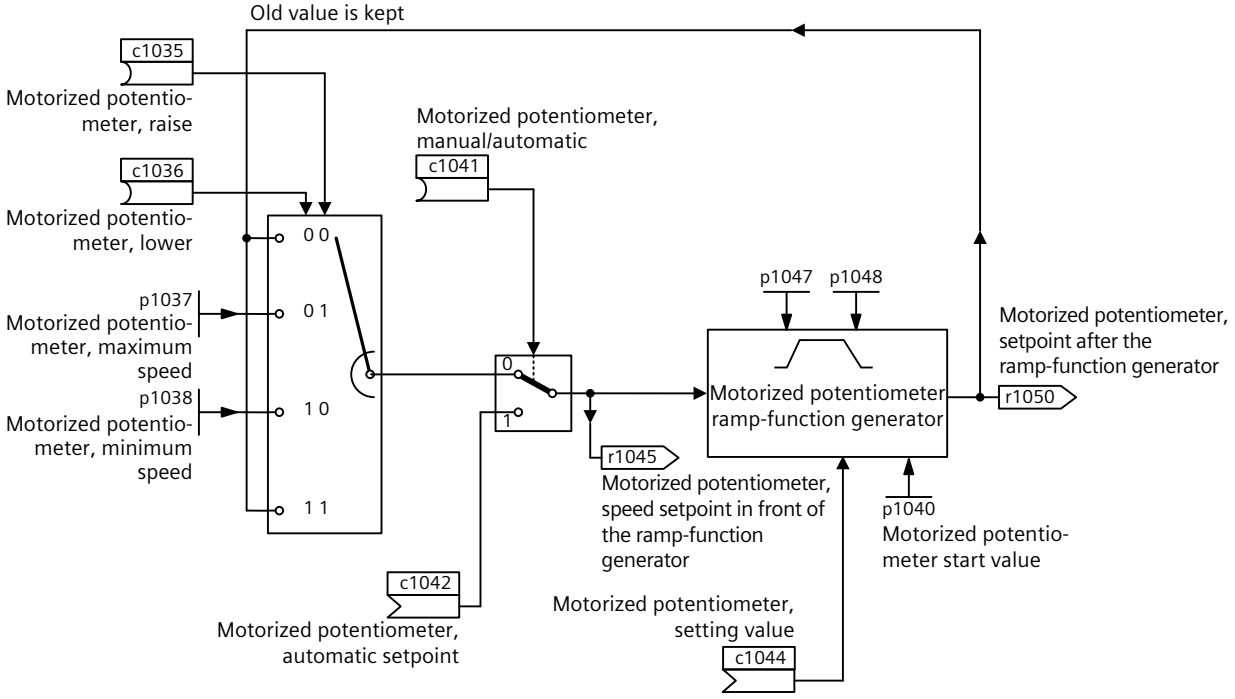


Figure 13-65 Simplified function diagram of the motorized potentiometer

The motorized potentiometer has 2 operating modes:

- In the manual mode, the output value of the motorized potentiometer responds to control signals "MOP higher" and "MOP lower".
  - MOP higher = 1 signal: The motorized potentiometer setpoint increases with ramp-up time p1047.
  - MOP lower = 1 signal: The motorized potentiometer setpoint decreases with ramp-down time p1048.

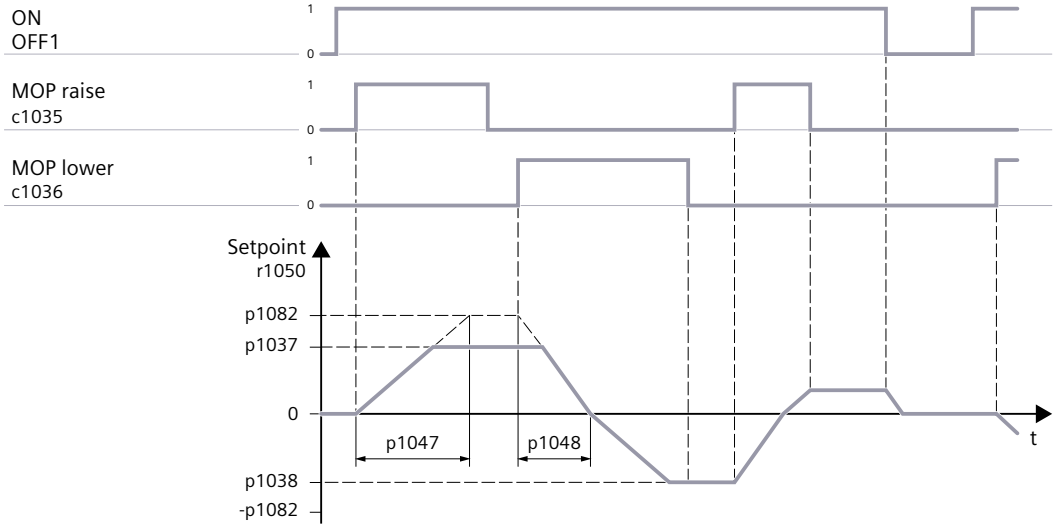


Figure 13-66 Function diagram of the motorized potentiometer in the manual mode

- c1041 = 1 signal switches the motorized potentiometer from the manual mode to the automatic mode.
  Control signals "MOP higher" and "MOP lower" are deactivated in the automatic mode. Instead, numerical sink c1042 specifies the setpoint for the ramp-function generator of the motorized potentiometer.

A 0→1 signal change of the binary sink c1043 immediately sets the output of the motorized potentiometer to the value of the numerical sink c1044.

The response of the motorized potentiometer depends on the configuration of p1030 as follows:

- p1030.00 = 1: The motorized potentiometer keeps its setpoint after an OFF command and after the ON command immediately supplies the saved value.
- p1030.01 = 1: In the automatic mode, the ramp-function generator of the motorized potentiometer is active.
- p1030.02 = 1: With the initial rounding, the motorized potentiometer progressively responds to control signals "MOP higher" and "MOP lower". The initial rounding allows an operator to make sensitive changes.
- p1030.03 = 1: The motorized potentiometer keeps its setpoint after a power failure.
- p1030.04 = 1: When the motor is switched off, the ramp-function generator of the motorized potentiometer responds to setpoint changes.

Parameters

The following list contains the parameters of function "Motorized potentiometer".

Number	Name	Unit
p1030[0...n].0...4	Motorized potentiometer configuration	-
c1035[0...n]	Motorized potentiometer raise setpoint	-
c1036[0...n]	Motorized potentiometer lower setpoint	-
p1037[0...n]	Motorized potentiometer maximum speed	rpm
p1038[0...n]	Motorized potentiometer minimum speed	rpm
c1039[0...n]	Motorized potentiometer inversion	-
p1040[0...n]	Motorized potentiometer starting value	rpm
c1041[0...n]	Motorized potentiometer manual/automatic	-
c1042[0...n]	Motorized potentiometer automatic setpoint	rpm
c1043[0...n]	Motorized potentiometer accept setting value	-
c1044[0...n]	Motorized potentiometer setting value	rpm
r1045	Mot potentiometer speed setpoint in front of ramp-function gen	rpm
p1047[0...n]	Motorized potentiometer ramp-up time	s
p1048[0...n]	Motorized potentiometer ramp-down time	s
r1050	Motorized potentiometer setpoint after ramp-function generator	rpm

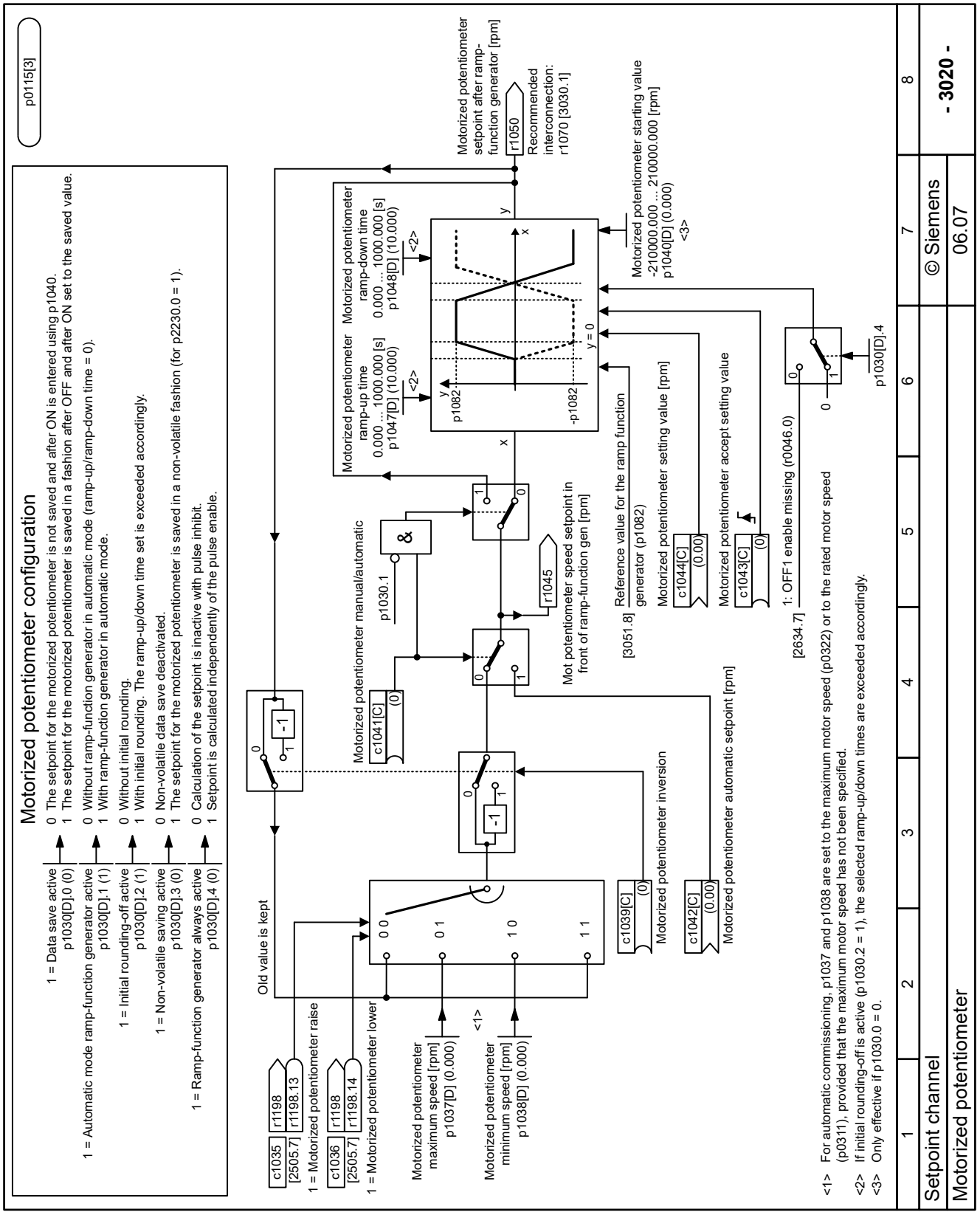


Figure 13-67 3020 - Motorized potentiometer

13.11.3 Fixed speed setpoint

Overview

The converter provides multiple fixed setpoints. You can interconnect the fixed setpoints with the main setpoint and you can select between different fixed setpoints during operation.

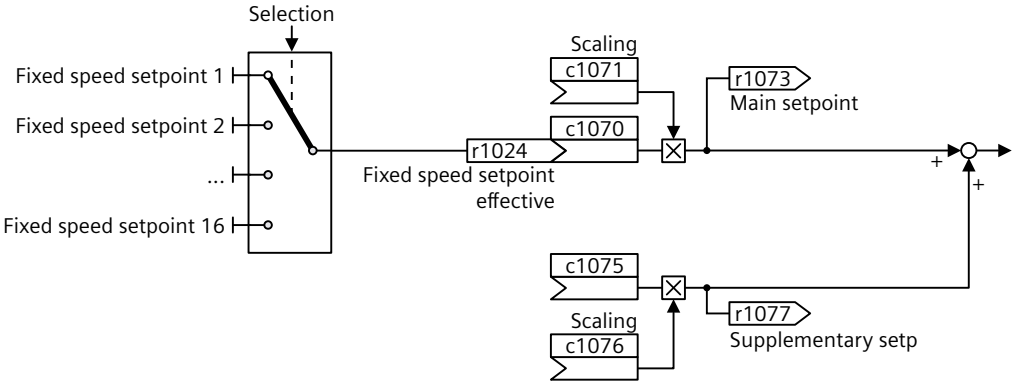


Figure 13-68 Fixed speed setpoint as setpoint source

Function description

The converter differentiates two modes for specifying the fixed speed setpoints:

- Direct mode
- Binary mode

Direct mode

Direct mode is recommended for selecting the fixed speed setpoints via digital inputs.

In the direct mode, precisely one selection bit c1020 ... c1023 is assigned to each fixed speed setpoint p1001 ... p1004.

With multiple selection, the converter adds the corresponding fixed speed setpoints. This results in an effective setpoint with up to 16 different values.

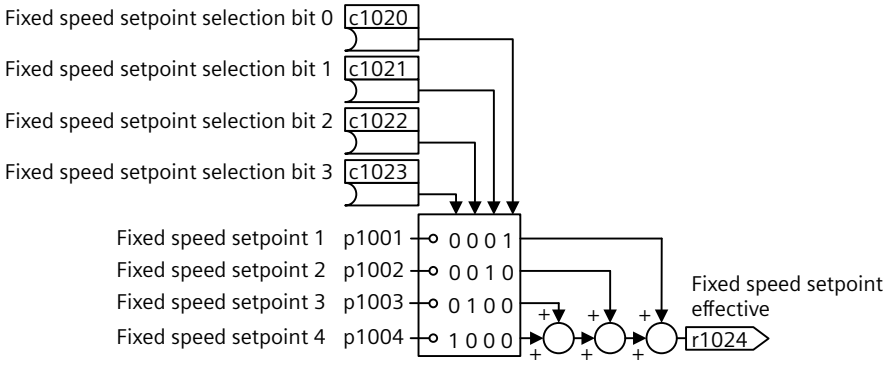


Figure 13-69 Direct selection of fixed speed setpoints

Table 13-95 Effective setpoint

c1020	c1021	c1022	c1023	r1024
0	0	0	0	0
1	0	0	0	p1001
0	1	0	0	p1002
1	1	0	0	p1001 + p1002
0	0	1	0	p1003
1	0	1	0	p1001 + p1003
0	1	1	0	p1002 + p1003
1	1	1	0	p1001 + p1002 + p1003
0	0	0	1	p1004
1	0	0	1	p1001 + p1004
0	1	0	1	p1002 + p1004
1	1	0	1	p1001 + p1002 + p1004
0	0	1	1	p1003 + p1004
1	0	1	1	p1001 + p1003 + p1004
0	1	1	1	p1002 + p1003 + p1004
1	1	1	1	p1001 + p1002 + p1003 + p1004

Binary mode

The binary mode is recommended to select fixed speed setpoints using a higher-level control system.

In the binary mode, up to 15 different fixed speed setpoints p1001 ... p1015 are defined. A certain combination of selection bits is assigned to each of the 15 fixed speed setpoints.

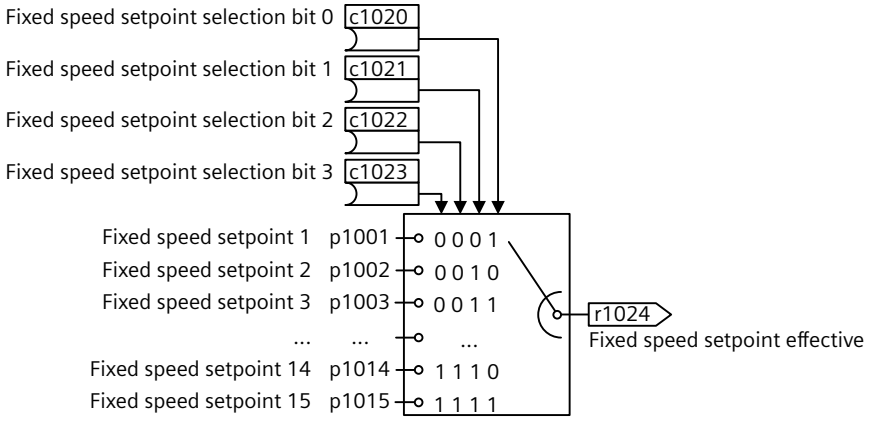


Figure 13-70 Binary selection of fixed speed setpoints

Table 13-96 Effective setpoint

c1020	c1021	c1022	c1023	r1024
0	0	0	0	0
1	0	0	0	p1001
0	1	0	0	p1002

c1020	c1021	c1022	c1023	r1024
1	1	0	0	p1003
0	0	1	0	p1004
1	0	1	0	p1005
0	1	1	0	p1006
1	1	1	0	p1007
0	0	0	1	p1008
1	0	0	1	p1009
0	1	0	1	p1010
1	1	0	1	p1011
0	0	1	1	p1012
1	0	1	1	p1013
0	1	1	1	p1014
1	1	1	1	p1015

Example

In the example, the motor accelerates to different speed setpoints:

- 300 r/min
- 2300 r/min

Digital inputs DI 0 and DI 1 switch the motor on and off and select one of the two speed setpoints.

Table 13-97 Set fixed speeds

Parameters	Description
p1001 = 300.000	Fixed speed setpoint 1
p1002 = 2000.000	Fixed speed setpoint 2
c0840 = r0722.0	ON/OFF1 switches the motor on via digital input 0.
c1070 = r1024	The main setpoint is interconnected with the fixed speed setpoint.
c1020 = r0722.0	Fixed speed setpoint selection bit 0 is interconnected with digital input 0 (DI 0).
c1021 = r0722.1	Fixed speed setpoint selection bit 1 is interconnected with digital input 1 (DI 1).
p1016 = 1	Directly selecting fixed speed setpoints is selected.

Table 13-98 Resulting fixed speed setpoints

Signal at the digital inputs	Resulting setpoint
DI 0 = 0	The motor stops
DI 0 = 1 and DI 1 = 0	The motor accelerates to 300 r/min
DI 0 = 1 and DI 1 = 1	The motor accelerates to 2300 r/min

Parameters

The following list contains the parameters of function "Fixed speed setpoint".

Number	Name	Unit
p1001[0...n]	Fixed speed setpoint 1	rpm
p1002[0...n]	Fixed speed setpoint 2	rpm
p1003[0...n]	Fixed speed setpoint 3	rpm
p1004[0...n]	Fixed speed setpoint 4	rpm
p1005[0...n]	Fixed speed setpoint 5	rpm
p1006[0...n]	Fixed speed setpoint 6	rpm
p1007[0...n]	Fixed speed setpoint 7	rpm
p1008[0...n]	Fixed speed setpoint 8	rpm
p1009[0...n]	Fixed speed setpoint 9	rpm
p1010[0...n]	Fixed speed setpoint 10	rpm
p1011[0...n]	Fixed speed setpoint 11	rpm
p1012[0...n]	Fixed speed setpoint 12	rpm
p1013[0...n]	Fixed speed setpoint 13	rpm
p1014[0...n]	Fixed speed setpoint 14	rpm
p1015[0...n]	Fixed speed setpoint 15	rpm
p1016	Fixed speed setpoint select mode	-
c1020[0...n]	Fixed speed setpoint selection bit 0	-
c1021[0...n]	Fixed speed setpoint selection bit 1	-
c1022[0...n]	Fixed speed setpoint selection bit 2	-
c1023[0...n]	Fixed speed setpoint selection bit 3	-
r1024	Fixed speed setpoint effective	rpm
r1025.0	Fixed speed setpoint status	-
c1070[0...n]	Main setpoint	rpm
c1071[0...n]	Main setpoint scaling	%
r1073	Main setpoint effective	rpm
c1075[0...n]	Supplementary setp	rpm
c1076[0...n]	Supplementary setpoint scaling	%
r1077	Supplementary setpoint effective	rpm

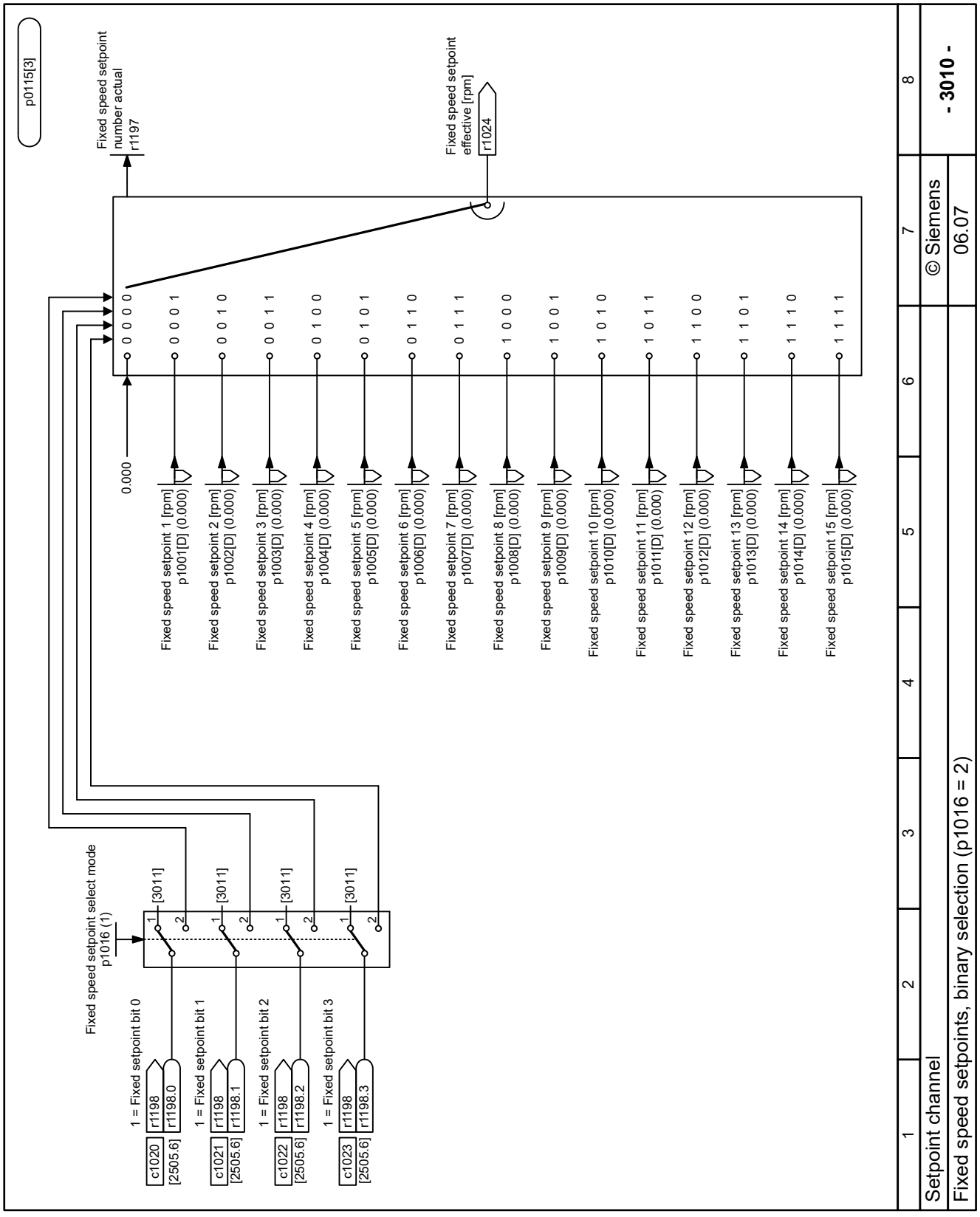


Figure 13-71 3010 - Fixed speed setpoints, binary selection

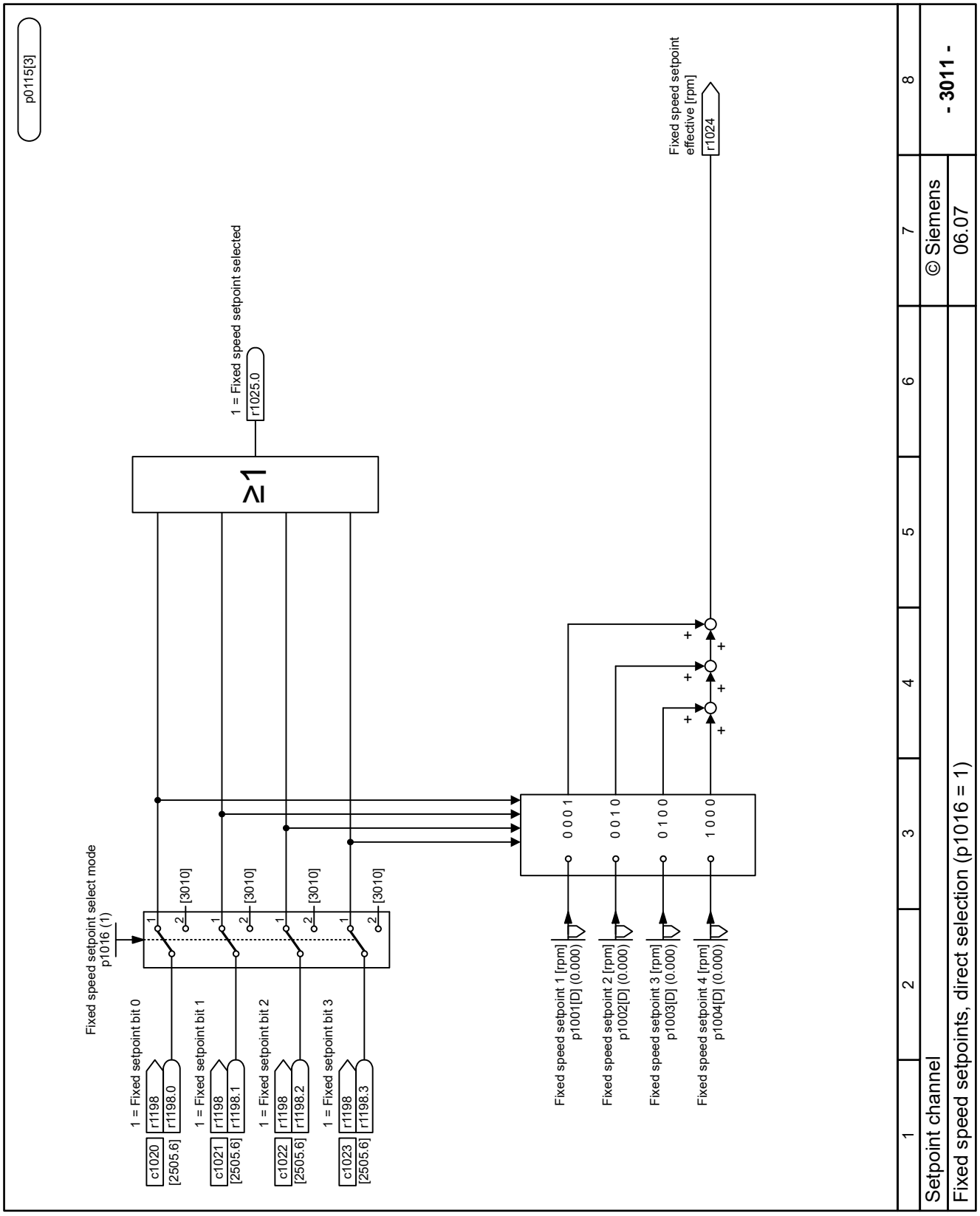


Figure 13-72 3011 - Fixed speed setpoints, direct selection

13.11.4 Setpoint inversion

Overview

The "Invert" function changes the setpoint polarity.

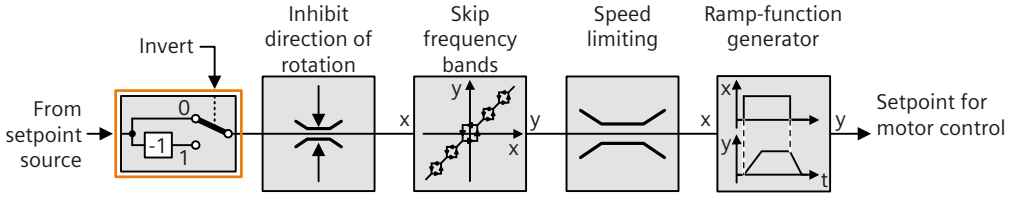


Figure 13-73 Setpoint processing in the converter

Description of function

The function inverts the sign of the setpoint using a binary signal.

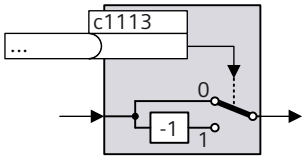


Figure 13-74 Setpoint inversion in the extended setpoint channel

Parameters

The following list contains the parameters of the "Setpoint inversion" function.

Number	Name	Unit
c1113[0...n]	Setpoint inversion	-

13.11.5 Direction reversal without changing the setpoint

Overview

Parameter p1821 changes the direction of rotation of the motor. It is not necessary to interchange the power connections of the motor.

Requirement

The converter is in the "Commissioning" mode.

Function description

Parameter p1821 changes the direction of rotation of the motor.

To prevent positive feedback of the speed controller, the converter inverts all internal actual values required for the closed-loop control when the direction of motion changes.

The direction reversal can be detected based on the motor direction of rotation and the line-to-neutral voltage r0089.

The speed setpoint and actual value, the torque setpoint and actual value and the relative position change remain unchanged.

The absolute position reference is lost on reversal.

Parameters

The following list contains the parameters of the "Direction reversal without changing the setpoint" function.

Number	Name	Unit
r0069[0...8]	Phase current actual value	A
r0089[0...2]	Actual phase voltage (motor)	V
p1820[0...n]	Reverse the output phase sequence	-
p1821[0...n]	Direction of rotation	-
p1959[0...n].0...14	Rotating measurement configuration	-
p2507[0...n]	LR absolute encoder adjustment status	-

13.11.6 Direction limiting

Overview

Function "Direction limitation" prevents a speed setpoint from being entered when the motor is rotating in a specific direction.

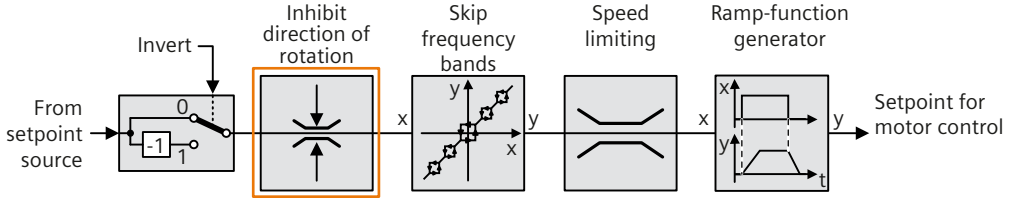


Figure 13-75 Setpoint processing in the converter

Function description

With a 1 signal at binary signal sinks c1110 and c1111, the converter inhibits setpoints in the negative or in the positive direction of motion of the motor.

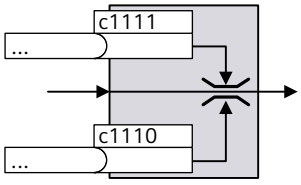


Figure 13-76 Direction limiting in the extended setpoint channel

Both motion directions of the motor are enabled in the factory setting of the converter.

Example

Typical applications with direction limiting are conveyor belts, extruders, pumps and fans.

Parameters

The following list contains the parameters of the "Direction limiting" function.

Number	Name	Unit
c1110[0...n]	Inhibit negative direction	-
c1111[0...n]	Inhibit positive direction	-

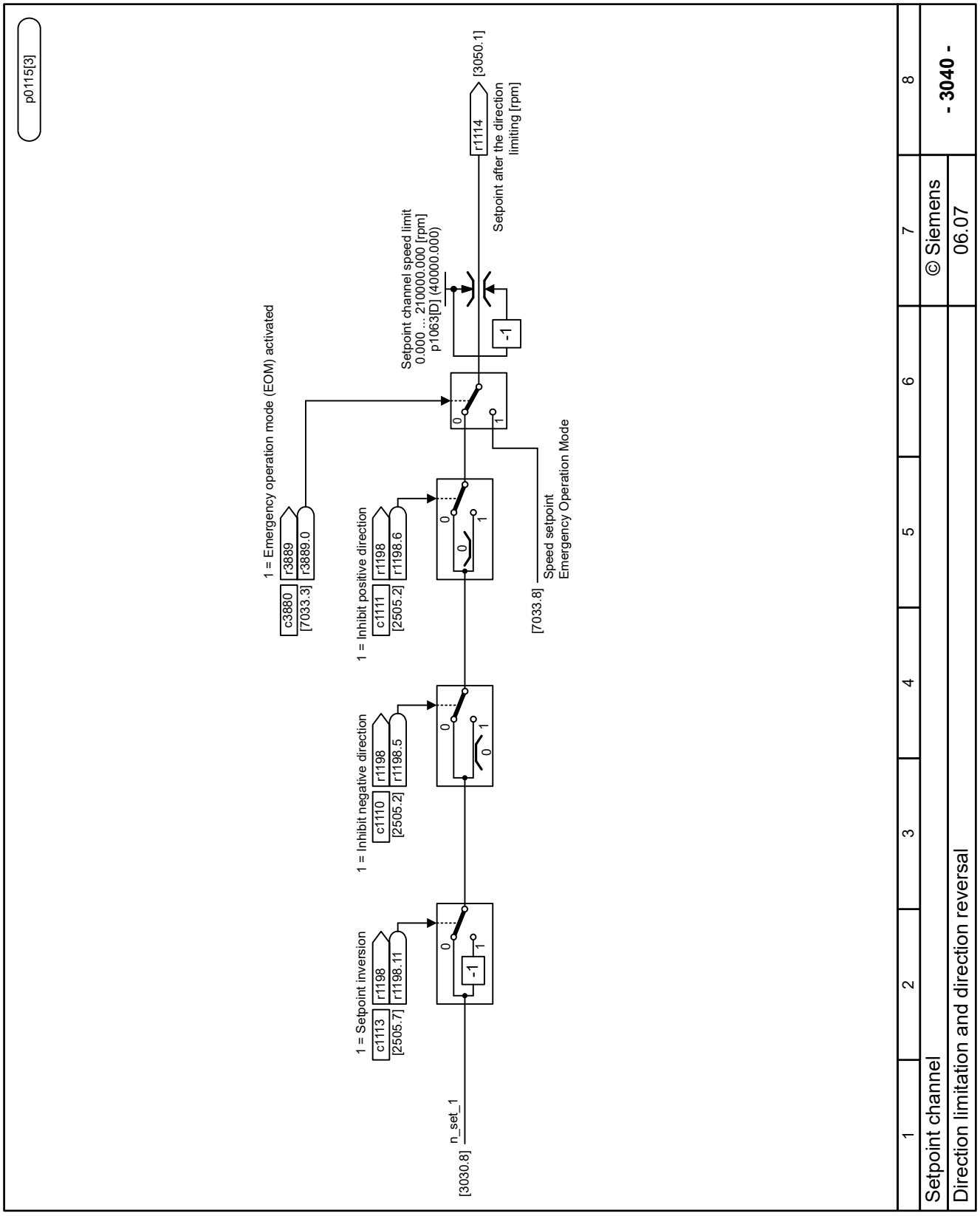


Figure 13-77 3040 - Direction limitation and direction reversal

13.11.7 Minimum speed

Overview

Function "Minimum speed" prevents a speed setpoint being continually entered below a specific speed.

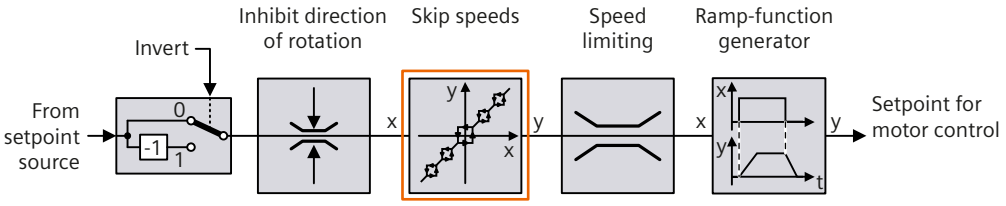


Figure 13-78 Setpoint processing in the converter

Function description

The maximum from the numerical signal sink c1106 and parameter p1080 defines the minimum motor speed.

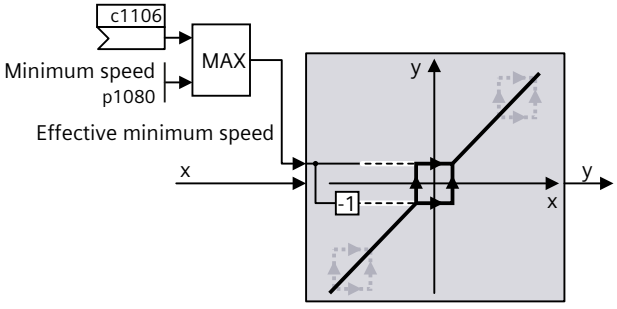


Figure 13-79 Minimum speed in the extended setpoint channel

The minimum speed is effective in both directions of motion.

Speeds between the positive and negative minimum speed are briefly possible when the motor is accelerating or braking.

Example

Typical applications with minimum speed are pumps to avoid dry running below a certain speed or fans to maintain basic cooling.

Parameters

The following list contains the parameters of the "Minimum speed" function.

Number	Name	Unit
c1051[0...n]	Speed limit RFG positive direction of rotation	rpm
c1052[0...n]	Speed limit RFG negative direction of rotation	rpm
p1080[0...n]	Minimum speed	rpm

p1083[0...n]	Speed limit in positive direction of rotation	rpm
r1084	Positive speed limit effective	rpm
c1085[0...n]	Speed limit in positive direction of rotation	rpm
c1106[0...n]	Minimum speed	rpm
r1112	Speed setpoint after minimum limiting	rpm
r1114	Setpoint after the direction limiting	rpm
r1119	Ramp-function generator setpoint at the input	rpm
r1170	Speed controller setpoint sum	rpm

13.11.8 Skip speeds

Overview

This function avoids the excitation of mechanical resonance effects by only permitting certain speeds temporarily.

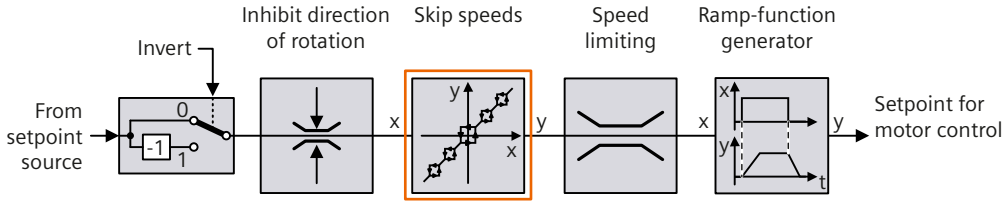


Figure 13-80 Setpoint processing in the converter

Function description

The converter has 4 skip speeds.

The converter prevents that the speed setpoint is continuously set within speed range "Skip speed ± bandwidth". When accelerating or braking, the motor only briefly passes through the speed range of the skip speed.

Function "Skip speed" does not monitor the actual speed. When the drive is overloaded, the motor speed actual value no longer follows its setpoint. In this case, the motor speed can lie continuously in the speed range of a skip speed and therefore excite mechanical resonance effects.

Parameters

The following list contains the parameters of function "Skip speeds".

Number	Name	Unit
p1091[0...n]	Skip speed 1	rpm
p1092[0...n]	Skip speed 2	rpm
p1093[0...n]	Skip speed 3	rpm
p1094[0...n]	Skip speed 4	rpm
c1098[0...n]	Skip speed scaling	%
r1099.0	Skip band status word	-

p1101[0...n]	Skip speed bandwidth	rpm

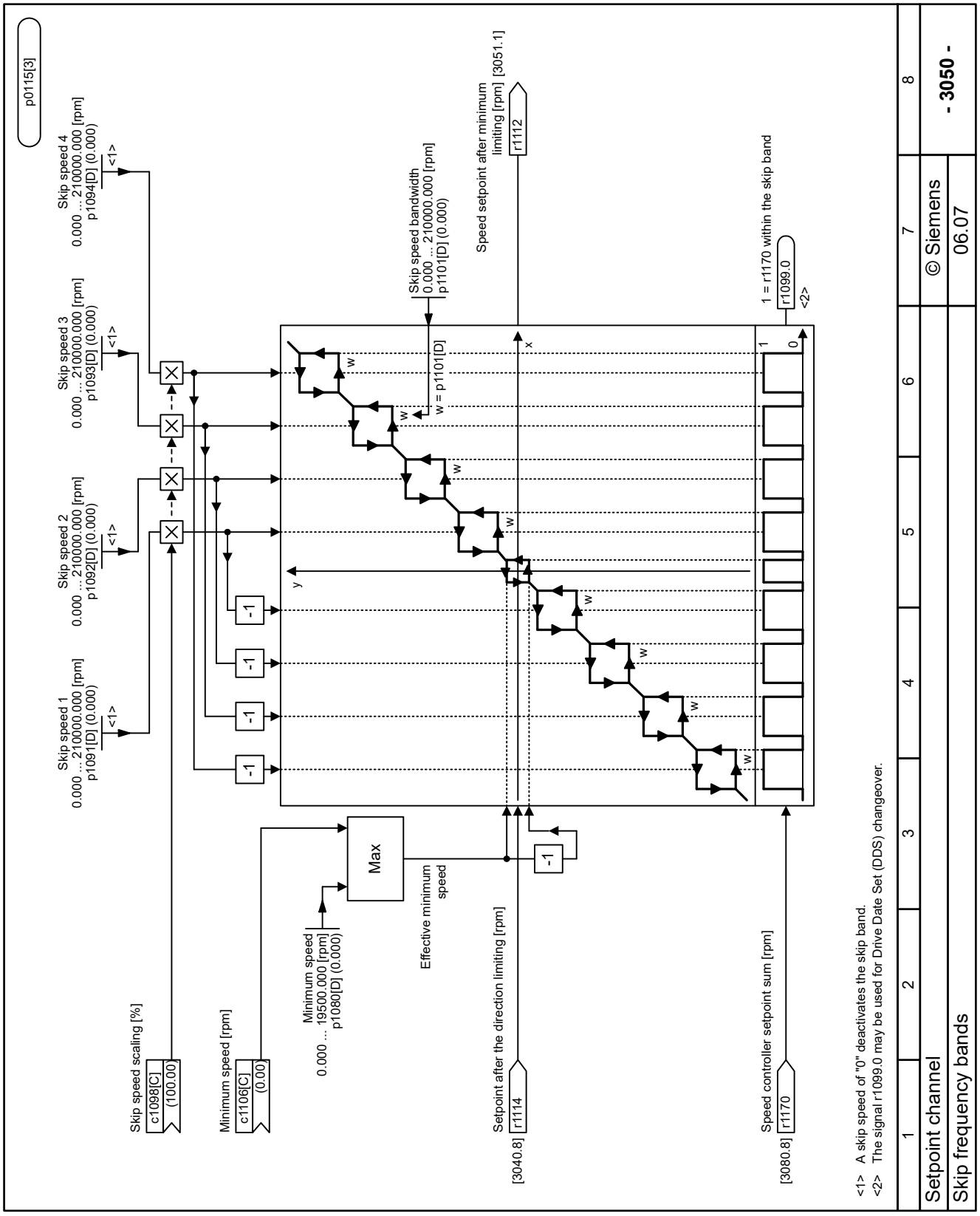


Figure 13-81 3050 - Skip frequency bands

13.11.9 Speed limiting

Overview

The speed limiting protects the motor and the driven load against excessively high speeds.

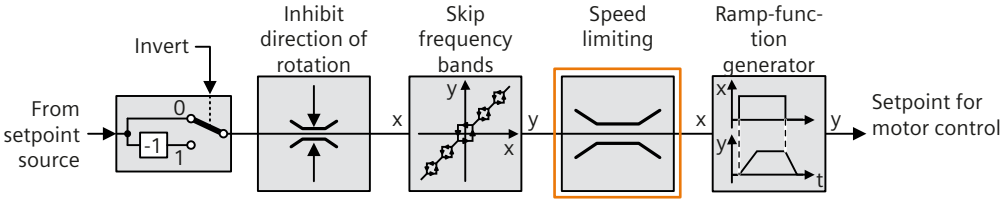


Figure 13-82 Setpoint processing in the converter

Function description

The maximum speed limits the speed setpoint range in both directions.

The converter issues a fault message when the maximum speed is exceeded.

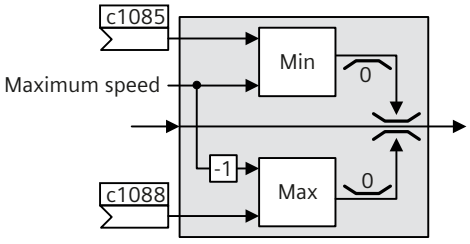


Figure 13-83 Speed limiting in the setpoint channel

Parameters

The following list contains the parameters of the "Speed limitation" function.

Number	Name	Unit
p1082[0...n]	Maximum speed	rpm
p1083[0...n]	Speed limit in positive direction of rotation	rpm
c1085[0...n]	Speed limit in positive direction of rotation	rpm
p1086[0...n]	Speed limit in negative direction of rotation	rpm
c1088[0...n]	Speed limit in negative direction of rotation	rpm

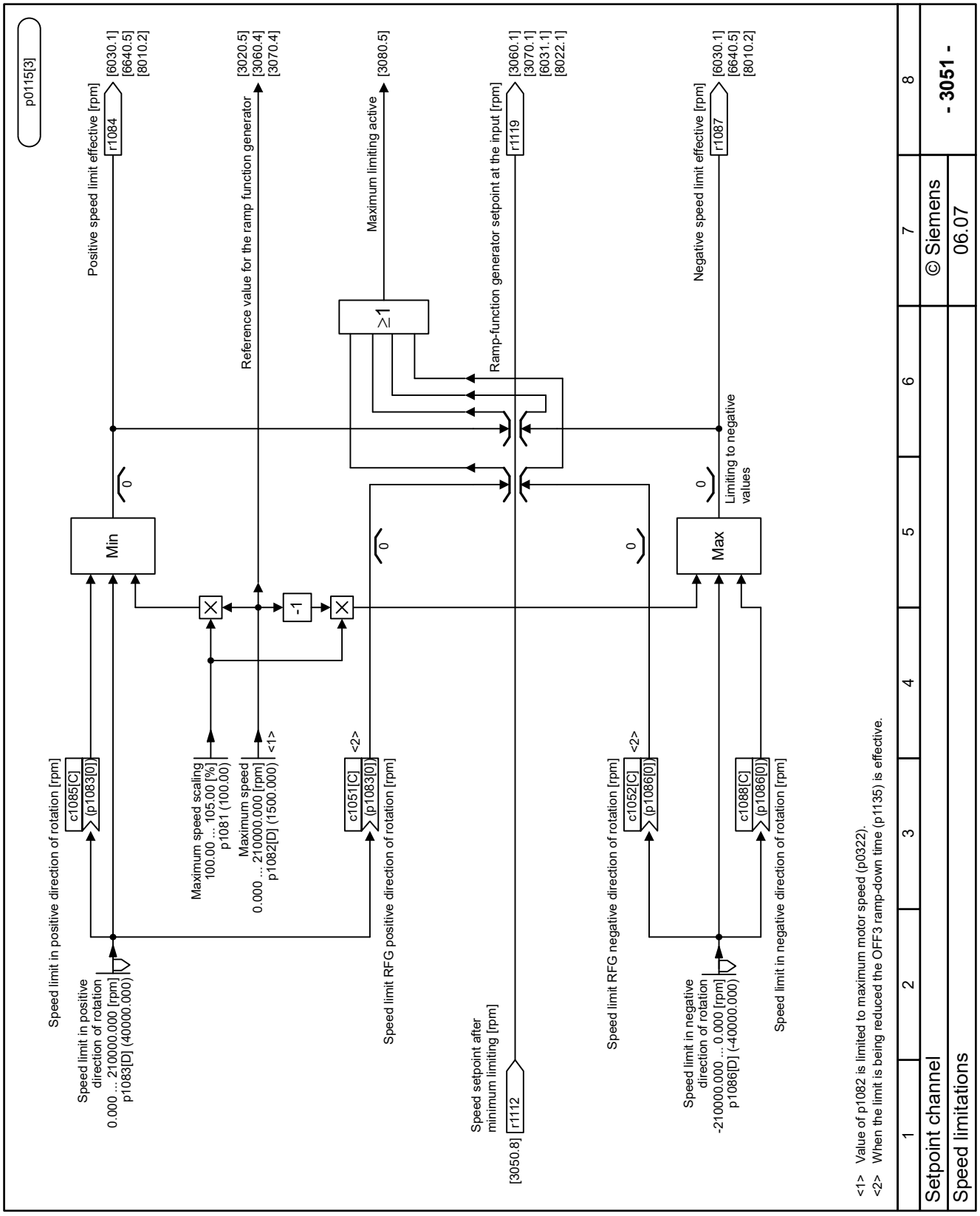


Figure 13-84 3051 - Speed limitations

13.11.10 Jog

Overview

The Jog function is typically used to temporarily move a motor using local control commands.

Function description

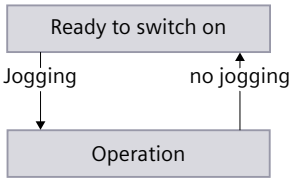


Figure 13-85 Jog

If the converter is in state "Ready for switching on" then commands Jog 1 or Jog 2 switch the motor on and off.

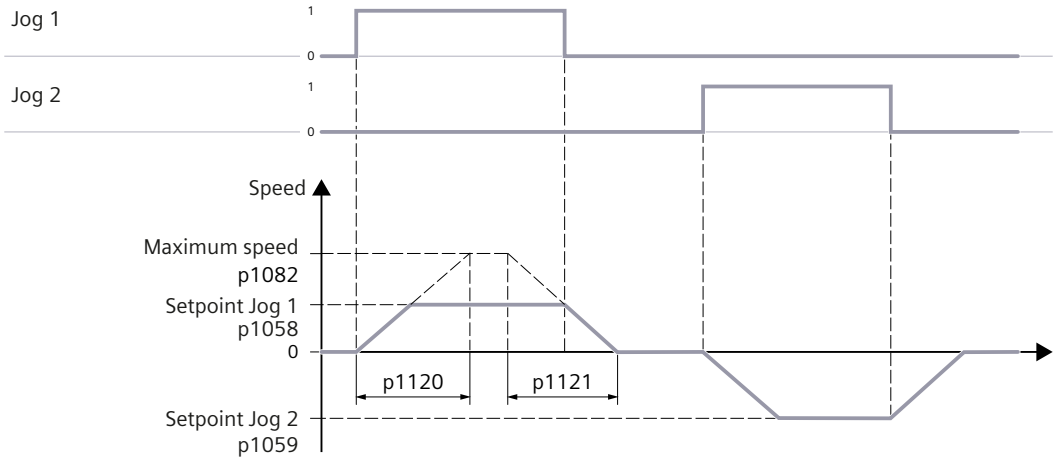


Figure 13-86 Behavior of the motor when jogging

After switch-on, the motor accelerates to setpoint Jog 1 or Jog 2. The two different setpoints can be assigned to clockwise and counter-clockwise rotation of the motor, for example.

When jogging, the same ramp-function generator is active as for the ON/OFF1 command.

Parameters

The following list contains the parameters of the "Jog" function.

Number	Name	Unit
c1055[0...n]	Jog 1 signal	-
c1056[0...n]	Jog 2 signal	-
p1058[0...n]	Jog 1 speed setpoint	rpm
p1059[0...n]	Jog 2 speed setpoint	rpm
p1082[0...n]	Maximum speed	rpm

c1110[0...n]	Inhibit negative direction	-
c1111[0...n]	Inhibit positive direction	-
c1113[0...n]	Setpoint inversion	-
p1120[0...n]	Ramp-function generator ramp-up time	s
p1121[0...n]	Ramp-function generator ramp-down time	s

13.11.11 Basic ramp-function generator

Overview

The ramp-function generator reduces the load on the mechanical system of the driven machine by limiting the acceleration of the motor.

Function description

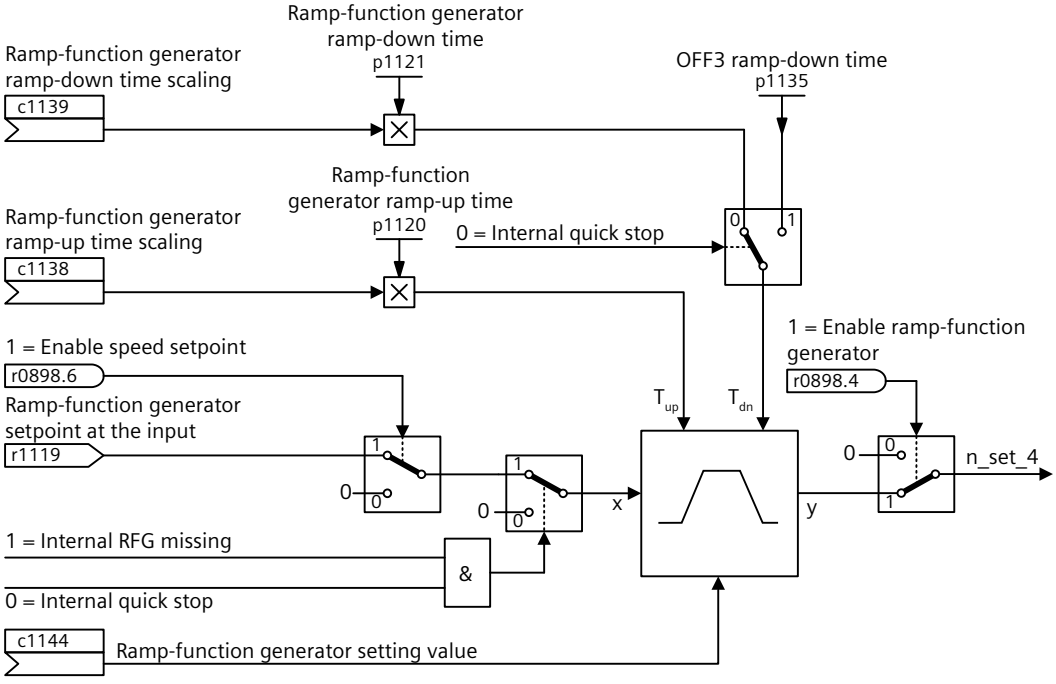


Figure 13-87 Simplified function diagram of the basic ramp-function generator

The basic ramp-function generator receives the speed setpoint via the numerical signal source r1119.

Ramp-up time p1120 and ramp-down time p1121 define the response of the basic ramp-function generator.

Numerical signal sinks c1139 and c1138 scale the ramp-up time and ramp-down time. Using a suitable signal interconnection, the ramp-up time and ramp-down time can be changed while the motor is operational, e.g. via a higher-level control.

For a quick stop, the motor does not brake with ramp-down time p1121, but with OFF3 ramp-down time p1135.

When required, numerical signal sink c1144 sets the output of the basic ramp-function generator to a settable value.

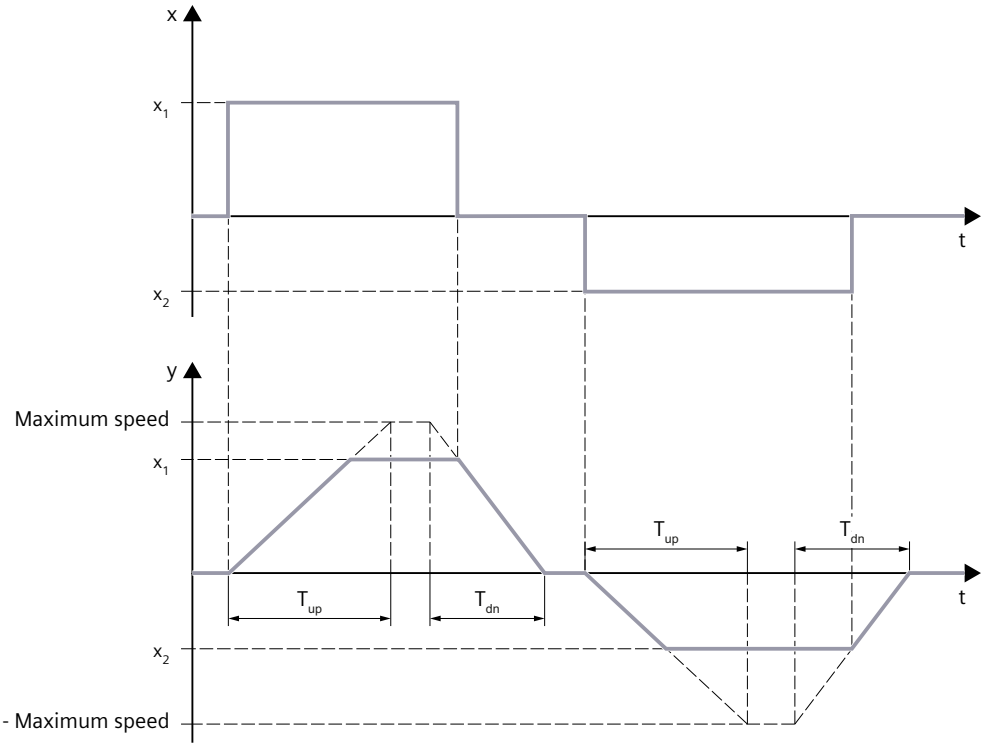


Figure 13-88 Time response of the basic ramp-function generator

Ramp-up time T_{up} and ramp-down time T_{dn} refer to the maximum speed p1082.

Parameters

The following list contains the parameters of the "Basic ramp-function generator" function.

Number	Name	Unit
r0898.0...14	Control word sequence control	-
p1082[0...n]	Maximum speed	rpm
p1115	Ramp-function generator selection	-
r1119	Ramp-function generator setpoint at the input	rpm
p1120[0...n]	Ramp-function generator ramp-up time	s
p1121[0...n]	Ramp-function generator ramp-down time	s
p1123[0...n]	Ramp-function generator minimum ramp-up time	s
p1127[0...n]	Ramp-function generator minimum ramp-down time	s
p1135[0...n]	OFF3 ramp-down time	s
c1138[0...n]	Ramp-function generator ramp-up time scaling	%
c1139[0...n]	Ramp-function generator ramp-down time scaling	%
c1140[0...n]	Enable ramp-function generator/inhibit ramp-function generator	-
c1141[0...n]	Continue ramp-function generator/ freeze ramp-function generator	-

c1142[0...n]	Enable setpoint/inhibit setpoint	-
c1143[0...n]	Ramp-function generator, accept setting value	-
c1144[0...n]	Ramp-function generator setting value	rpm
p1145[0...n]	Ramp-function generator tracking intensity	-
p1148[0...n]	Ramp-function gen. tolerance for ramp-up and ramp-down active	rpm
r1149	Ramp-function generator acceleration	rev/s²
r1150	Ramp-function generator speed setpoint at the output	rpm
r1198.0...15	Control word setpoint channel	-

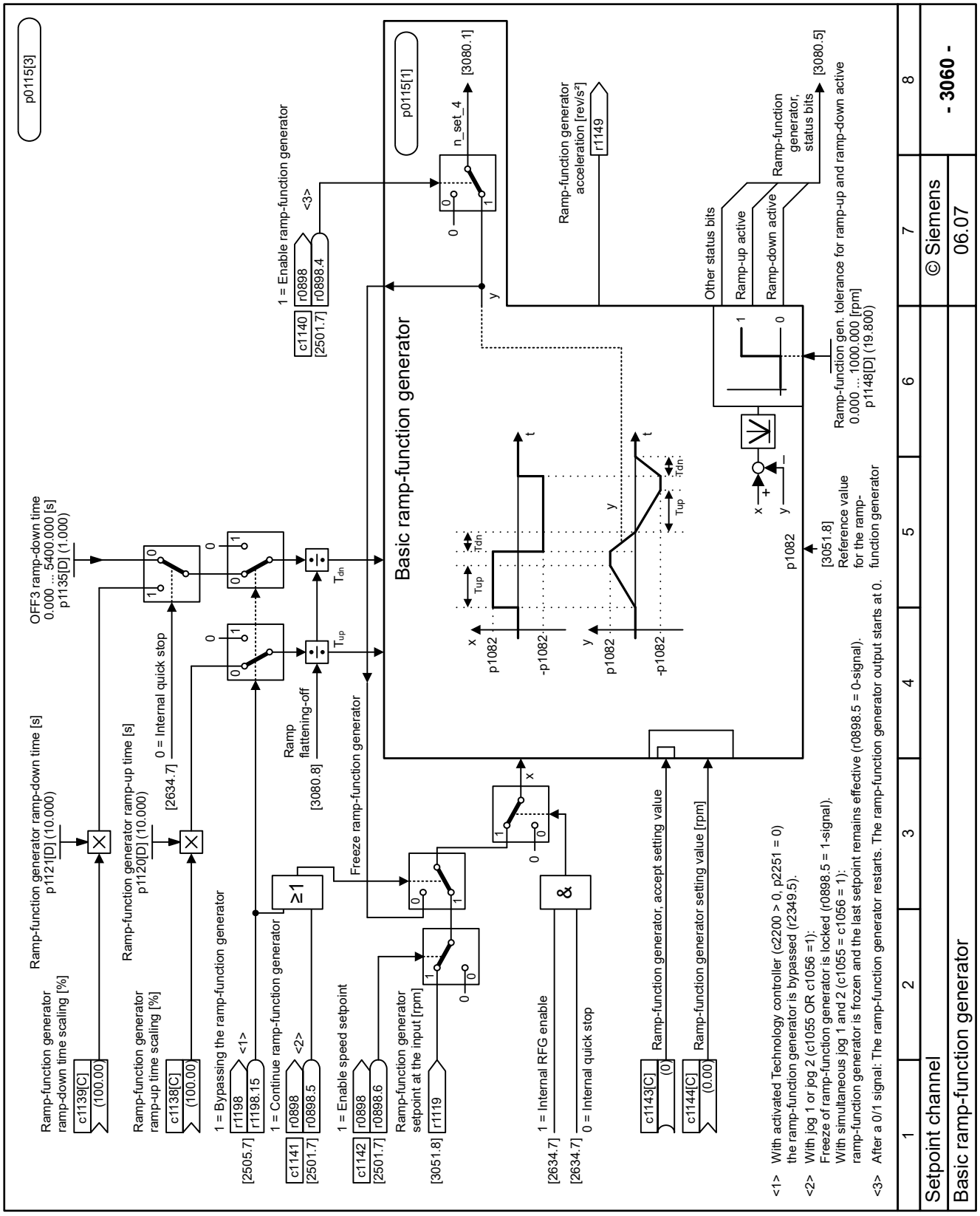


Figure 13-89 3060 - Basic ramp-function generator

13.11.12 Extended ramp-function generator

Overview

The extended ramp-function generator reduces the load on the mechanical system of the driven machine by limiting the acceleration and jerk of the motor.

Function description

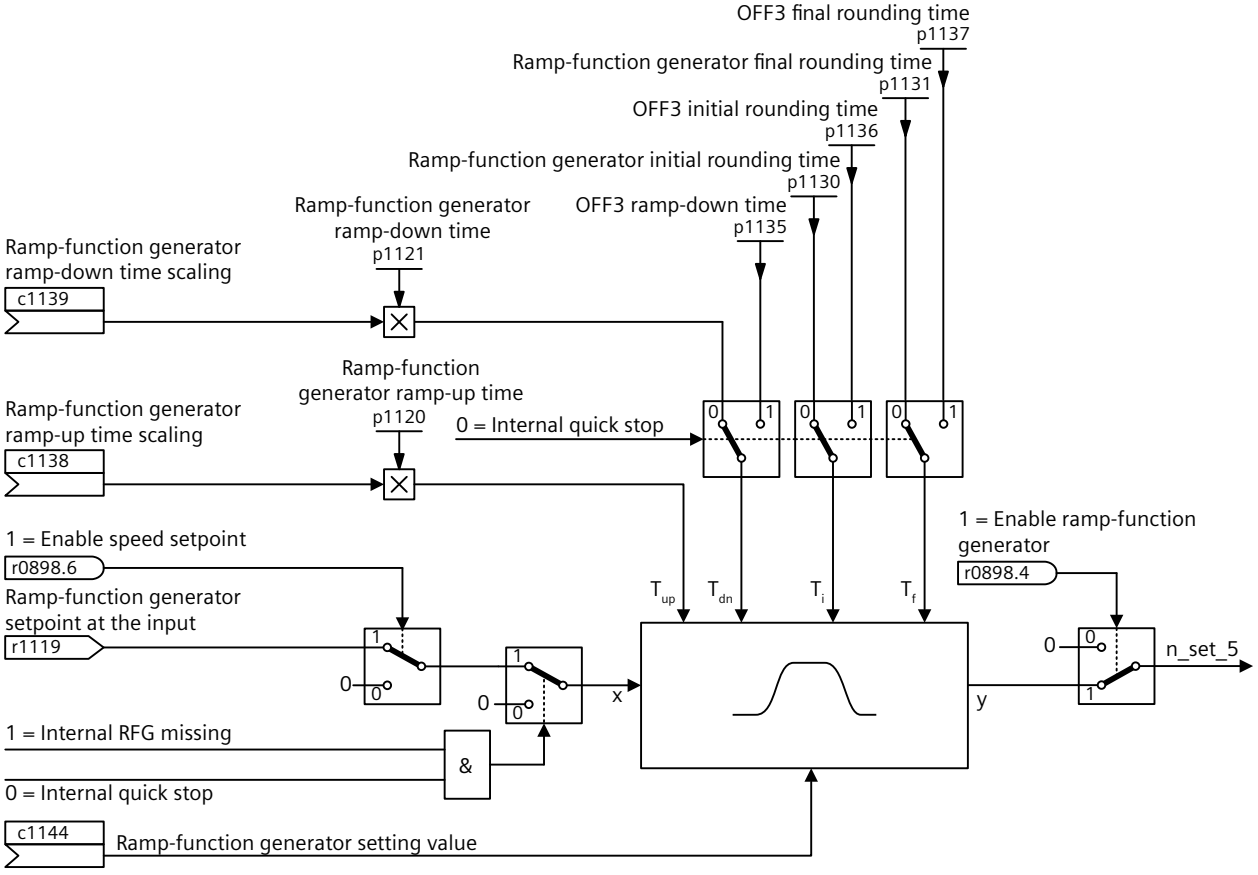


Figure 13-90 Simplified function diagram of the extended ramp-function generator

The extended ramp-function generator receives the speed setpoint via the numerical signal source r1119.

The following parameters define the response of the extended ramp-function generator:

- Ramp-up time p1120
- Ramp-down time p1121
- Initial rounding time p1130
- Final rounding time p1131

Rounding the setpoint limits the change of acceleration (jerk). As a result, the torque does not build up suddenly in the motor.

Numerical signal sinks c1138 and c1139 scale the ramp-up time and ramp-down time. Using a suitable signal interconnection, the ramp-up time and ramp-down time can be changed while the motor is operational, e.g. via a higher-level control.

When an OFF3 command is active, then the following applies:

- The motor brakes with the OFF3 ramp-down time p1135.
- OFF3 rounding times p1136 and p1137 are active.

Numerical signal sink c1144 sets the output of the extended ramp-function generator to a settable value.

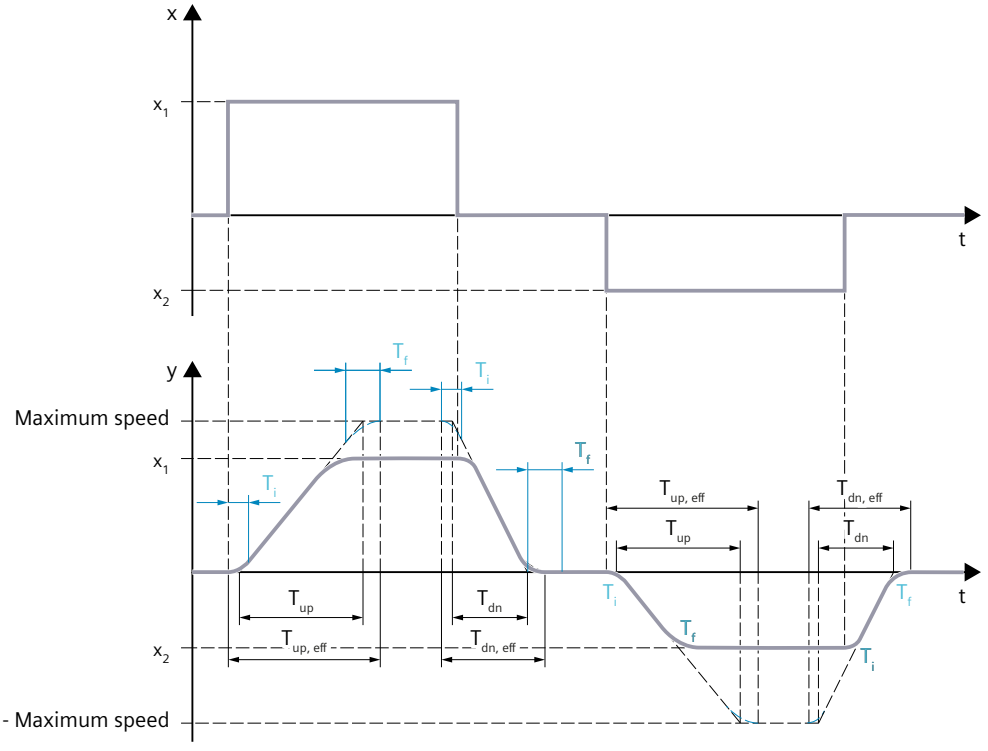


Figure 13-91 Time response of the extended ramp-function generator

The rounding times have the following effect:

- Initial rounding T_i is effective at the start of a setpoint change.
- Final rounding T_f is active at the end of a setpoint change.

The rounding times extend the ramp-up and ramp-down times:

- Effective ramp-up time $T_{up, eff} = (T_{up} + 0.5 \cdot (T_i + T_f)) \cdot c1138$
- Effective ramp-down time $T_{dn, eff} = (T_{dn} + 0.5 \cdot (T_i + T_f)) \cdot c1139$

Parameters

The following list contains the parameters of the "Extended ramp-function generator" function.

Number	Name	Unit

r0898.0...14	Control word sequence control	-
p1115	Ramp-function generator selection	-
r1119	Ramp-function generator setpoint at the input	rpm
p1120[0...n]	Ramp-function generator ramp-up time	s
p1121[0...n]	Ramp-function generator ramp-down time	s
p1123[0...n]	Ramp-function generator minimum ramp-up time	s
p1127[0...n]	Ramp-function generator minimum ramp-down time	s
p1130[0...n]	Ramp-function generator initial rounding-off time	s
p1131[0...n]	Ramp-function generator final rounding-off time	s
p1135[0...n]	OFF3 ramp-down time	s
p1136[0...n]	OFF3 initial rounding-off time	s
p1137[0...n]	OFF3 final rounding-off time	s
c1138[0...n]	Ramp-function generator ramp-up time scaling	%
c1139[0...n]	Ramp-function generator ramp-down time scaling	%
c1140[0...n]	Enable ramp-function generator/inhibit ramp-function generator	-
c1141[0...n]	Continue ramp-function generator/ freeze ramp-function generator	-
c1142[0...n]	Enable setpoint/inhibit setpoint	-
c1143[0...n]	Ramp-function generator, accept setting value	-
c1144[0...n]	Ramp-function generator setting value	rpm
p1145[0...n]	Ramp-function generator tracking intensity	-
p1148[0...n]	Ramp-function gen. tolerance for ramp-up and ramp-down active	rpm
r1149	Ramp-function generator acceleration	rev/s²
r1150	Ramp-function generator speed setpoint at the output	rpm
r1198.0...15	Control word setpoint channel	-

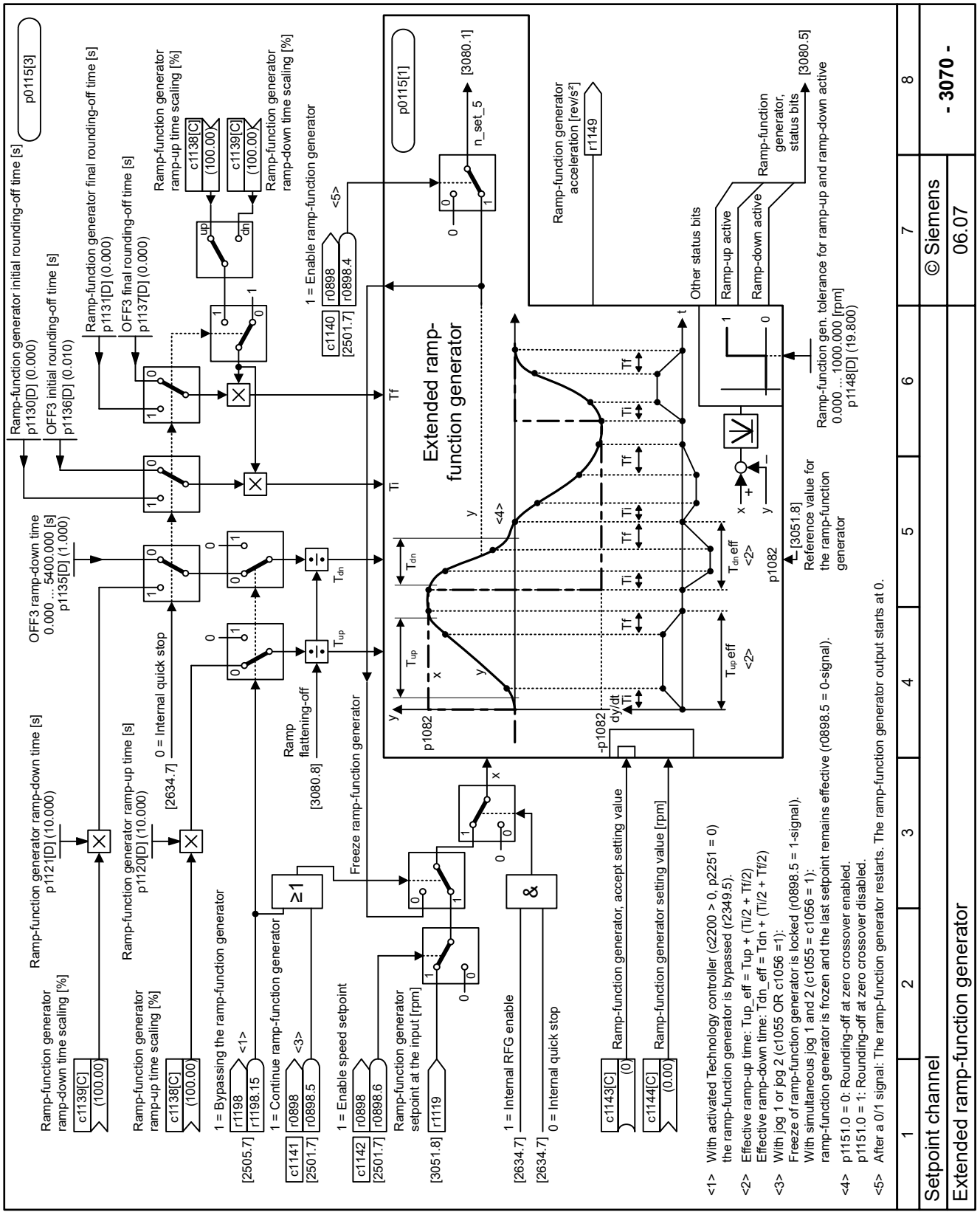


Figure 13-92 3070 - Extended ramp-function generator

13.11.13 Ramp-function generator tracking

Overview

Ramp-function generator tracking minimizes the deviation between the actual speed value and ramp-function generator output when the torque limit is reached. As a consequence, the ramp-function generator tracking reduces the converter response time to setpoint changes, therefore facilitating defined acceleration values after the motor load has been removed.

Function description

Ramp-function generator tracking is only active if the load torque or the acceleration torque of the motor is higher than the set torque limit.

In this case, the drive reaches its torque limit and the motor no longer follows the torque setpoint. As a consequence, a deviation occurs between the ramp-function generator output and the actual speed value.

The following diagram illustrates the different drive responses when reaching the torque limit after a setpoint change with and without ramp-function generator tracking:

- On the left-hand side: Response without ramp-function generator tracking
- On the right-hand side: Response with ramp-function generator tracking

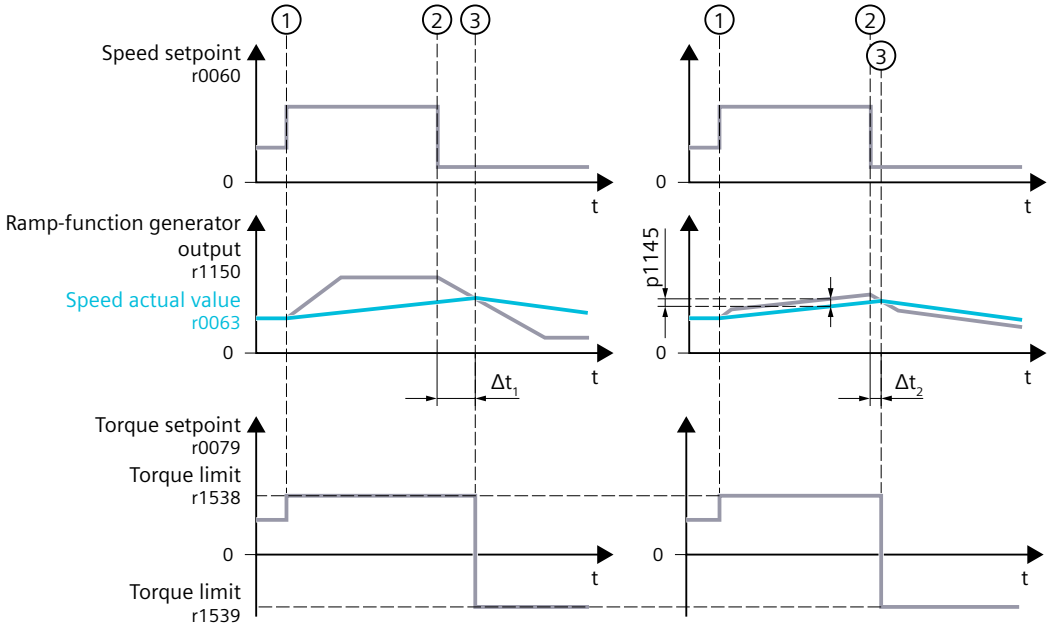


Figure 13-93 Effect of the ramp-function generator tracking

	Specifying the speed setpoint	Drive response without ramp-function generator tracking	Drive response with ramp-function generator tracking
①	The speed setpoint increases as step function. The actual speed value no longer follows the ramp-function generator output as the ramp-up time has been set too short, for example.	Ramp-function generator output and actual speed value deviate from one another.	Ramp-function generator tracking adapts the gradient of the ramp-function generator output to the actual speed value.
②	The speed setpoint decreases as step function. The ramp-function generator output decreases with the set ramp-down time.	The converter continues to accelerate the motor for time Δt_1	The converter only briefly continues to accelerate the motor for time Δt_2
③	The ramp-function generator output reaches the actual speed value.	The motor responds to a speed setpoint change after time Δt_1	The motor responds to a speed setpoint change after time Δt_2 The response time with ramp-function generator tracking is significantly shorter than the response time without ramp-function generator tracking: $\Delta t_2 \ll \Delta t_1$

1) p1145 > 1 activates the ramp-function generator tracking

1) p1400.16 = 1 signal increases the effect of the ramp-function generator tracking. Setting p1400.16 = 1 signal means that the integral component of the speed controller stops when the torque limit is reached.

Ramp-function generator tracking can be extended to include a function that always influences the ramp-function generator output when reaching the torque limit.

The following diagram illustrates the different drive responses when reaching the torque limit:

- On the left-hand side: Ramp-function generator tracking is only active if the ramp-function generator is active when accelerating or braking the motor
- On the right-hand side: The extended ramp-function generator tracking is always active when reaching the torque limit

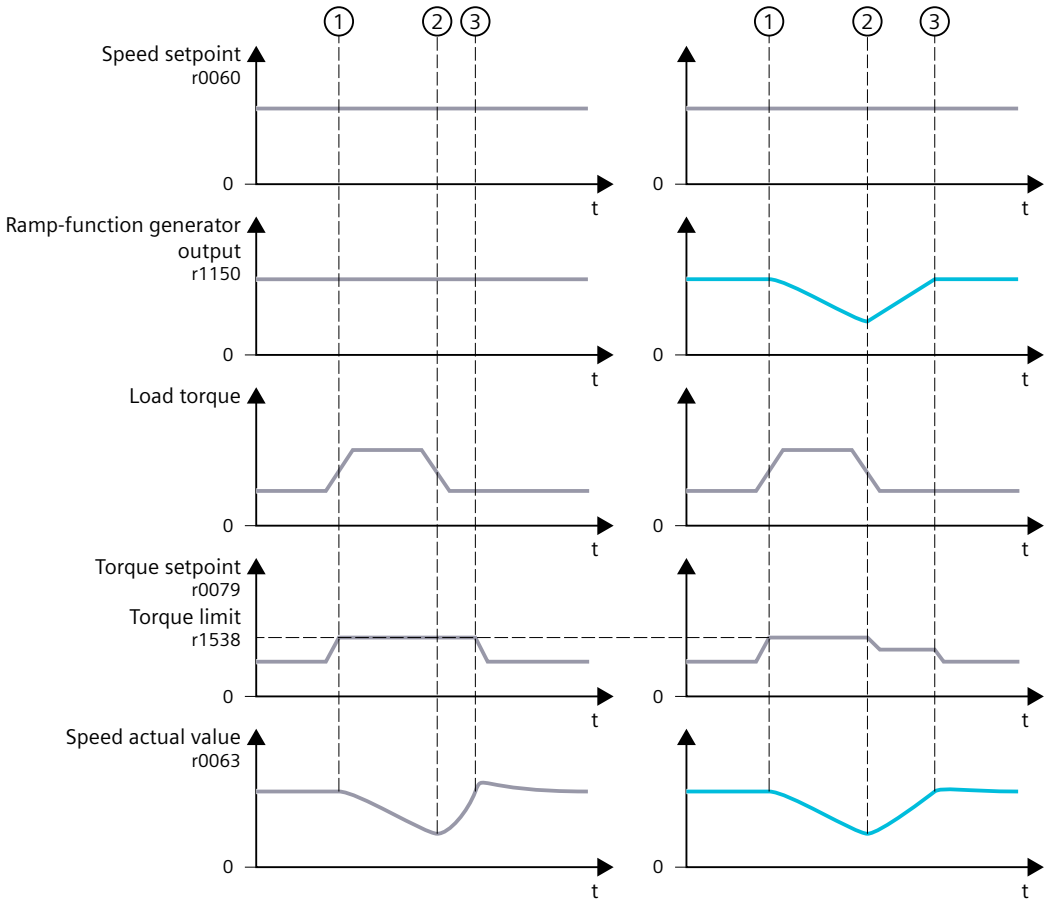


Figure 13-94 Effect of the extended ramp-function generator tracking

	Specifying the load torque	Drive response with the default setting of the ramp-function generator tracking	Drive response with extended ramp-function generator tracking p1151.01 = 1 signal activates the extended ramp-function generator tracking [1) 2)]
①	The load torque becomes higher than the torque limit. The actual speed value no longer follows the ramp-function generator output.	Ramp-function generator output and actual speed value deviate from one another	Ramp-function generator tracking adapts the ramp-function generator output to the actual speed value.
②	The load torque becomes lower than the torque limit.	The converter accelerates the motor at the torque limit.	The converter accelerates the motor corresponding to the ramp-up time of the ramp-function generator.
③	The ramp-function generator output reaches the actual speed value.	The motor moves with a constant velocity Acceleration torque no longer required	

1) p1151.01 = 1 signal: The extended ramp-function generator tracking ends at speed setpoint = 0

2) p1151.02 = 1 signal: The extended ramp-function generator tracking remains active when the speed setpoint polarity changes

Parameters

The following list contains the parameters of the "Ramp-function generator tracking" function.

Number	Name	Unit
p1145[0...n]	Ramp-function generator tracking intensity	-
r1150	Ramp-function generator speed setpoint at the output	rpm
p1151[0...n].0...2	Ramp-function generator configuration	-
p1400[0...n].0...31	Speed control configuration	-

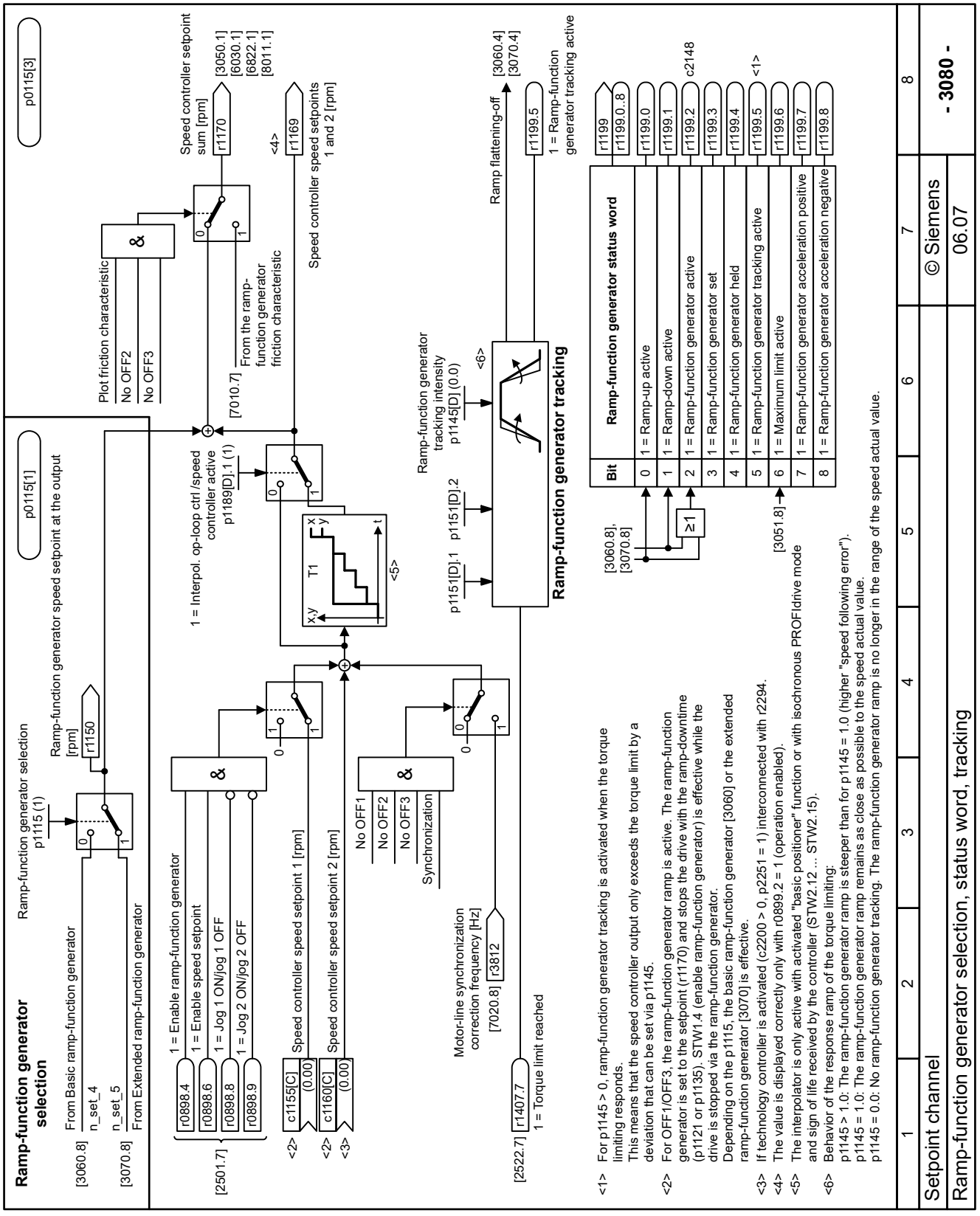


Figure 13-95 3080 - Ramp-function generator selection, status word, tracking

13.12 Drive control

13.12.1 Motors that can be operated

Precondition

NOTICE
Damage to an unsuitable motor as a result of converter operation In converter operation, the motor is subject to a higher thermal stress as a result of the non-sinusoidal current. In addition, switching operations in the converter cause brief voltage peaks at the motor, which are higher than the motor voltage in line (DOL) operation. For an unsuitable motor, this can result in thermal motor overload and damage to the motor winding insulation. • Check whether the motor is suitable for converter operation.

Description

Operating an induction motor with a rated power = 25 % ... 125 % · of the rated converter power is permissible.

Operating a synchronous motor with a rated power = 50 % ... 125 % · of the rated converter power is permissible.

If the rated current of the synchronous motor is higher than the base-load value (Low Overload) of the converter output current, then special requirements apply to the converter settings:

- The following parameters of the saturation measurement should be reduced corresponding to the ratio between the converter current and motor current:
  Saturation measurement measuring range direct axis positive, p2941
  Saturation measurement measuring range direct axis negative, p2942
  Saturation measurement measuring range quadrature axis, p2943
- If the converter cannot provide sufficient current to saturate the motor for pole position identification, the remedy is to switch over the pole position identification from "saturation-based" (p1980 = 1) to "DC current-based" (p1980 = 10 and p1909.11 = 1).
  This remedy is especially relevant for some third-party permanent-magnet synchronous motors and synchronous servomotors.

The converter supports the operation of the following motors:

Number	Name
0:	No motor
1:	Induction motor
2:	Synchronous motor
6:	Reluctance motor
8:	Synchronous or reluctance motor with starting cage

1000:	1LE1 induction motor
1001:	1PC1 induction motor
1002:	1LE0 induction motor
1005:	1LE5 induction motor
1020:	1PH3 induction motor
1022:	1PH8 induction motor
1040:	2KJ3 induction motor
2020:	1PH8 synchronous motor
2023:	1FG1 synchronous geared motor
2024:	1FK7 synchronous motor
2030:	1FT2 synchronous motor
2040:	1FW3 synchronous motor
2050:	1FW4 synchronous motor
2100:	1FZ1 synchronous motor
2101:	1FZ3 synchronous motor
2102:	1FZ4 synchronous motor
2103:	1FZ5 synchronous motor
2104:	1FZ8 synchronous motor
6000:	1FP1 synchronous reluctance motor
6001:	1FP3 synchronous reluctance motor OEM
6002:	1PH8 synchronous reluctance motor
6010:	2KJ3 synchronous reluctance motor
10000:	Motor with DRIVE-CLiQ
10001:	Motor with DRIVE-CLiQ 2nd data set

13.12.2 Multi-motor operation

Description

Multi-motor operation involves simultaneously operating several identical motors at the power output of one converter.

Multi-motor operation is generally permissible for standard induction motors.

More information

Additional preconditions and restrictions relating to multi-motor operation are available on the Internet:

Multi-motor operation (https://support.industry.siemens.com/cs/ww/en/view/109827721)

13.12.3 Components on the motor side, cable resistance

Overview

The following components between the converter and the motor influence drive control:

- dv/dt filter with Voltage Peak Limiter
- Motor reactor
- Sine-wave filter
- Motor connection cable with unusually high cable resistance

Description

In the factory setting, for the motor data identification, the converter assumes that no components are connected between the converter and motor.

Depending on the component, the converter limits the output frequency, e.g. after assigning a motor reactor, the output frequency is limited to 150 Hz.

Correct parameter setting of the components between the converter and the motor improves the closed-loop control quality of the motor.

If, when commissioning, a Siemens component is configured on the motor side, then the converter sets the associated parameter to values appropriate for this particular component.

Motor data identification is necessary after changing a parameter.

Before the stationary measurement of the motor data identification, we recommend that a different cable resistance is entered in parameter p0352.

The stationary measurement of the motor data identification measures the total resistance as sum of the stator resistance and cable resistance. The result of the stationary measurement depends on the following specifications:

- For Siemens motors the converter knows stator resistance p0350:
  Cable resistance p0352 = total resistance - stator resistance p0350.
- For third-party motors the converter does not know stator resistance p0350:
  - The cable resistance is entered in p0352:
    Stator resistance p0350 = total resistance - cable resistance p0352.
  - The cable resistance is not entered in p0352 (p0352 = 0):
    The converter sets the cable resistance to 20 % of the stator resistance of the cold motor.

Parameters

The following list contains the parameters of function "Motor-side components, line resistance".

Number	Name	Unit
p0230	Drive filter type motor side	-
p0233	Power unit motor reactor	mH
p0234	Power unit sine-wave filter capacitance	µF
p0235	Motor reactor in series number	-

p0352[0...n]	Cable resistance	ohm

13.12.4 Checking the motor connection cable and the motor

Overview

When the function is active, the drive checks the motor connecting cable and the motor for an interrupted cable, short-circuit and fault to ground.

Requirement

The following requirements apply for function "Checking the motor connection cable and the motor":

- It is not permissible that a sine-wave filter is configured.
- Function "Flying restart" must be deactivated as the test is only possible when the motor is stationary: p1200 = 0.

Function description

When the function is active, the drive impresses current pulses in the motor when the motor starts. Using the current pulses, the drive detects possible faults in the motor connection cable and in the motor.

The function slightly delays motor starting.

Parameter p1901 defines the scope of the test:

Parameters	Check	p1901.02 = 0 signal	p1901.02 = 1 signal
p1901.00 = 1 signal	Short-circuit between 2 motor cable phases	Single check after switching on the supply voltage, when the motor starts for the first time. If a fault does not occur, then the drive only repeats the check after the supply voltage has been switched on again.	Check each time the motor starts
p1901.01 = 1 signal	Short-circuit between a motor cable phase and the protective conductor		
p1901.03 = 1 signal	Interrupted motor cable phase		

Display parameter r1902 supplies the result of the test:

Parameters	
r1902.00 = 1 signal	Checking for a short-circuit between 2 motor cable phases has been completed.
r1902.01 = 1 signal	The drive has detected a short-circuit between 2 motor cable phases.
r1902.02 = 1 signal	Checking for a short-circuit between a motor cable phase and the protective conductor has been completed.
r1902.03 = 1 signal	The drive has detected a ground fault between 1 motor cable phase and the protective conductor.
r1902.04 ... r1902.07	For additional diagnostics

Parameters	
r1902.08 = 1 signal	Checking the interruption of the motor cable phases has been completed.
r1902.09 = 1 signal	The drive has detected an interruption in a motor cable phase.

More information

More information about the parameters is provided in the List Manual of the drive system.

Parameters

The following list contains the parameters of function "Checking the motor connection cable and the motor".

Number	Name	Unit
p1901.0...3	Test pulse evaluation configuration	-
r1902.0...9	Test pulse evaluation status	-

13.12.5 Operating mode "Other control mode", U/f control

13.12.5.1 V/f control

Overview

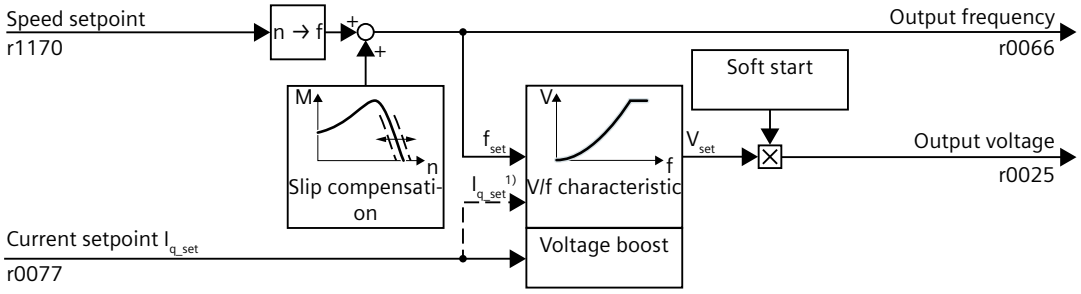
V/f control is open-loop speed control where the converter sets the output voltage using a V/f characteristic. The V/f control is sufficient for many simple applications.

Precondition

V/f control is only available in operating mode "Other control mode", V/f control:

- Select another control mode, p0504 = 0
- V/f control, p1300 < 20

Function description



1) In the "Flux current control (FCC)" variant of V/f control, the converter controls the motor current (starting current) at low speeds.

Figure 13-96 Simplified representation of V/f control

p1300 ≤ 20 activates V/f control.

The V/f control has the following properties:

- The converter sets the output voltage on the basis of a V/f characteristic.
- The output frequency results largely from the speed setpoint and the number of pole pairs of the motor.
- The slip compensation corrects the output frequency depending on the load and thus increases the speed accuracy.
- Because the control loop is eliminated, the V/f control is stable in all cases.
- In applications with higher speed accuracy requirements, a load-dependent voltage boost can be selected (flux current control, FCC)

With increasing speed or output frequency, the converter increases its output voltage U. The maximum possible output voltage of the converter depends on the line voltage.

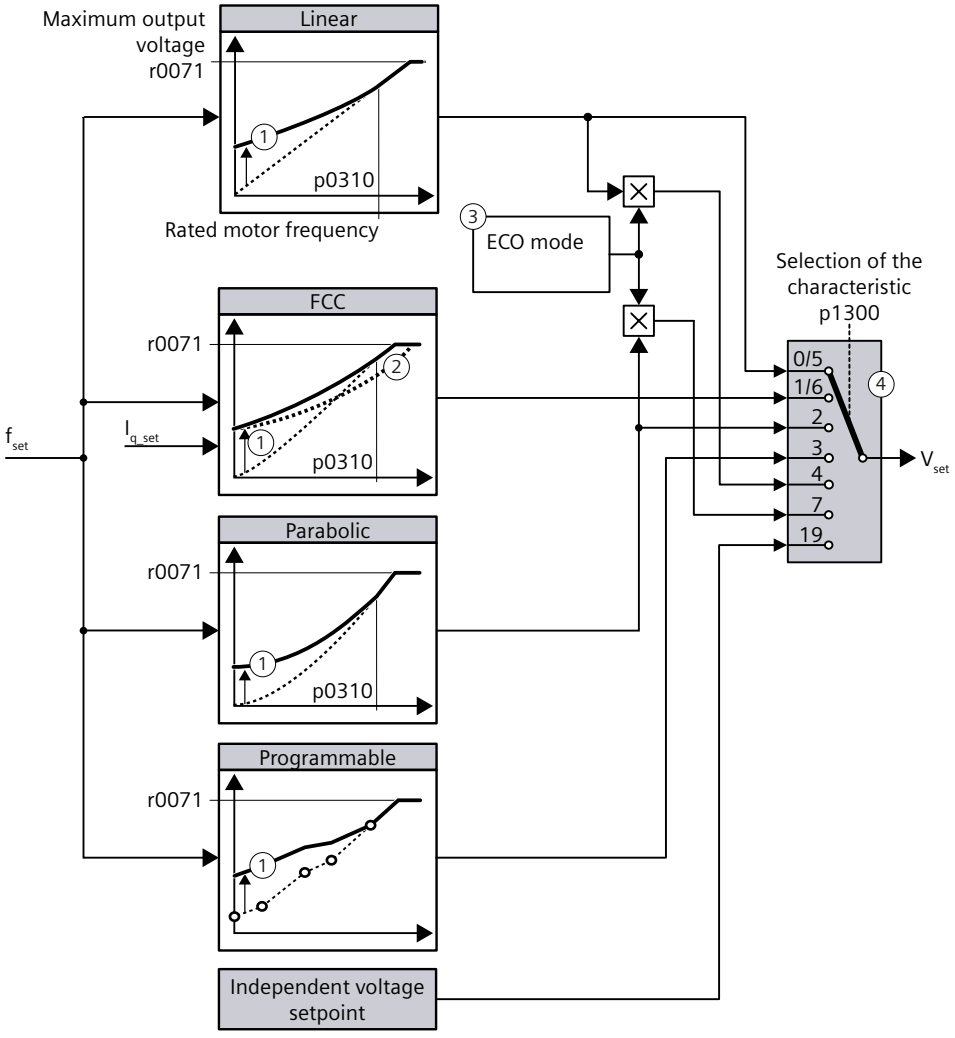
The converter can increase the output frequency even at the maximum output voltage. The motor is then operated with field weakening.

The value of the output voltage at the rated motor frequency p0310 depends, among other things, on the following variables:

- Ratio of the rated powers of the converter and motor
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible output voltage as a function of the input voltage is provided in the technical data.

The converter has different V/f characteristics.



① The voltage boost of the characteristics improves speed accuracy at low speeds

② When the flux current control (FCC) is used, the converter compensates for the voltage drop in the stator resistance of the motor

③ In the ECO mode, the converter optimizes the motor efficiency in steady-state operation. The optimization is only effective when the ramp-function generator is not bypassed.

④ For settings 5 and 6, the converter keeps the output frequency constant:

- Slip compensation is inhibited
- When reaching the current limit, the I_max controller only reduces the motor voltage but not the output frequency.

Figure 13-97 Characteristics of V/f control

Parameters

The following list contains the parameters of the "U/f control" function.

Number	Name	Unit
r0025	Output voltage smoothed	Vrms
r0066	Output frequency	Hz

r0071	Maximum output voltage	Vrms
p0304[0...n]	Rated motor voltage	Vrms
p0310[0...n]	Rated motor frequency	Hz
p0501[0...n]	Technological application (Standard Drive Control)	-
p1300[0...n]	Open-loop/closed-loop control mode	-
p1320[0...n]	U/f control programmable characteristic frequency 1	Hz
p1321[0...n]	U/f control programmable characteristic voltage 1	Vrms
p1322[0...n]	U/f control programmable characteristic frequency 2	Hz
p1323[0...n]	U/f control programmable characteristic voltage 2	Vrms
p1324[0...n]	U/f control programmable characteristic frequency 3	Hz
p1325[0...n]	U/f control programmable characteristic voltage 3	Vrms
p1326[0...n]	U/f control programmable characteristic frequency 4	Hz
p1327[0...n]	U/f control programmable characteristic voltage 4	Vrms
c1330[0...n]	U/f control independent voltage setpoint	Vrms
p1331[0...n]	Voltage limiting	Vrms
p1333[0...n]	U/f control FCC starting frequency	Hz
p1334[0...n]	U/f control slip compensation starting frequency	Hz
p1335[0...n]	Slip compensation scaling	%
p1338[0...n]	U/f mode resonance damping gain	-

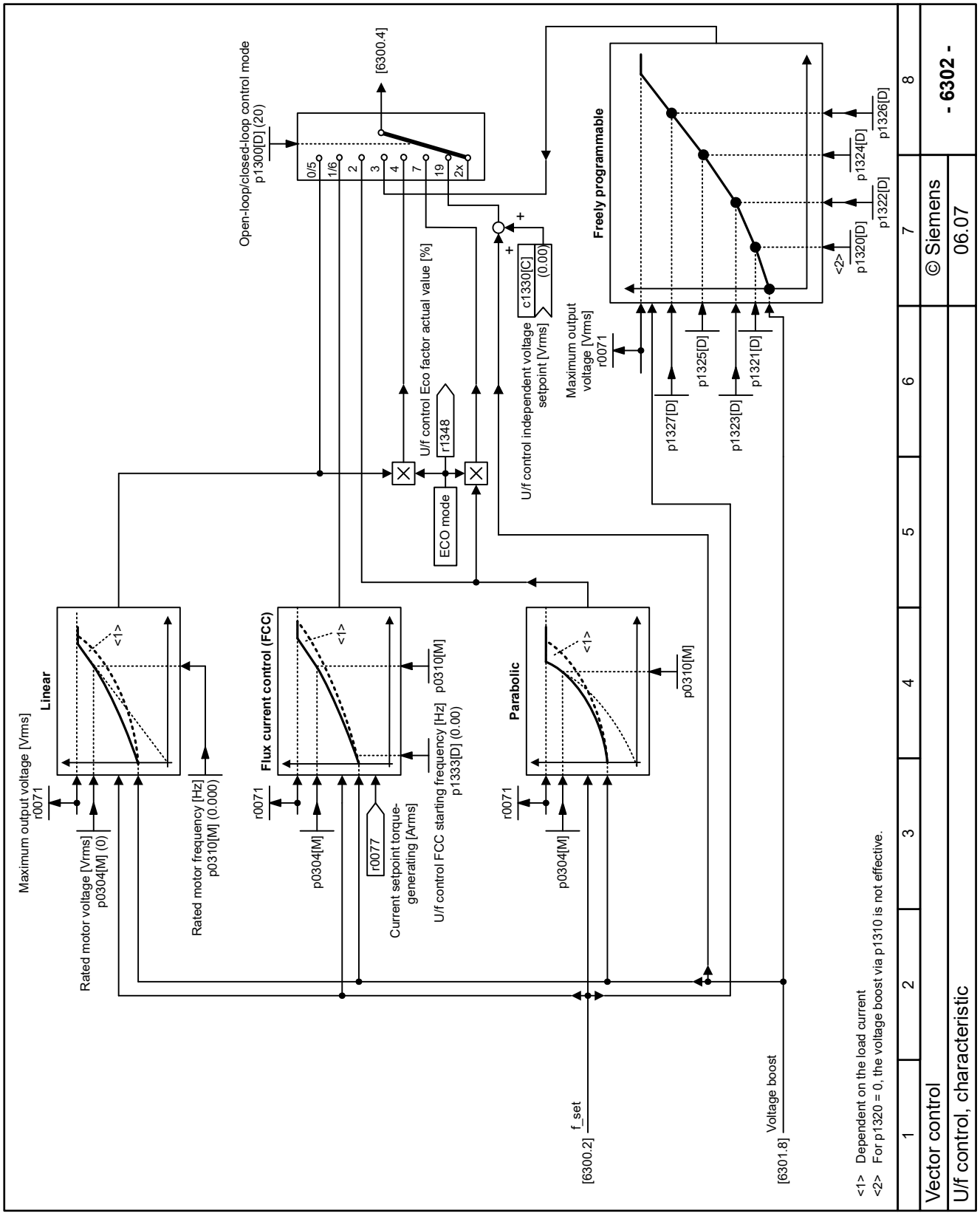


Figure 13-98 6302 - U/f characteristic

13.12.5.2 Voltage boost

Overview

The "voltage boost" function compensates for ohmic losses in the motor and the motor connection cable. This causes the motor to develop additional torque when starting or accelerating.

Function description

The V/f characteristic without voltage boost supplies an output voltage of 0 V at an output frequency of 0 Hz. The motor does not generate any torque at 0 V. A voltage boost is therefore required to start the motor.

There are three elements to the voltage boost:

- Permanent voltage boost corresponding to starting current p1310
- Voltage boost during acceleration only corresponding to starting current p1311
- Voltage boost only during initial starting corresponding to starting current p1312

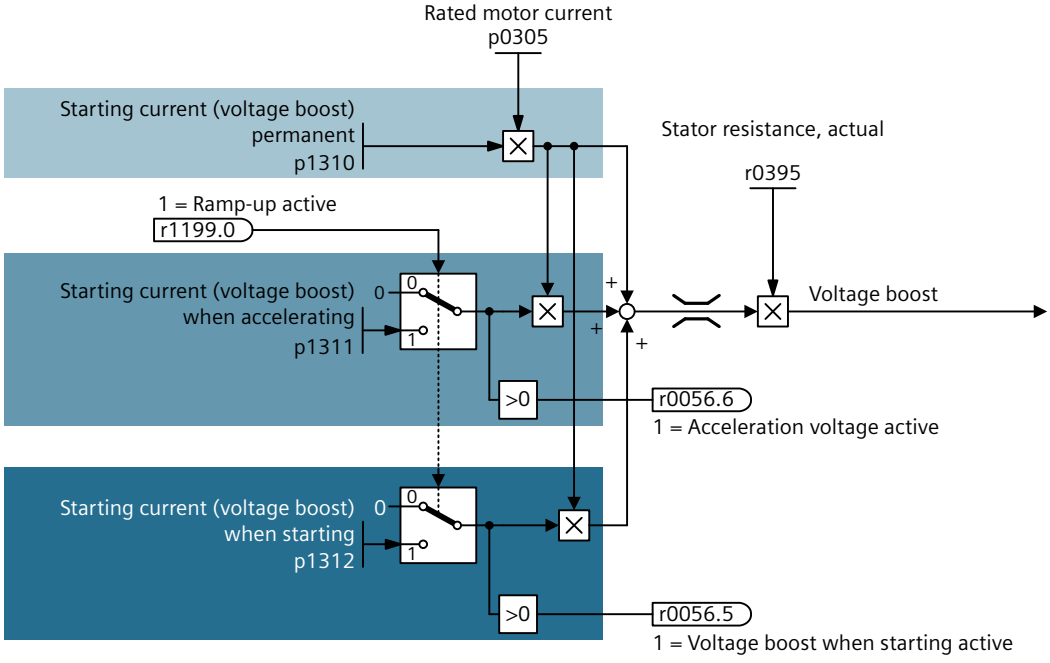


Figure 13-99 Simplified function diagram of the voltage boost

The resulting voltage boost combines the three elements for the V/f characteristic as shown in the following example.

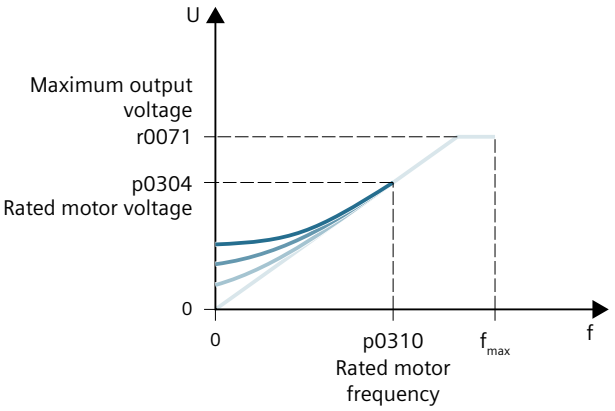


Figure 13-100 Resulting voltage boost example for a linear V/f characteristic

Parameters

The following list contains the parameters of function "Voltage boost".

Number	Name	Unit
r0071	Maximum output voltage	Vrms
p0310[0...n]	Rated motor frequency	Hz
p1310[0...n]	Starting current (voltage boost) permanent	%
p1311[0...n]	Starting current (voltage boost) when accelerating	%
p1312[0...n]	Starting current (voltage boost) when starting	%

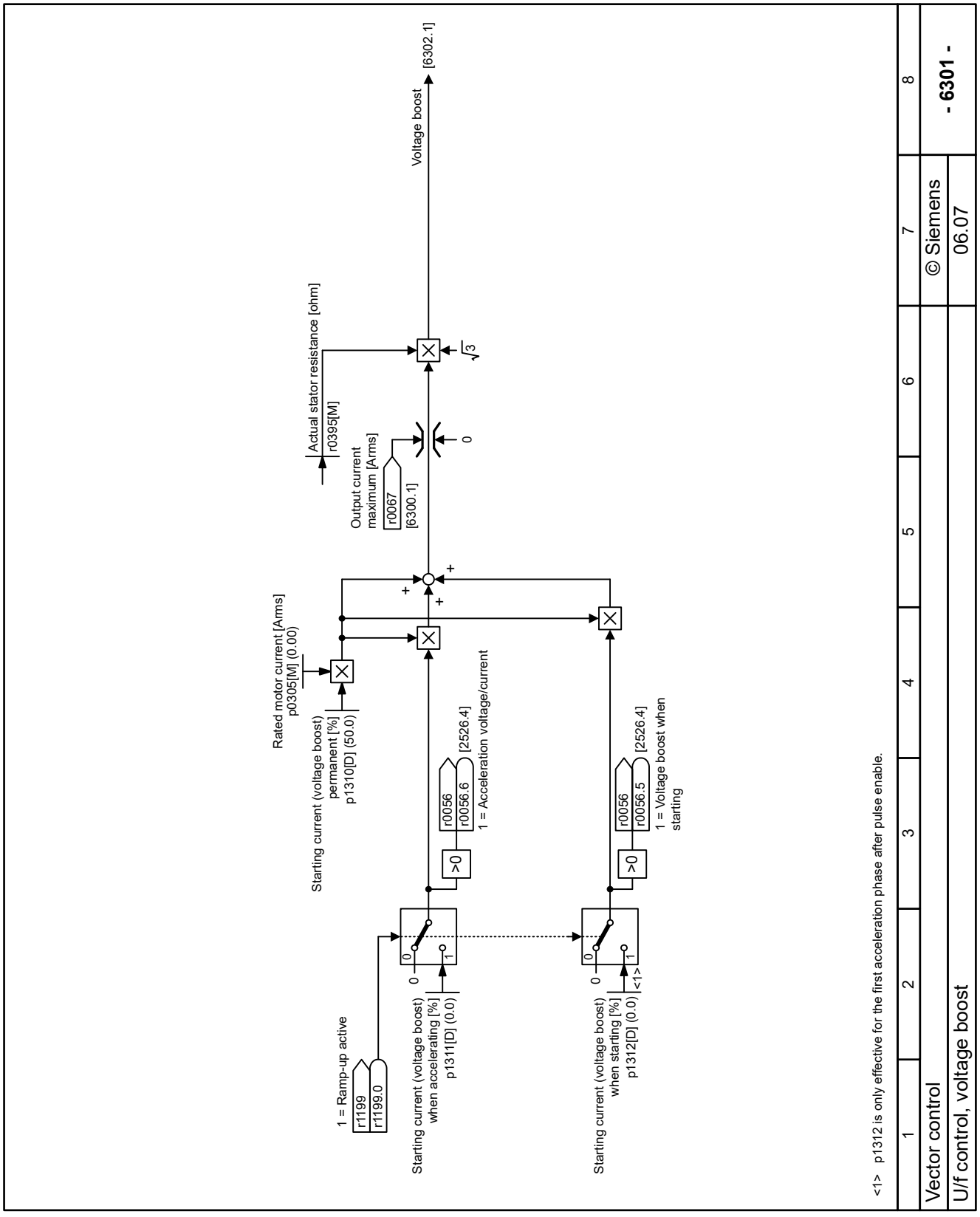


Figure 13-101 6301 - Voltage boost

13.12.5.3 Vdc_min controller (kinetic buffering)

Overview

The Vdc_min controller (kinetic buffering) increases the drive availability because the kinetic energy of the load accommodates brief power dips or failures.

Requirement

The driven load has a sufficiently high inertia.

The application allows braking of the motor during a power failure.

Function description

The DC link voltage in the converter decreases when the line supply dips or fails. The Vdc_min controller intervenes starting from an adjustable threshold. With kinetic buffering active, the converter covers its power loss and the losses in the motor with the kinetic energy of the load. The speed of the load decreases but the DC link voltage remains constant with the Vdc_min controller active. After the line supply returns, the converter resumes normal operation.

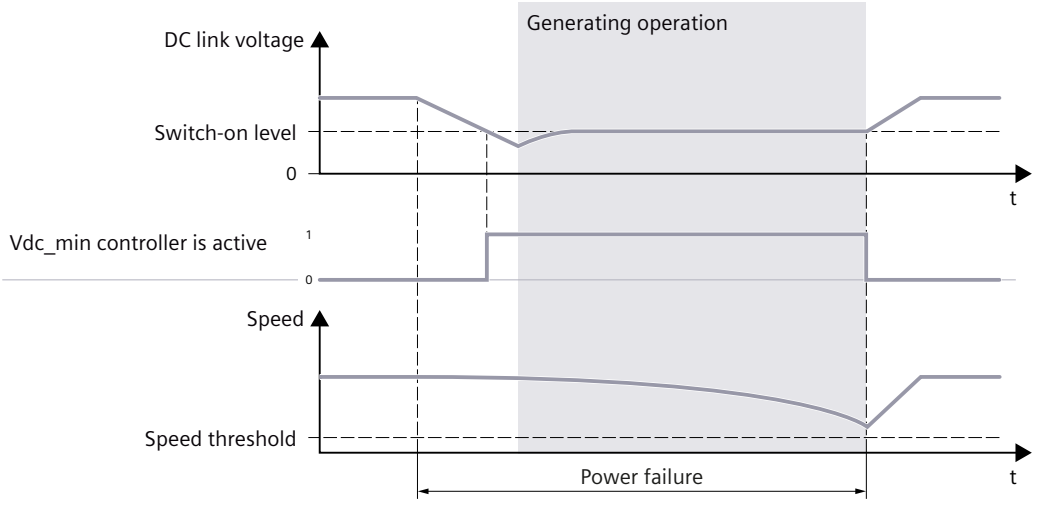


Figure 13-102 Principal mode of operation of the Vdc_min controller

Parameters

The following list contains the parameters of the "Vdc_min controller" function for U/f control.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
p0210	Device supply voltage	V
p1280[0...n]	Vdc controller or Vdc monitoring configuration (U/f)	-
p1281[0...n].0...2	Vdc controller configuration	-
p1285[0...n]	Vdc_min controller switch-in level (kinetic buffering) (U/f)	%
r1286	Vdc_min controller switch-in level (kinetic buffering) (U/f)	V

p1287[0...n]	Vdc_min controller dynamic factor (kinetic buffering) (U/f)	%
p1295[0...n]	Vdc_min controller time threshold (U/f)	s
p1296[0...n]	Vdc_min controller response (kinetic buffering) (U/f)	-
p1297[0...n]	Vdc_min controller speed threshold (U/f)	rpm
r1298	Vdc controller output (U/f)	rpm
p1390[0...n]	Vdc_min controller proportional gain (U/f)	-
p1391[0...n]	Vdc_min controller integral time (U/f)	ms
p1392[0...n]	Vdc_min controller rate time (U/f)	ms

13.12.5.4 Vdc_max controller (voltage limitation)

Overview

The Vdc_max control limits the DC link voltage in the converter and prevents unwanted switching off of the motor.

Precondition

The Vdc_max control is suitable for applications with short-time generator operation of the motor, e.g. pumps or fans.

The Vdc_max control is not suitable for applications where the motor is in continuous regenerative operation, e.g. as is the case for hoisting gear and centrifuges.

Function description

If the converter cannot transfer the electrical energy delivered by the motor during braking, e.g. to a braking resistor, the converter stores the energy in its DC link capacitors. This causes the DC link voltage Vdc in the converter to increase.

An excessively high DC link voltage damages the converter as well as the motor.

The Vdc_max control extends the ramp-down time of the motor when braking. Consequently, the motor feeds only so much energy back into the converter to cover the losses in the converter. The DC link voltage remains in the permissible range.

The following figure illustrates the motor and converter protection in the case of overvoltage.

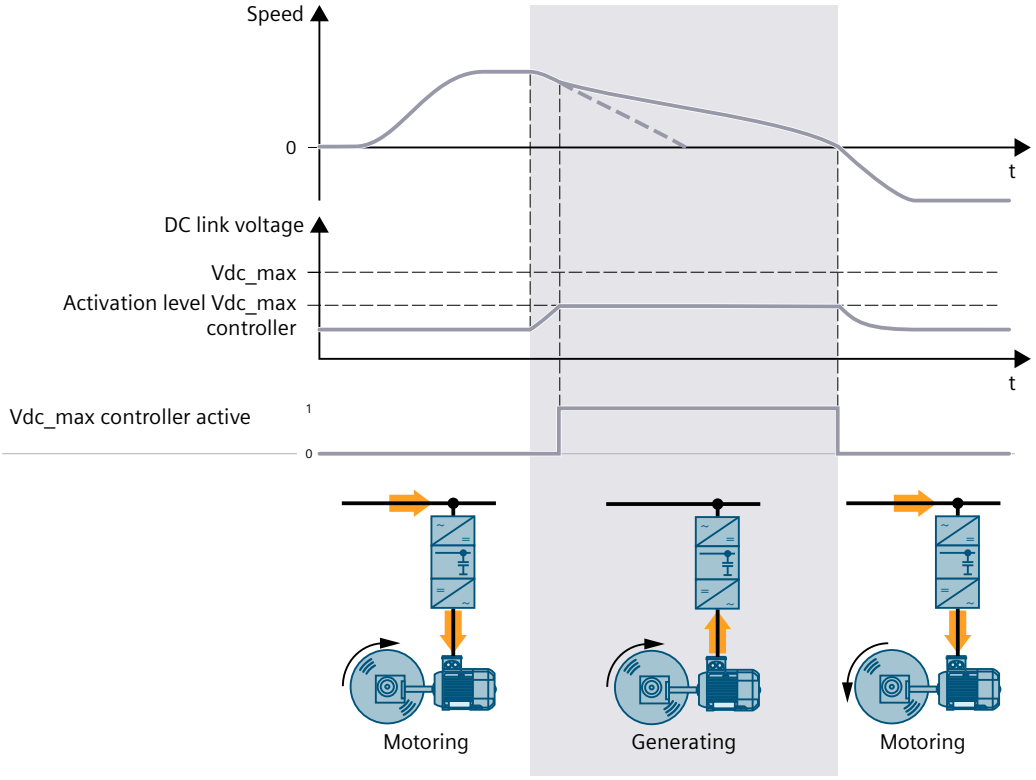


Figure 13-103 Simplified representation of the Vdc_max control

Parameters

The following list contains the parameters of the "Vdc_max controller" function for U/f control.

Number	Name	Unit
p0210	Device supply voltage	V
p1280[0...n]	Vdc controller or Vdc monitoring configuration (U/f)	-
p1281[0...n].0...2	Vdc controller configuration	-
r1282	Vdc_max controller switch-in level (U/f)	V
p1283[0...n]	Vdc_max controller dynamic factor (U/f)	%
p1284[0...n]	Vdc_max controller time threshold (U/f)	s
p1290[0...n]	Vdc_max controller proportional gain (U/f)	-
p1291[0...n]	Vdc_max controller integral time (U/f)	ms
p1292[0...n]	Vdc_max controller rate time (U/f)	ms
p1294	Vdc_max controller automatic sensing of switch-on level (U/f)	-
r1298	Vdc controller output (U/f)	rpm

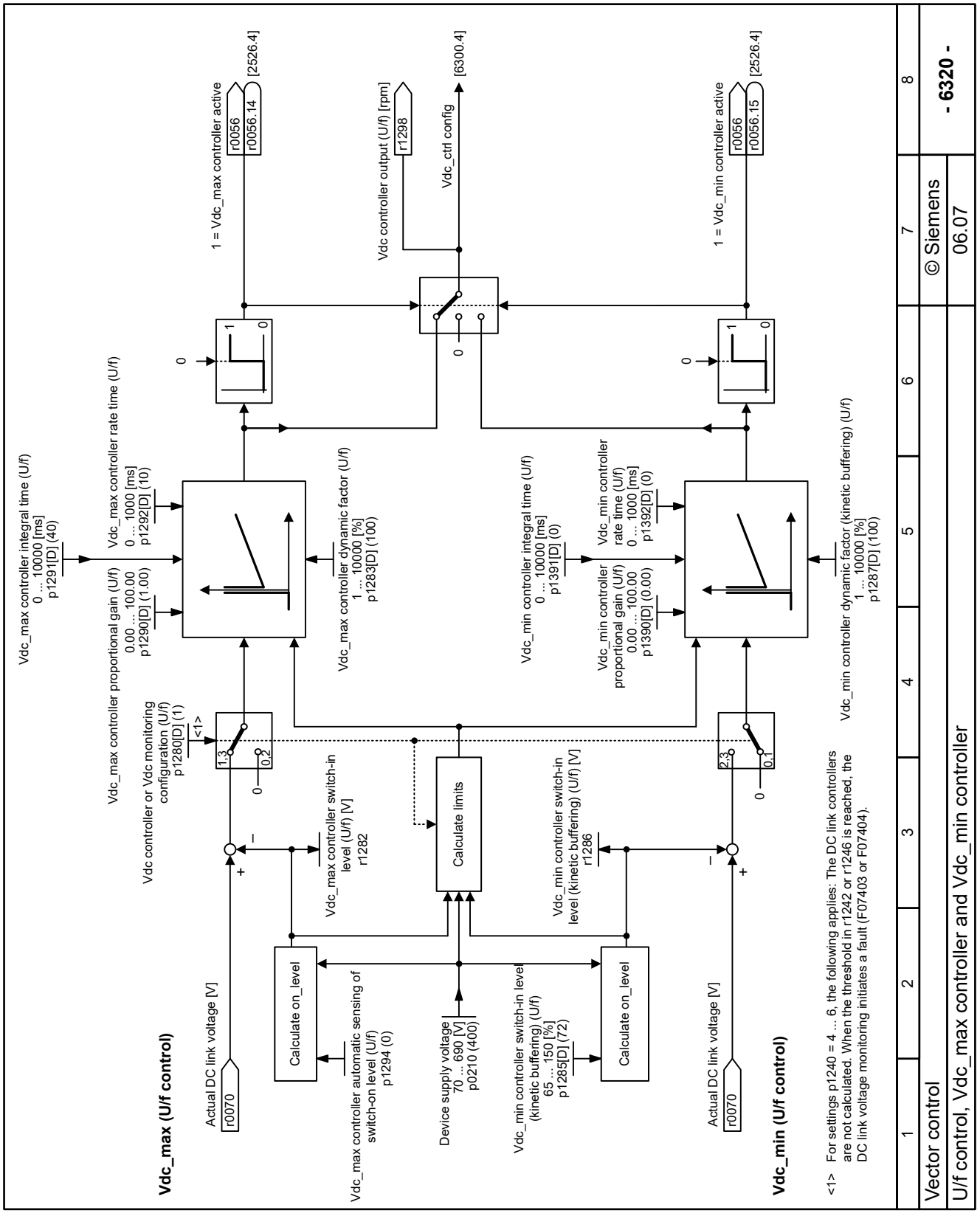


Figure 13-104 6320 - Vdc_max controller and Vdc_min controller (U/f)

13.12.5.5 Slip compensation

Overview

Slip compensation keeps the speed of an induction motor as constant as possible, regardless of the load on the motor.

Description of function

When the load torque M increases from M1 to M2, slip compensation increases the setpoint frequency. As a result, the motor speed remains largely constant.

When the load torque M returns to M1, slip compensation reduces the setpoint frequency accordingly.

Setting the parameter p1351 > 0 switches on slip compensation p1335 = 100%.

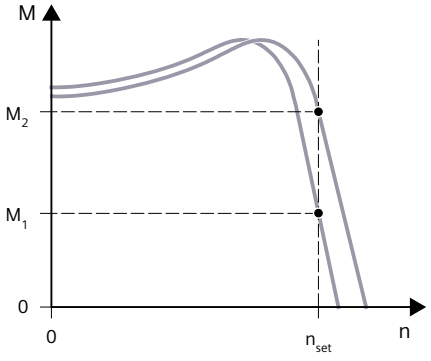


Figure 13-105 Slip compensation

Parameters

The following list contains the parameters of the "Slip compensation" function.

Number	Name	Unit
r0330[0...n]	Rated motor slip	Hz
p1334[0...n]	U/f control slip compensation starting frequency	Hz
p1335[0...n]	Slip compensation scaling	%
p1336[0...n]	Slip compensation limit value	%
r1337	Actual slip compensation	%
p1351[0...n]	Motor holding brake starting frequency	%

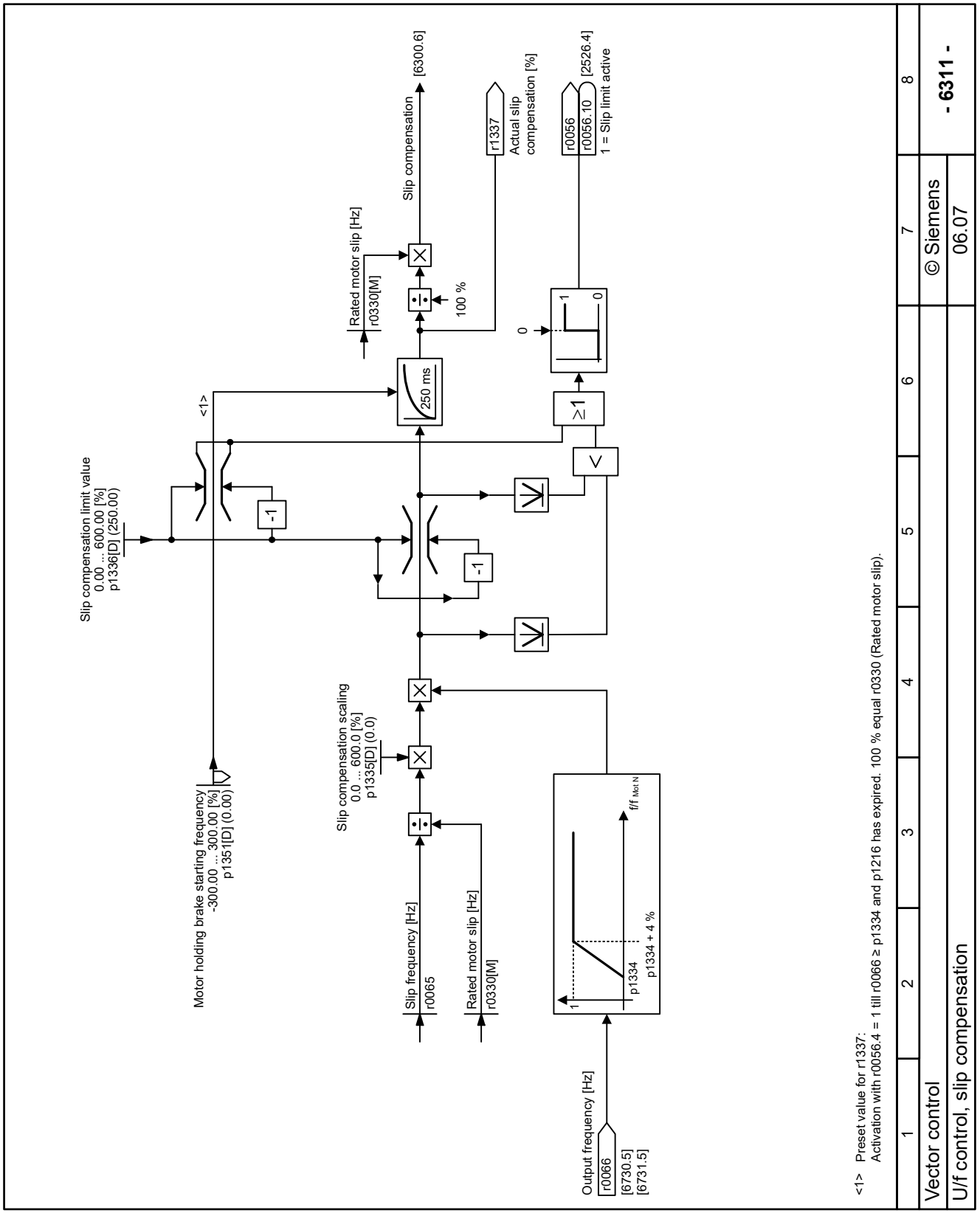


Figure 13-106 6311 - Slip compensation (U/f)

13.12.5.6 Resonance damping

Overview

Resonance damping reduces speed oscillations for a motor without load or for sudden load changes.

Function description

For p1349 > 0, resonance damping is active between 6 % and 90 % of the motor rated frequency f_{MotN}

With p1349 = 0, resonance damping is active for the following output frequencies:

- 95 % of the motor rated frequency f_{MotN}
- Maximum 45 Hz

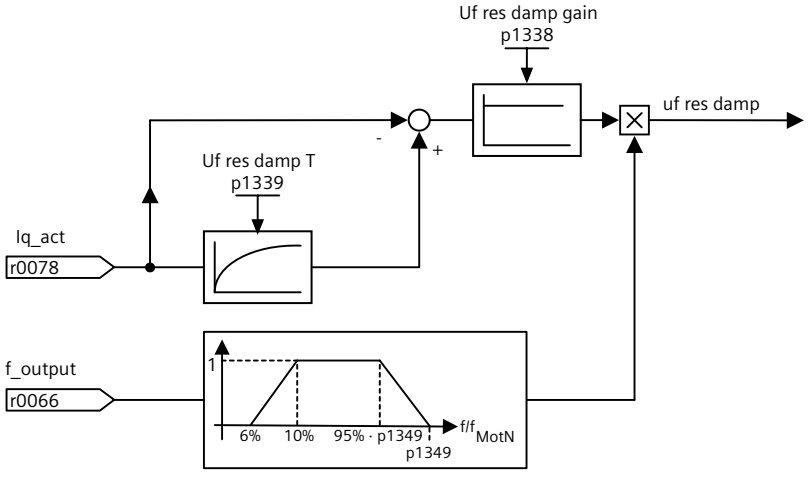


Figure 13-107 Resonance damping

Parameters

The following list contains the parameters of the "Resonance damping" function.

Number	Name	Unit
r0066	Output frequency	Hz
r0078[0...1]	Current actual value torque-generating	Arms
p0310[0...n]	Rated motor frequency	Hz
p1338[0...n]	U/f mode resonance damping gain	-
p1339[0...n]	U/f mode resonance damping filter time constant	ms
p1349[0...n]	U/f mode resonance damping maximum frequency	Hz

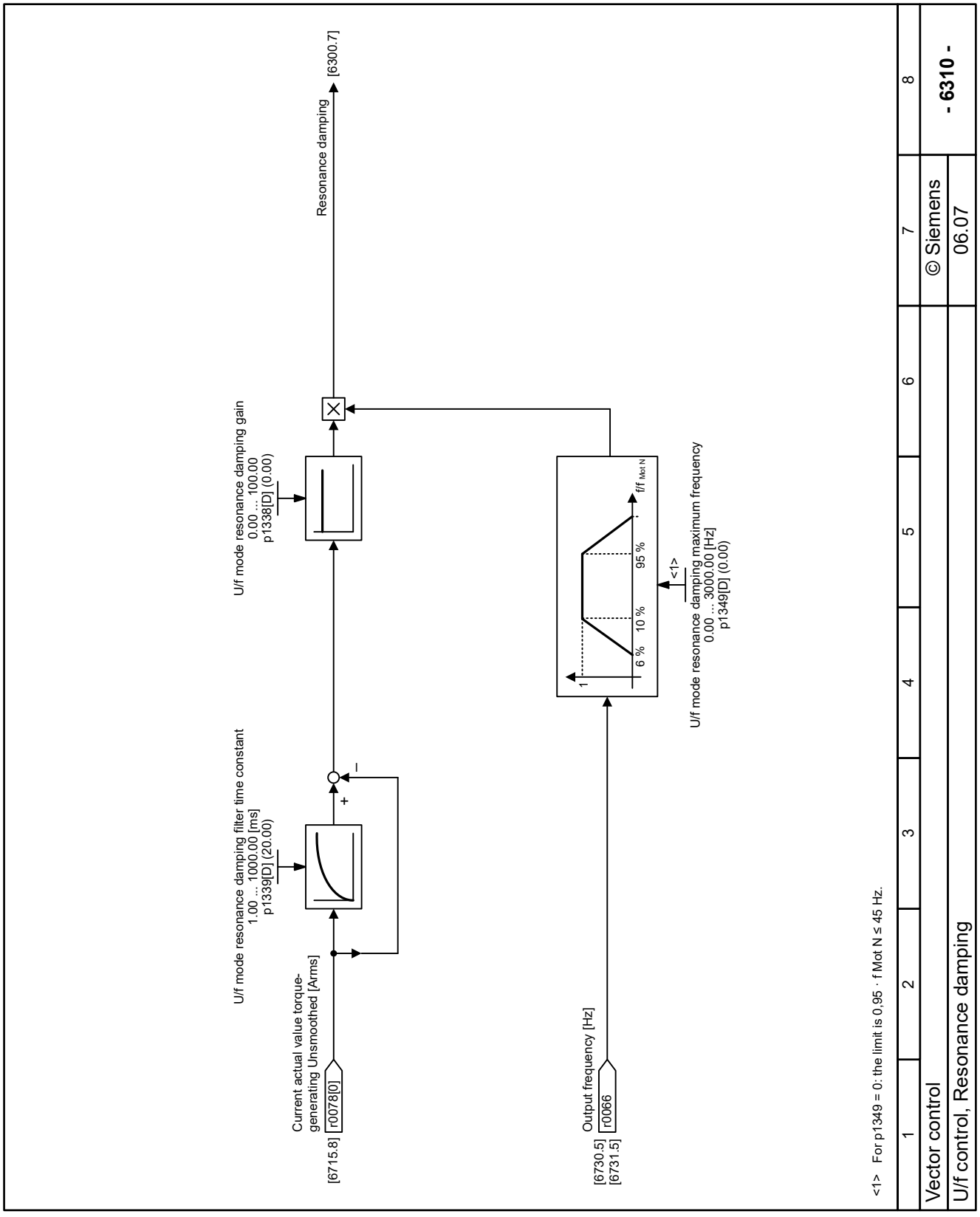


Figure 13-108 6310 - Resonance damping

13.12.5.7 Overcurrent protection

Overview

To limit the motor current, when reaching the current limit, the I_max controller reduces the output frequency and the motor voltage.

Requirement

The V/f control is active.

Description of function

When reaching the current limit, the I_max controller has the following effect on motor operation:

- When accelerating, the I_max controller extends the acceleration phase.
- When braking, the I_max controller extends the braking phase.
- Steady-state operation:
  - For characteristic “V/f control for a drive that requires precise frequency", the I_max controller reduces the motor voltage until the motor current returns to the permissible range.
  - For all other V/f characteristics, the I_max controller reduces the speed and the motor voltage until the motor current returns to the permissible range.

Parameters

The following list contains the parameters of the "Overcurrent protection" function.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
p0305[0...n]	Rated motor current	Arms
p0640[0...n]	Motor current limit	Arms
p1340[0...n]	I_max frequency controller proportional gain	-
p1341[0...n]	I_max frequency controller integral time	s
r1343	I_max controller frequency output	rpm

13.12.6 Operating mode "Standard Drive Control"

13.12.6.1 Standard Drive Control

Overview

Standard Drive Control is open-loop speed control, and is more robust and has a higher speed accuracy than V/f control when starting the motor as well as when accelerating and braking the driven load.

Precondition

Standard Drive Control works only with an induction motor.

The motor data were correctly set when commissioning. The degree of ruggedness and speed accuracy can be additionally improved if short time measurement (p1909.15) is deselected for the motor data identification.

Function description

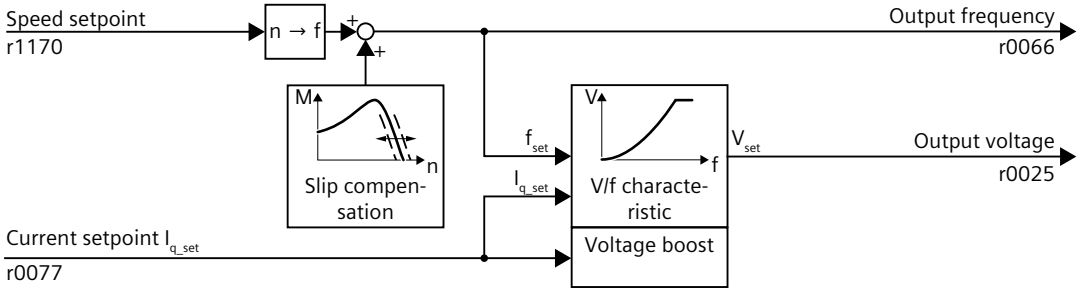
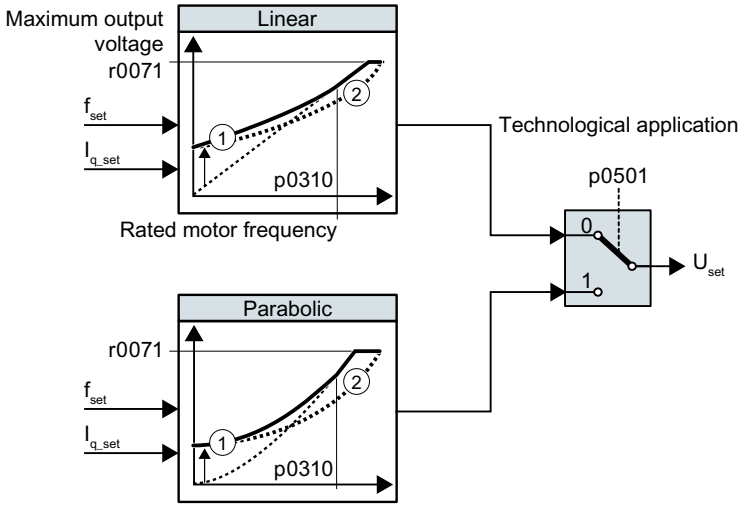


Figure 13-109 Default setting of the V/f control after selecting Standard Drive Control

The Standard Drive Control mode has the following properties:

- At low speeds, a controlled motor current reduces the tendency of the motor to oscillate.
- With increasing speed, the converter changes from controlled motor current to V/f control with load-dependent voltage boost.

- Selecting a technological application defines the characteristic:



① A voltage boost optimizes open-loop speed control at low speeds
② The converter compensates the voltage drop across the stator resistance of the motor

Figure 13-110 Characteristics after selecting Standard Drive Control

- Slip compensation is activated.
- Soft starting is possible.
- Fewer setting options compared to V/f control

Parameters

The following list contains the parameters of function "Standard Drive Control".

Number	Name	Unit
r0025	Output voltage smoothed	Vrms
r0066	Output frequency	Hz
r0071	Maximum output voltage	Vrms
p0304[0...n]	Rated motor voltage	Vrms
p0310[0...n]	Rated motor frequency	Hz
p0501[0...n]	Technological application (Standard Drive Control)	-
p1740[0...n]	Gain resonance damping for encoderless closed-loop control	-
p1793[0...n]	Slip compensation scaling (SDC)	%

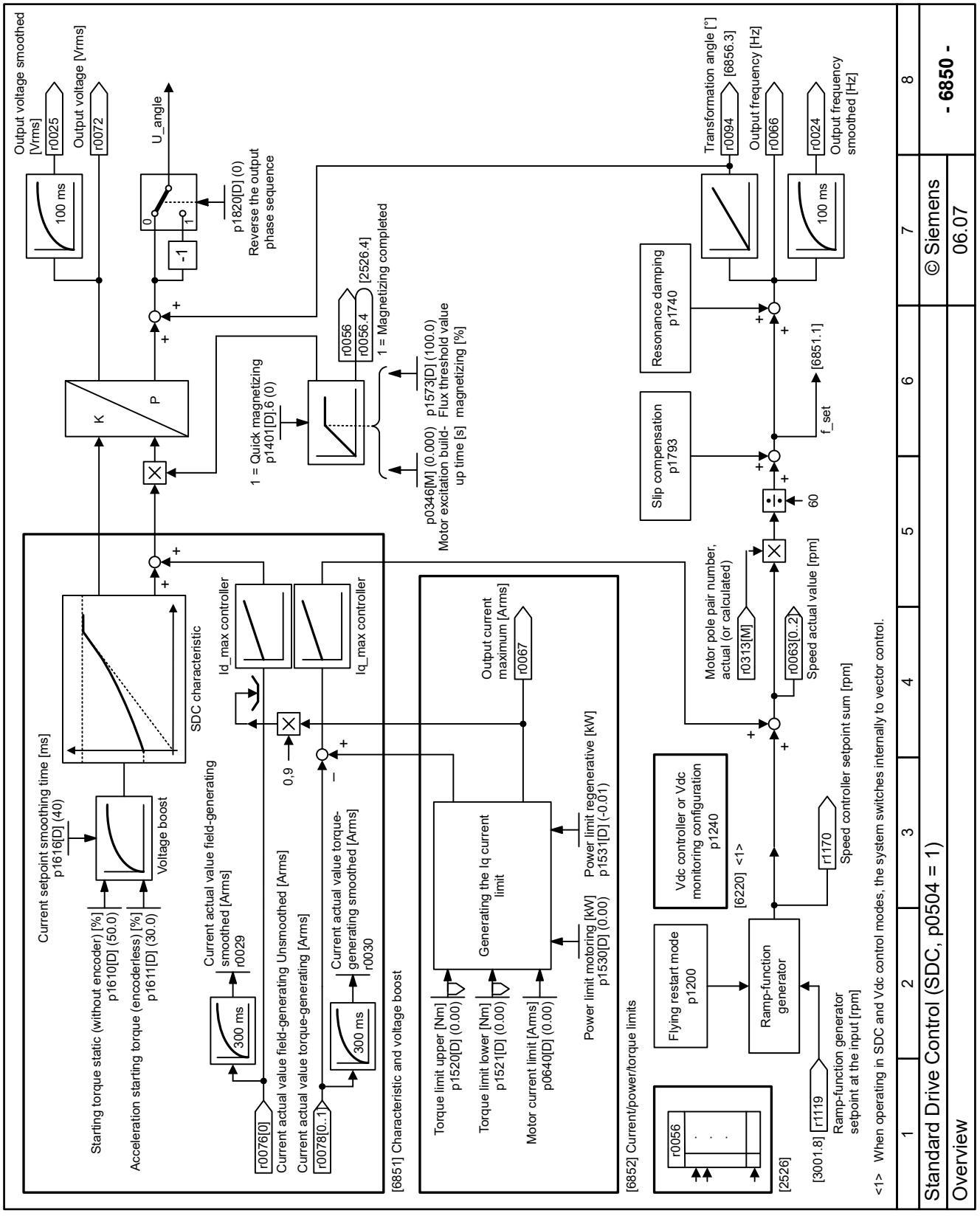


Figure 13-111 6850 - Overview

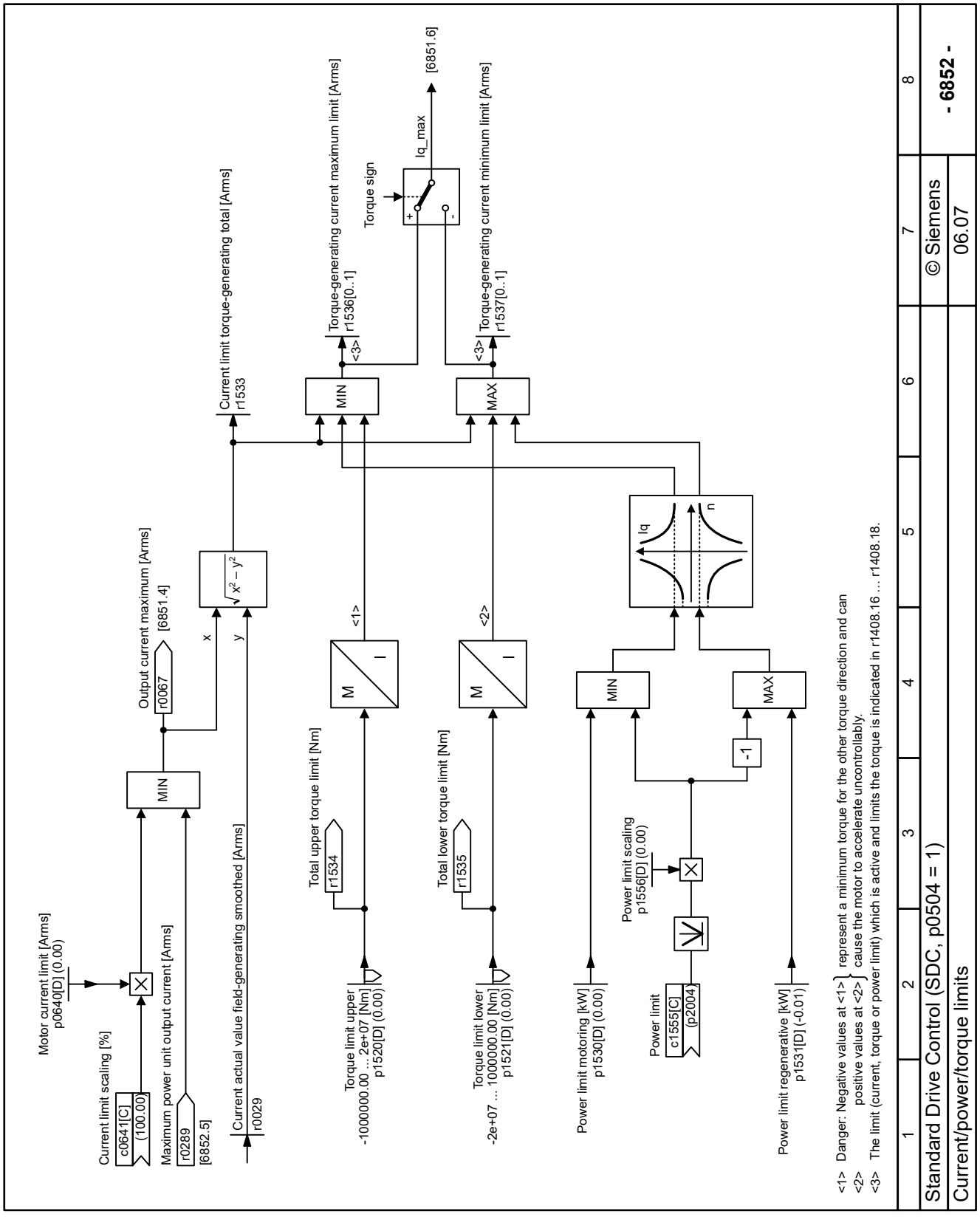


Figure 13-112 6852 - Current/power/torque limits

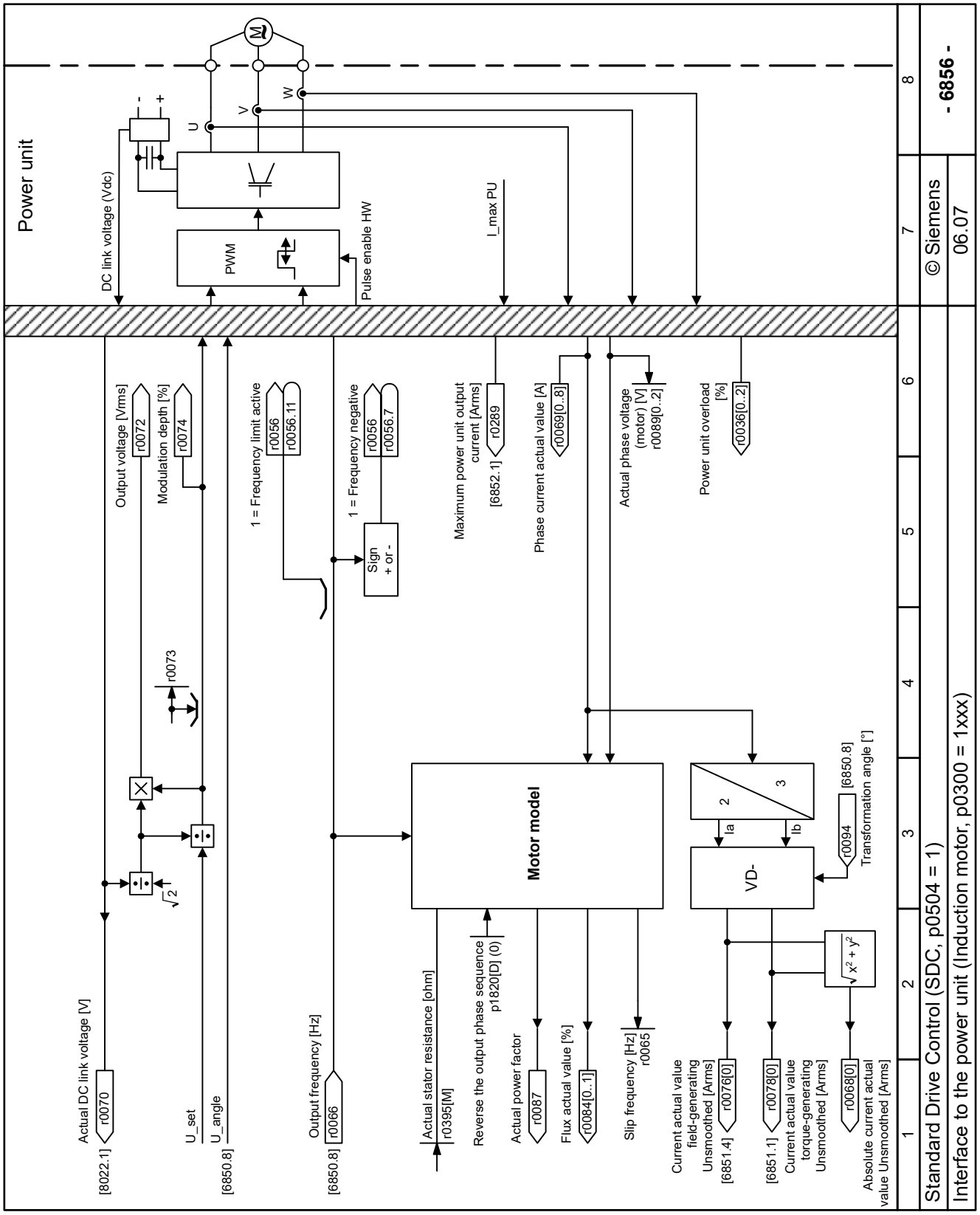


Figure 13-113 6856 - Interface to power unit (induction motor)

13.12.6.2 Setting of technological application in Standard Drive Control

Overview

The selected technology application optimizes the calculation of the open-loop and closed-loop control parameters in Standard Drive Control operating mode.

Description of function

The following settings are available to select for open-loop speed control with parameter p0501.

Table 13-99 Setting of technology application in Standard Drive Control

0	Constant load (linear characteristic)	• Setting for all applications without speed-dependent load characteristic • High load torque even at low speeds
1	Speed-dependent load (parabolic characteristic)	• Setting, e.g. for parabolic load characteristics for pumps, fans • Only small load torques at low speeds • Full load is reached at the rated operating point • If high load surges in the range of low and medium speeds cannot be ruled out, then we recommend setting p0501 = 0.

13.12.6.3 Voltage boost

Overview

The "voltage boost" function compensates for ohmic losses in the motor and the motor connection cable. This causes the motor to develop additional torque when starting or accelerating.

Description of function

The converter calculates a current setpoint from the specified starting torque and then calculates the voltage boost from the current setpoint.

There are two components to the specified starting torque:

- Starting torque static p1610
  - At p1610 = 0 %, the motor starts with the current for an unloaded motor.
  - At p1610 = 100 %, the motor starts with a current corresponding to the rated torque.
- Acceleration starting torque p1611
  During acceleration and deceleration, the converter adds p1611 and p1610.

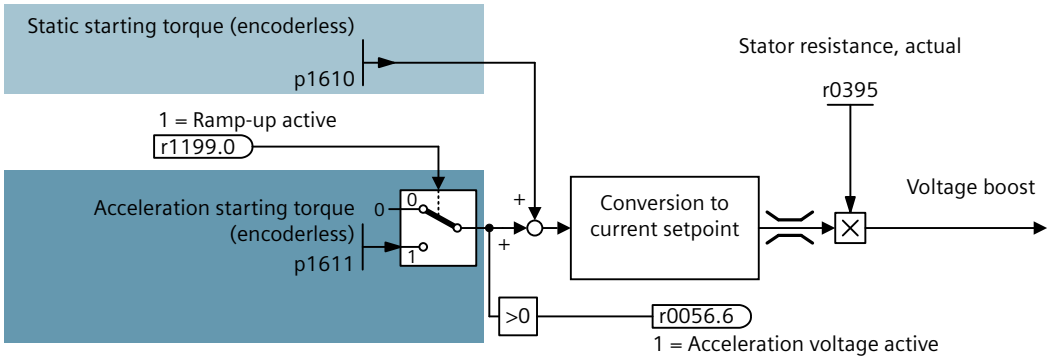


Figure 13-114 Simplified function diagram of the voltage boost

The following example shows the voltage boost for the V/f characteristic.

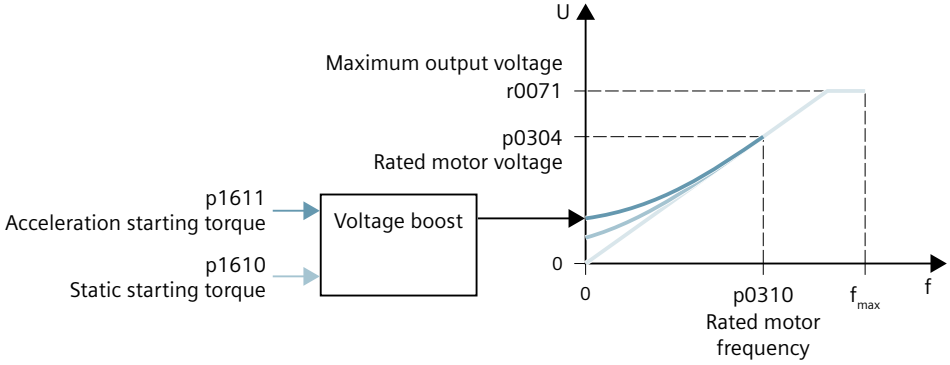


Figure 13-115 Voltage boost example for a linear V/f characteristic

Parameters

The following list contains the parameters of function "Voltage boost".

Number	Name	Unit
r0071	Maximum output voltage	Vrms
p0310[0...n]	Rated motor frequency	Hz
p0320[0...n]	Motor rated magnetizing current/short-circuit current	Arms
p0640[0...n]	Motor current limit	Arms
p1401[0...n].0...30	Flux control configuration	-
p1530[0...n]	Power limit motoring	kW
p1531[0...n]	Power limit regenerative	kW
p1610[0...n]	Starting torque static (without encoder)	%
p1611[0...n]	Acceleration starting torque (encoderless)	%
p1616[0...n]	Current setpoint smoothing time	ms
r1751.0...22	Motor model status	-

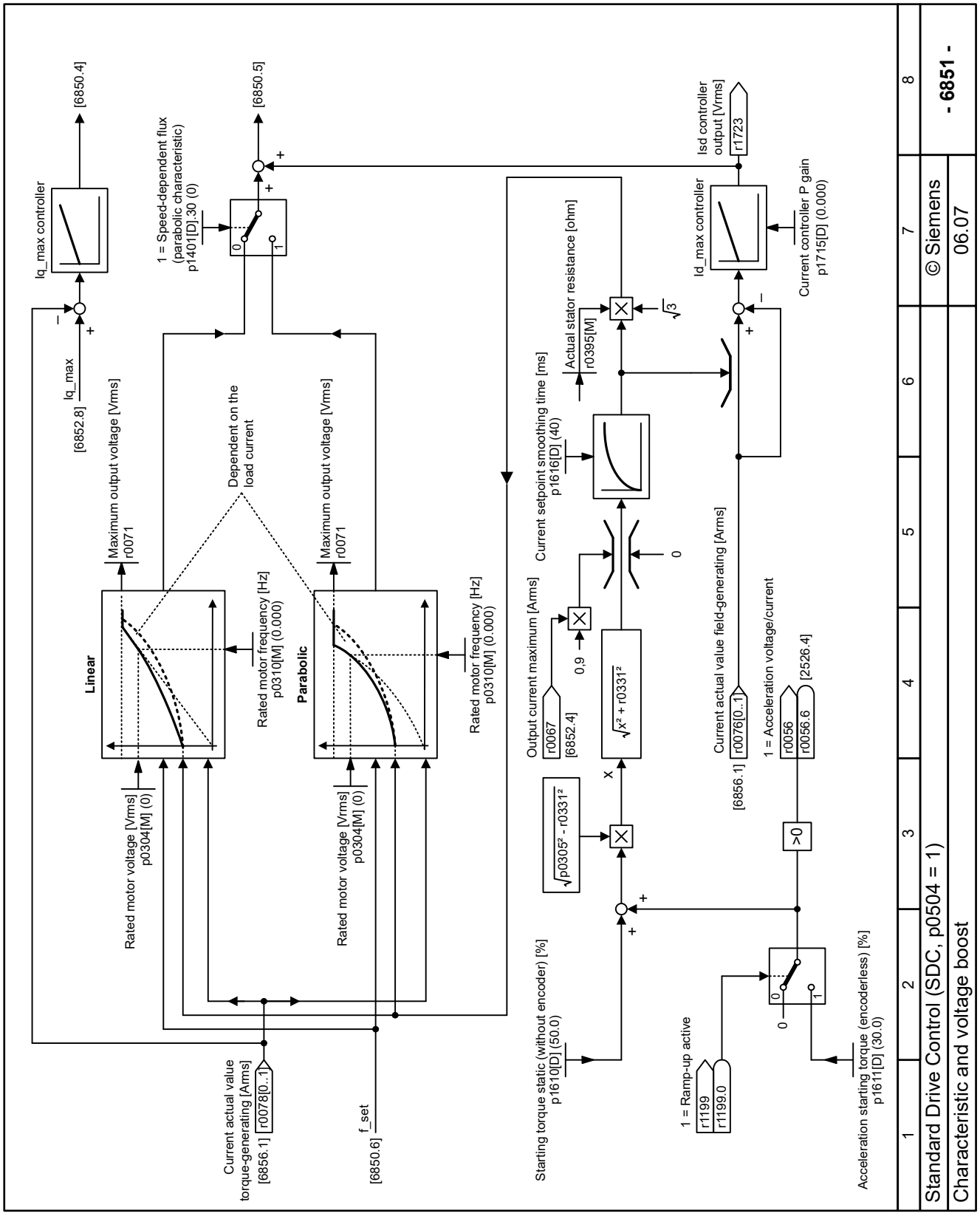


Figure 13-116 6851 - Characteristic and voltage boost

13.12.6.4 Settings with dv/dt filter plus VPL

Overview

A du/dt filter plus VPL at the converter's power output affects the drive control.

With suitable parameterization, the converter compensates the influence of the du/dt filter on the drive control.

Requirement

Requirement for applications with du/dt filter plus VPL:

- The du/dt filter plus VPL is activated with p0230 = 2.
- With the correct motor data, the motor data identification and optimization of the drive control have been completed.
- Motor data identification is completed with setting p1909.15 = 1 signal.

Procedure

We recommend the following settings if the motor stalls or has difficulty starting:

- Decrease p1610 and p1611 incrementally by 10%.

13.12.7 Operating mode "Other control mode", closed-loop speed control

13.12.7.1 Basic properties of closed-loop speed control

Overview

The closed-loop speed control comprises a speed controller and a subordinate closed-loop control for torque and flux.

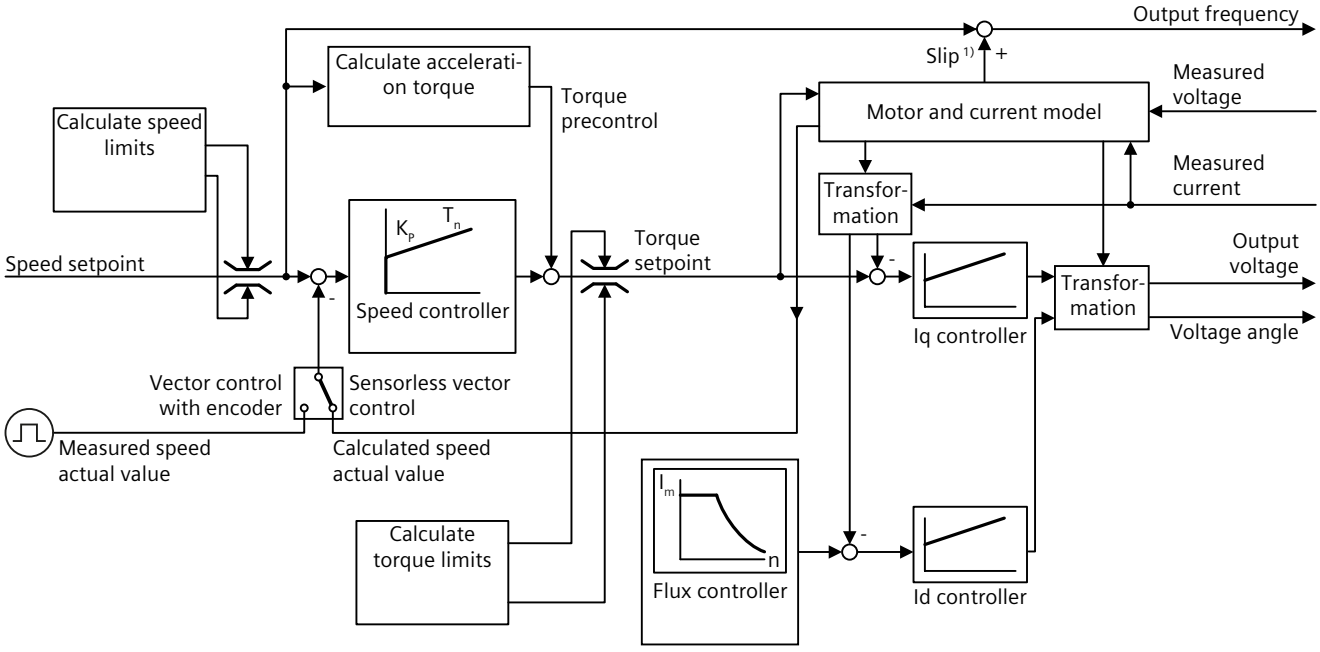
Precondition

The Dynamic Drive Control operating mode functions with the following motors:

- Induction motor
- Synchronous motor without starting cage
- Reluctance motor without starting cage

In the commissioning tool, the closed-loop speed control can be configured in operating mode "Other control mode", p0504 = 0

Function description



1) Only for induction motors

Figure 13-117 Simplified function diagram of the closed-loop speed control

Using the motor model and current model, the converter calculates the following closed-loop control signals from the measured phase currents and the output voltage:

- Flux-generating current component I_d
- Torque-generating current component I_q
- Speed actual value for encoderless speed control

The motor and current model is based on vector control. The vector control transforms voltage and current AC variables of an induction motor or synchronous motor into torque and flux DC variables. After the transformation, the vector control controls the torque and flux according to the specified setpoints.

The setpoint of the current component I_d (flux setpoint) is obtained from the motor data. For speeds above the rated speed, the converter reduces the flux setpoint along the field weakening characteristic.

For a higher speed setpoint, the speed controller responds with a higher setpoint of the current component I_q (torque setpoint). The speed controller responds to the higher torque setpoint depending on the motor type:

- For induction motors, the closed-loop control adds a higher slip frequency to the output frequency. The higher output frequency also results in a higher motor slip. The higher slip in the motor is proportional to the acceleration torque.
- For synchronous motors, the closed-loop control increases the rotor angle instead of the slip.

I_q and I_d controllers keep the motor flux constant using the output voltage, and adjust the matching current component I_q in the motor.

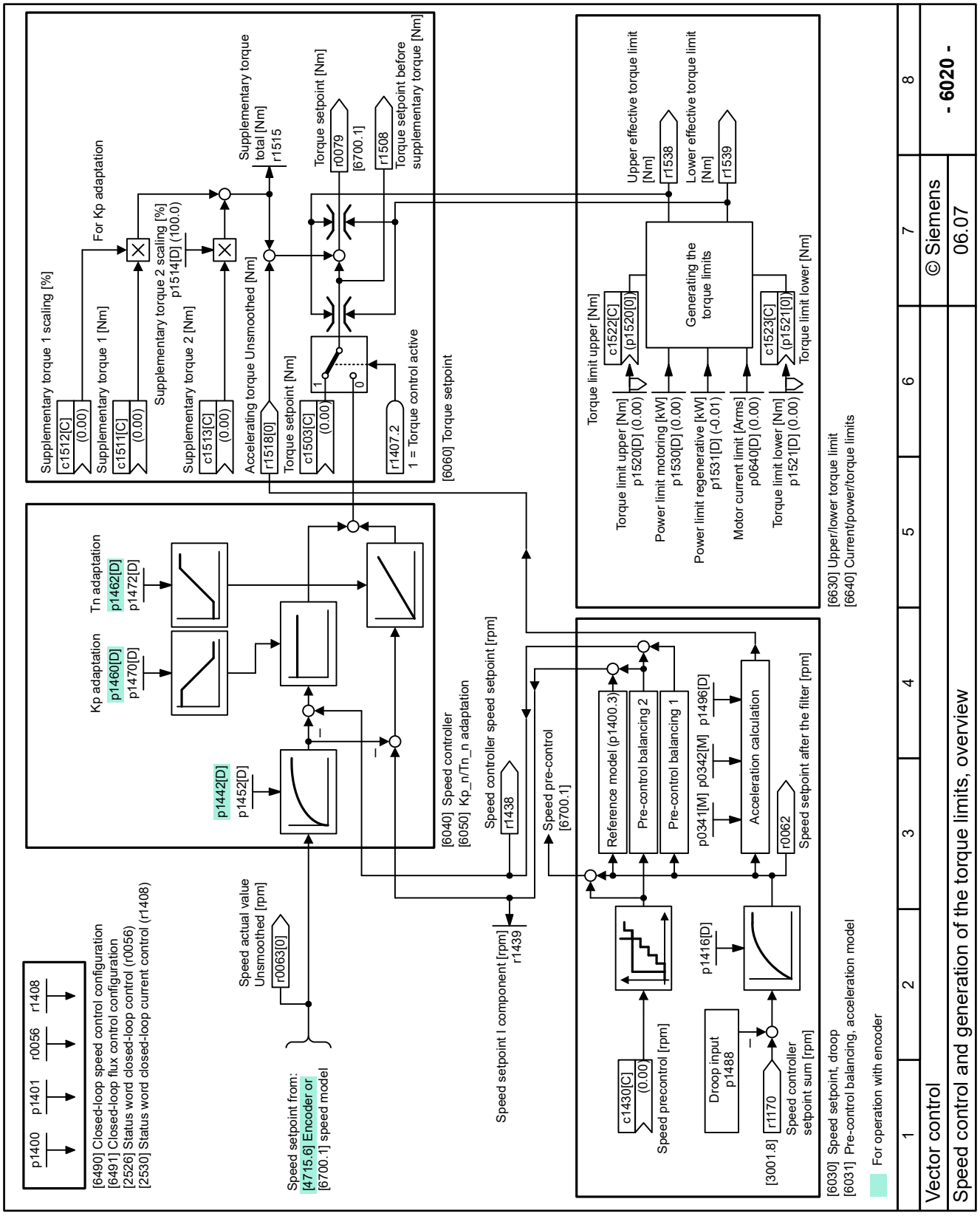


Figure 13-118 6020 - Closed-loop speed control and generation of the torque limits, overview

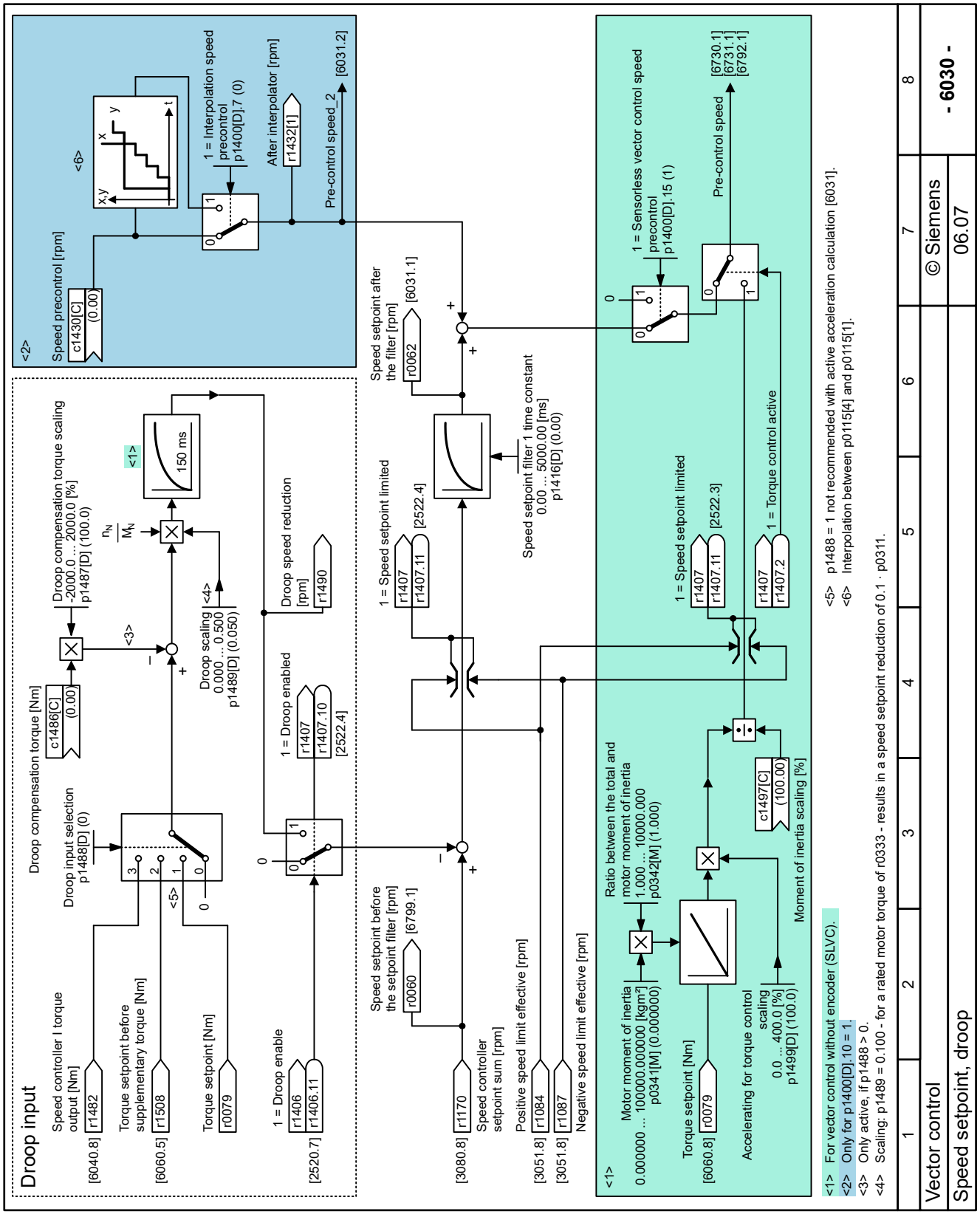


Figure 13-119 6030 - Speed setpoint, droop

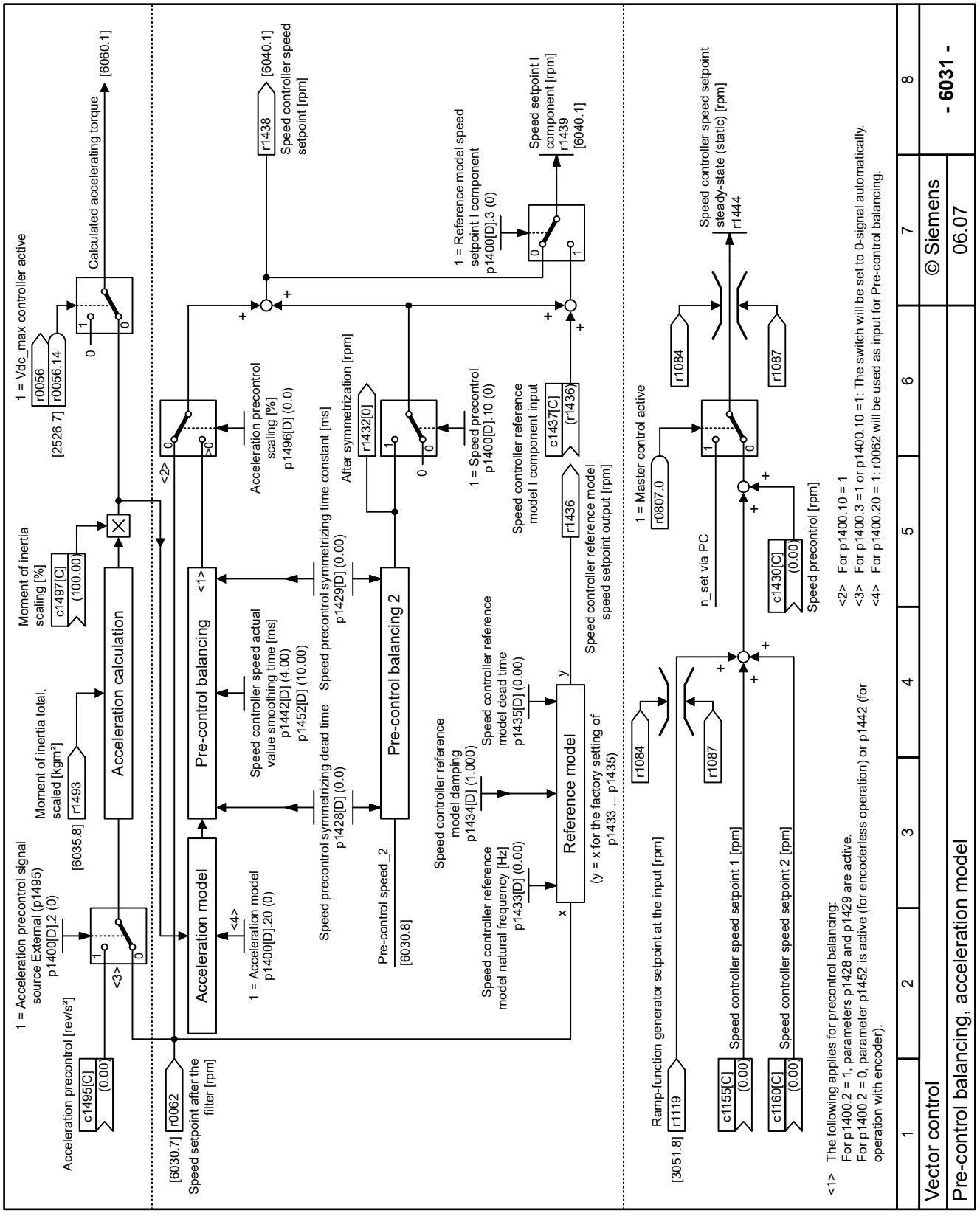


Figure 13-120 6031 - Precontrol balancing, acceleration model

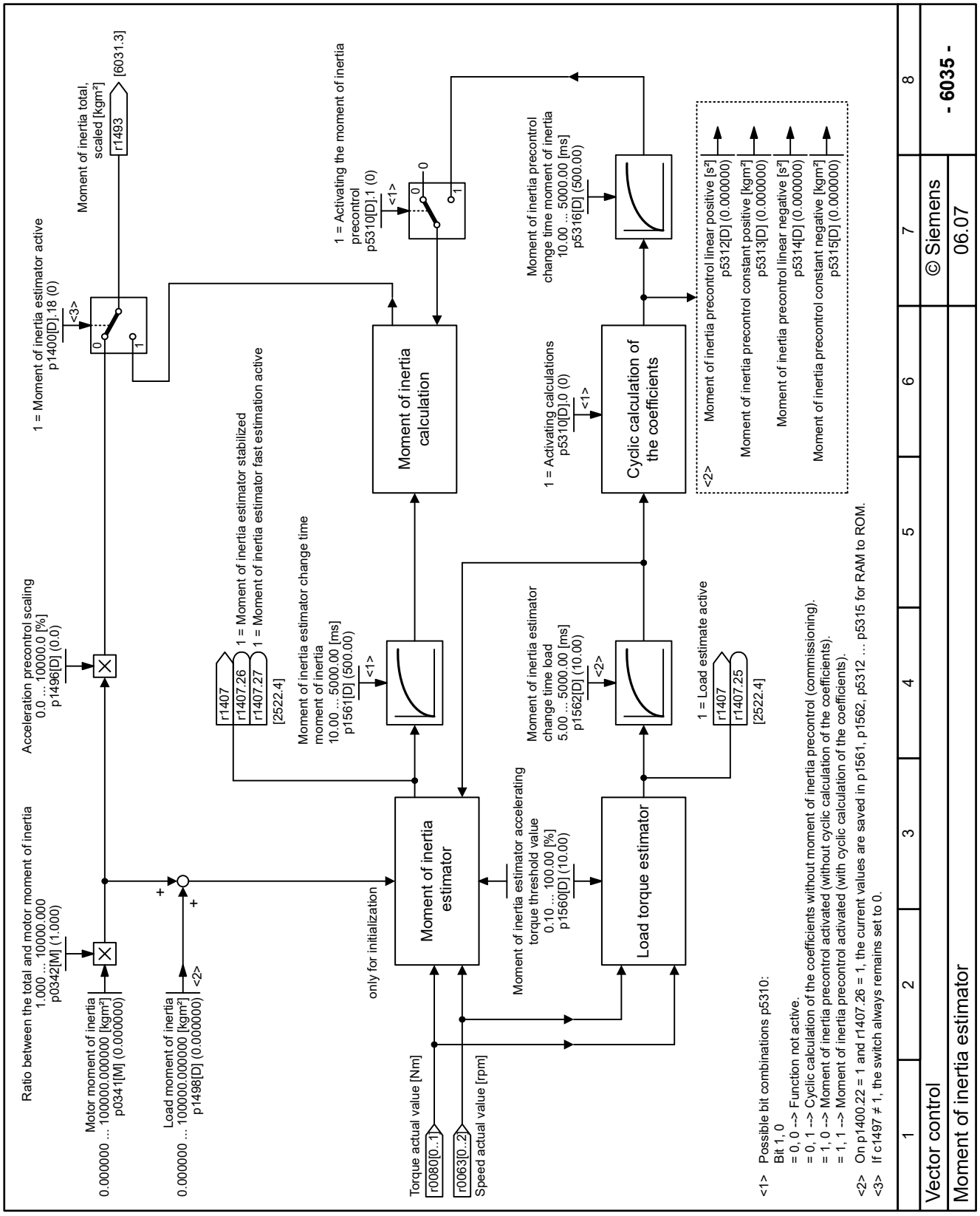


Figure 13-121 6035 – Moment of inertia estimator

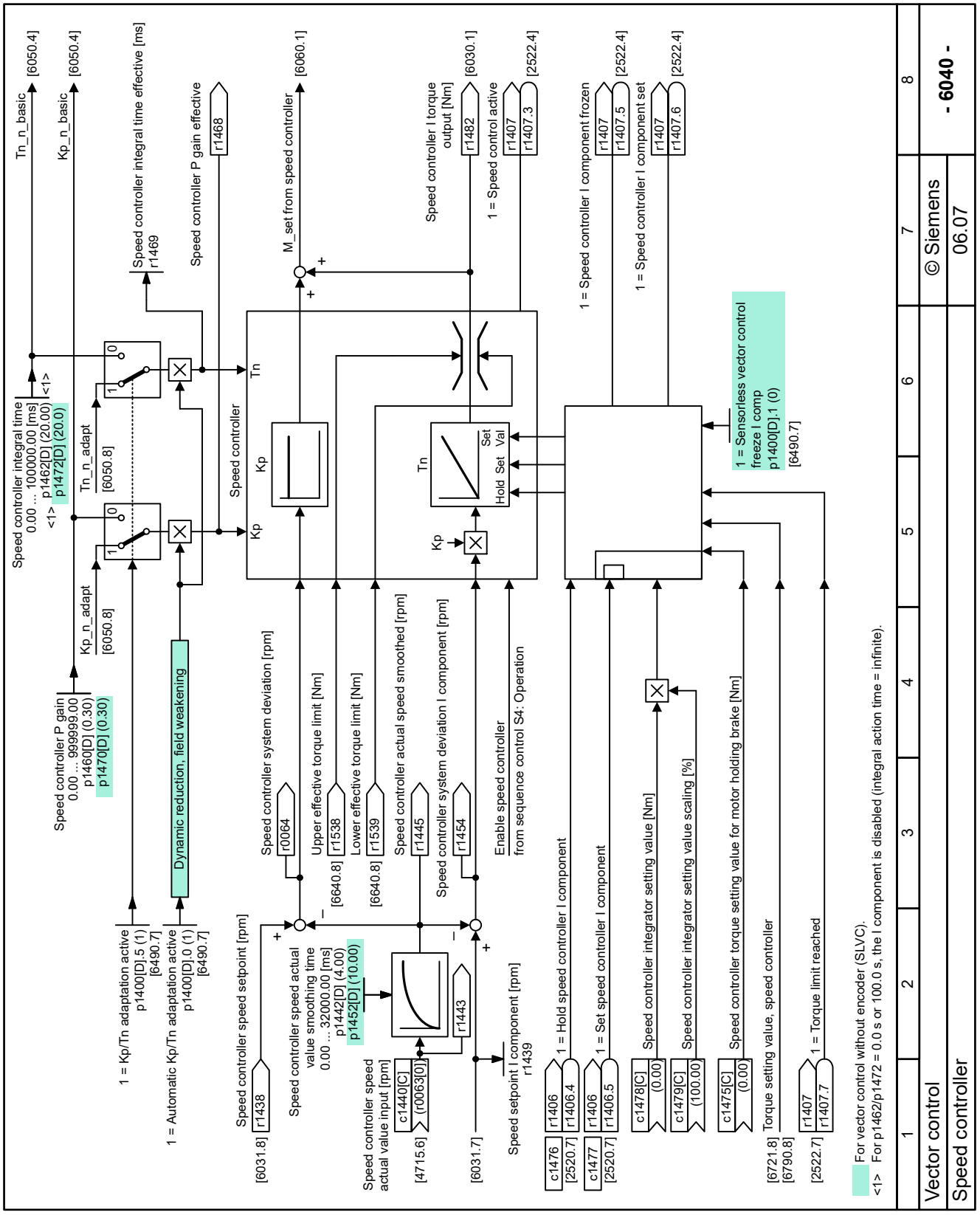


Figure 13-122 6040 - Speed controller

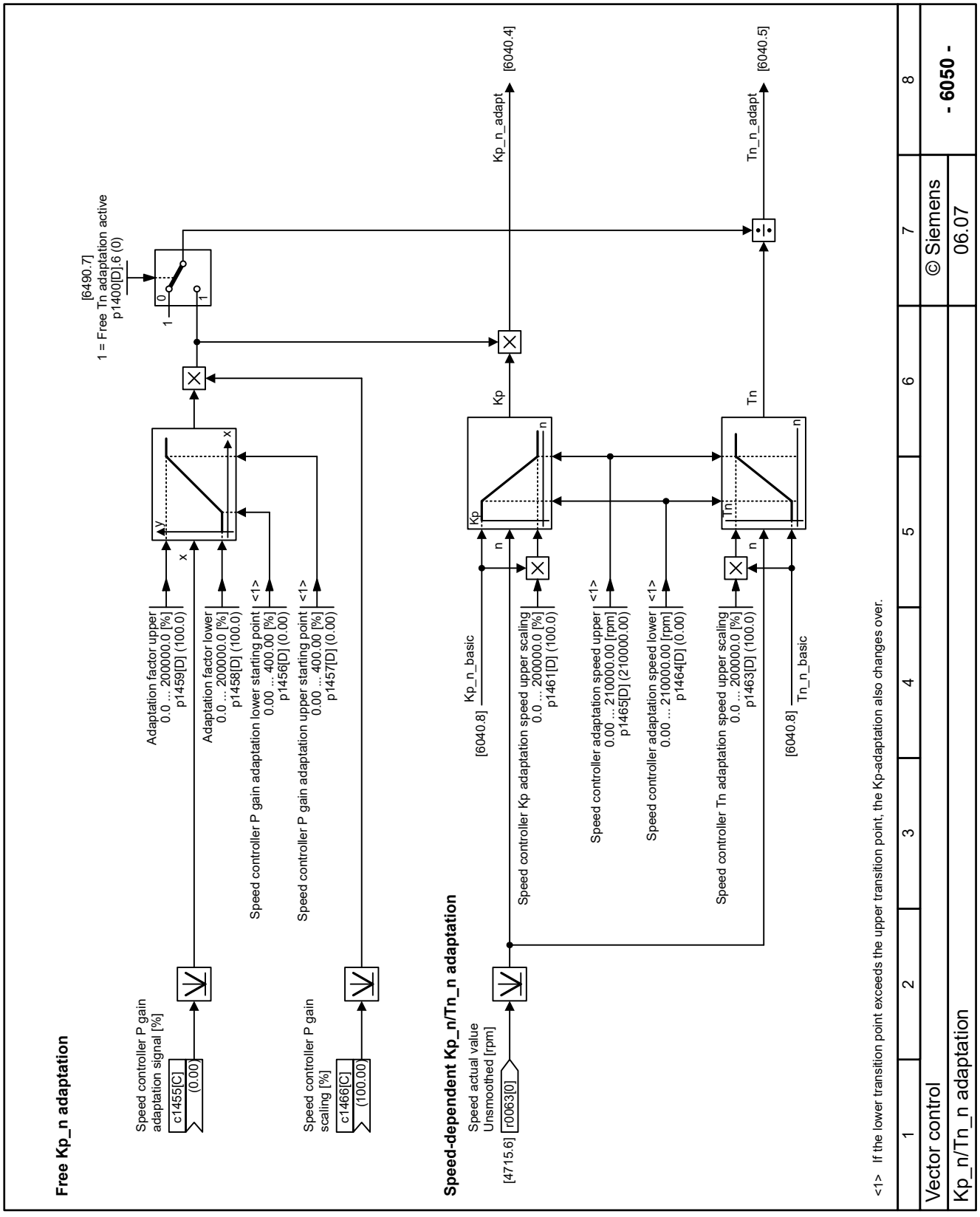


Figure 13-123 6050 - Kp_n-/Tn_n adaptation

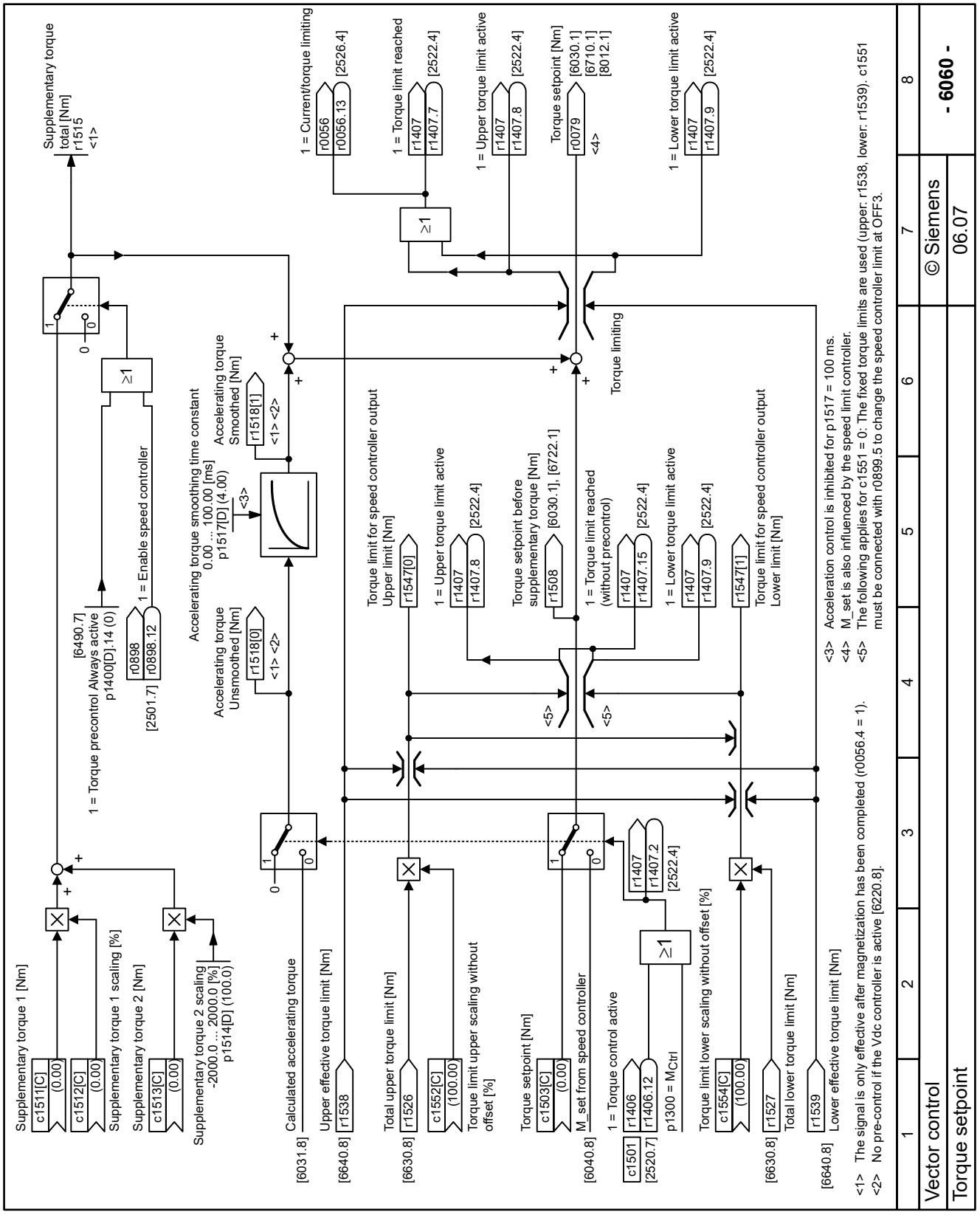


Figure 13-124 6060 - Torque setpoint

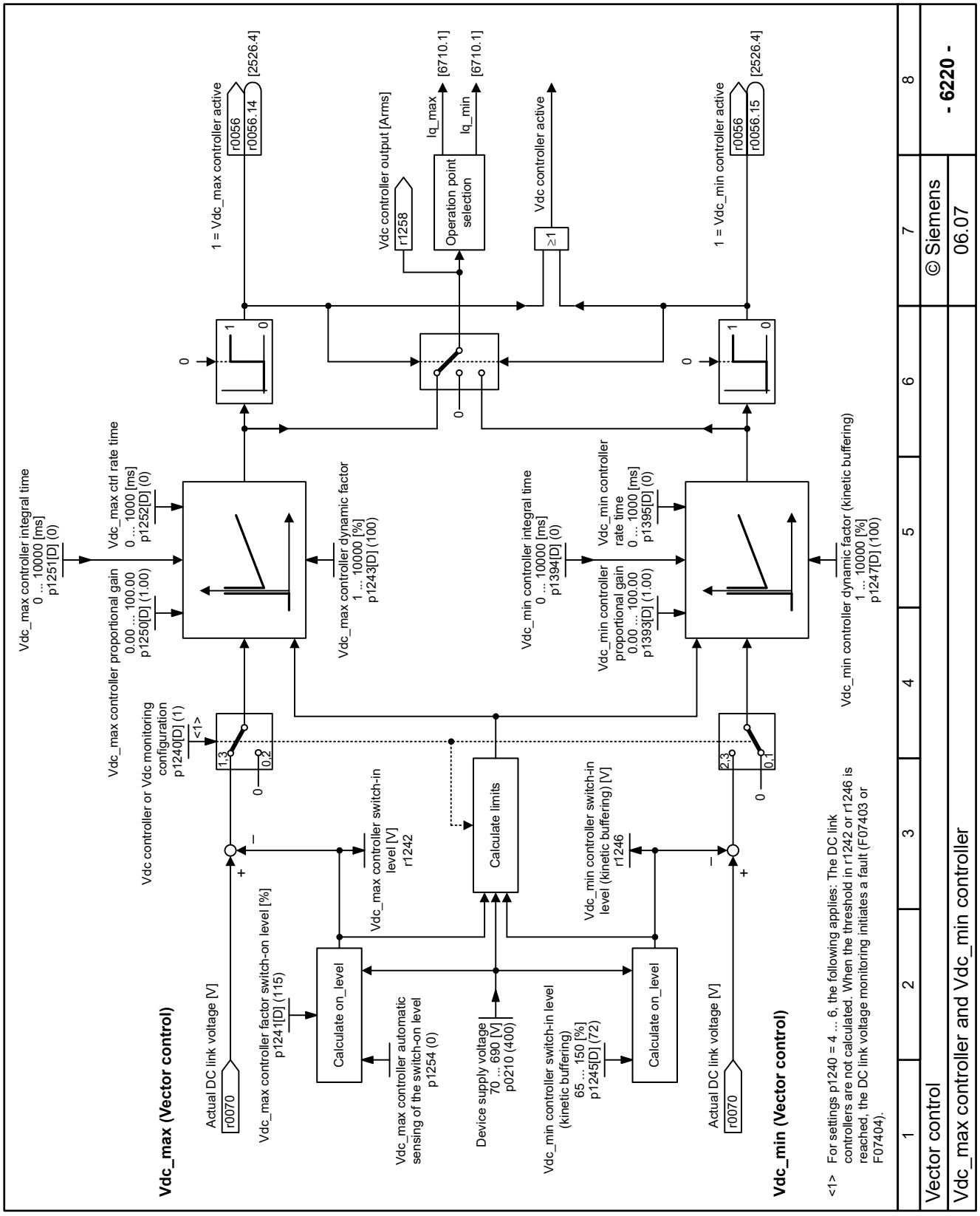
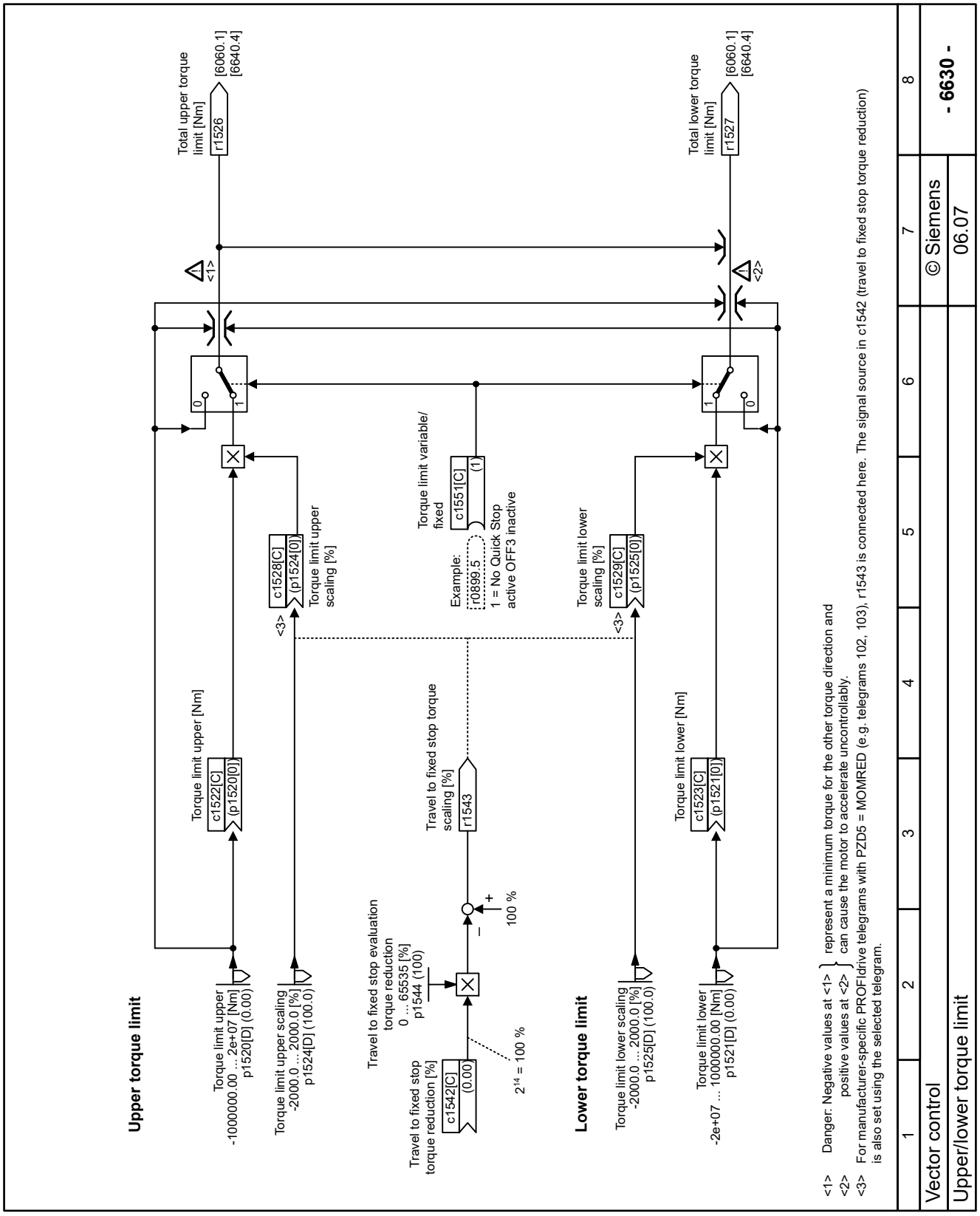


Figure 13-125 6220 - Vdc_max controller and Vdc_min controller (VECTOR)



<1> Danger: Negative values at <1> represent a minimum torque for the other torque direction and positive values at <2> can cause the motor to accelerate uncontrollably.
<2>
<3> For manufacturer-specific PROFIdrive telegrams with PZD5 = MOMRED (e.g. telegrams 102, 103), r1543 is connected here. The signal source in c1542 (travel to fixed stop torque reduction) is also set using the selected telegram.

Figure 13-126 6630 - Upper/lower torque limit

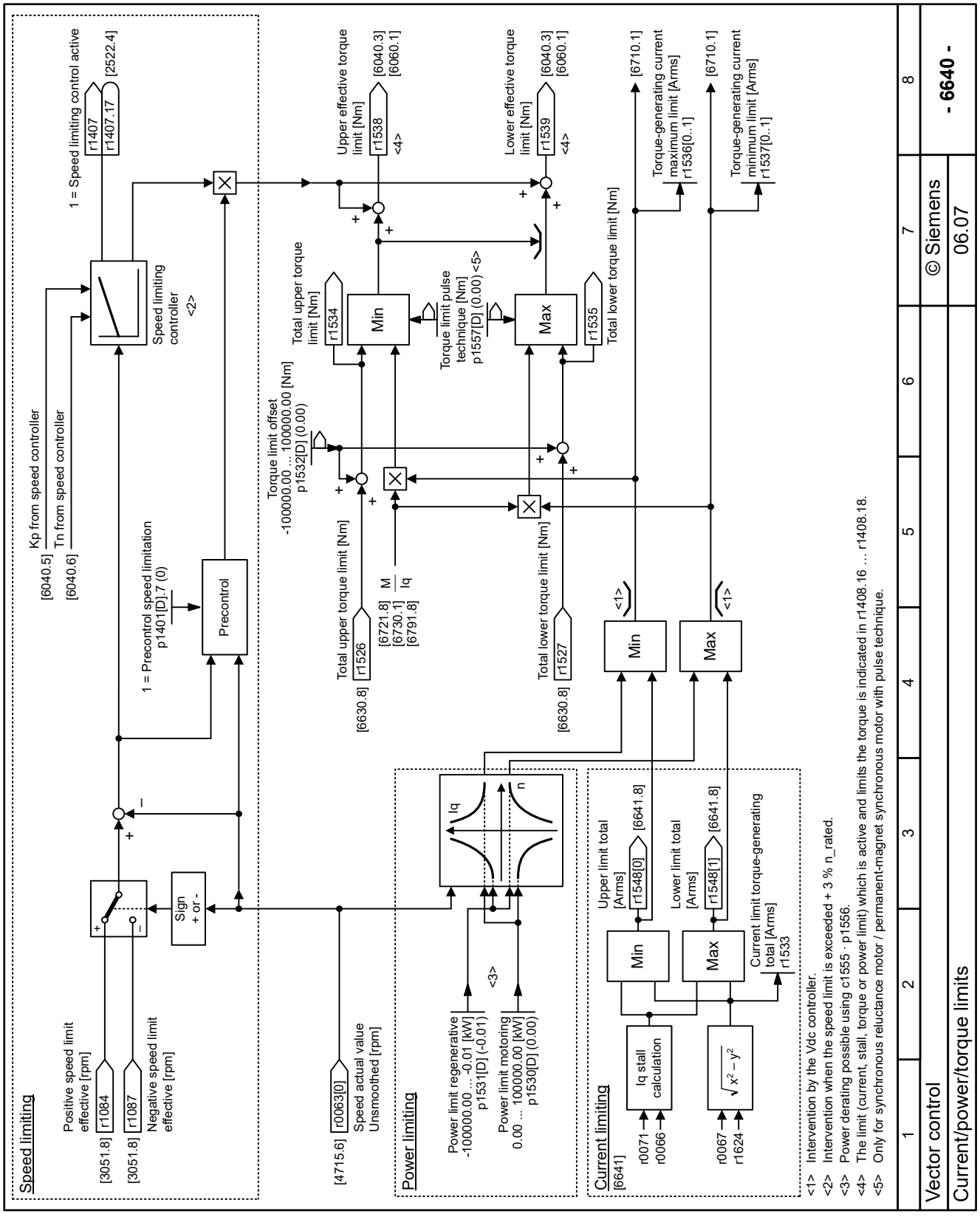


Figure 13-127 6640 - Current/power/torque limits

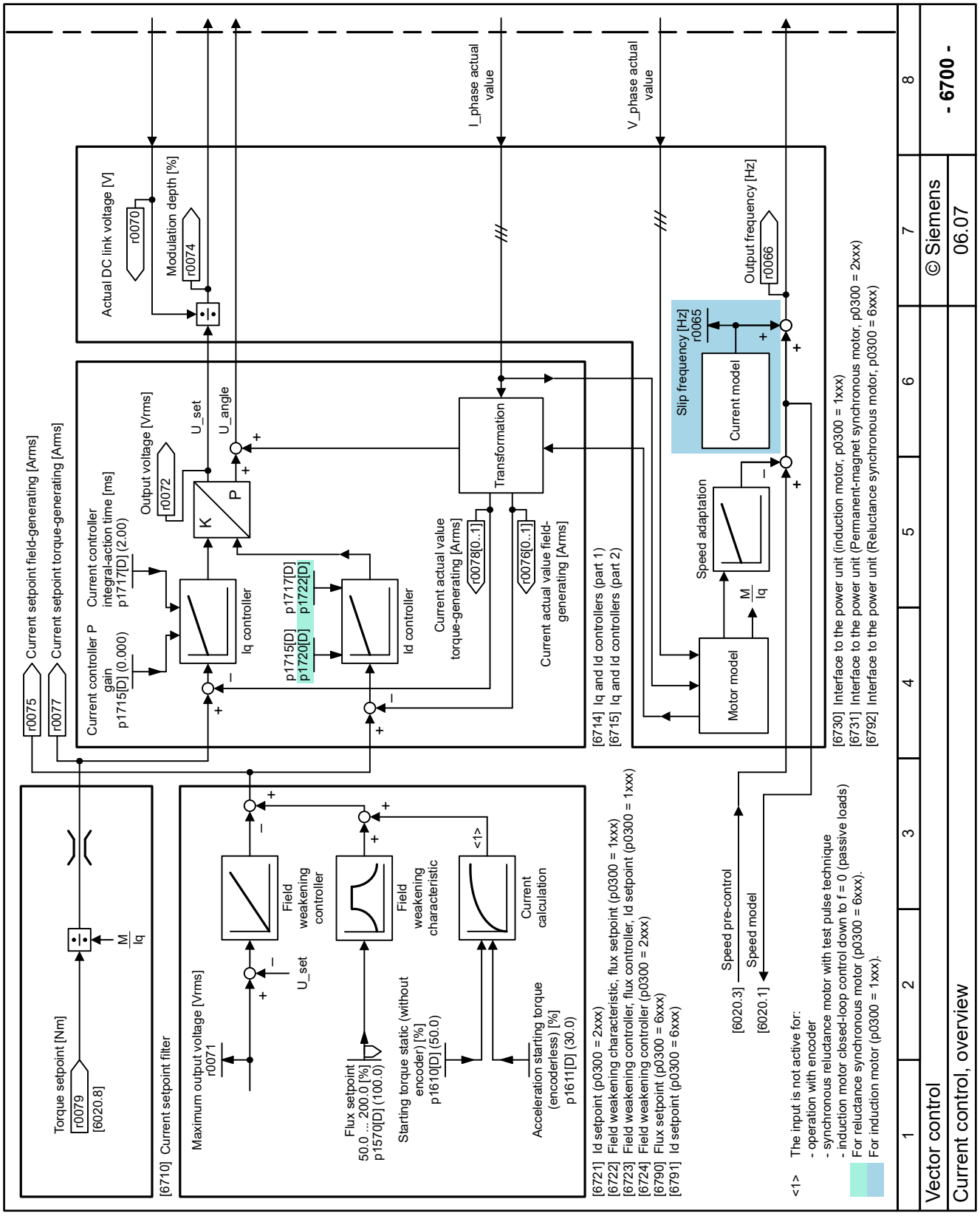


Figure 13-128 6700 - Current regulation, overview

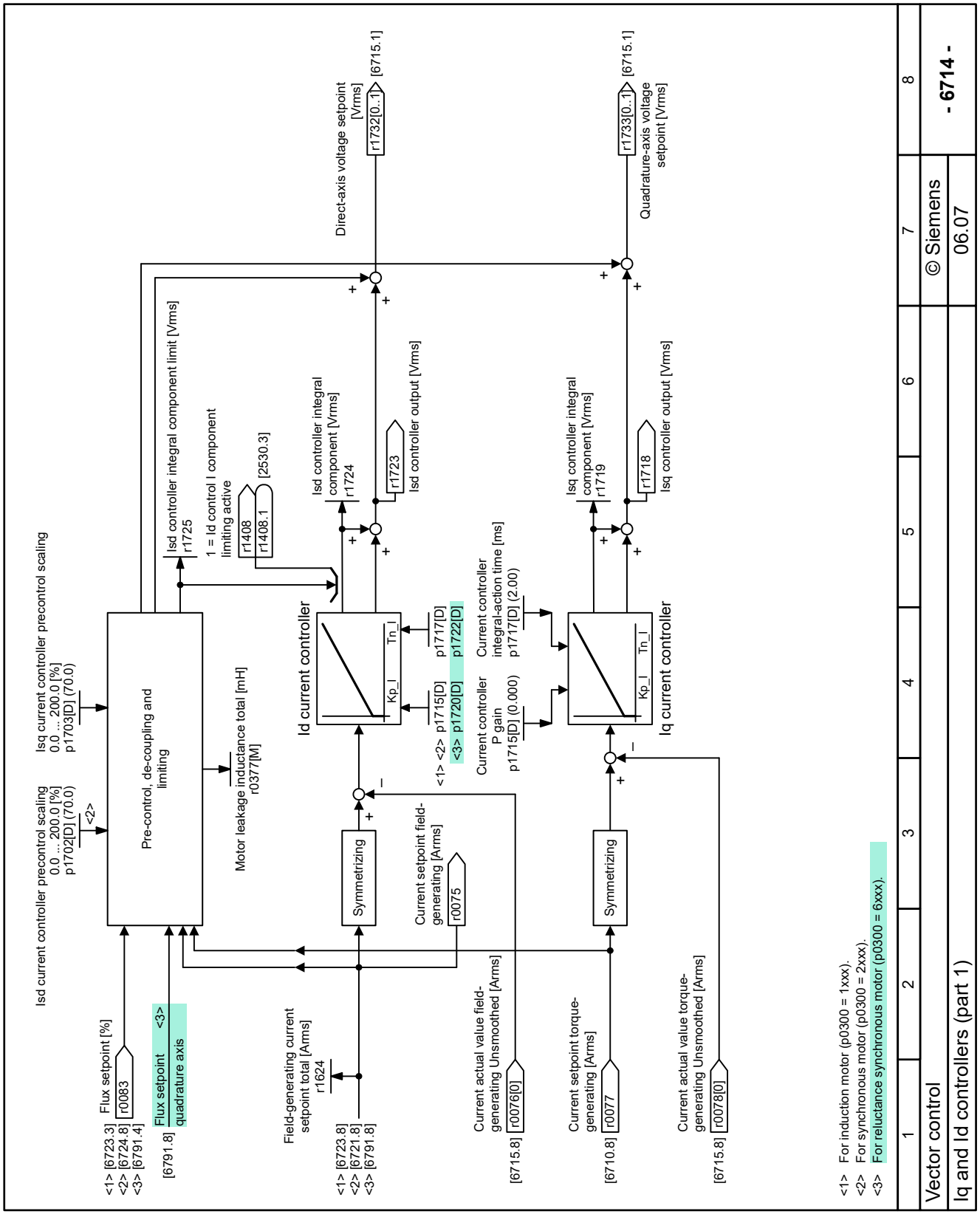


Figure 13-129 6714 - Iq and Id controllers (Part 1)

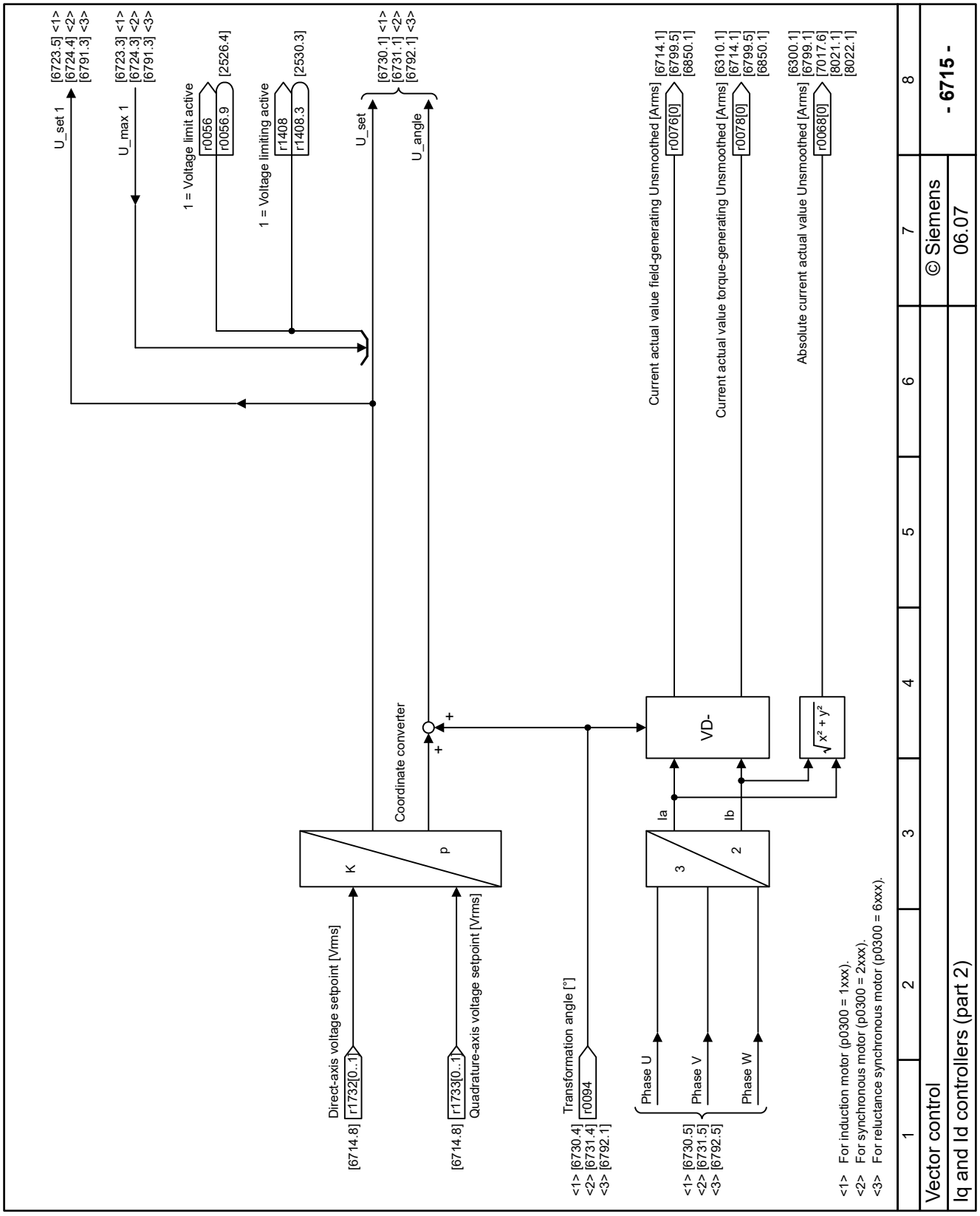


Figure 13-130 6715 - Iq and Id controllers (Part 2)

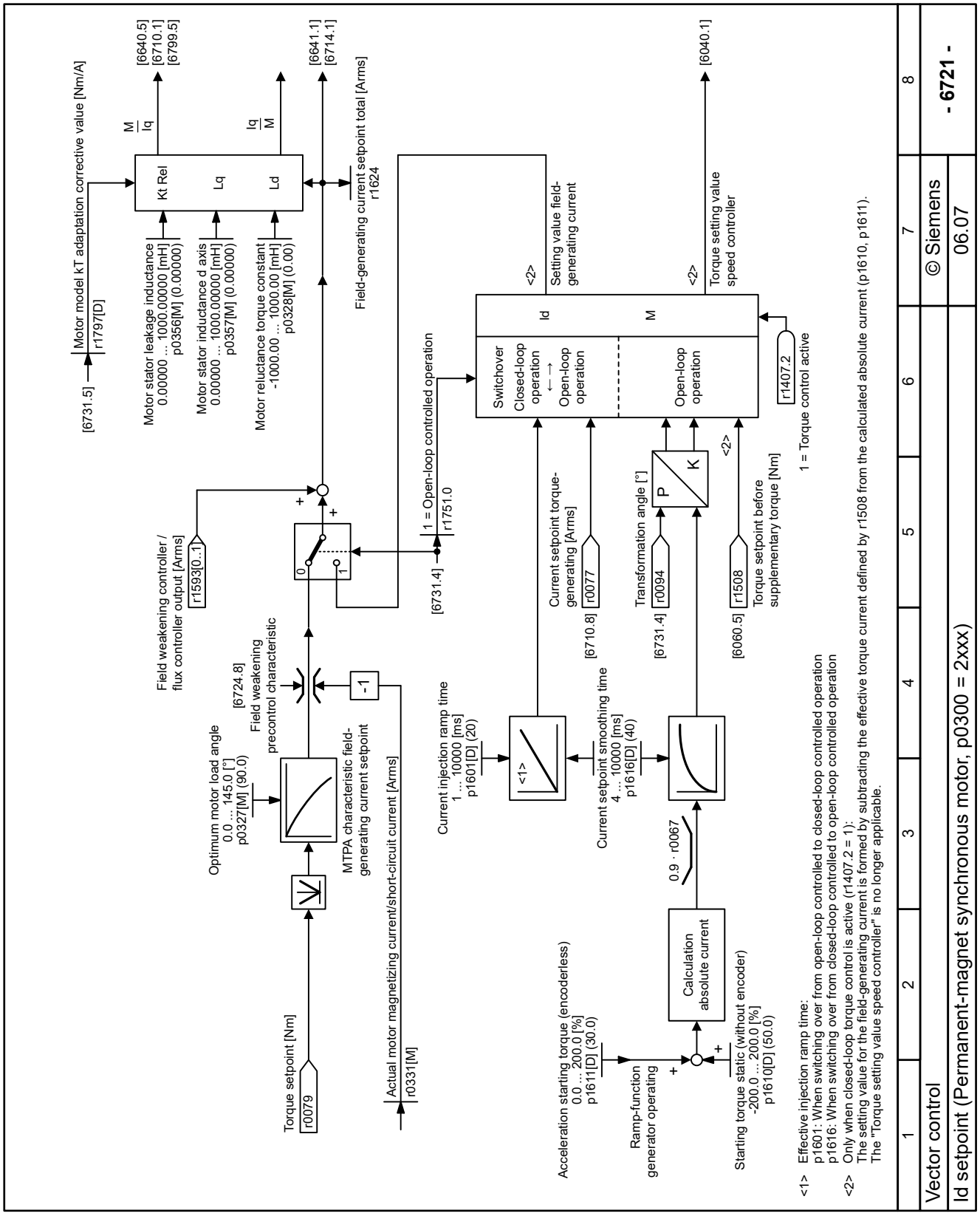


Figure 13-131 6721 - Id setpoint (permanent-magnet synchronous motor)

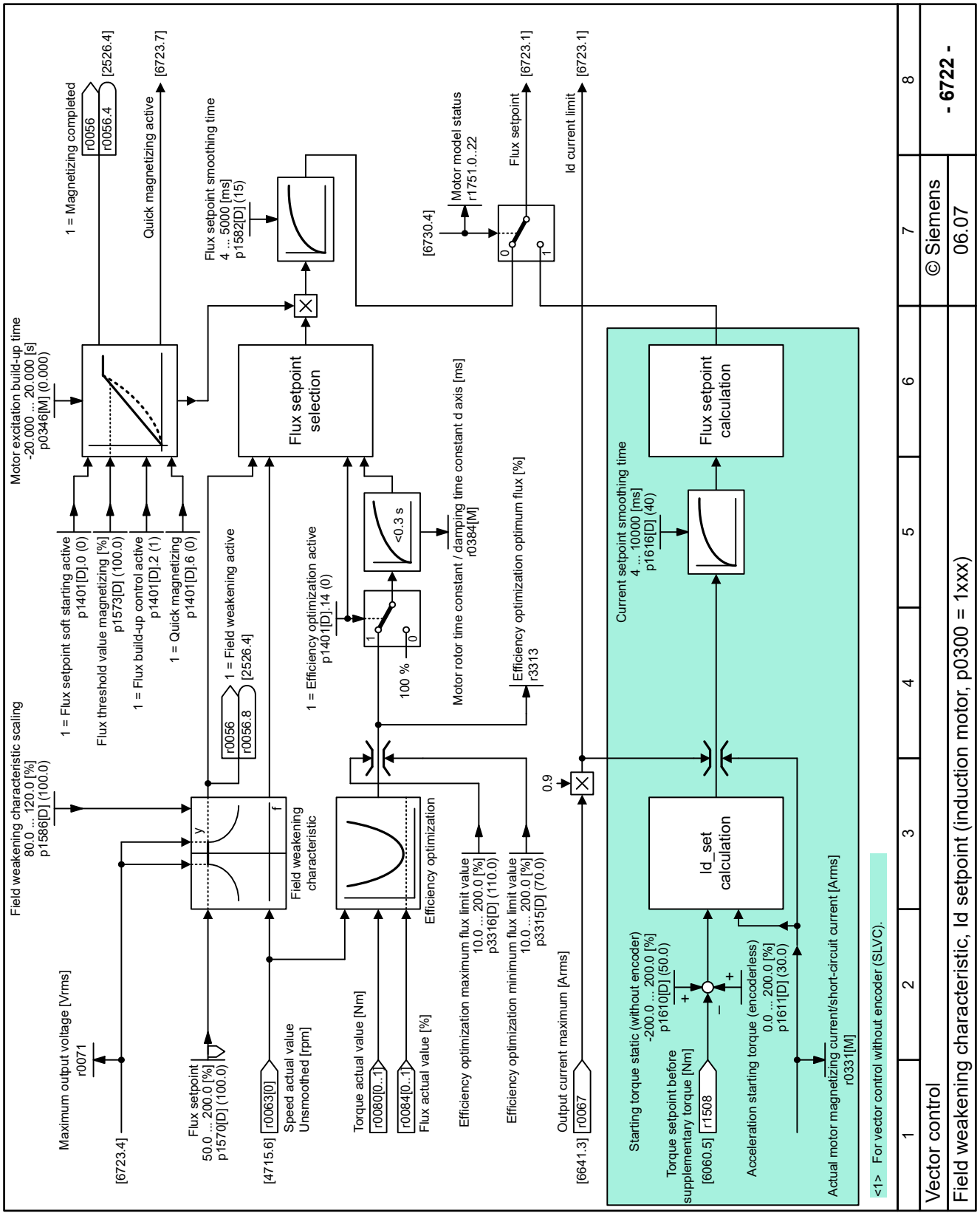


Figure 13-132 6722 - Field weakening characteristic, Id setpoint (induction motor)

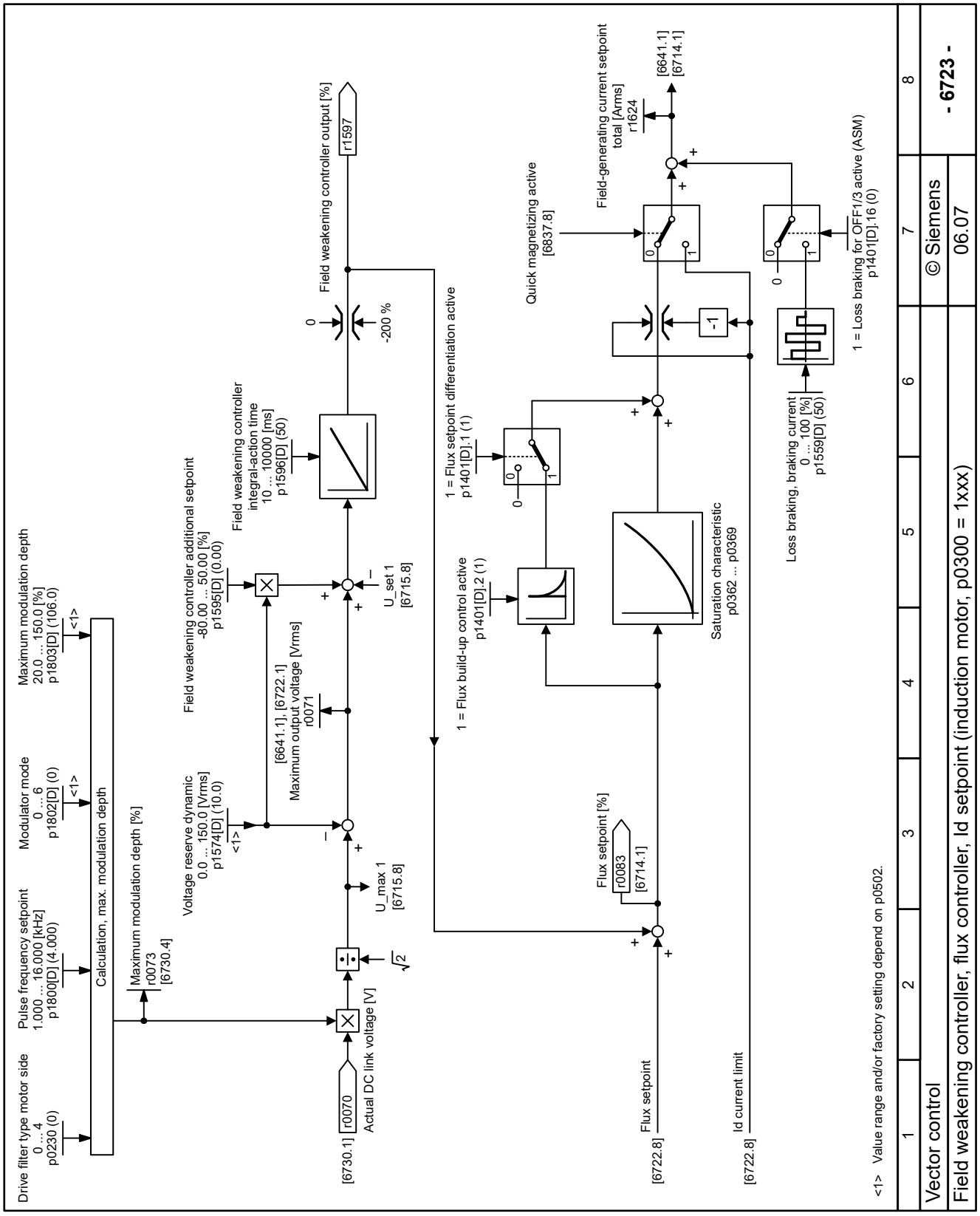


Figure 13-133 6723 – Field weakening controller, flux controller, Id setpoint (induction motor)

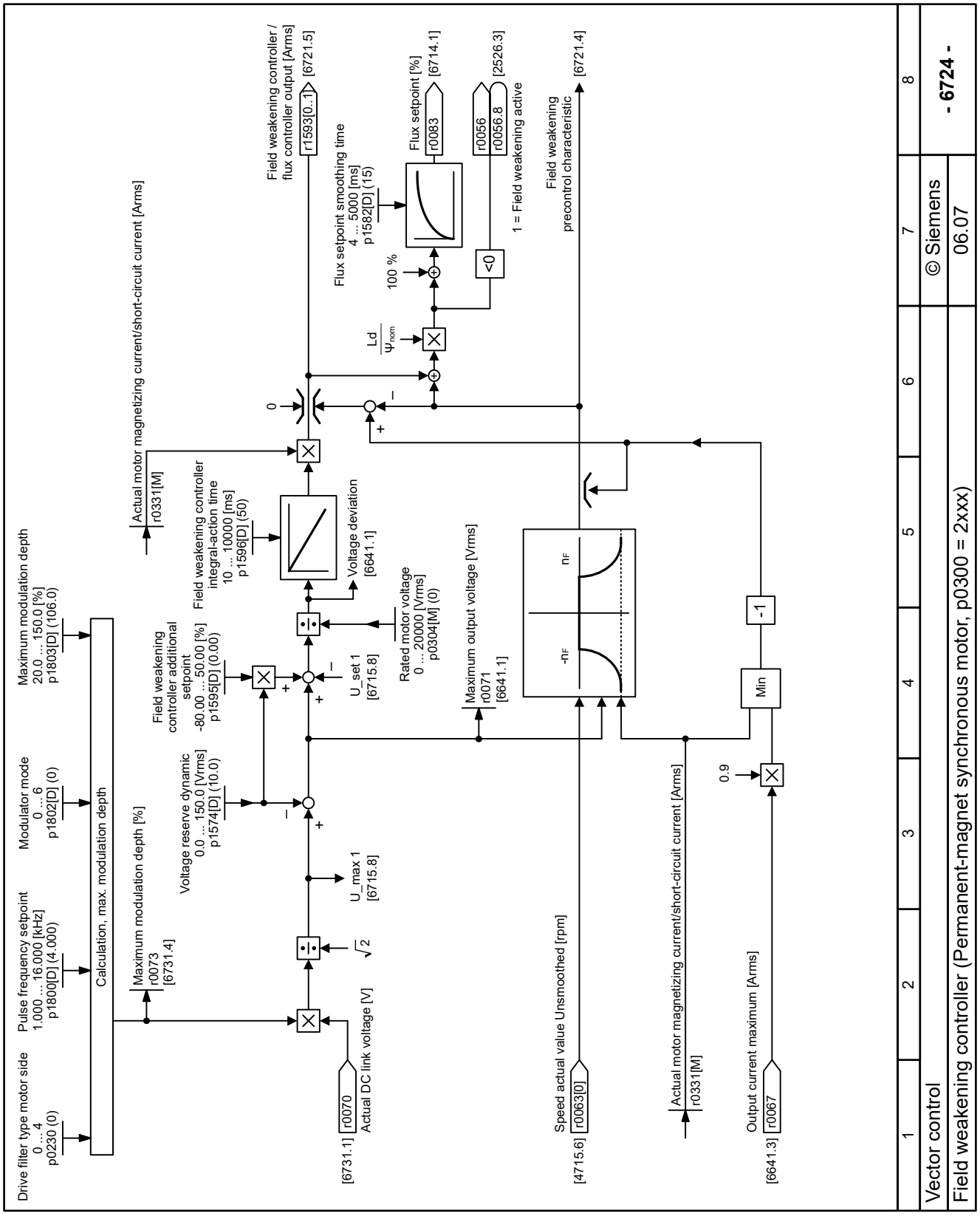


Figure 13-134 6724 - Field weakening controller (permanent-magnet synchronous motor)

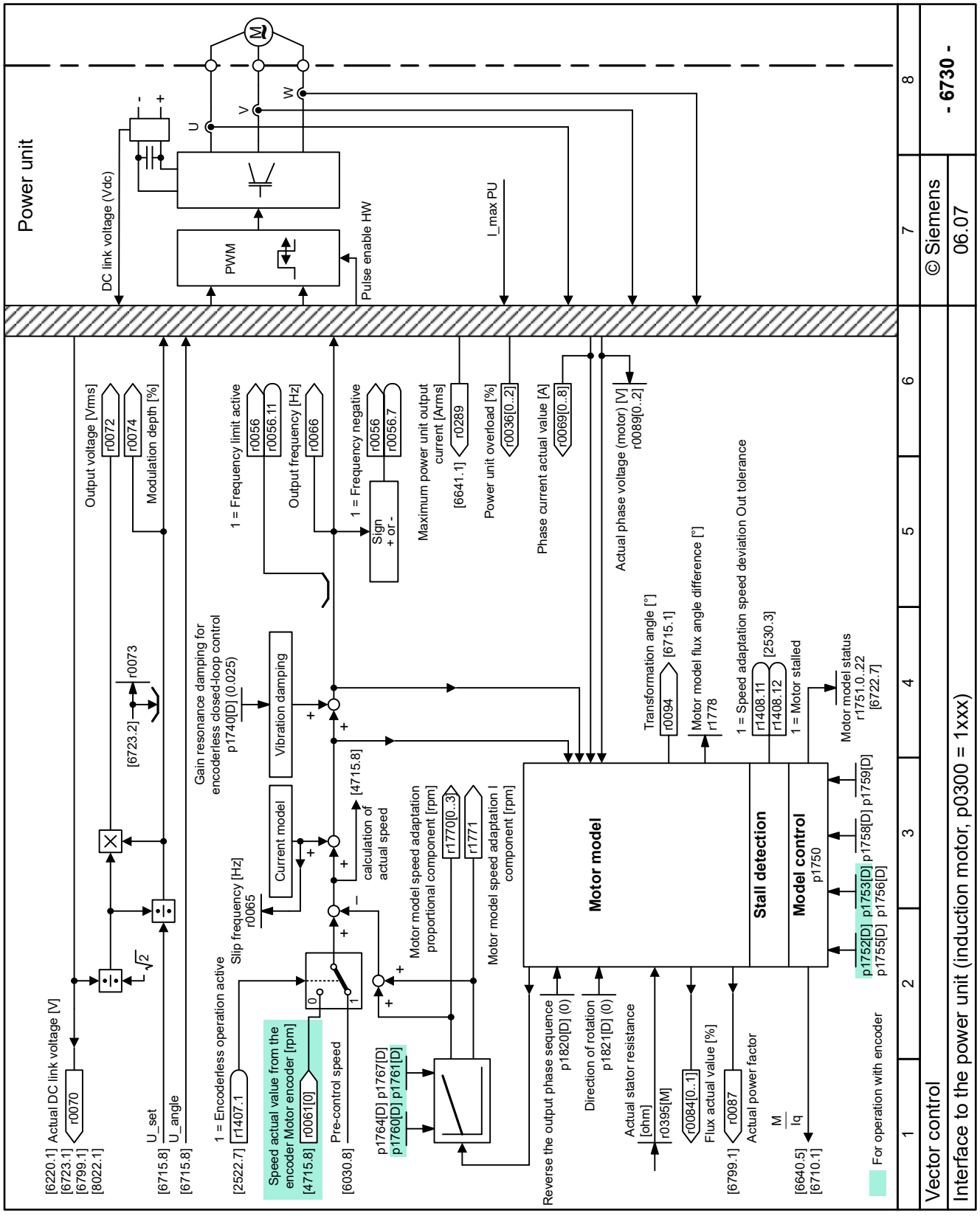


Figure 13-135 6730 - Interface to power unit (induction motor)

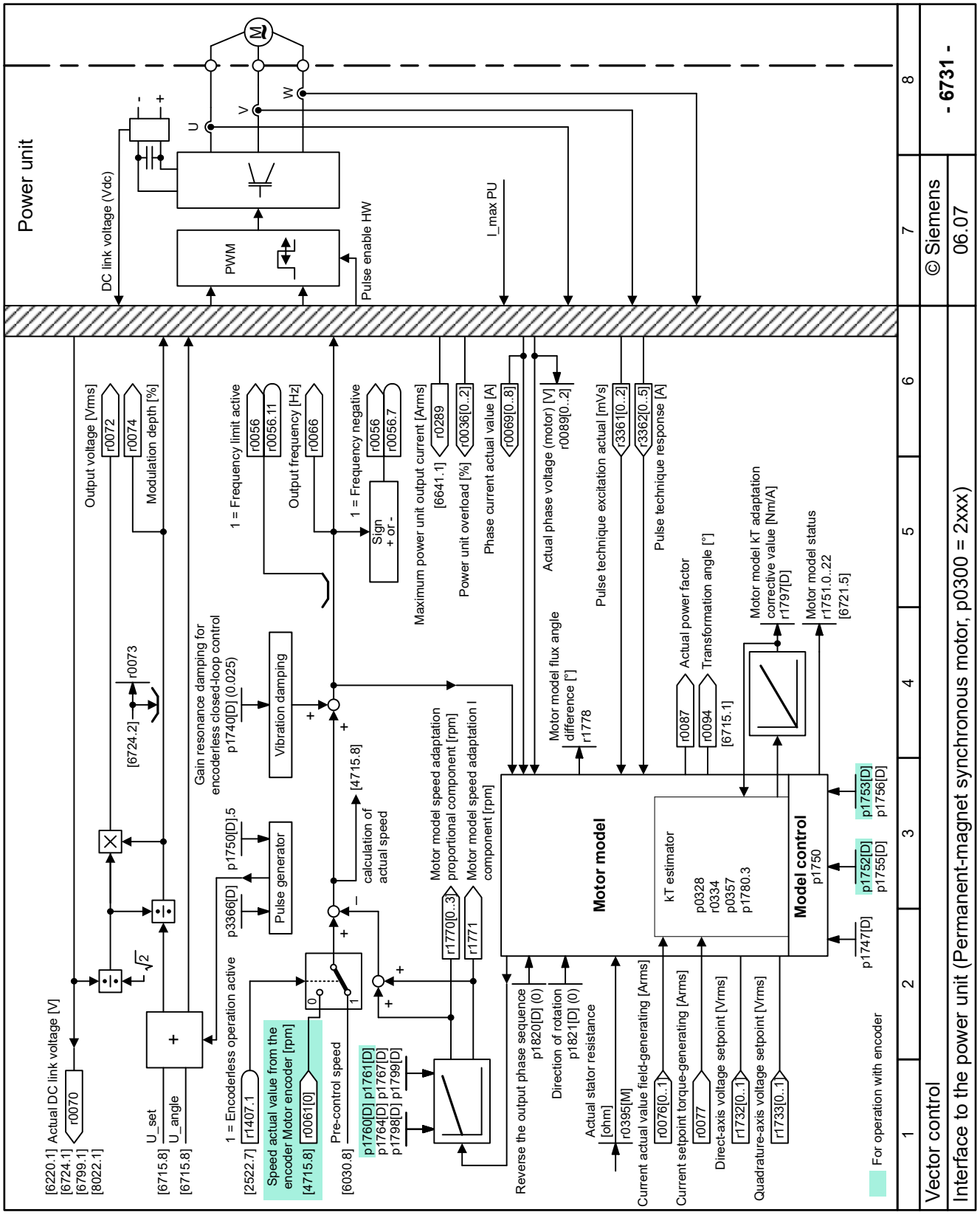


Figure 13-136 6731 - Interface to the power unit (permanent-magnet synchronous motor)

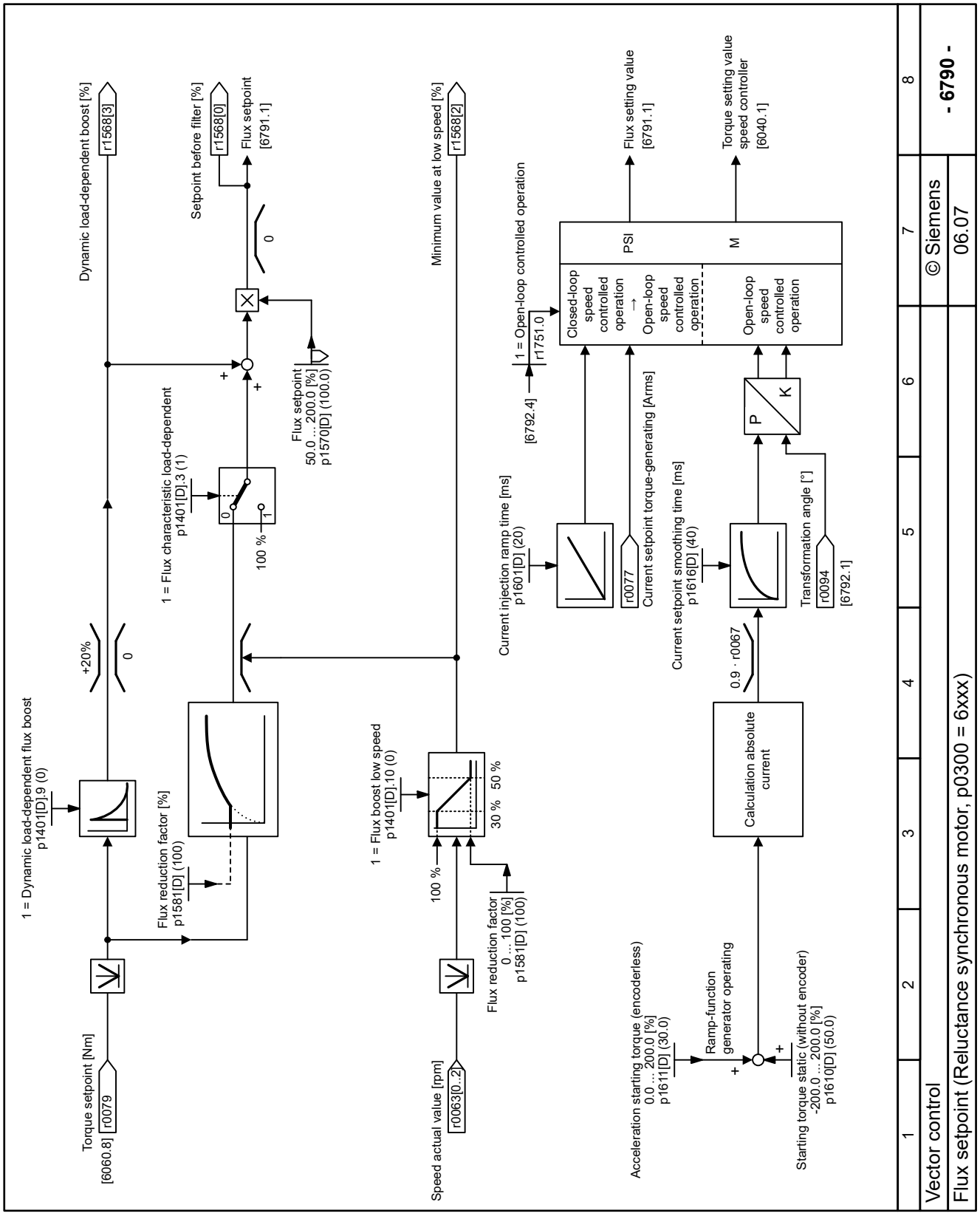


Figure 13-137 6790 - Flux setpoint (synchronous reluctance motor)

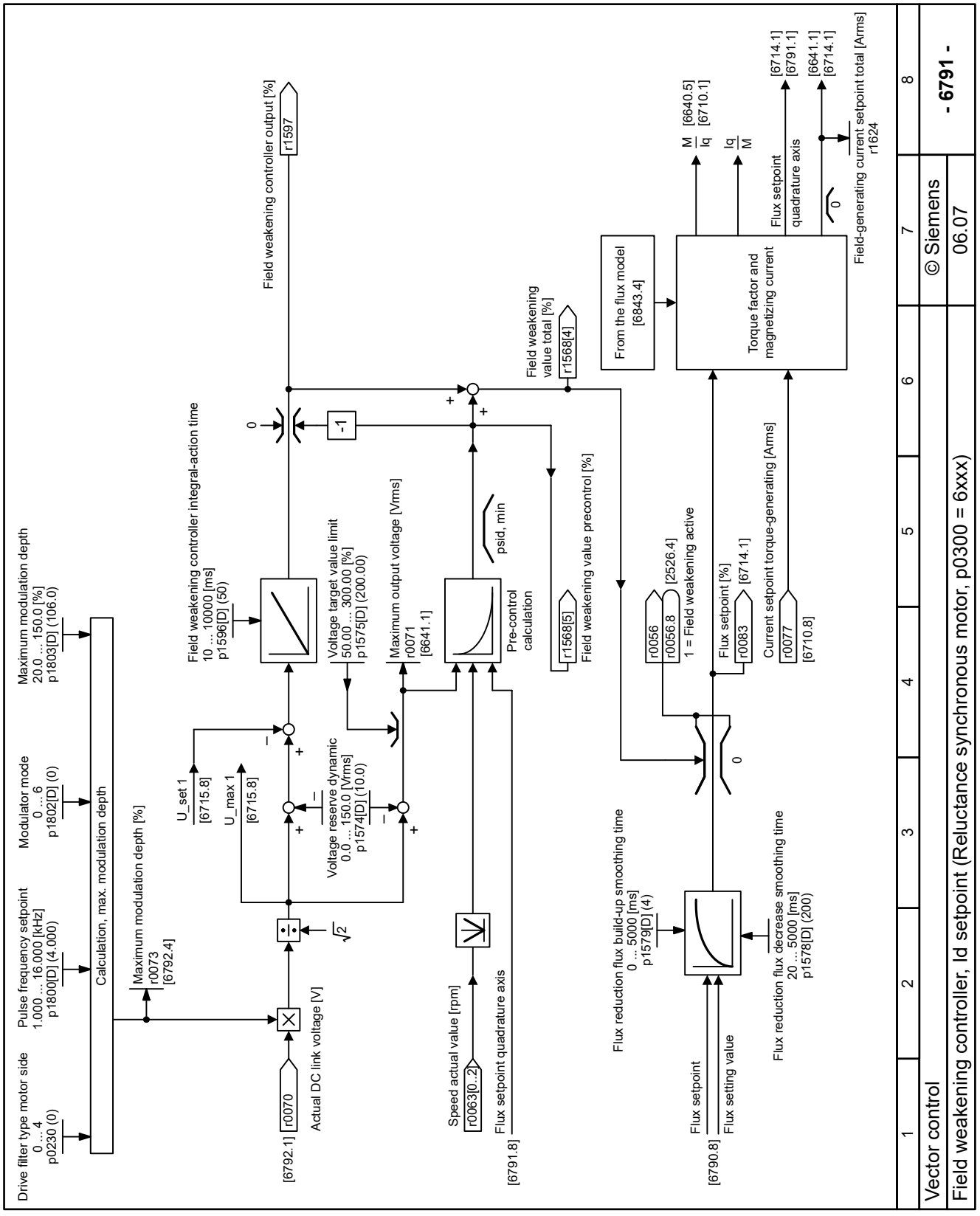


Figure 13-138 6791 - Field weakening controller, Id setpoint (synchronous reluctance motor)

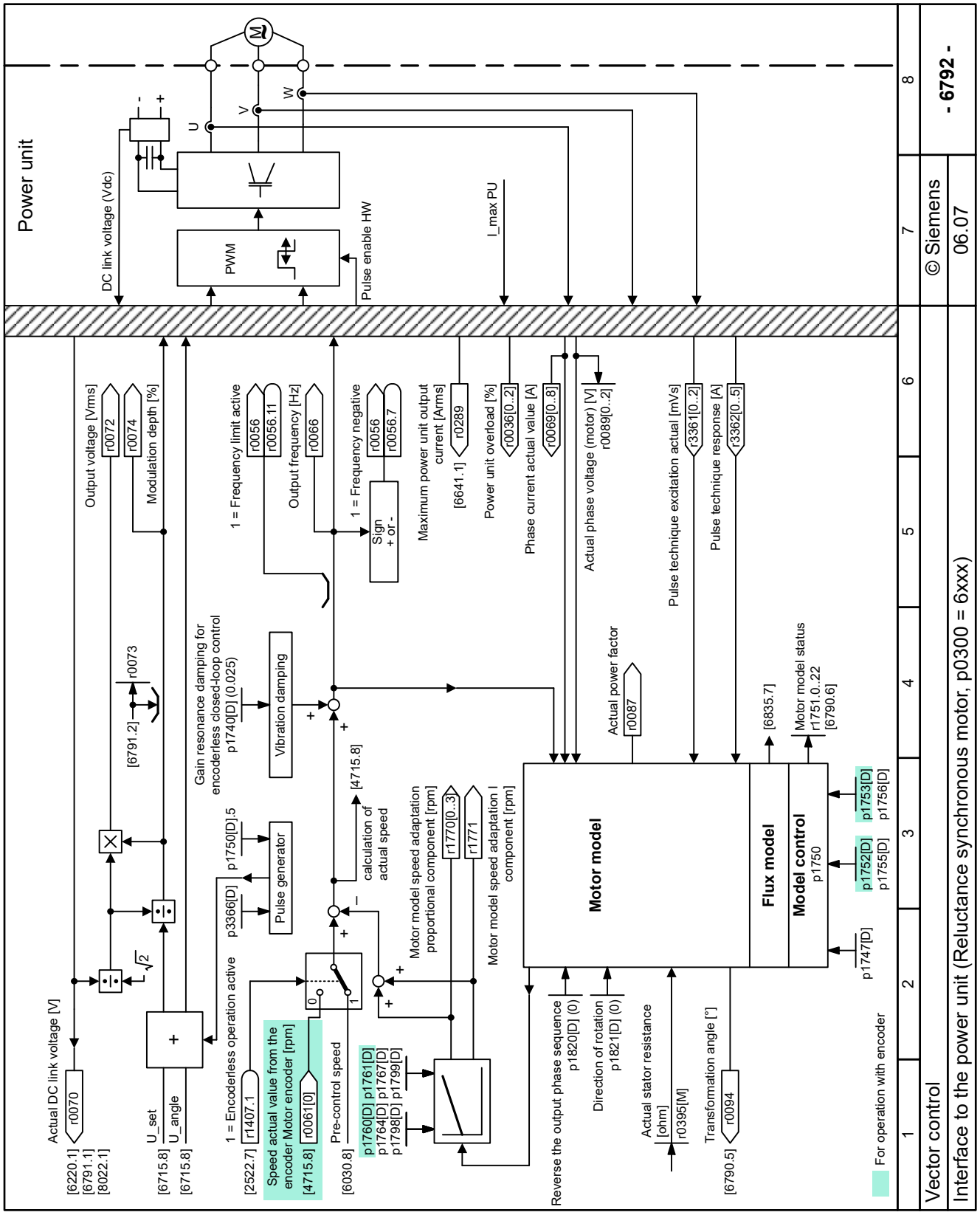


Figure 13-139 6792 - Interface to the power unit (synchronous reluctance motor)

13.12.7.2 Settings for the technological application for the closed-loop speed control

Overview

To improve the closed-loop motor control, the converter adapts the closed-loop speed control to the selected technology application.

Function description

Depending on p0500, the following default settings of the closed-loop speed control apply:

Table 13-100 Technological application for closed-loop speed control

p0500	Technological application	Default setting of the closed-loop speed control
0	Standard drive	• Factory setting for closed-loop speed control with or without speed encoder • In all applications that do not fit the other setting options.
1	Pumps and fans	• Optimized utilization of the power output by reducing the voltage reserve at higher speeds If high load surges in the range of low and medium speeds cannot be ruled out, then we recommend setting p500 = 0. • Application with pumps and fans
2	Encoderless closed-loop control up to f = 0	• Setting for encoderless closed-loop control of an induction motor, reluctance motor and permanent-magnet synchronous motor • Closed-loop speed controlled operation of an induction motor at low speeds For an induction motor, p0500 = 2 is only suitable for operation with a passive load. A passive load does not accelerate a motor when it is in a no-current condition. Examples are pumps, fans, extruders, but not hoisting gear. • Encoderless closed-loop speed control of a synchronous motor from standstill (optimized pulse technique) – For reluctance motors – For permanent magnet synchronous motors
3	Pumps and fans, efficiency optimization	• Setting for the closed-loop control of an induction motor • Suitable for applications without dynamic requirements for speed and load changes • Application with pumps and fans • Efficiency optimization Less energy consumption and reduced noise • The setting only makes sense for operation with slow speed changes. We recommend the setting 0 if load surges in operation cannot be ruled out.

p0500	Technological application	Default setting of the closed-loop speed control
5	Starting with high break loose torque	• Setting for encoderless control (all motor types) • For speed-controlled operation at low speeds, the current is raised via p1610. • A break loose torque is a high load in the lower speed range • Increased default setting of the static torque setpoint (p1610)
6	High load inertia	• Setting for a drive with high power and a total moment of inertia at least 5 times higher than the motor moment of inertia • Increased default setting of speed actual value smoothing • Optimized default setting of the speed controller

13.12.8 Operating mode "Dynamic Drive Control"

13.12.8.1 Basic properties of Dynamic Drive Control

Overview

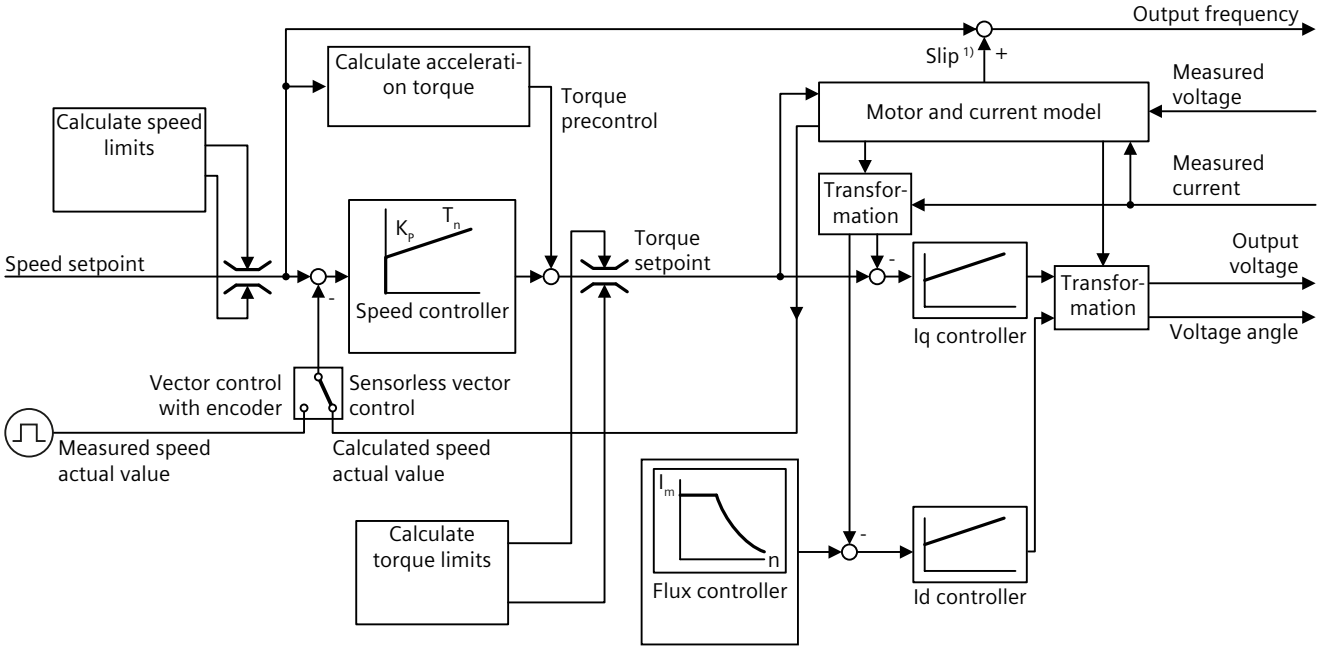
Operating mode Dynamic Drive Control comprises a speed controller and a subordinate closed-loop control for torque and flux.

Requirement

The Dynamic Drive Control operating mode functions with the following motors:

- Induction motor
- Synchronous motor without starting cage
- Reluctance motor without starting cage

Function description



1) Only for induction motors

Figure 13-140 Simplified function diagram of the Dynamic Drive Control operating mode

Using the motor model and current model, the converter calculates the following closed-loop control signals from the measured phase currents and the output voltage:

- Flux-generating current component I_d
- Torque-generating current component I_q
- Speed actual value for encoderless speed control

The motor and current model is based on vector control. The vector control transforms voltage and current AC variables of an induction motor or synchronous motor into torque and flux DC variables. After the transformation, the vector control controls the torque and flux according to the specified setpoints.

The setpoint of the current component I_d (flux setpoint) is obtained from the motor data. For speeds above the rated speed, the converter reduces the flux setpoint along the field weakening characteristic.

For a higher speed setpoint, the speed controller responds with a higher setpoint of the current component I_q (torque setpoint). The speed controller responds to the higher torque setpoint depending on the motor type:

- For induction motors, the closed-loop control adds a higher slip frequency to the output frequency. The higher output frequency also results in a higher motor slip. The higher slip in the motor is proportional to the acceleration torque.
- For synchronous motors, the closed-loop control increases the rotor angle instead of the slip.

I_q and I_d controllers keep the motor flux constant using the output voltage, and adjust the matching current component I_q in the motor.

More information

When compared to the "Closed-loop speed control" control mode, Dynamic Drive Control has a simplified structure and therefore less setting options:

	Dynamic Drive Control operating mode	**Operating mode "Other controls", closed-loop speed control**
Closed-loop torque control without higher-level speed controller	Not possible	Possible
Droop	Not possible	Possible
K_P- and $T_I$adaptation	Simplified	Advanced
Hold or set the integral component of the speed controller	Not possible	Possible
Acceleration model for pre-control	Default setting	Can be activated
Motor data identification at standstill or with rotating measurement	Shortened, with optional transition into operation	Complete

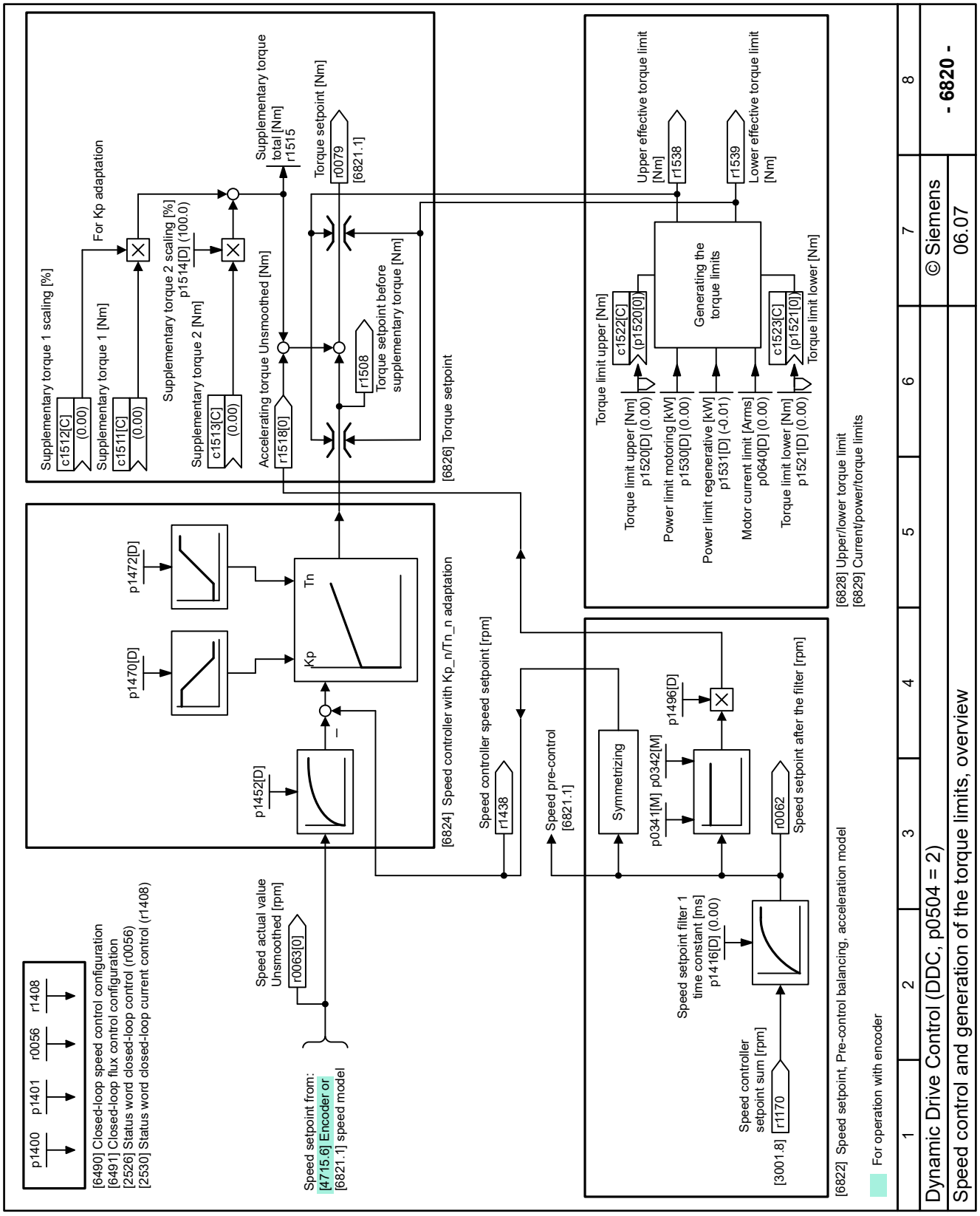


Figure 13-141 6820 - Speed control and generation of the torque limits, overview

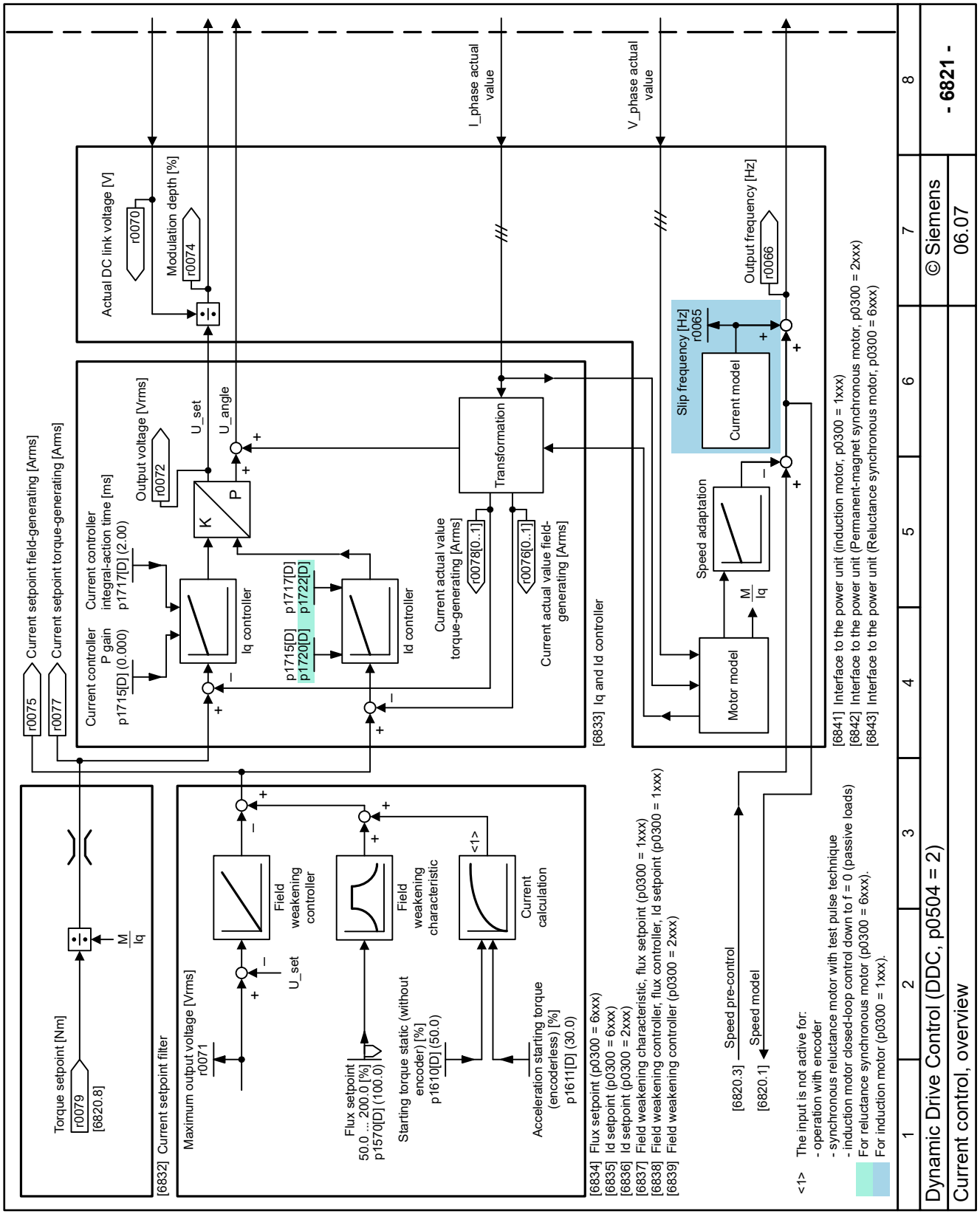


Figure 13-142 6821 - Current control, overview

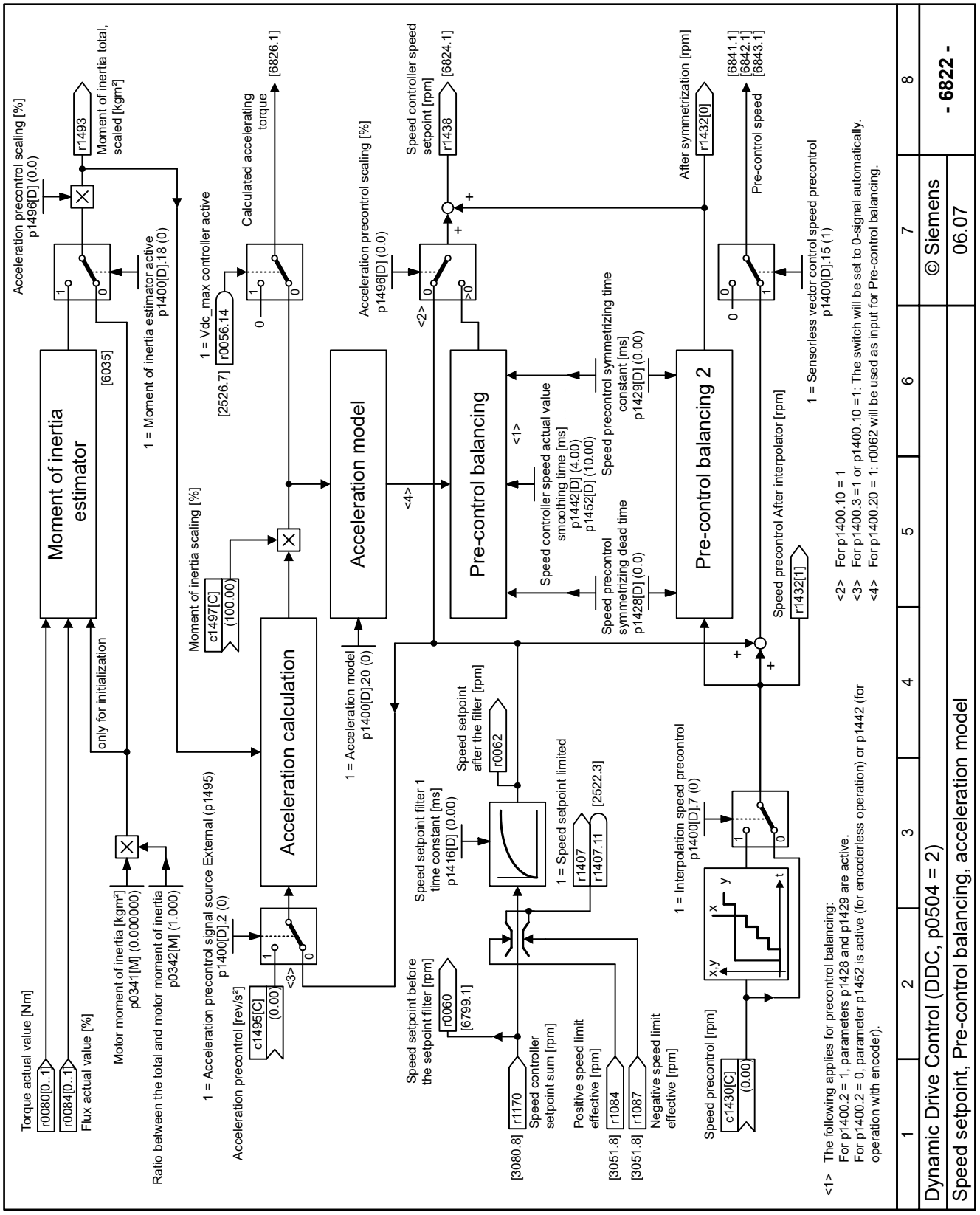


Figure 13-143 6822 - Speed setpoint, pre-control balancing, acceleration model

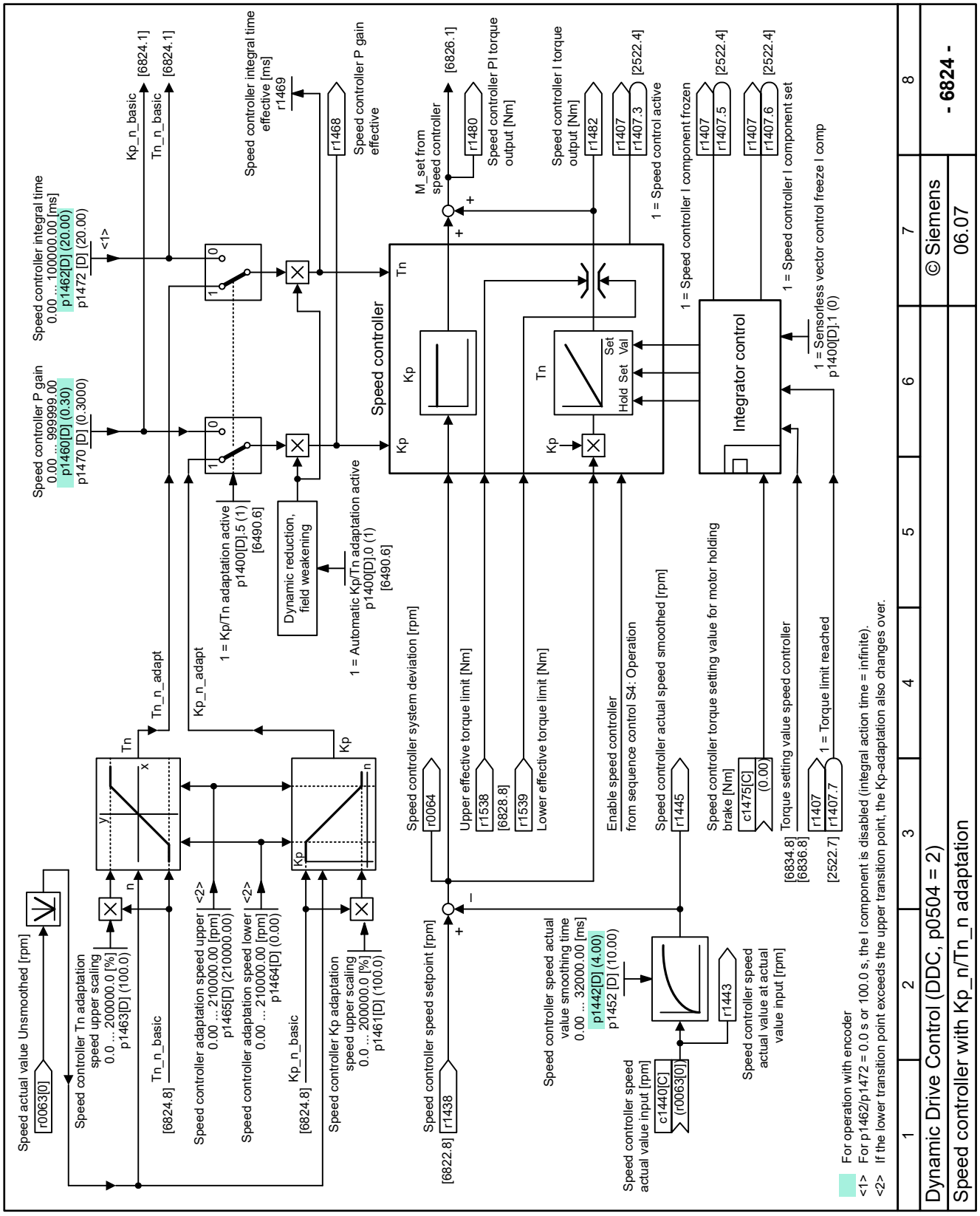


Figure 13-144 6824 - Speed controller with Kp_n-/Tn_n adaptation

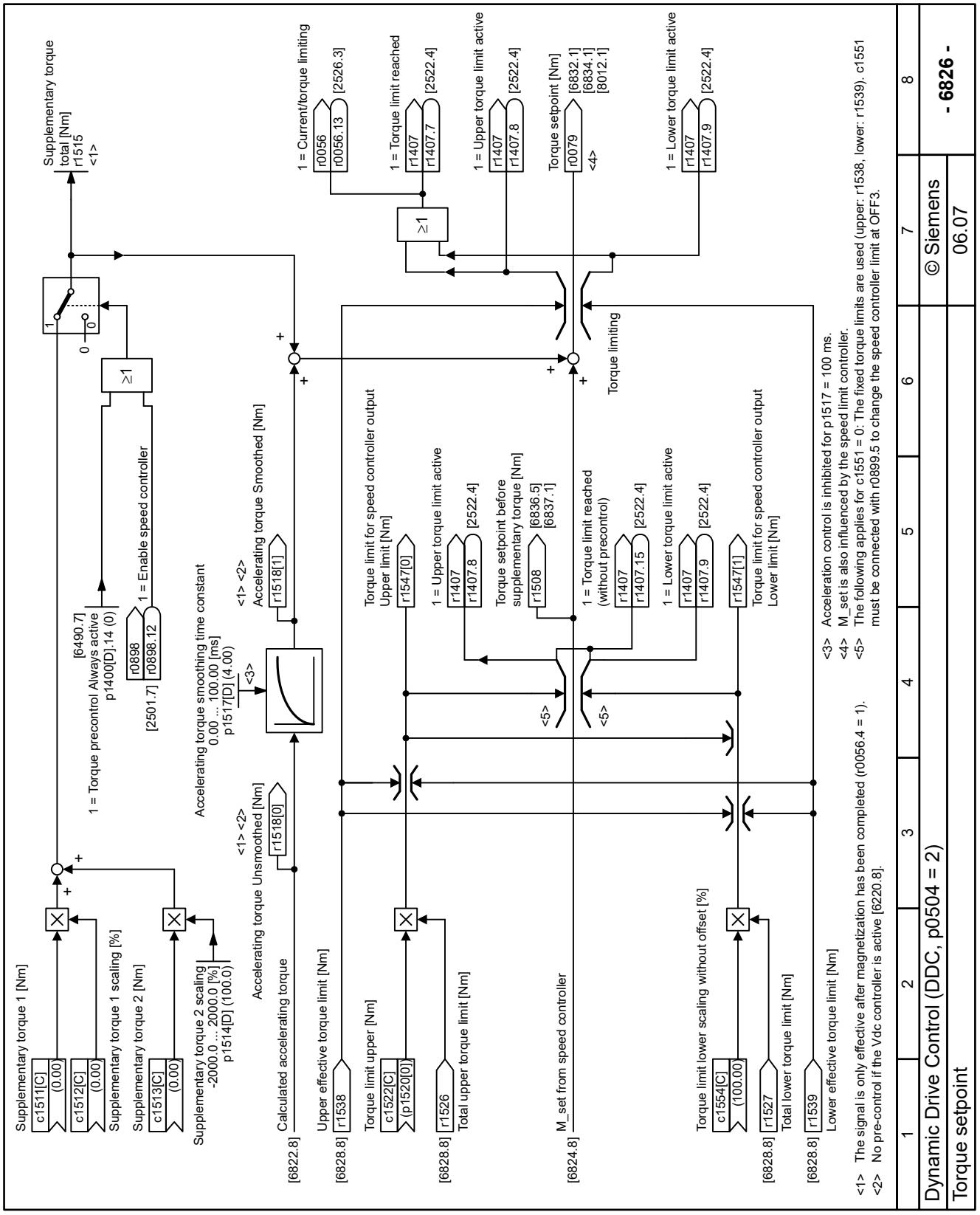


Figure 13-145 6826 - Torque setpoint

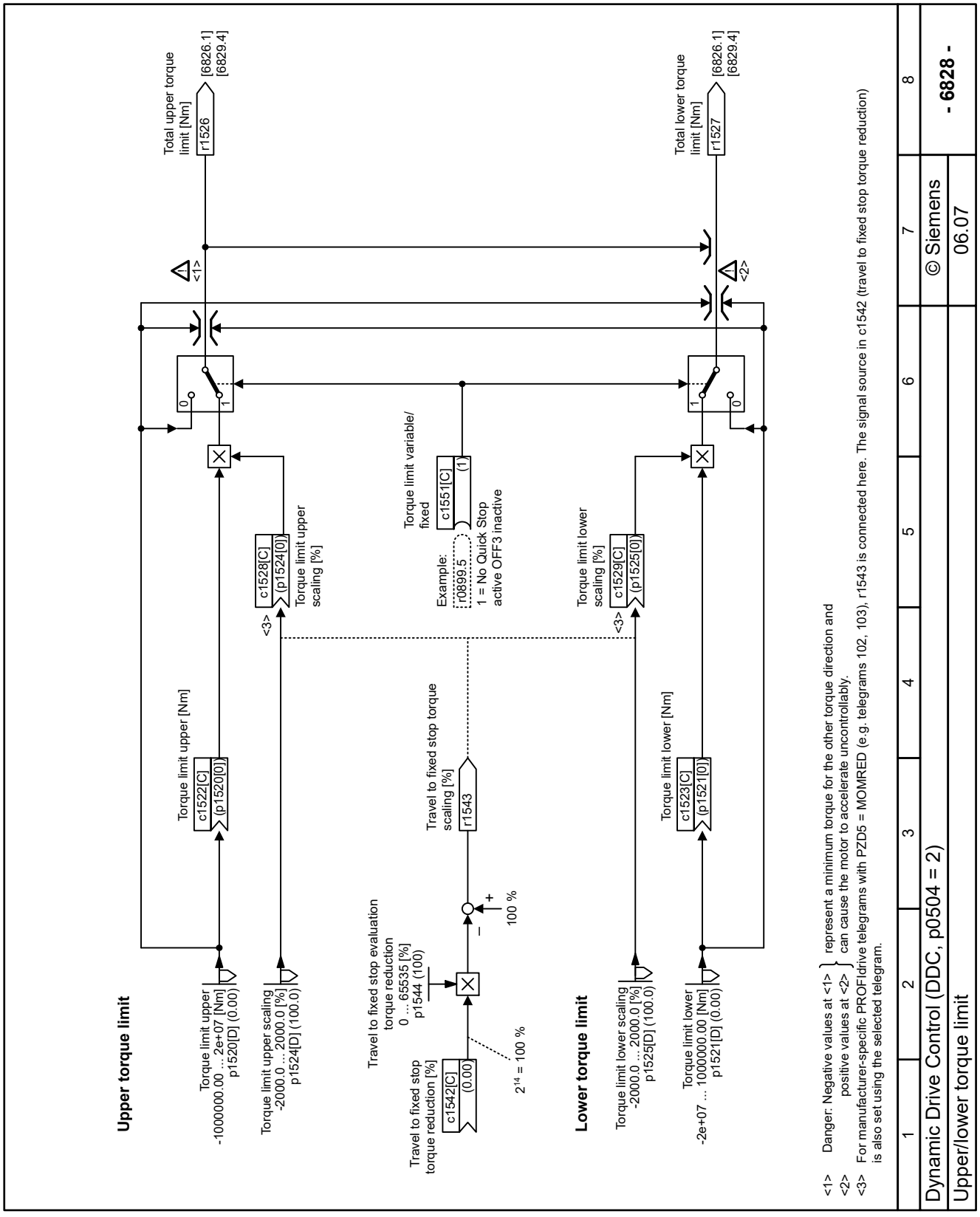


Figure 13-146 6828 - Upper/lower torque limit

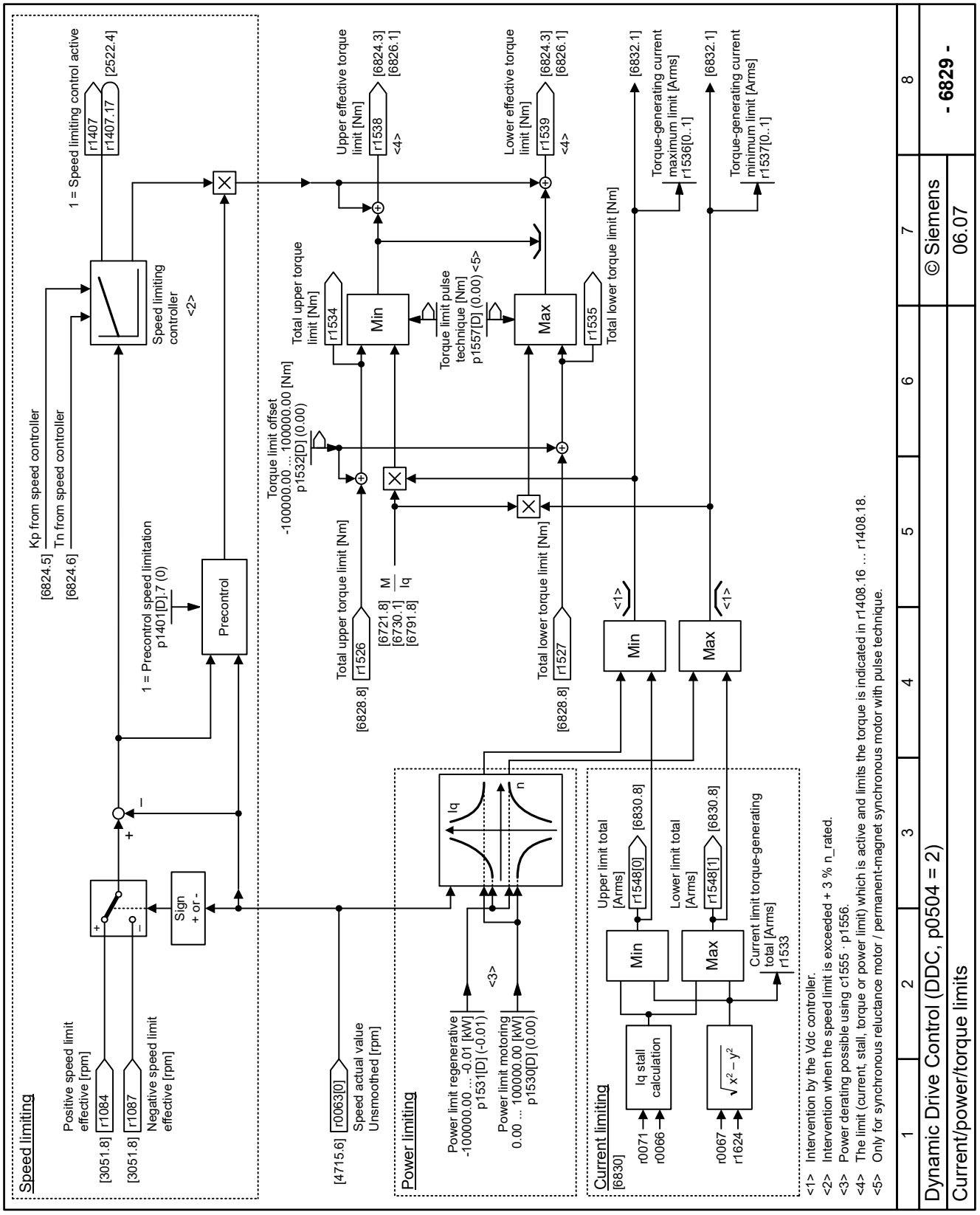


Figure 13-147 6829 - Current/power/torque limits

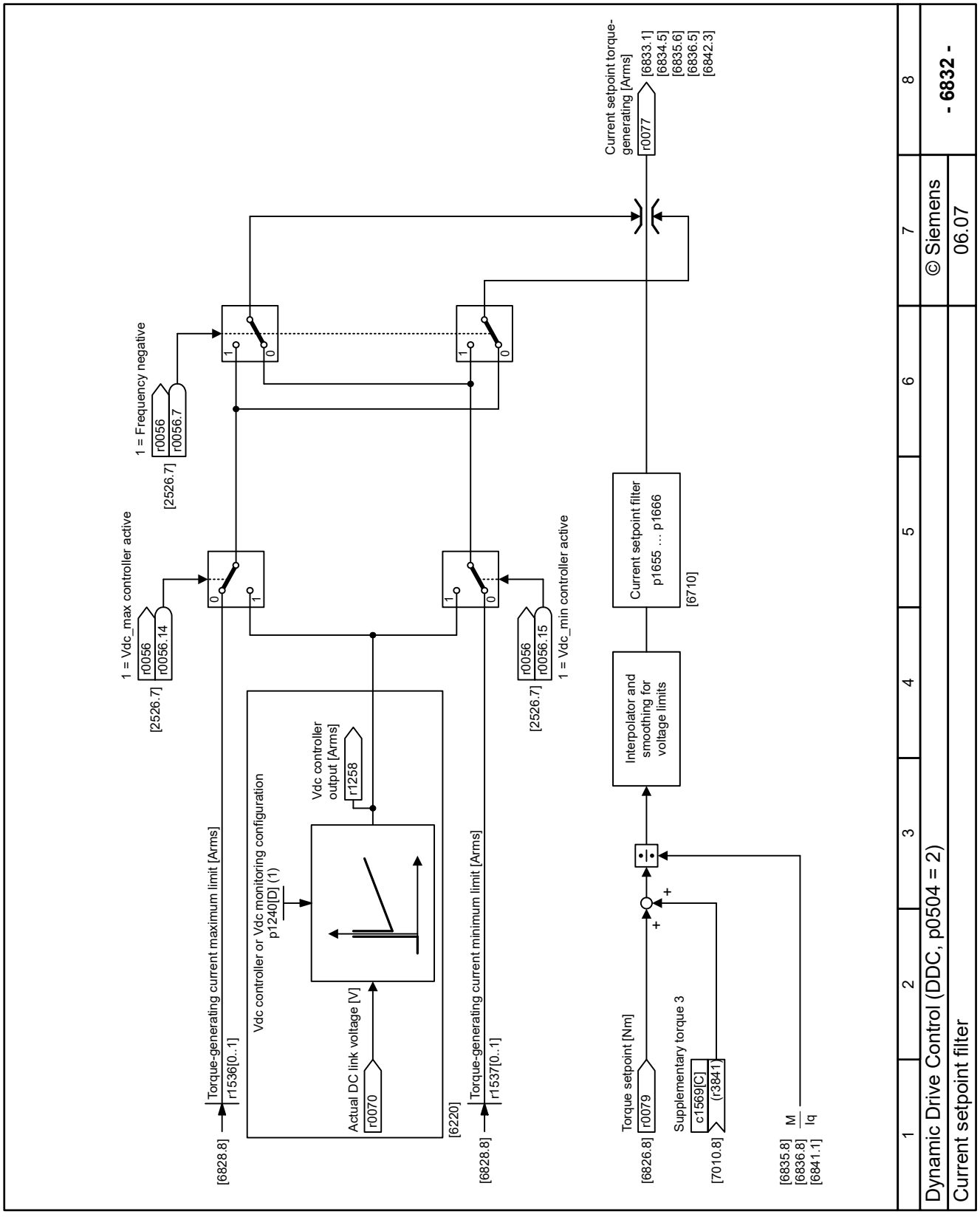


Figure 13-148 6832 - Current setpoint filter

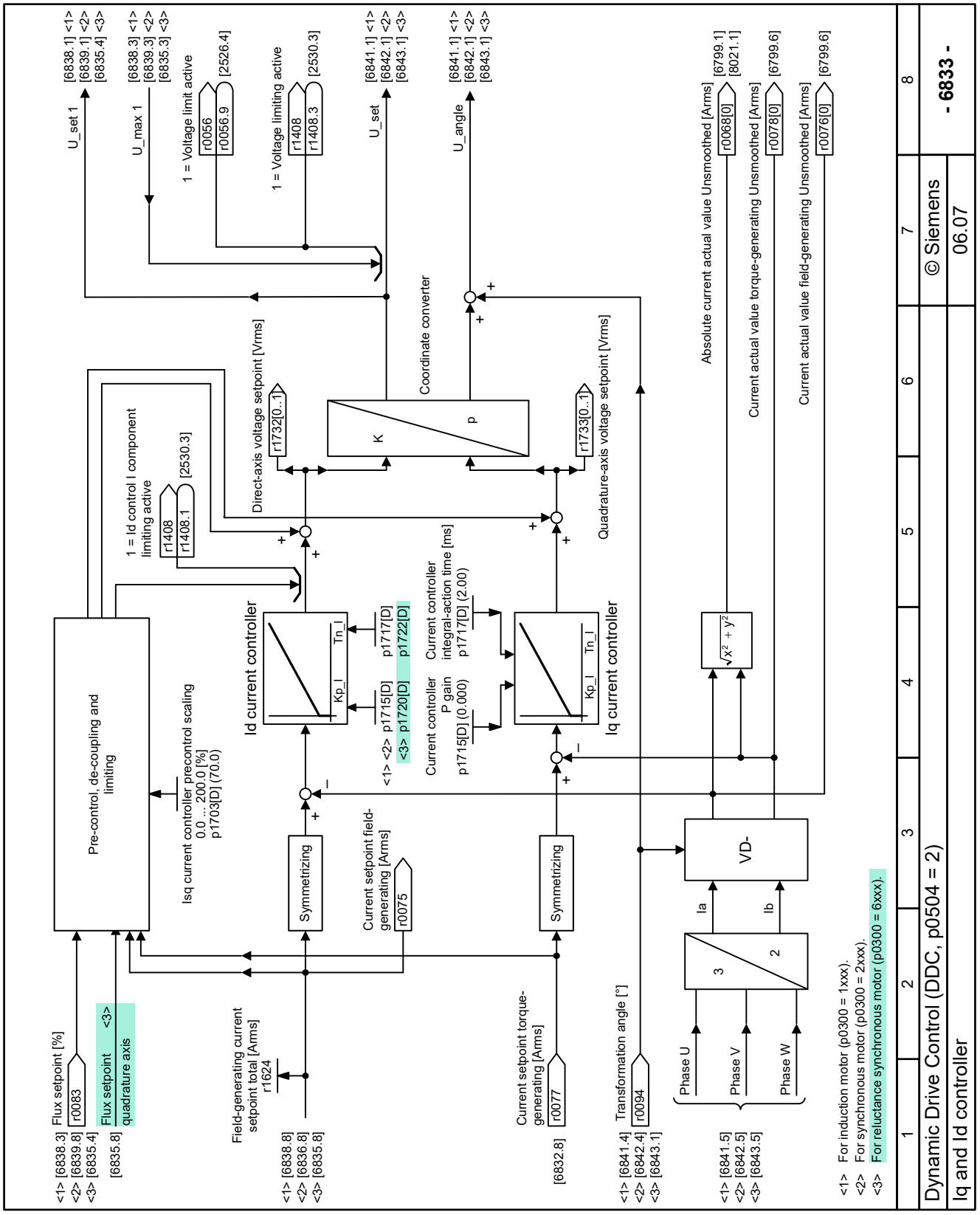


Figure 13-149 6833 - Iq and Id controllers

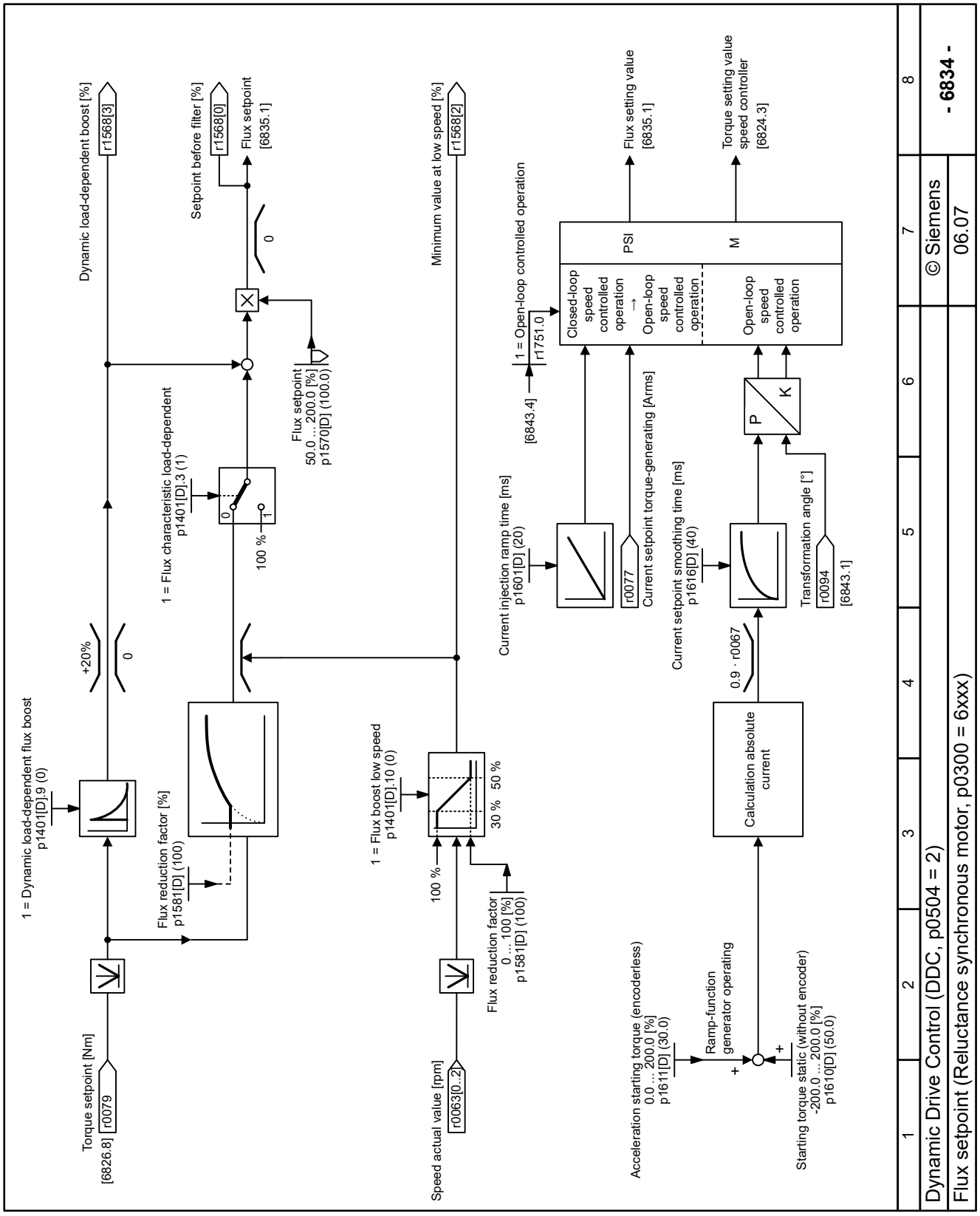


Figure 13-150 6834 - Flux setpoint (synchronous reluctance motor)

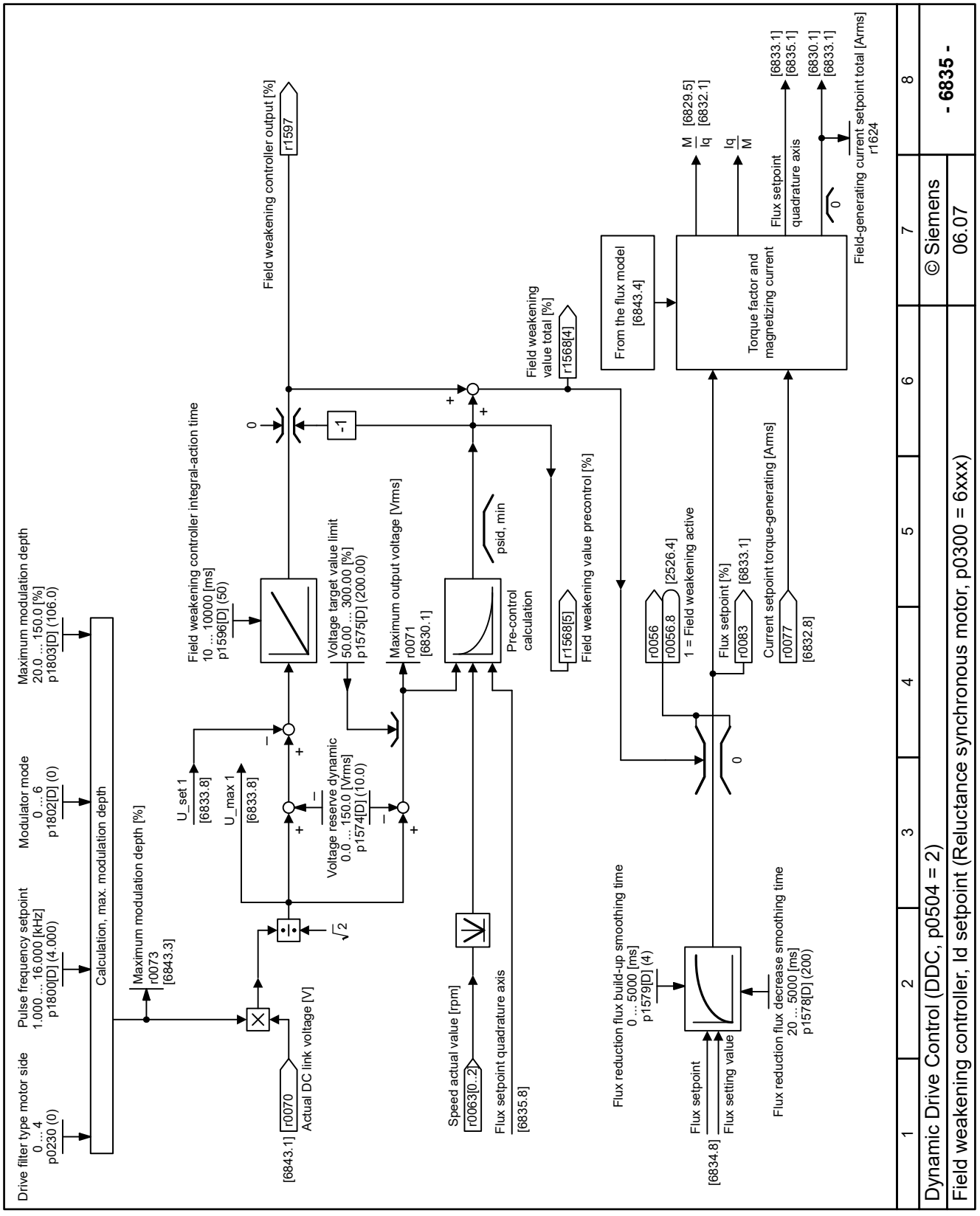


Figure 13-151 6835 – Field weakening controller, Id setpoint (synchronous reluctance motor)

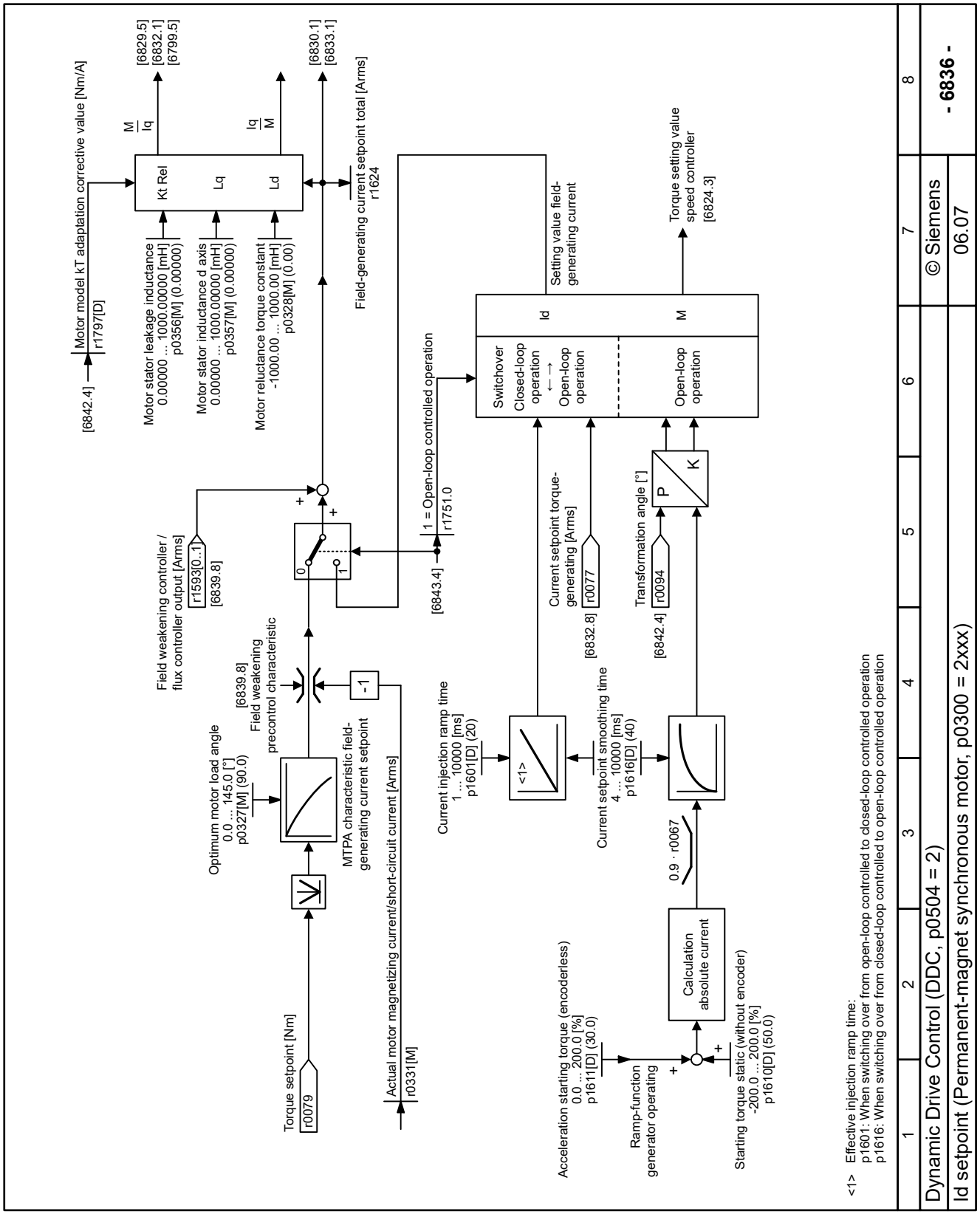


Figure 13-152 6836 - Id setpoint (permanent-magnet synchronous motor)

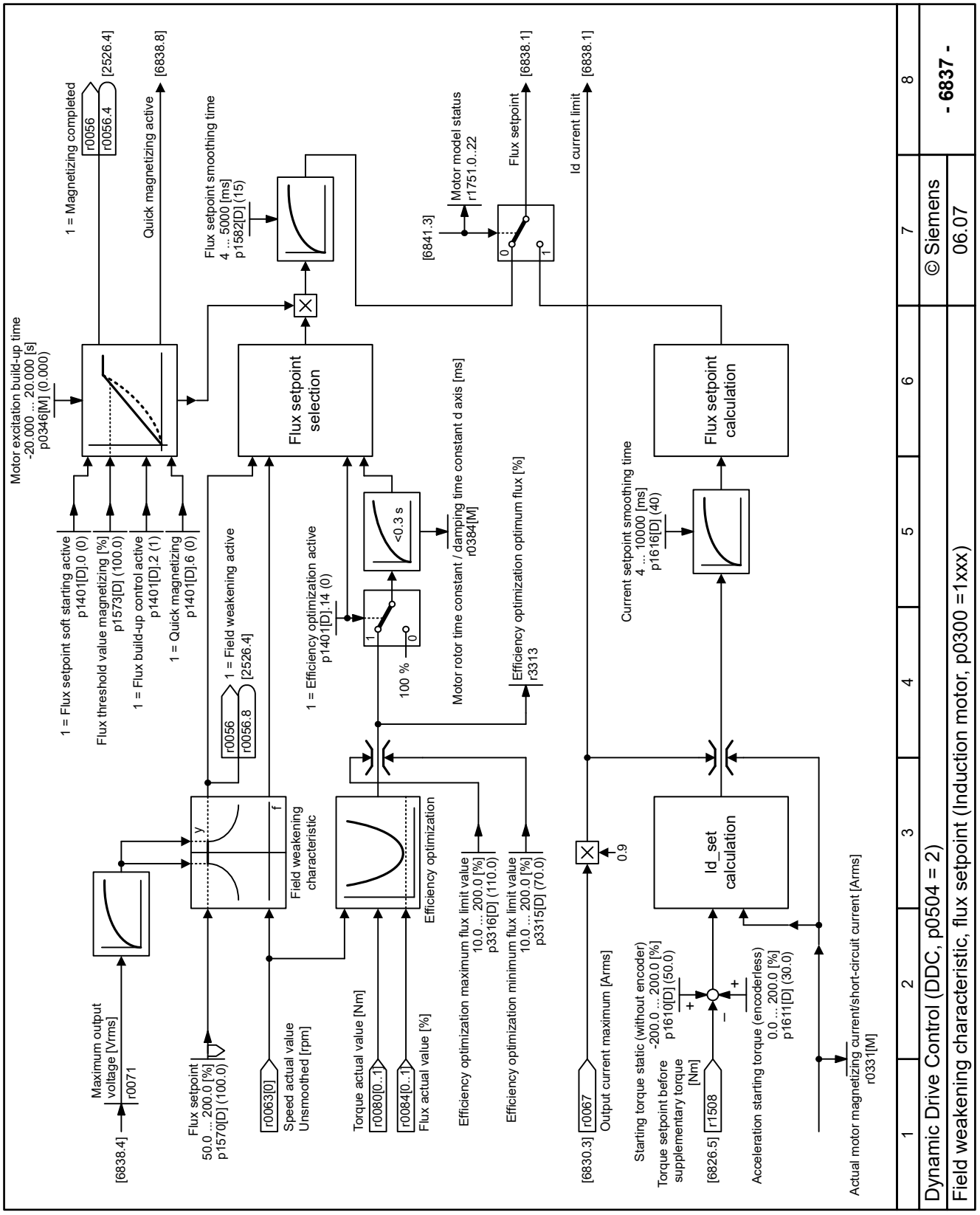


Figure 13-153 6837 – Field weakening characteristic, flux setpoint (induction motor)

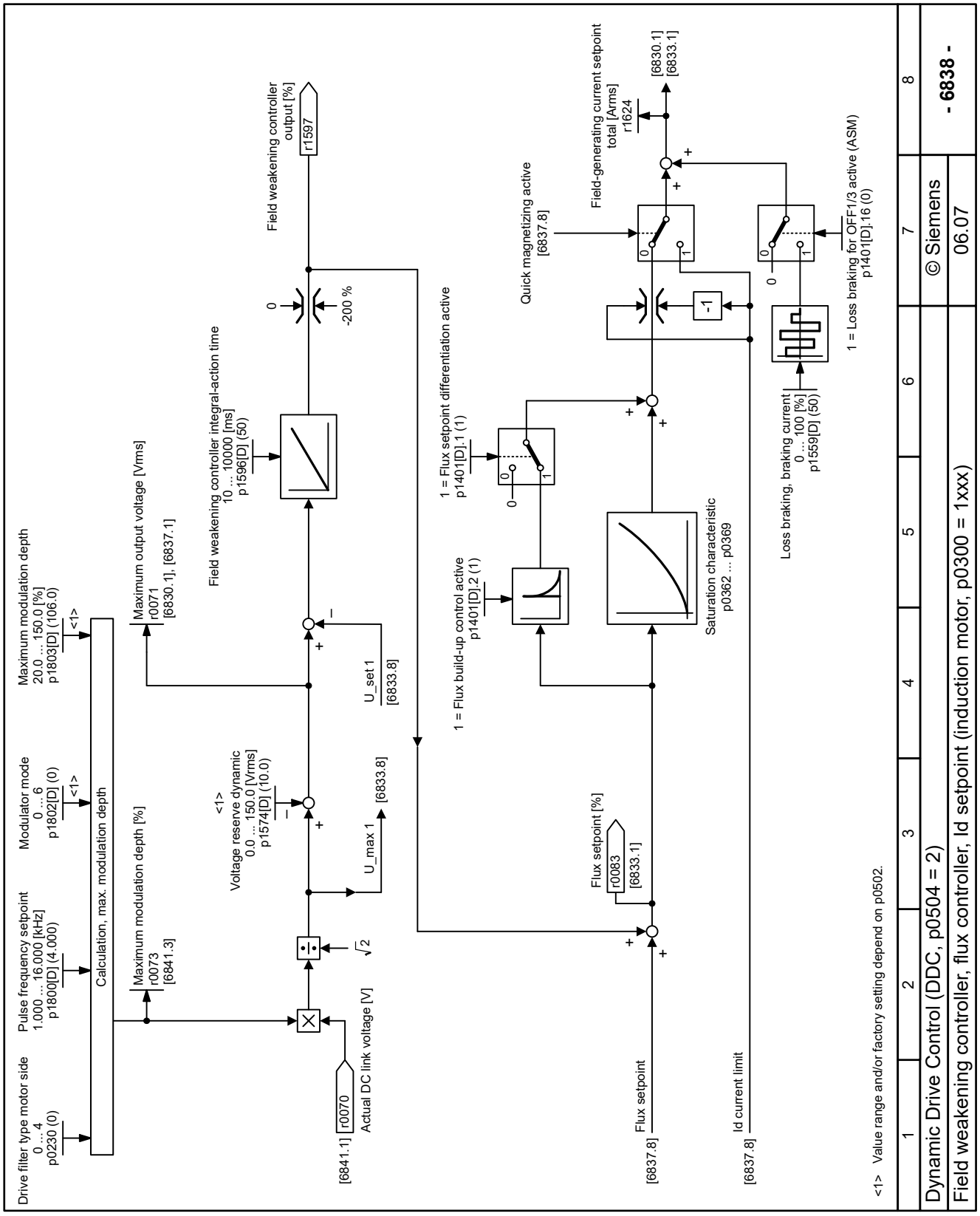


Figure 13-154 6838 – Field weakening controller, flux controller, Id setpoint (induction motor)

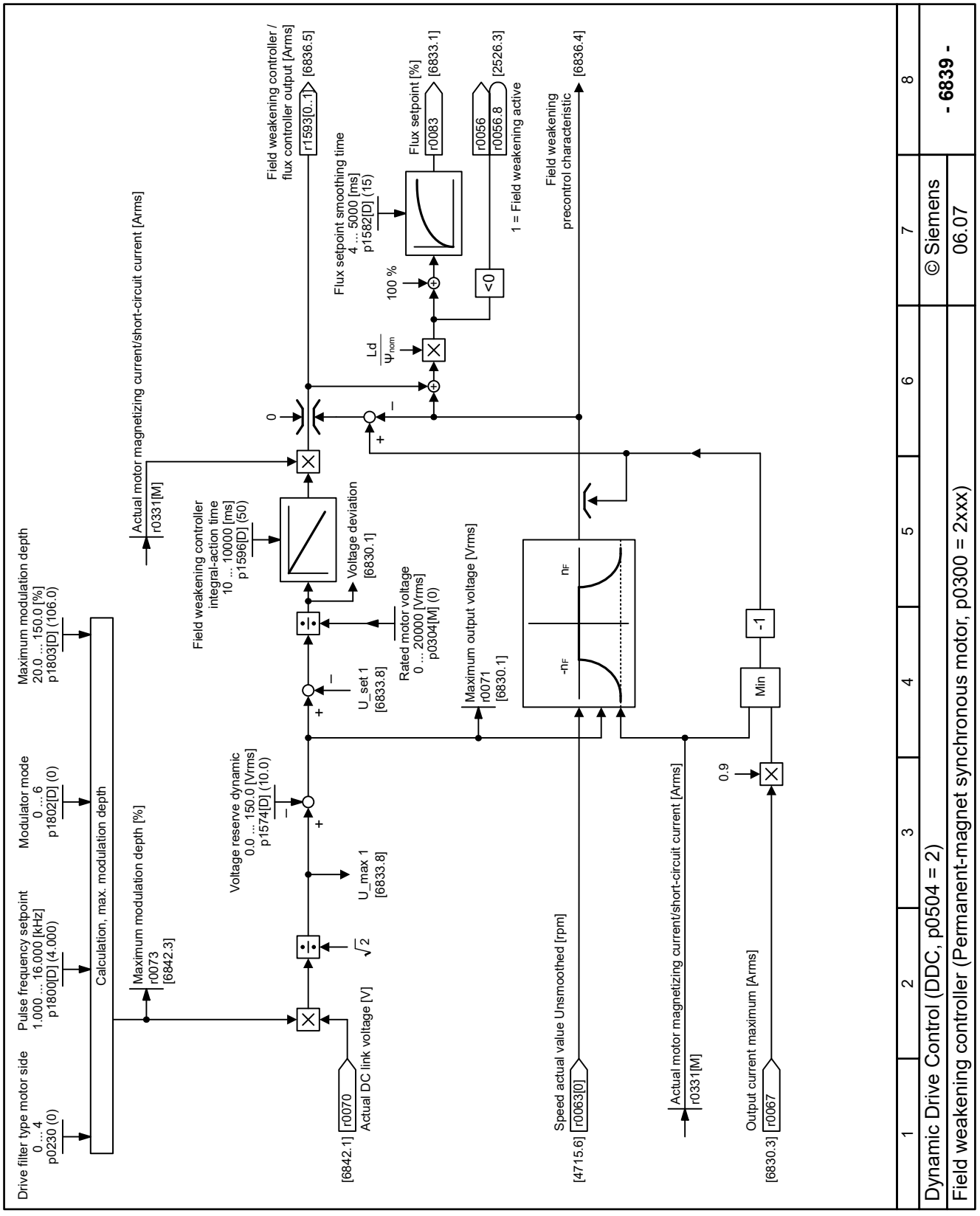


Figure 13-155 6839 - Field weakening controller (permanent-magnet synchronous motor)

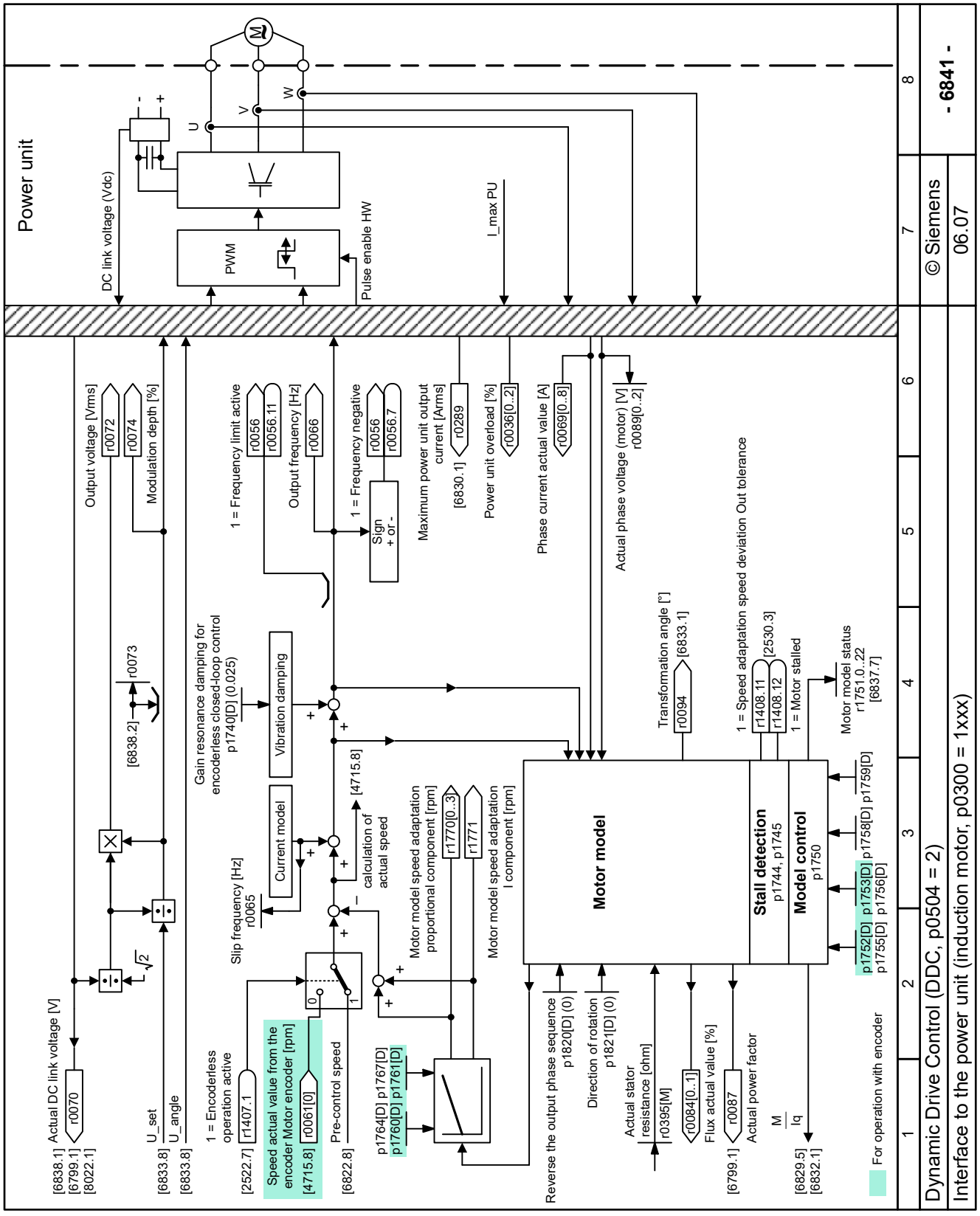


Figure 13-156 6841 - Interface to power unit (induction motor)

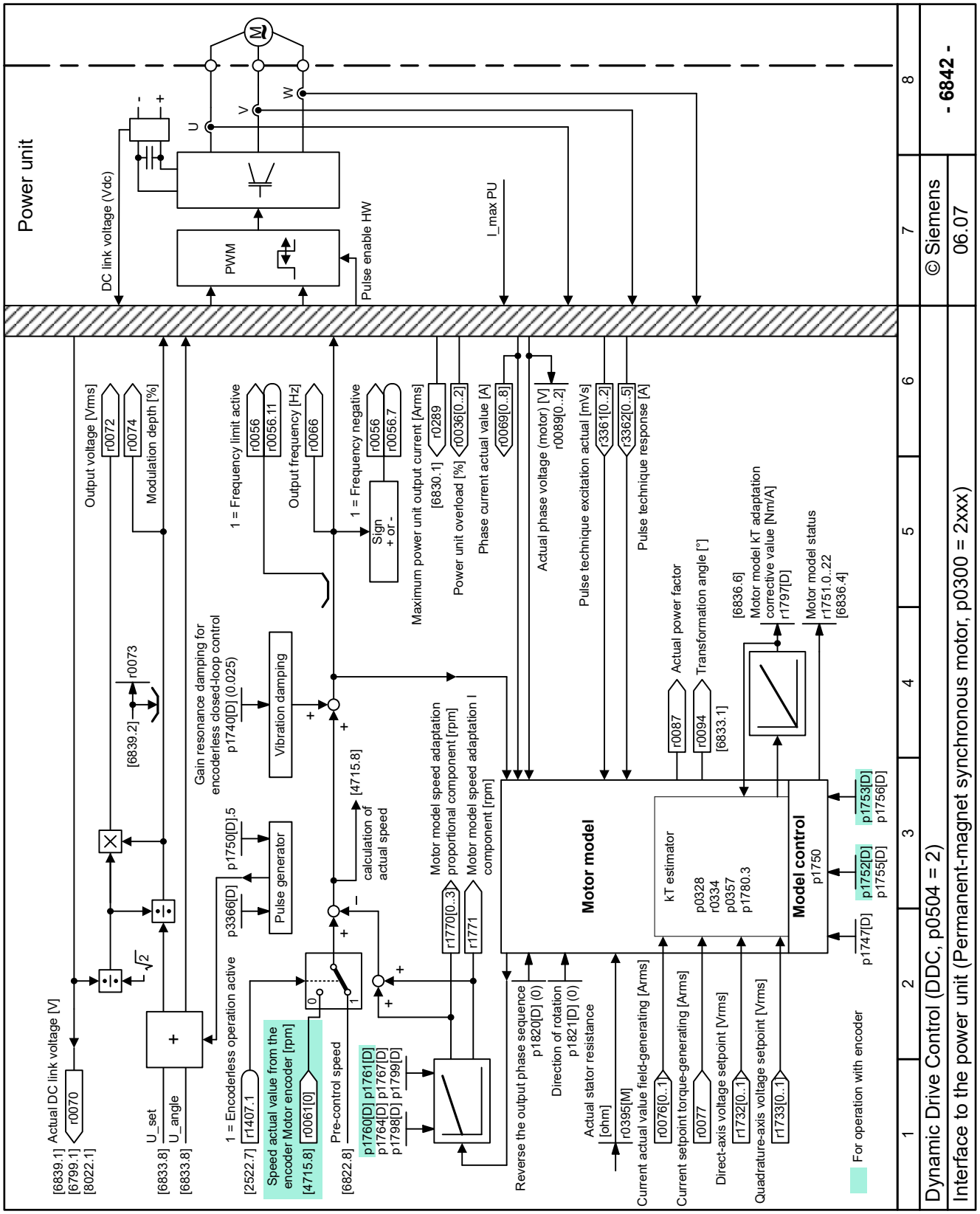


Figure 13-157 6842 - Interface to the power unit (permanent-magnet synchronous motor)

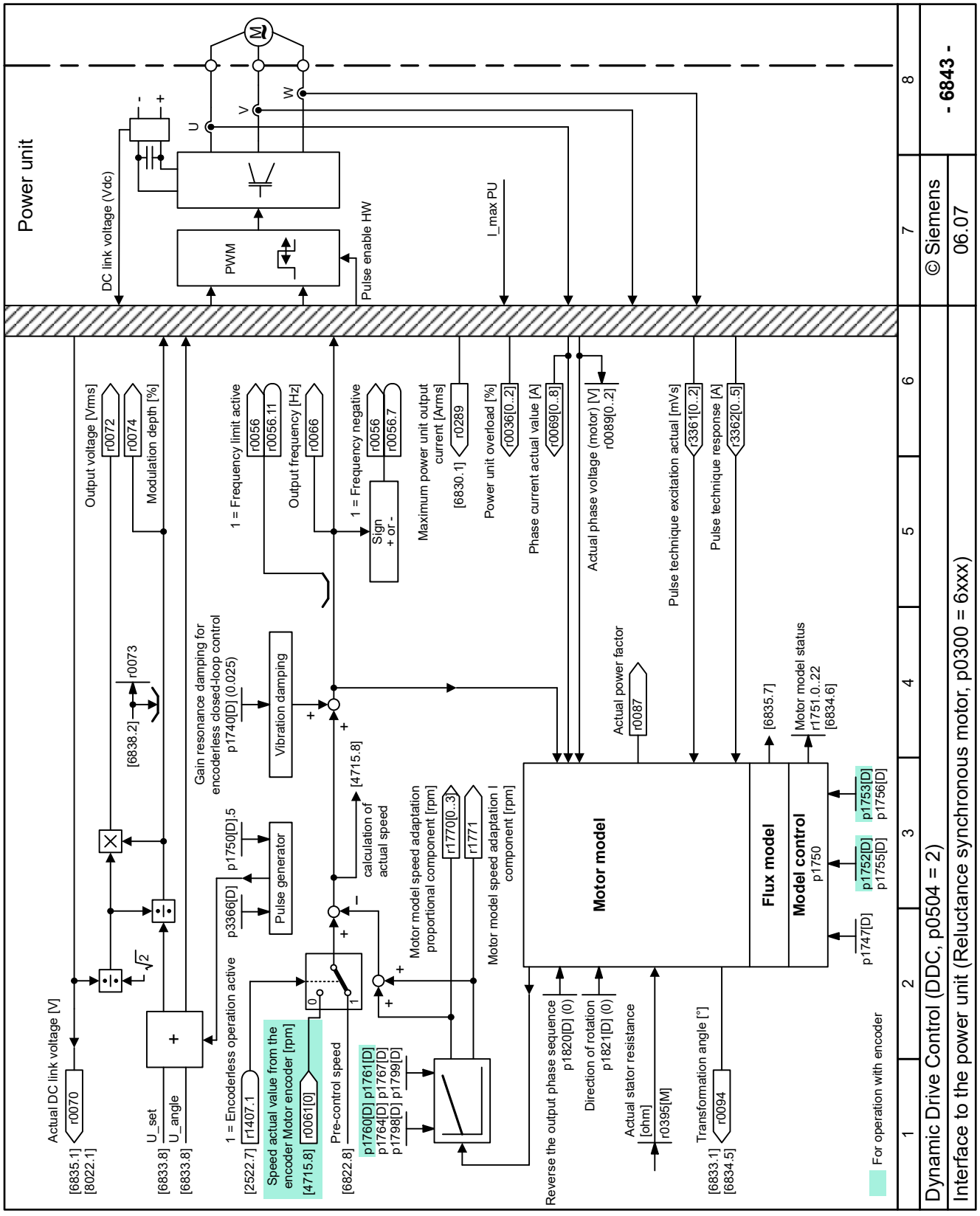


Figure 13-158 6843 - Interface to the power unit (synchronous reluctance motor)

13.12.8.2 Settings for the technological application for Dynamic Drive Control

Overview

The selected technological application optimizes the calculation of the open-loop and closed-loop control parameters in Dynamic Drive Control operating mode.

Function description

The following settings are available to select for motor control with parameter p0502.

Table 13-101 Setting of technological application in Dynamic Drive Control

0	Standard drive, e.g. pumps and fans	• Default setting for a synchronous motor with or without speed encoder
1	Dynamic starting or reversing	• Default setting for an induction motor without encoder • Recommended setting for applications with short ramp-up and ramp-down times of less than 10 s • Starting from standstill with closed-loop speed control Prerequisite: The speed setpoint at the ramp-function generator input is greater than the switchover speed p1755
2	Encoderless closed-loop control up to f = 0	• Setting for encoderless closed-loop control of an induction motor, reluctance motor and permanent-magnet synchronous motor • Closed-loop speed controlled operation of an induction motor at low speeds For an induction motor, p0500 = 2 is only suitable for operation with a passive load. A passive load does not accelerate a motor when it is in a no-current condition. Examples are pumps, fans, extruders, but not hoisting gear. • Encoderless closed-loop speed control of a synchronous motor from standstill (optimized pulse technique) – For reluctance motors – For permanent magnet synchronous motors

5	Starting with high break loose torque	• Setting for every motor type without an encoder • For speed-controlled operation at low speeds, the current is raised via p1610. • A break loose torque is a high load in the lower speed range • Increased default setting of the static torque setpoint (p1610)
6	High load inertia	• Setting for a drive with high power and a total moment of inertia at least 5 times higher than the motor moment of inertia • Increased default setting of speed actual value smoothing • Optimized default setting of the speed controller

13.12.8.3 Settings with dv/dt filter plus VPL

Overview

A dv/dt filter plus VPL at the converter's power output affects the drive control.

With suitable parameterization, the converter compensates the influence of the dv/dt filter on the drive control.

Precondition

Requirement for applications with dv/dt filter plus VPL:

- The dv/dt filter plus VPL is activated with p0230 = 2.
- Commissioning has been completed with the correct motor data.
- Motor data identification is completed with setting p1909.15 = 1 signal.

Procedure

We recommend the following settings if the motor stalls or has difficulty starting:

- Set p0247.00 to a 0 signal.
- Increase acceleration time p1120.

13.12.9 Operating mode "Other control mode", closed-loop torque control

Overview

Torque control is part of the speed control and is used when the speed controller has been disabled.

Requirement

Closed-loop torque control is only available in operating mode "Other control mode", closed-loop speed control:

- Select another control mode, p0504 = 0
- Encoderless closed-loop torque control, p1300 = 22
- Closed-loop torque control with encoder, p1300 = 23

Function description

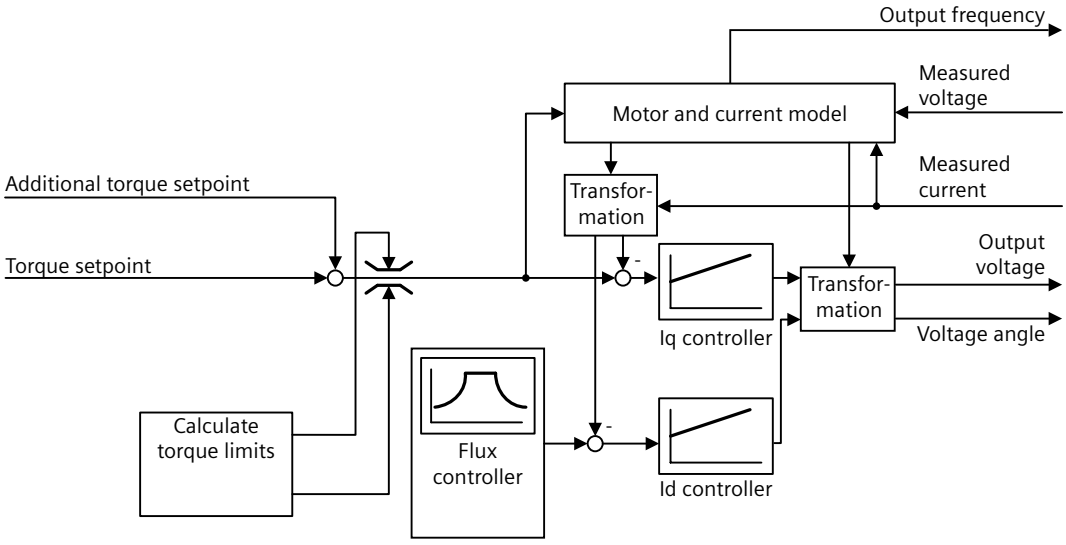


Figure 13-159 Simplified function diagram of the closed-loop torque control

The torque control normally receives its setpoint from the output of the speed controller. By disabling the speed controller and directly setting the torque setpoint, the closed-loop speed control becomes a closed-loop torque control. The converter then no longer controls the speed of the motor, but instead the torque that the motor generates.

Example

The torque control is used in applications where the motor speed is specified by the connected driven load. Typical examples of such applications include:

- Load distribution between lead and follower drives:
  The lead drive is speed controlled, the follower drive is torque controlled.
- Winding machines

Parameters

The following list contains the parameters of the "Torque control" function.

Number	Name	Unit
p0300[0...n]	Motor type selection	-

p0301[0...n]	Motor code number selection	-
r0302[0...n]	Motor code number of motor with DRIVE-CLiQ	-
r0303[0...n].0...8	Motor with DRIVE-CLiQ status word	-
p0304[0...n]	Rated motor voltage	Vrms
p0305[0...n]	Rated motor current	Arms
p0306[0...n]	Number of motors connected in parallel	-
p0307[0...n]	Rated motor power	kW
p0308[0...n]	Rated motor power factor	-
p0309[0...n]	Rated motor efficiency	%
p0310[0...n]	Rated motor frequency	Hz
p0311[0...n]	Rated motor speed	rpm
r0313[0...n]	Motor pole pair number, actual (or calculated)	-
p0314[0...n]	Motor pole pair number	-
p0316[0...n]	Motor torque constant	Nm/A
p0317[0...n]	Motor voltage constant	Vrms
p0318[0...n]	Motor stall current	Arms
p0320[0...n]	Motor rated magnetizing current/short-circuit current	Arms
p0322[0...n]	Maximum motor speed	rpm
p0323[0...n]	Maximum motor current	Arms
p0324[0...n]	Winding maximum speed	rpm
p0325[0...n]	Motor pole position identification current 1st phase	Arms
p0327[0...n]	Optimum motor load angle	°
p0328[0...n]	Motor reluctance torque constant	mH
p0329[0...n]	Motor pole position identification current	Arms
r0330[0...n]	Rated motor slip	Hz
r0331[0...n]	Actual motor magnetizing current/short-circuit current	Arms
r0332[0...n]	Rated motor power factor	-
r0333[0...n]	Rated motor torque	Nm
r0334[0...n]	Actual motor-torque constant	Nm/A
p0335[0...n]	Motor cooling type	-
r0336[0...n]	Actual rated motor frequency	Hz
r0337[0...n]	Rated motor EMF	Vrms
r0339[0...n]	Rated motor voltage	Vrms
p0341[0...n]	Motor moment of inertia	kgm²
p0342[0...n]	Ratio between the total and motor moment of inertia	-
p0344[0...n]	Motor mass (for the thermal motor model)	kg
r0345[0...n]	Nominal motor starting time	s
p0346[0...n]	Motor excitation build-up time	s
p0347[0...n]	Motor de-excitation time	s
p0349	System of units motor equivalent circuit diagram data	-
p0350[0...n]	Motor stator resistance cold	ohm
p0351[0...n]	Motor stator resistance 20 °C	ohm
p0352[0...n]	Cable resistance	ohm
p0353[0...n]	Motor series inductance	mH
p0354[0...n]	Motor rotor resistance cold / damping resistance d axis	ohm
p0356[0...n]	Motor stator leakage inductance	mH
p0357[0...n]	Motor stator inductance d axis	mH
p0358[0...n]	Motor rotor leakage inductance / damping inductance d axis	mH

p0360[0...n]	Motor magnetizing inductance/magn. inductance d axis saturated	mH
p1300[0...n]	Open-loop/closed-loop control mode	-
c1511[0...n]	Supplementary torque 1	Nm
p1520[0...n]	Torque limit upper	Nm
p1521[0...n]	Torque limit lower	Nm
p1530[0...n]	Power limit motoring	kW
p1531[0...n]	Power limit regenerative	kW

13.12.10 Encoderless closed-loop speed control of a synchronous motor from standstill

Overview

Function "Encoderless closed-loop speed control of a synchronous motor from standstill" (optimized pulse technique) extends the range of applications of an encoderless synchronous motor:

- Closed-loop speed controlled operation from speed = 0
  No open-loop controlled operation at speeds close to 0
- Starting with high load
- Acceleration with ramp-up times close to 0
- Encoderless torque control possible

Precondition

The following motors are suitable for the function:

- Synchronous reluctance motor
- Permanent-magnet synchronous motor
  The function requires an adequately high magnetic anisotropy of the permanent-magnet synchronous motor and is therefore not suitable for every motor.
  For a third-party motor, the stationary measurement of the motor identification is required.

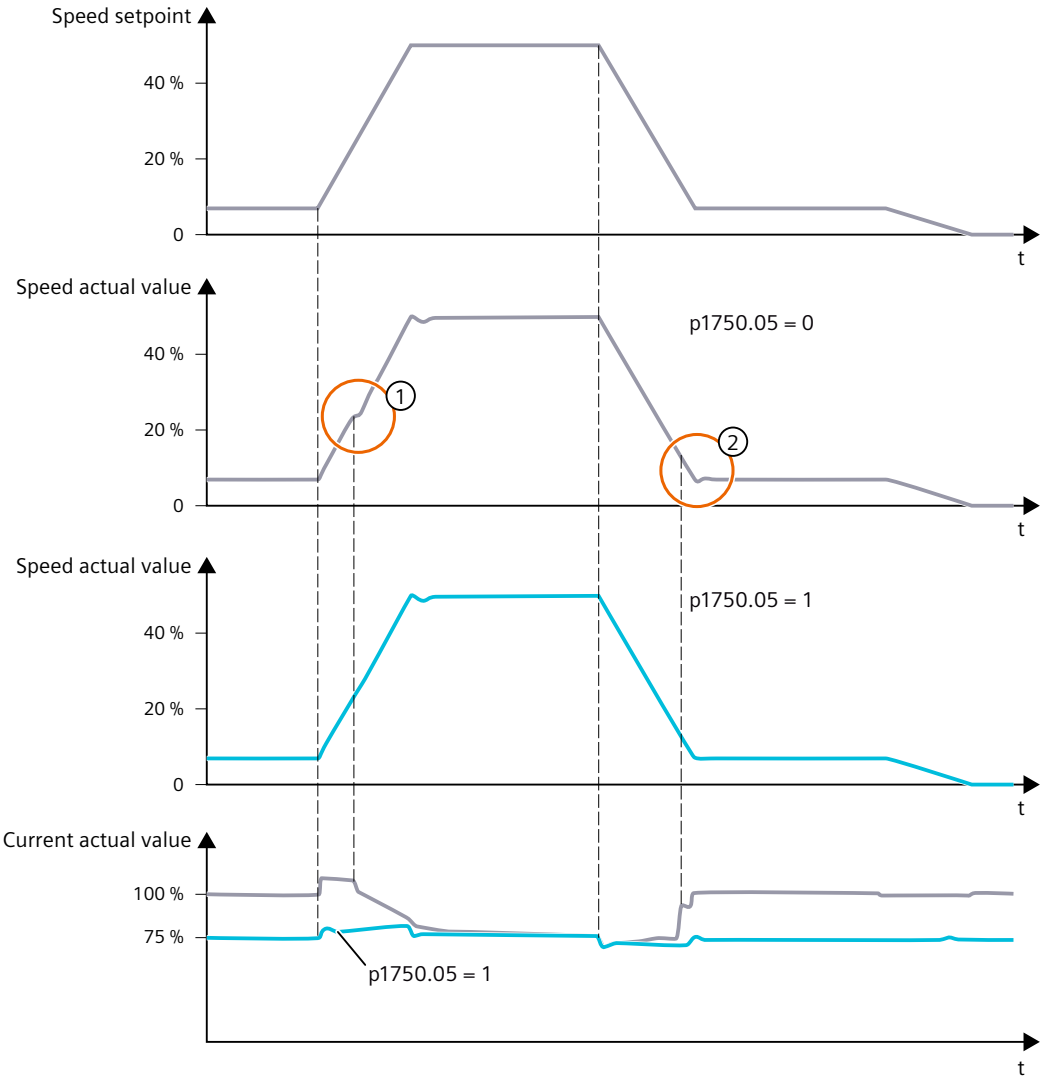
Function description

Function "Encoderless closed-loop speed control of a synchronous motor from standstill" (optimized pulse technique) acquires the rotor position and speed of an encoderless synchronous motor at speeds close to 0 down to standstill of the motor.

An optimized pulse technique is used to acquire the rotor position.

p1750.05 = 1 activates the function.

The following diagram provides a qualitative illustration of the differences between the actual speed value and actual current value with and without the optimized pulse technique.



① Transition from open-loop controlled into closed-loop controlled operation of the motor
② Transition from closed-loop controlled into open-loop controlled operation of the motor

Figure 13-160 Typical motor response with and without the optimized pulse technique

Without the optimized pulse technique, the motor is in open-loop controlled operation at speeds close to 0.

The optimized pulse technique enables closed-loop controlled operation of the motor down to standstill.

The optimized pulse technique reduces the motor current at speeds close to 0. Continuous duty with high loads is also possible at speeds close to 0.

Parameters

The following list contains the parameters of the "Encoderless speed control synchronous reluctance motor from standstill" function.

Number	Name	Unit
p1747[0...n]	Motor model pulse technique transition speed	rpm
p1750[0...n].0...10	Motor model configuration	-
r1751.0...22	Motor model status	-
p1798[0...n]	Motor model pulse technique speed adaptation Kp	-
p1799[0...n]	Motor model pulse technique speed adaptation Tn	ms
r3361[0...2]	Pulse technique excitation actual	mVs
r3362[0...5]	Pulse technique response	A
p3366[0...n]	Pulse technique excitation	mVs
r3963[0...3]	Current actual values pulse technique	A
r3964[0...1]	Voltage-time areas actual values pulse technique	mVs
r3965[0...1]	Voltage-time areas setpoints pulse technique	mVs

13.12.11 Speed actual value

Overview

The speed control receives the speed actual value either from the signal of a sensor or from a motor and current model.

Function description

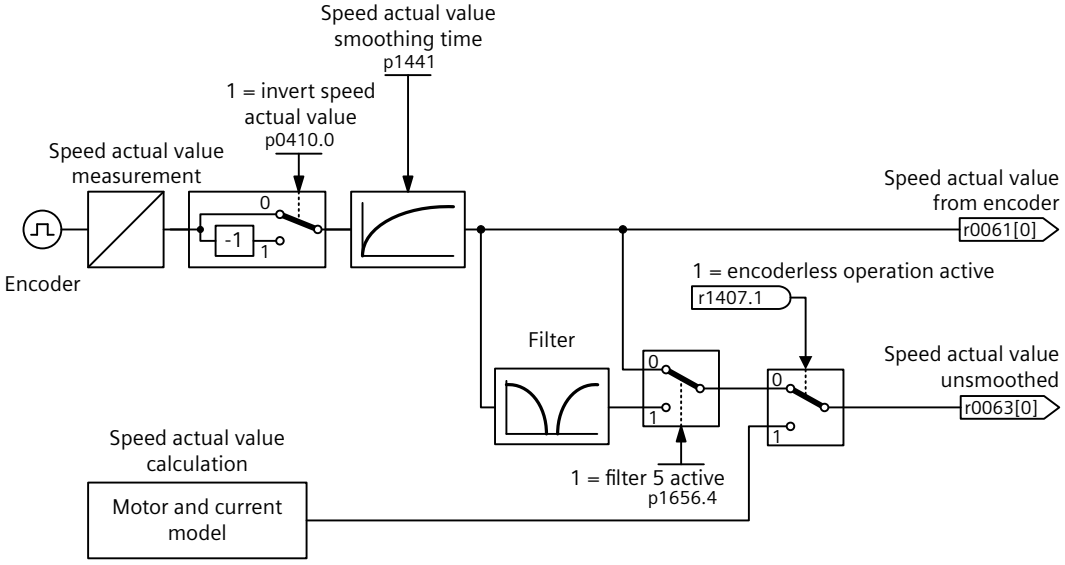


Figure 13-161 Simplified function diagram of the speed actual value

Without encoder, the drive control uses the calculated speed actual value from a motor and current model.

With encoder, the closed-loop drive control uses the measured actual speed value.

When appropriately set, the closed-loop drive control switches over to the calculated actual speed value when an encoder fault occurs.

In the factory setting, the unsmoothed speed actual value r0063[0] is interconnected with the numerical signal sink c1440 and provides the input signal for the speed control.

p1656 activates a filter for the speed actual value.

Parameters

The following list contains the parameters of the "Speed actual value" function.

Number	Name	Unit
r0061[0...2]	Speed actual value from the encoder	rpm
r0063[0...2]	Speed actual value	rpm
p0410[0...n].0...1	Encoder invert actual value	-
r1407.0...31	Status word speed controller	-
c1440[0...n]	Speed controller speed actual value input	rpm
p1441[0...n]	Actual speed smoothing time	ms
p1442[0...n]	Speed controller speed actual value smoothing time	ms
r1443	Speed controller speed actual value at actual value input	rpm
p1656[0...n].0...4	Current setpoint/Speed actual value filter activation	-

13.12.12 Speed actual value filter

Overview

The speed actual value filter reduces mechanical oscillations in the drive system.

Description of function

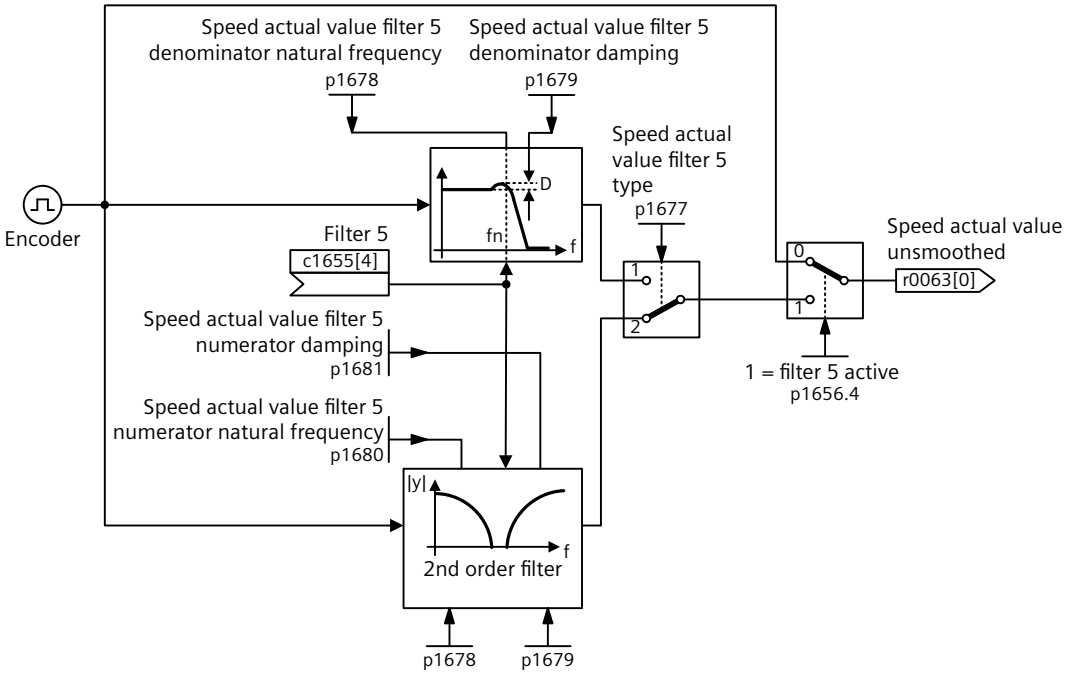


Figure 13-162 Simplified function diagram of the speed actual value filter

p1656.4 activates the filter for the speed actual value of the encoder.

p1677 defines the type of the speed actual value filter:

- 2nd order lowpass, PT2 element with damping of -40 dB/decade
- General 2nd order filter

Parameters

The following list contains the parameters of the "Speed actual value filter" function.

Number	Name	Unit
c1655[0...4]	Current setpoint/Speed actual value filter nat. frequency tuning	%
p1656[0...n].0...4	Current setpoint/Speed actual value filter activation	-
p1677[0...n]	Speed actual value filter 5 type	-
p1678[0...n]	Speed actual value filter 5 denominator natural frequency	Hz
p1679[0...n]	Speed actual value filter 5 denominator damping	-
p1680[0...n]	Speed actual value filter 5 numerator natural frequency	Hz
p1681[0...n]	Speed actual value filter 5 numerator damping	-
p1699	Filter data acceptance	-

13.12.13 Speed controller

Overview

The speed controller ensures that the motor follows its speed setpoint.

Requirement

The converter calculates the speed controller setting when commissioning and performs the rotating measurement during the motor data identification.

Function description

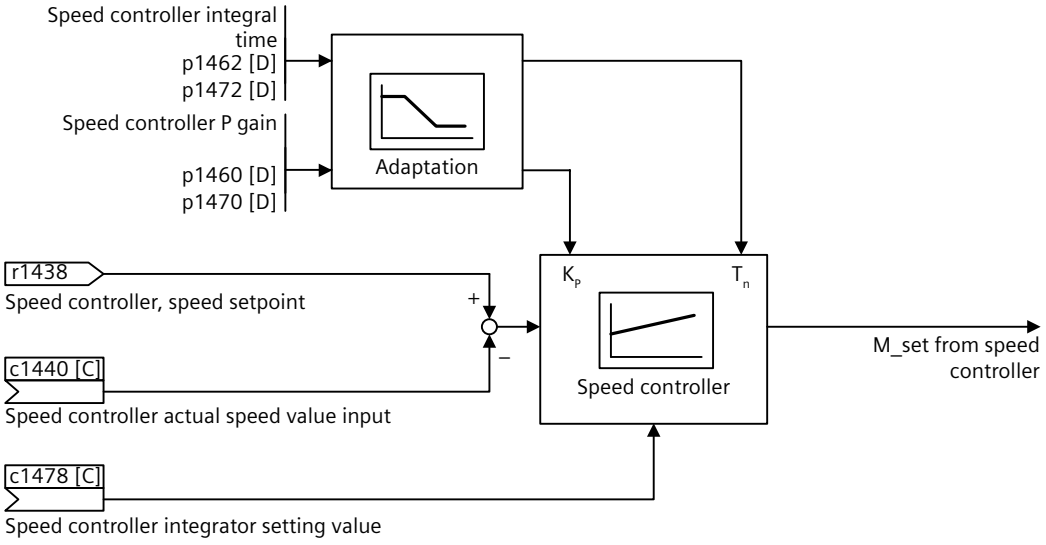


Figure 13-163 Simplified representation of the speed controller

The speed controller responds to a difference between the speed setpoint and speed actual value by changing torque setpoint M_set. The torque setpoint specifies the motor torque. Depending on the torque, the motor either accelerates or brakes and changes its speed until the speed setpoint is reached.

For applications involving hoisting gear or hoisting mechanisms the integrator setting value specifies a torque when the motor starts. The torque when the motor starts prevents the load temporarily sagging immediately after the speed controller has been enabled.

The optional adaptation of the integral time and the P gain suppresses motor speed oscillations.

In the factory setting, the speed actual value is interconnected with the smoothed speed actual value r0063[0].

The speed controller also interprets every other interconnection of c1440 with a numerical signal source as speed actual value. In this case, the interconnected numerical signal source must be scaled corresponding to p2000.

Parameters

The following list contains the parameters of function "Speed controller".

Number	Name	Unit
p0230	Drive filter type motor side	-
p0235	Motor reactor in series number	-
p0342[0...n]	Ratio between the total and motor moment of inertia	-
p0350[0...n]	Motor stator resistance cold	ohm
p0352[0...n]	Cable resistance	ohm
p1441[0...n]	Actual speed smoothing time	ms
p1442[0...n]	Speed controller speed actual value smoothing time	ms
p1452[0...n]	Speed controller speed actual value smoothing time (sensorless)	ms
p1460[0...n]	Speed controller P gain	-
p1462[0...n]	Speed controller integral time	ms
p1470[0...n]	Speed controller encoderless operation P gain	-
p1472[0...n]	Speed controller encoderless operation integral time	ms
p1496[0...n]	Acceleration precontrol scaling	%
p1610[0...n]	Starting torque static (without encoder)	%
p1750[0...n].0...10	Motor model configuration	-

13.12.14 Checking the encoder signal

Overview

Check the scaling and polarity of the encoder signal before the encoder feedback becomes active.

Requirement

The encoder feedback is not yet active.

Procedure

Proceed as follows to check the encoder signal:

1. Set the control mode "Encoderless speed control": p1300 = 20.
2. Switch-on the motor with an average speed.
3. Compare parameters r0061 (speed encoder signal in r/min) and r0021 (calculated speed in r/min) regarding the sign and absolute value.
4. If the signs do not match, invert the speed encoder signal: Set p0410 = 1.
5. If the absolute values of the two values do not match, check the setting of p0408 and the encoder wiring.

13.12.15 Setting closed-loop speed control for critical applications

Overview

If, in spite of automatic optimization, the closed-loop speed control is unstable, then this can be resolved by manually setting some parameters.

Requirement

The following applications are critical when it comes to automatically setting the closed-loop speed control:

- The load moment of inertia is significantly higher than the motor moment of inertia.
- Gearbox play or coupling play between the motor and load machine
- Torsionally flexible coupling between the motor and the load machine

Procedure

We recommend the following settings to handle critical applications:

- Encoderless closed-loop speed control
  - Increase the smoothing of the actual speed value (p1452).
  - Increase the integral time T_I: p1472 ≥ 4 · p1452.
  - If, after these measures, the speed closed-loop speed control does not operate with an adequate dynamic performance, increase the gain K_P step by step (p1470).
- Closed-loop speed control with encoder
  - In the closed-loop speed control, increase the smoothing of the actual speed value (p1442).
  - In the encoder evaluation, increase the smoothing of the actual speed value: p1441 = 2 ... 4 ms.
  - Increase the integral time T_I: p1462 ≥ 4 · p1442
  - If, after these measures, the closed-loop speed control does not operate with an adequate dynamic performance, increase the gain K_P step by step (p1460).

You have set the motor closed-loop control for critical applications.

13.12.16 Settings for a pulling load

Overview

For a pulling load, e.g. a hoisting gear, a permanent force is exerted on the motor.

For a pulling load, we recommend that you use closed-loop speed control with an encoder.

For encoderless closed-loop speed control a number of special settings are required to further ensure safe operation.

Precondition

⚠ WARNING

The load falls due to incorrect closed-loop control settings

For encoderless speed control, the converter calculates the actual speed based on an electric motor model. In applications with pulling loads - e.g. hoisting gear, lifting tables or vertical conveyors - an incorrectly set motor model or other incorrect settings can mean that the load falls. A falling load can result in death or serious injury.

- Carefully follow the setting recommendations.

Precondition for applications with pulling load:

- Correctly set the motor data during quick setup.
- Carry out the motor data identification.

Procedure

For a pulling load, we recommend the following settings for the motors:

- Motor with encoder
  - Before switching on, enter a speed setpoint > 0.
    As a consequence, the speed controller establishes the setpoint torque more quickly.
- Encoderless induction motor
  - Before switching on and before enabling the pulses, enter a speed setpoint > p1755.
  - For speed setpoint = 0, and with the motor holding brake open, the load drops because the induction motor rotates backwards with the slip frequency as a result of the pulling load.
  - Set the ramp-up and ramp-down times ≤ 10 s in the ramp-function generator.
  - To avoid open-loop speed controlled operation, close the holding brake and at standstill, switch the converter off.
  - For safety reasons, in p1610 set an absolute current value that is high enough so that the heaviest load that occurs can be held at the constant setpoint speed.
  - If, in quick setup, you have selected the Dynamic Drive Control operating mode, set p0502 = 1 (technological application: dynamic starting or reversing).

- Encoderless synchronous-reluctance motor and permanent-magnet synchronous motor with reluctance component
  - Set p1750.05 = 1.
    With this setting, use function "Encoderless closed-loop speed control of a synchronous motor from standstill" (optimized pulse technique). The motor responds like a motor equipped with an encoder.
- Other encoderless synchronous motors
  - For safety reasons we recommend using a synchronous motor with encoder.
  - If you are using an encoderless synchronous motor, in p1610 set an absolute current value that is high enough so that the highest load that occurs can be held at a constant setpoint speed.

13.12.17 Speed controller precontrol

Overview

The speed controller precontrol improves the response to setpoint changes of the speed control loop. The speed controller precontrol calculates the required acceleration torque and specifies the acceleration torque directly to the torque controller, bypassing the speed controller.

Precondition

With speed controller optimization, the converter determined the motor moment of inertia and the total moment of inertia of the load.

The speed controller optimization activates the speed controller precontrol with p1496 = 100%.

When accelerating and braking, the motor speed follows the setpoint without the motor reaching its torque limit.

We recommend that the extended ramp-function generator is used with rounding times > 0.

To avoid sudden torque changes, the speed setpoint only changes continuously, i.e. without any signal steps and without any disturbing signal.

Function description

A parameter value p1496 > 0 activates the speed controller precontrol.

The speed controller precontrol calculates the required acceleration torque r1518 from the following variables:

- Change in the speed setpoint over time
- Moment of inertia of the motor and load

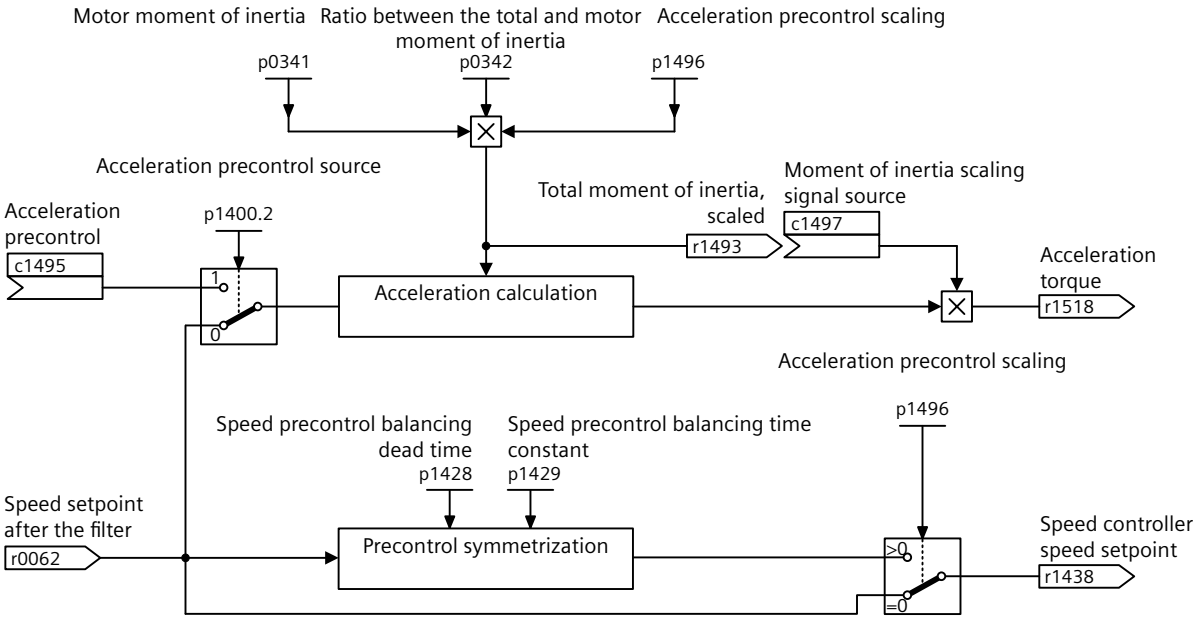


Figure 13-164 Simplified function diagram of the speed controller precontrol

The speed controller precontrol specifies the acceleration torque directly to the torque controller, bypassing the speed controller. As a consequence, the speed controller settling time is eliminated and the motor torque changes without any significant time delay.

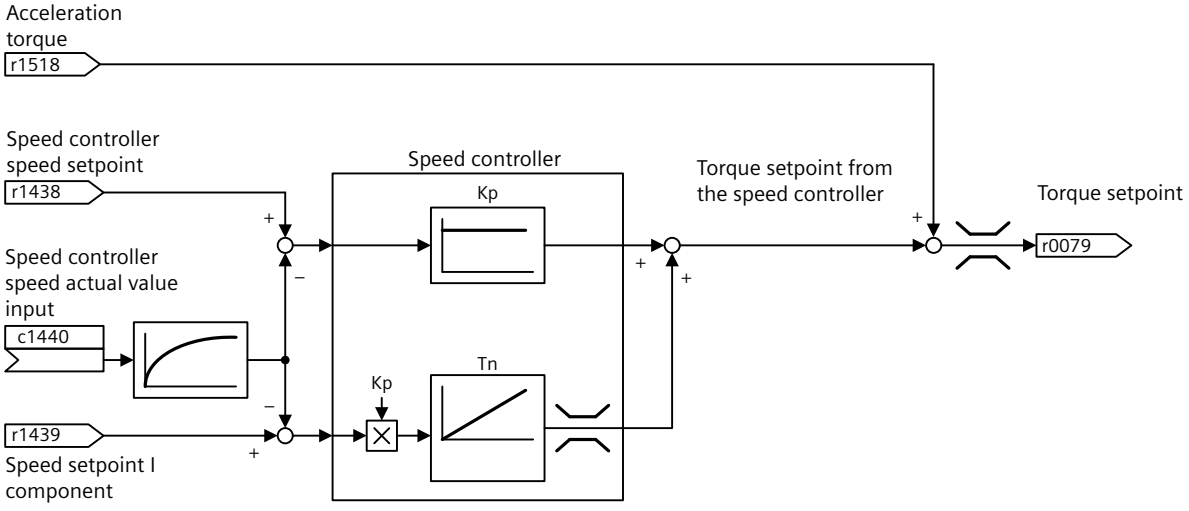


Figure 13-165 Simplified function diagram of the speed controller

When the speed controller precontrol is optimally set, the I component of the speed controller (r1482) does not change when changing the speed setpoint in the range n > 20 % · p0310. The speed controller then only corrects disturbance variables.

Parameters

The following list contains the parameters of function "Speed controller precontrol".

Number	Name	Unit
p0311[0...n]	Rated motor speed	rpm
r0333[0...n]	Rated motor torque	Nm
p0341[0...n]	Motor moment of inertia	kgm²
p0342[0...n]	Ratio between the total and motor moment of inertia	-
r0345[0...n]	Nominal motor starting time	s
p1400[0...n].0...31	Speed control configuration	-
p1428[0...n]	Speed precontrol symmetrizing dead time	-
p1429[0...n]	Speed precontrol symmetrizing time constant	ms
p1496[0...n]	Acceleration precontrol scaling	%
r1518[0...1]	Accelerating torque	Nm

13.12.18 Droop

Overview

Function "Droop" reduces the speed setpoint as a function of the torque.

Requirement

The "Droop" function is only available in operating mode "Other control mode", closed-loop speed control.

Function description

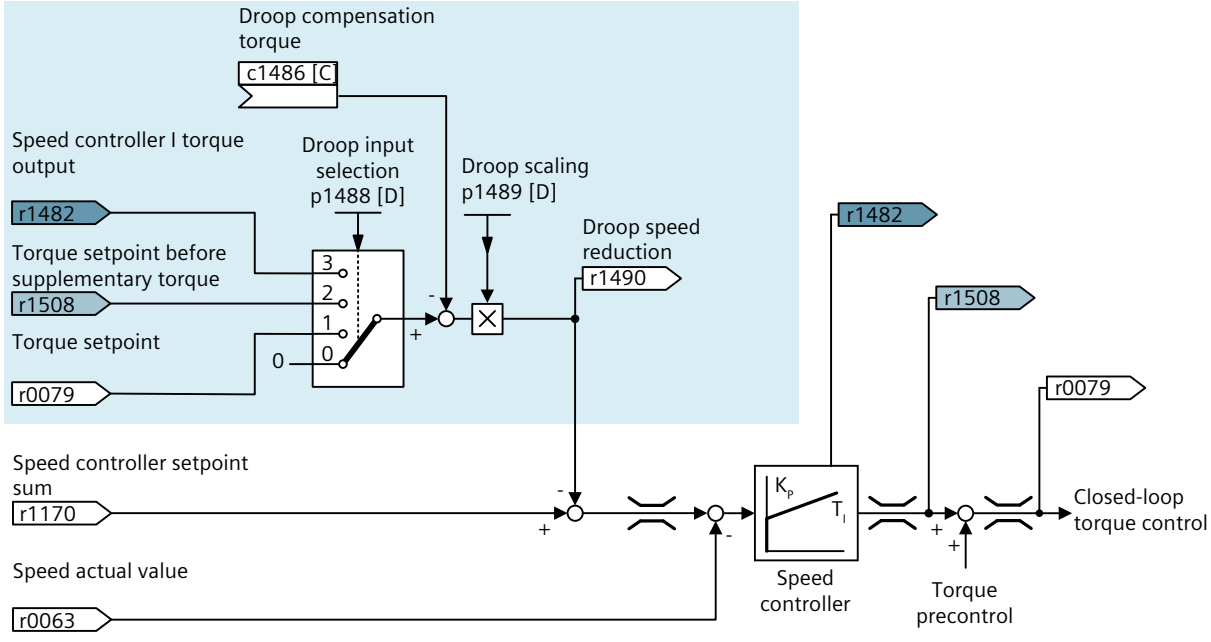


Figure 13-166 Schematic representation of the "Droop" function

c1492 = 1 signal enables the "Droop" function.

Function "Droop" reduces the speed setpoint proportional to the increasing load torque. The following numerical signal sources can be selected:

- r0079: Sum of the speed controller output and the torque precontrol
- r1508: Speed controller output
- r1482: Integrator component of the speed controller output

The scaling of the droop p1489 defines the extent to which the torque influences the speed setpoint.

Compensation torque c1486 can be interconnected with signals that are available in the converter or were received via fieldbus.

Example

For drive systems with mechanically coupled motors, slight deviations of the speed setpoints or actual values result in the torque being non-uniformly distributed between the motors.

Function "Droop" reduces the speed setpoint as a function of the torque setpoint. As a consequence, the speed controller reduces the torque setpoint and reduces the load on the connected motor. The mechanical coupling distributes the torque to the other motors.

Identical ramp-up and ramp-down times and rounding in the ramp-function generators of the coupled drive systems ensure that the torque is evenly distributed between the motors, even when accelerating.

Parameters

The following list contains the parameters of the "Droop" function.

Number	Name	Unit
r0079	Torque setpoint	Nm
r1406.4...15	Control word speed controller	-
r1407.0...31	Status word speed controller	-
r1482	Speed controller I torque output	Nm
c1486[0...n]	Droop compensation torque	Nm
p1487[0...n]	Droop compensation torque scaling	%
p1488[0...n]	Droop input selection	-
p1489[0...n]	Droop scaling	-
r1490	Droop speed reduction	rpm
c1492[0...n]	Droop enable	-
r1508	Torque setpoint before supplementary torque	Nm

13.12.19 Reference model

Overview

The reference model suppresses the settling of the speed controller by delaying the setpoint-actual value deviation for the integral component of the speed controller.

Requirement

The reference model is only available in the following operating modes:

- Operating mode "Other control mode", closed-loop speed control
- Operating mode "Other control mode", closed-loop torque control

Function description

The reference model emulates the time response of the speed control loop with P characteristic using a PT2 element.

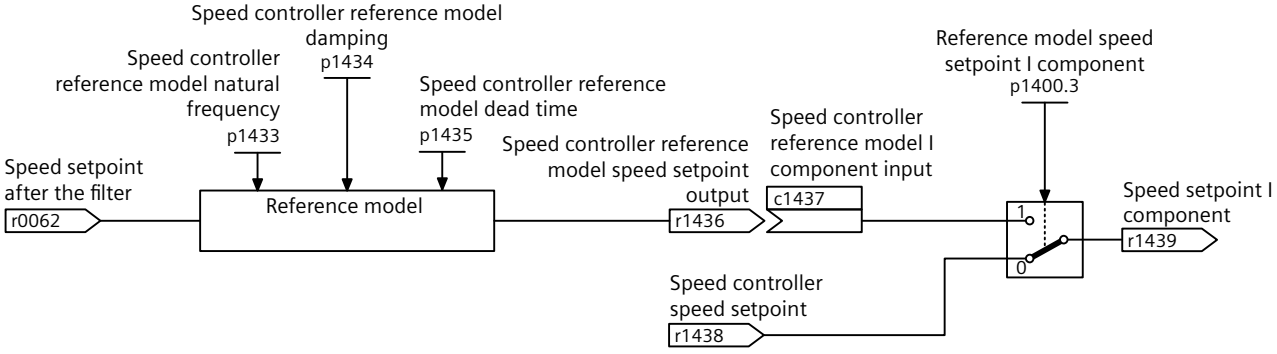


Figure 13-167 Simplified function diagram of the reference model

The reference model is correctly set when the characteristics of r1439 and p1445 (speed actual value) are virtually identical when the I-component of the speed controller is deactivated.

Parameters

The following list contains the parameters of function "Reference model".

Number	Name	Unit
p1400[0...n].0...31	Speed control configuration	-
p1433[0...n]	Speed controller reference model natural frequency	Hz
p1434[0...n]	Speed controller reference model damping	-
p1435[0...n]	Speed controller reference model dead time	-
r1436	Speed controller reference model speed setpoint output	rpm
c1437[0...n]	Speed controller reference model I component input	rpm

13.12.20 Resonance damping

Overview

Resonance damping is active at low speeds. Resonance damping reduces speed oscillations for a motor without load or for sudden load changes.

Requirement

The motor is being operated without an encoder.

"Encoderless closed-loop speed control of a synchronous motor from standstill" (pulse technique) is not active.

Function description

A 0 signal in r1751.0 indicates that at low speeds the closed-loop speed control is in the open-loop controlled mode. In the open-loop controlled mode, the converter injects a current into the motor.

Resonance damping is active in the open-loop controlled mode. p1740 defines the controller gain for resonance damping.

Parameters

The following list contains the parameters of the "Resonance damping" function.

Number	Name	Unit
r0066	Output frequency	Hz
p1740[0...n]	Gain resonance damping for encoderless closed-loop control	-
r1751.0...22	Motor model status	-

13.12.21 Torque limiting

Overview

The converter limits the motor torque to prevent an overload of the motor and the machine or system.

Function description

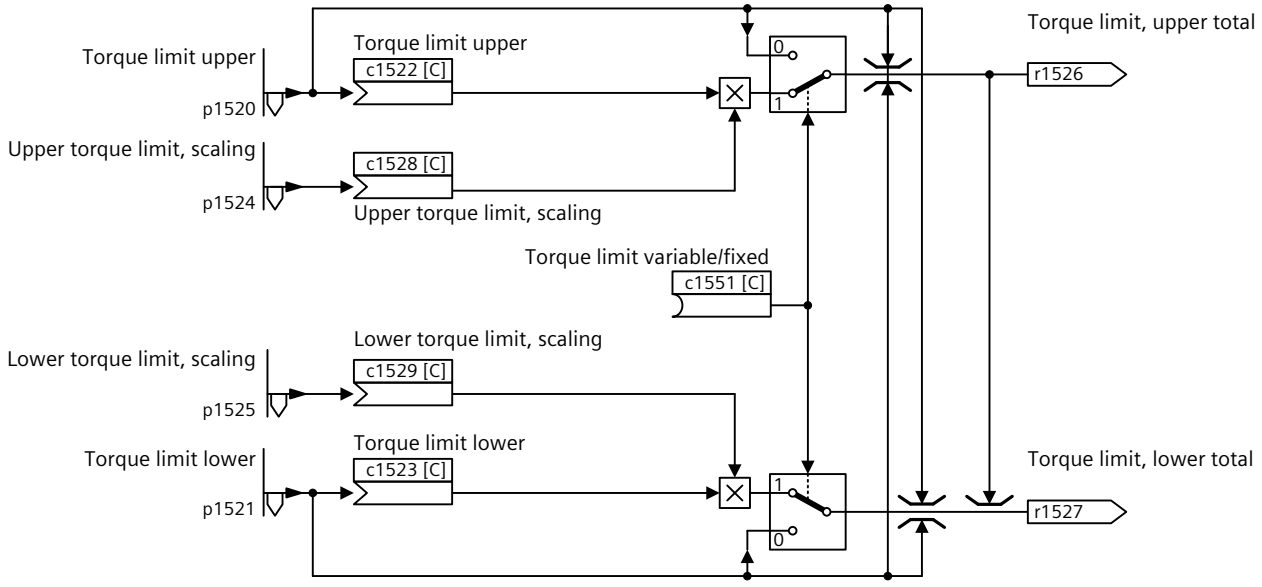


Figure 13-168 Simplified function diagram to calculate the torque limits

Numerical sinks c1522 and c1529 are either interconnected with set values p1520 and p1521 or with an external source for the torque limits. The external source for the torque limits is closed-loop tension control, for example, which specifies the torque limits.

Torque limits r1526 and r1527 are obtained after scaling with p1524 and p1525.

For a 0 signal of the binary signal sink c1551, the converter switches the torque limits to the set values p1520 and p1521. The torque limits must be switched over if, for example, the motor must be braked with the maximum torque when a machine stop is requested; however, the torque limits are reduced when interconnected with an external source.

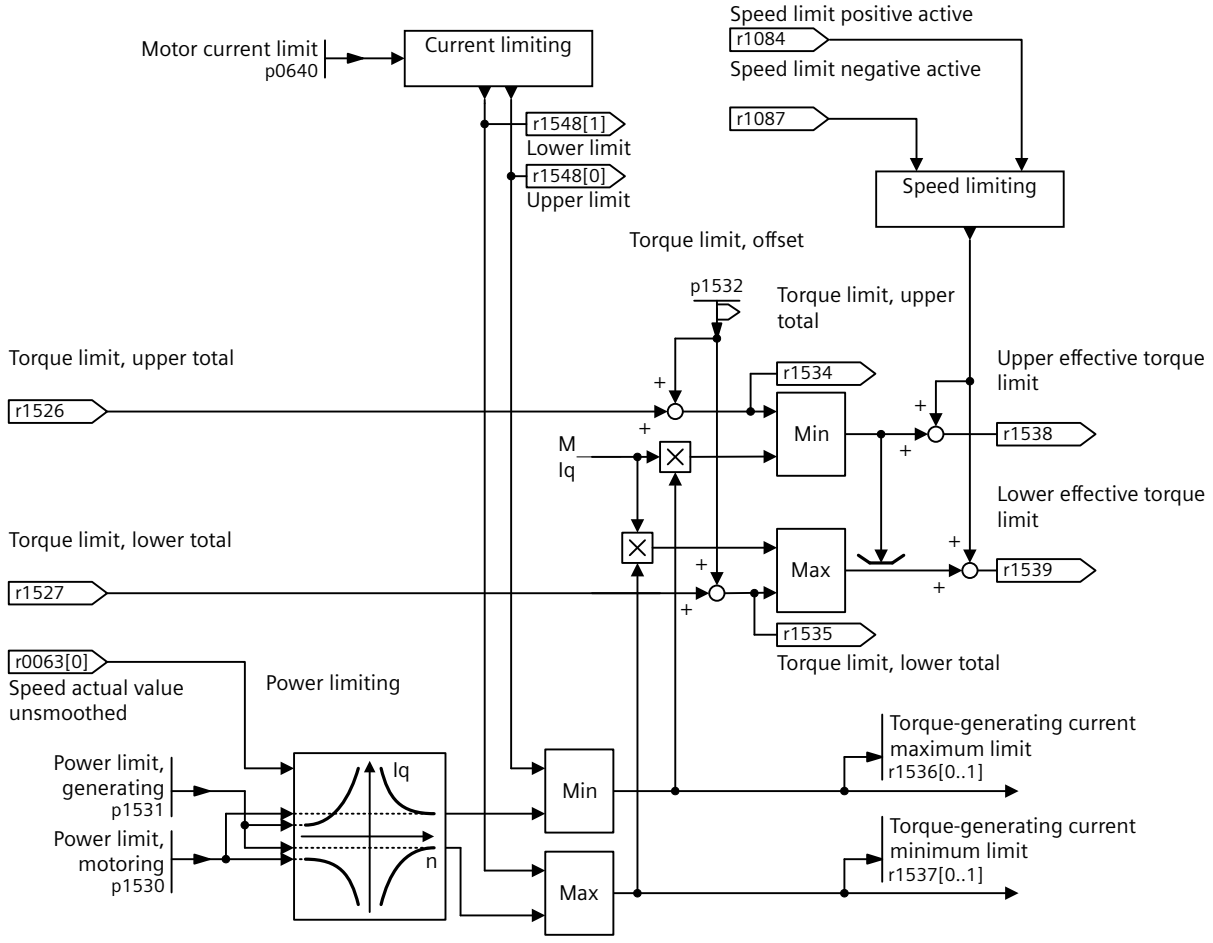


Figure 13-169 Simplified function diagram to take into consideration current, speed and power limits

The following functions additionally limit preliminary torque limits r1526 and r1527:

- Power limiting
  The converter calculates the currently permissible limit of the torque-generating current from power limits p1530 and p1531 and the speed actual value.
- Current limiting
  The converter calculates the currently permissible torque-generating current from current limit p0640.

The speed limiting influences the torque limits when speed limit r1084 or r1087 is reached.

r1538 and r1539 supply the active torque limits for the torque setpoint.

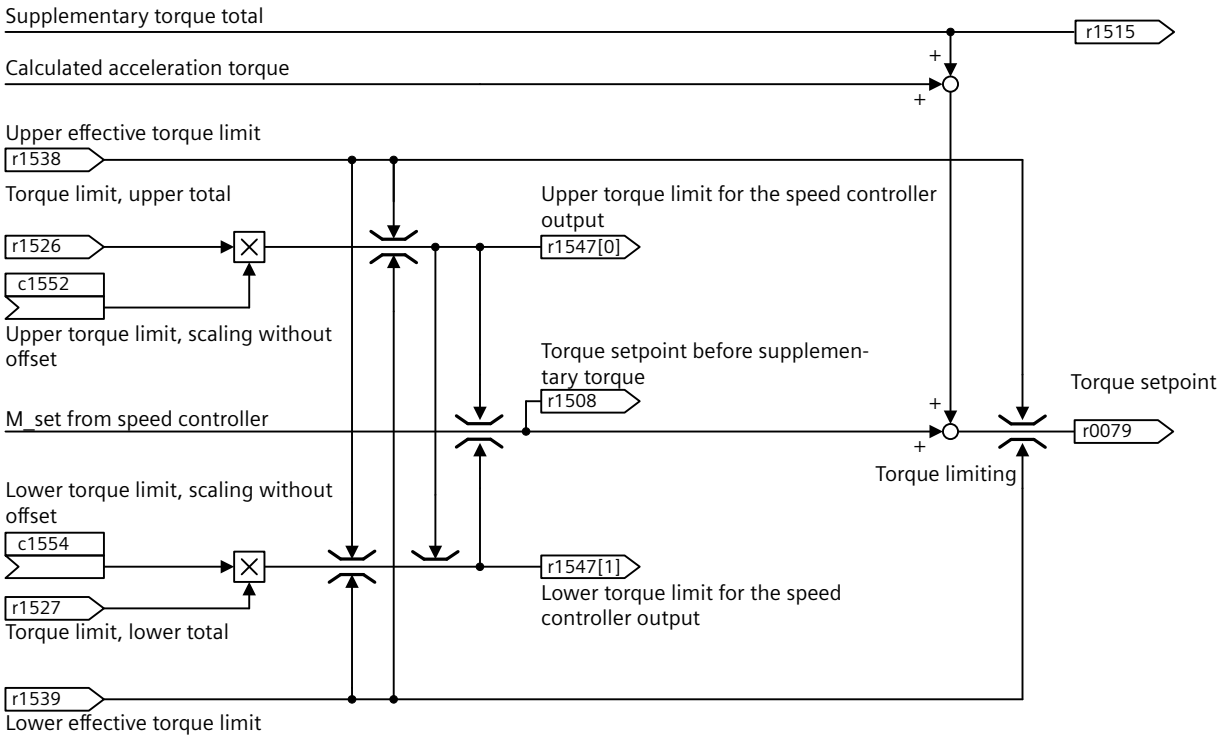


Figure 13-170 Simplified function diagram to limit the torque setpoint

The total torque setpoint is obtained from the sum of the following variables:

- Torque setpoint M_set from the speed controller output
- Supplementary torque r1515, which the higher-level control specifies via a converter interface, for example
- The acceleration torque calculated by the speed controller

r0079 supplies the final torque setpoint after torque limiting.

Parameters

The following list contains the parameters of function "Torque limits".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r0079	Torque setpoint	Nm
p0640[0...n]	Motor current limit	Arms
r1084	Positive speed limit effective	rpm
r1087	Negative speed limit effective	rpm
c1511[0...n]	Supplementary torque 1	Nm
c1512[0...n]	Supplementary torque 1 scaling	%
c1513[0...n]	Supplementary torque 2	Nm
p1514[0...n]	Supplementary torque 2 scaling	%
r1515	Supplementary torque total	Nm
r1516	Supplementary torque and acceleration torque	Nm
p1517[0...n]	Accelerating torque smoothing time constant	ms

r1518[0...1]	Accelerating torque	Nm
p1520[0...n]	Torque limit upper	Nm
p1521[0...n]	Torque limit lower	Nm
c1522[0...n]	Torque limit upper	Nm
c1523[0...n]	Torque limit lower	Nm
p1524[0...n]	Torque limit upper scaling	%
p1525[0...n]	Torque limit lower scaling	%
r1526	Total upper torque limit	Nm
r1527	Total lower torque limit	Nm
c1528[0...n]	Torque limit upper scaling	%
c1529[0...n]	Torque limit lower scaling	%
p1530[0...n]	Power limit motoring	kW
p1531[0...n]	Power limit regenerative	kW
p1532[0...n]	Torque limit offset	Nm
r1533	Current limit torque-generating total	Arms
r1534	Total upper torque limit	Nm
r1535	Total lower torque limit	Nm
r1536[0...1]	Torque-generating current maximum limit	Arms
r1537[0...1]	Torque-generating current minimum limit	Arms
r1538	Upper effective torque limit	Nm
r1539	Lower effective torque limit	Nm
c1542[0...n]	Travel to fixed stop torque reduction	%
r1543	Travel to fixed stop torque scaling	%
p1544	Travel to fixed stop evaluation torque reduction	%
c1545[0...n]	Activates travel to a fixed stop	-
r1547[0...1]	Torque limit for speed controller output	Nm
r1548[0...3]	Stall current limit torque-generating maximum	Arms
c1551[0...n]	Torque limit variable/fixed	-
c1552[0...n]	Torque limit upper scaling without offset	%
p1553[0...n]	Stall limit scaling	%
c1554[0...n]	Torque limit lower scaling without offset	%
c1555[0...n]	Power limit	kW
p1556[0...n]	Power limit scaling	-
p1557[0...n]	Torque limit pulse technique	Nm

13.12.22 Current setpoint filter

Overview

The current setpoint filter filters the mechanical natural frequencies of the driven machine and permits a dynamic closed-loop speed control with high speed controller gain to be achieved in spite of the fact that the load has a tendency to oscillate.

Requirement

Closed-loop speed control is active.

Function description

The converter has 2 current setpoint filters connected in series. The following choices are available for each current setpoint filter:

- PT2 low-pass

$$H_{(s)} = \frac{1}{\left(\frac{s}{2\pi f_N}\right)^2 + \frac{2D_N}{2\pi f_N} \cdot s + 1}$$

f_N = Denominator natural frequency

D_N = Denominator damping

Figure 13-171 Transfer function of the 2nd order low-pass

- General 2nd order filter

$$H_{(s)} = \frac{\left(\frac{s}{2\pi f_Z}\right)^2 + \frac{2D_Z}{2\pi f_Z} \cdot s + 1}{\left(\frac{s}{2\pi f_N}\right)^2 + \frac{2D_N}{2\pi f_N} \cdot s + 1}$$

f_Z = Numerator natural frequency

D_Z = Numerator damping

f_N = Denominator natural frequency

D_N = Denominator damping

Figure 13-172 Transfer function for a general 2nd order filter.

A bandstop or a low-pass filter with attenuation can be realized using the current setpoint filter.

Depending on p1699, changed filter settings take effect at different times:

- p1699 = 0
  The changed settings take effect immediately.
- p1699 = 1
  The changed settings do not take effect until p1699 = 0.

Example

The following examples show the amplitude response and phase response of the current setpoint filter. A phase offset results in a controlled system delay.

Table 13-102 PT2 low-pass

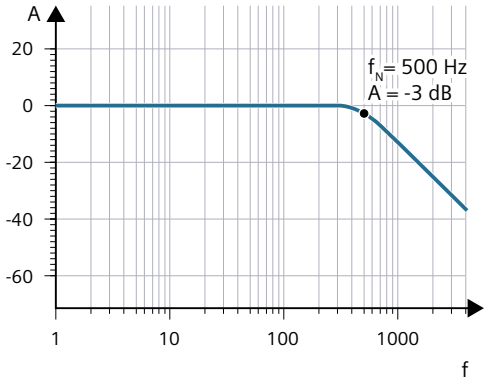
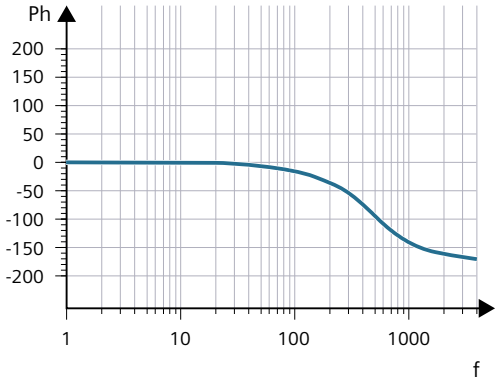
Amplitude response A in dB	Phase response Ph in degrees
	
Denominator natural frequency f_N = 500 Hz Denominator damping D_N = 0.7 dB	

Table 13-103 General 2nd order filter

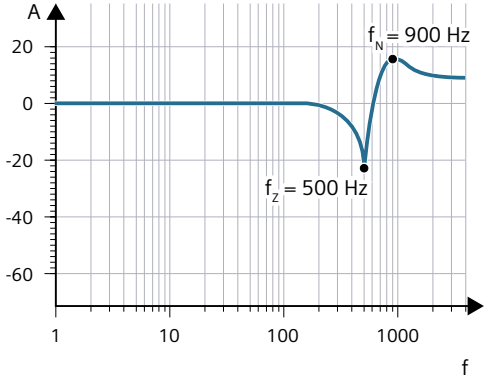
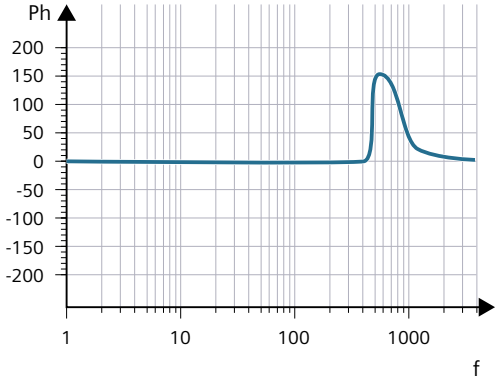
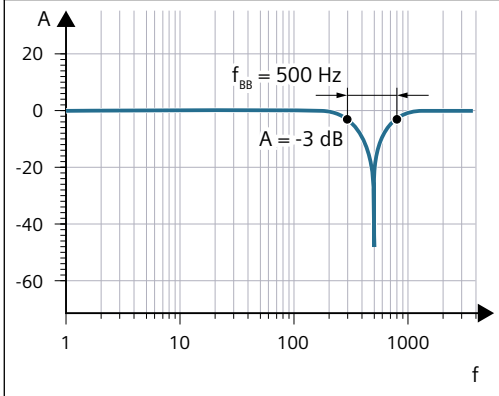
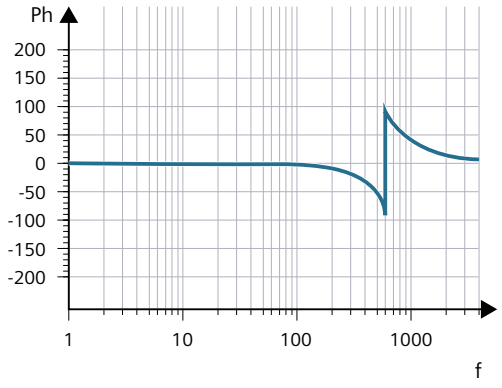
Amplitude response A in dB	Phase response Ph in degrees
	
Numerator natural frequency f_Z = 500 Hz Numerator damping D_Z = 0.02 dB Denominator natural frequency f_N = 900 Hz Denominator damping D_N = 0.15 dB	

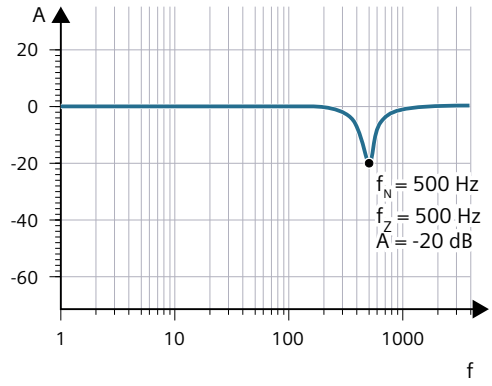
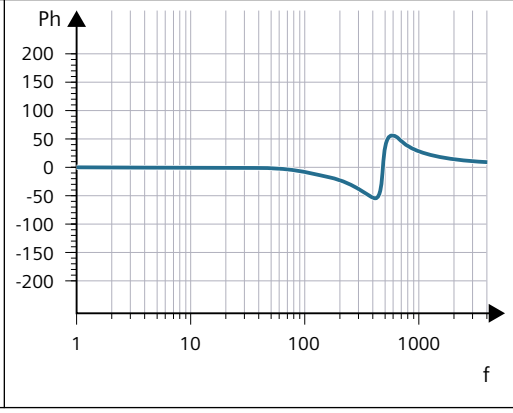
Table 13-104 Bandstop with infinite notch depth and no reduction

Amplitude response A in dB	Phase response Ph in degrees
	

Blocking frequency f_{Sp} = 500 Hz
Bandwidth (-3 dB) f_{BB} = 500 Hz
Notch depth K = -∞ dB
Reduction Abs = 0 dB
Numerator natural frequency $f_Z = f_{Sp}$
Numerator damping D_Z = 0
Denominator natural frequency $f_N = f_{Sp}$
Denominator damping

$$D_N = \frac{f_{BB}}{2\, f_{Sp}}$$

Table 13-105 Bandstop with defined notch depth and no reduction

Amplitude response A in dB	Phase response Ph in degrees
	

Blocking frequency f_{Sp} = 500 Hz

Bandwidth f_{BB} = 500 Hz

Notch depth K = -20 dB

Reduction Abs = 0 dB

Numerator natural frequency $f_Z = f_{Sp}$

Numerator damping

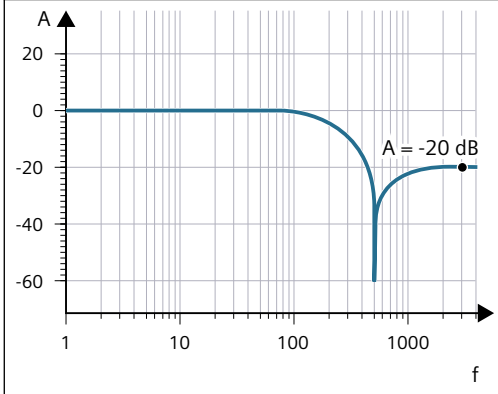
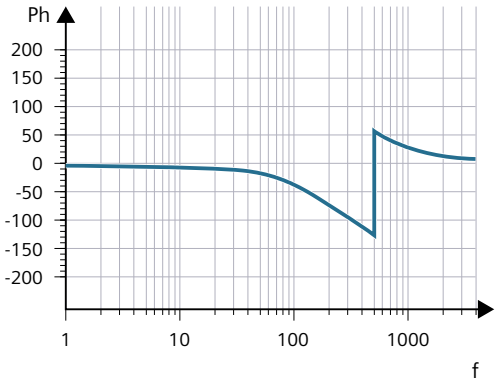
$$D_Z = \frac{f_{BB} \cdot 10^{\frac{K}{20}}}{2\, f_{Sp}}$$

Denominator natural frequency $f_N = f_{Sp}$

Denominator damping

$$D_N = \frac{f_{BB}}{2\, f_{Sp}}$$

Table 13-106 Bandstop with infinite notch depth and defined reduction

Amplitude response A in dB	**Phase response Ph in degrees**
	

Blocking frequency f_{SP} = 500 Hz

Bandwidth f_{BB} = 500 Hz

Notch depth K = -∞ dB

Reduction Abs = -20 dB

Numerator natural frequency

$$f_Z = \frac{\omega_Z}{2\pi} = f_{Sp}$$

Numerator damping

$$D_Z = 10^{\frac{K}{20}} \cdot \frac{1}{2} \cdot \sqrt{\left(1 - \frac{1}{10^{\frac{Abs}{20}}}\right)^2 + \frac{f_{BB}^{\ 2}}{f_{Sp}^{\ 2} \cdot 10^{\frac{Abs}{10}}}}$$

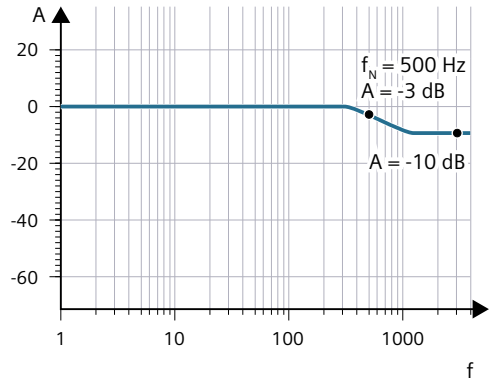
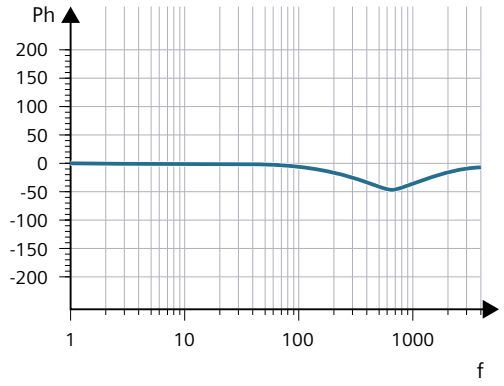
Denominator natural frequency

$$f_N = \frac{\omega_N}{2\pi} = f_{Sp} \cdot 10^{\frac{Abs}{40}}$$

Denominator damping

$$D_N = \frac{f_{BB}}{2\, f_{Sp} \cdot 10^{\frac{Abs}{40}}}$$

Table 13-107 Low-pass with reduction

Amplitude response A in dB	Phase response Ph in degrees
	

Characteristic frequency f_{Abs} = 500 Hz

Damping D = 0.7

Reduction Abs = -10 dB

Denominator natural frequency $f_N = f_{Abs}$ (start of reduction)

Numerator natural frequency

$$f_Z = \frac{f_{Abs}}{10^{\frac{Abs}{40}}}$$

Denominator damping D_N = 0.7

Numerator damping: D_Z = 0.7

Parameters

The following list contains the parameters of function "Current setpoint filter".

Number	Name	Unit
c1655[0...4]	Current setpoint/Speed actual value filter nat. frequency tuning	%
p1656[0...n].0...4	Current setpoint/Speed actual value filter activation	-
p1657[0...n]	Current setpoint filter 1 type	-
p1658[0...n]	Current setpoint filter 1 denominator natural frequency	Hz
p1659[0...n]	Current setpoint filter 1 denominator damping	-
p1660[0...n]	Current setpoint filter 1 numerator natural frequency	Hz
p1661[0...n]	Current setpoint filter 1 numerator damping	-
p1662[0...n]	Current setpoint filter 2 type	-
p1663[0...n]	Current setpoint filter 2 denominator natural frequency	Hz
p1664[0...n]	Current setpoint filter 2 denominator damping	-
p1665[0...n]	Current setpoint filter 2 numerator natural frequency	Hz
p1666[0...n]	Current setpoint filter 2 numerator damping	-
p1699	Filter data acceptance	-

13.12.23 Current controller with adaptation

Overview

The current controller controls the flux-generating and torque-generating current components of the motor.

Requirement

When commissioning, the converter calculates the current controller setting during the motor data identification.

Function description

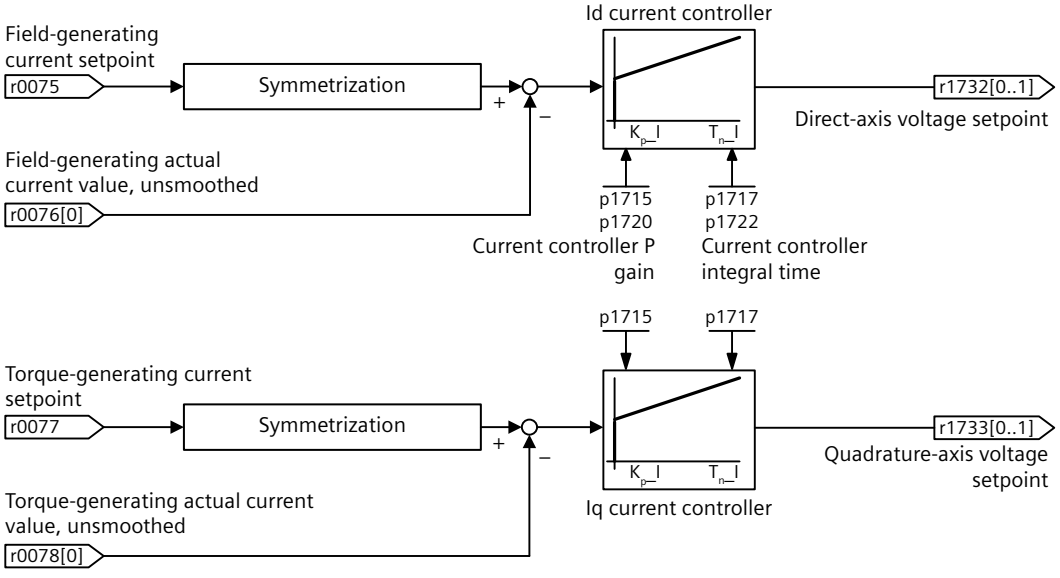


Figure 13-173 Simplified representation of the current controller

The current controller responds to a difference between the current setpoint and actual value when the corresponding voltage setpoint changes.

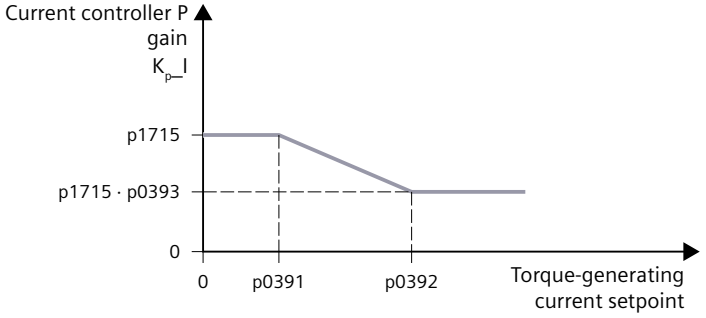


Figure 13-174 Current controller adaptation

The optional current controller adaptation adapts the P gain of both current controllers to the absolute value of the torque-generating current setpoint.

Parameters

The following list contains the parameters of function "Current controller with adaptation".

Number	Name	Unit
r0075	Current setpoint field-generating	Arms
r0076[0...1]	Current actual value field-generating	Arms
r0077	Current setpoint torque-generating	Arms
r0078[0...1]	Current actual value torque-generating	Arms
r0377[0...n]	Motor leakage inductance total	mH
p0391[0...n]	Current controller adaptation starting point Kp	Arms
p0392[0...n]	Current controller adaptation starting point Kp adapted	Arms
p0393[0...n]	Current controller adaptation P gain scaling	%
p1402[0...n].0...30	Closed-loop current control and motor model configuration	-
r1408.0...31	Status word current controller	-
r1624	Field-generating current setpoint total	Arms
p1702[0...n]	Isd current controller precontrol scaling	%
p1703[0...n]	Isq current controller precontrol scaling	%
p1715[0...n]	Current controller P gain	-
p1717[0...n]	Current controller integral-action time	ms
r1718	Isq controller output	Vrms
r1719	Isq controller integral component	Vrms
p1720[0...n]	Current controller d axis P gain	-
p1722[0...n]	Current controller d axis integral time	ms
r1723	Isd controller output	Vrms
r1724	Isd controller integral component	Vrms
r1725	Isd controller integral component limit	Vrms
r1732[0...1]	Direct-axis voltage setpoint	Vrms
r1733[0...1]	Quadrature-axis voltage setpoint	Vrms
p1959[0...n].0...14	Rotating measurement configuration	-

13.12.24 Moment of inertia estimator

Overview

The moment of inertia estimator continuously corrects the value of the load moment of inertia for the closed-loop control. As a consequence, the moment of inertia estimator minimizes the overshoot for speed changes in applications where the load moment of inertia changes in operation.

The more precise the value of the moment of inertia in the converter, the lower the overshoot after speed changes.

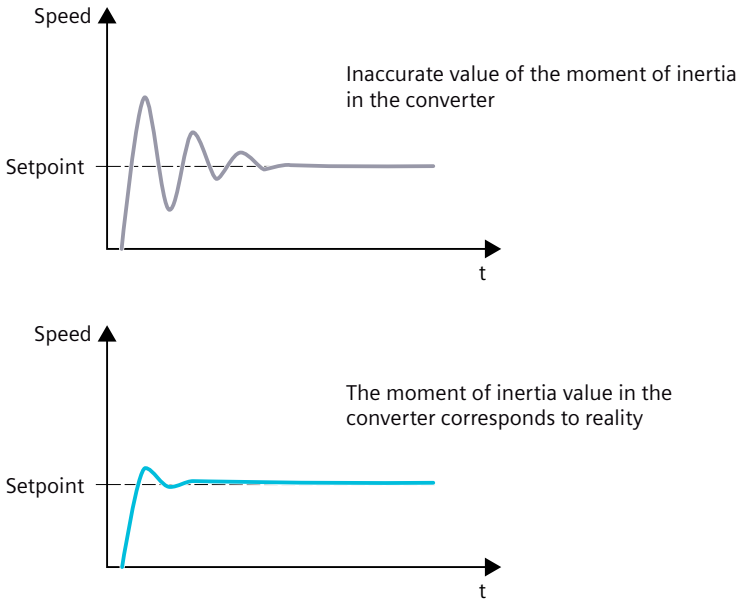


Figure 13-175 Influence of the moment of inertia on the speed

Requirement

Required settings:

- Parameter p1498 = maximum load moment of inertia to be expected
- Parameter p1400.22 = 0 signal

The friction characteristic is activated for a load with comparatively high friction.

Function description

The converter calculates the total moment of inertia of the load and motor. The calculation comprises the following components:

- Actual speed
- Actual motor torque
- Friction torque of the load

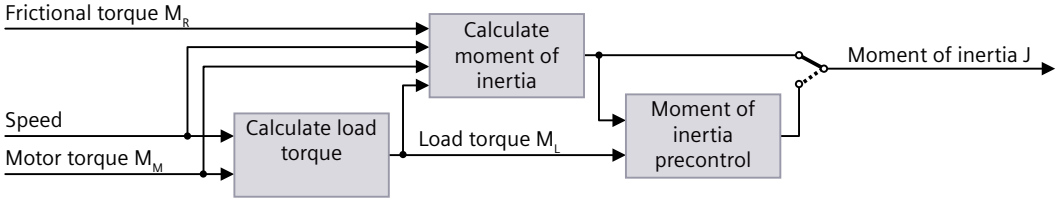


Figure 13-176 Overview of the function of the moment of inertia estimator

When using the moment of inertia estimator, we recommend that you also activate the friction characteristic.

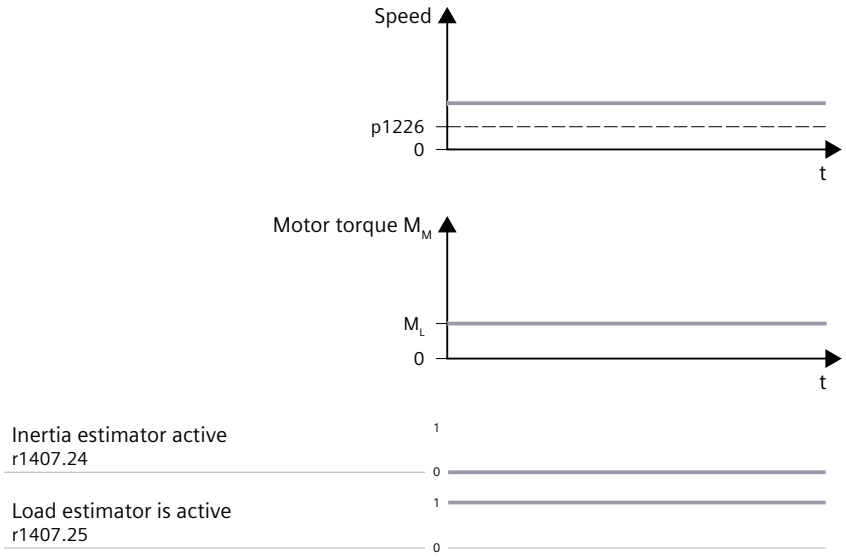


Figure 13-177 Calculation of the load torque

In the case of small speed changes, the converter calculates the load torque M_L from the actual motor torque.

The calculation takes place under the following conditions:

- Speed ≥ p1226
- Acceleration setpoint < 8 1/s² (≙ speed change 480 r/min per s)
- Acceleration · moment of inertia (r1493) < 0.9 · p1560

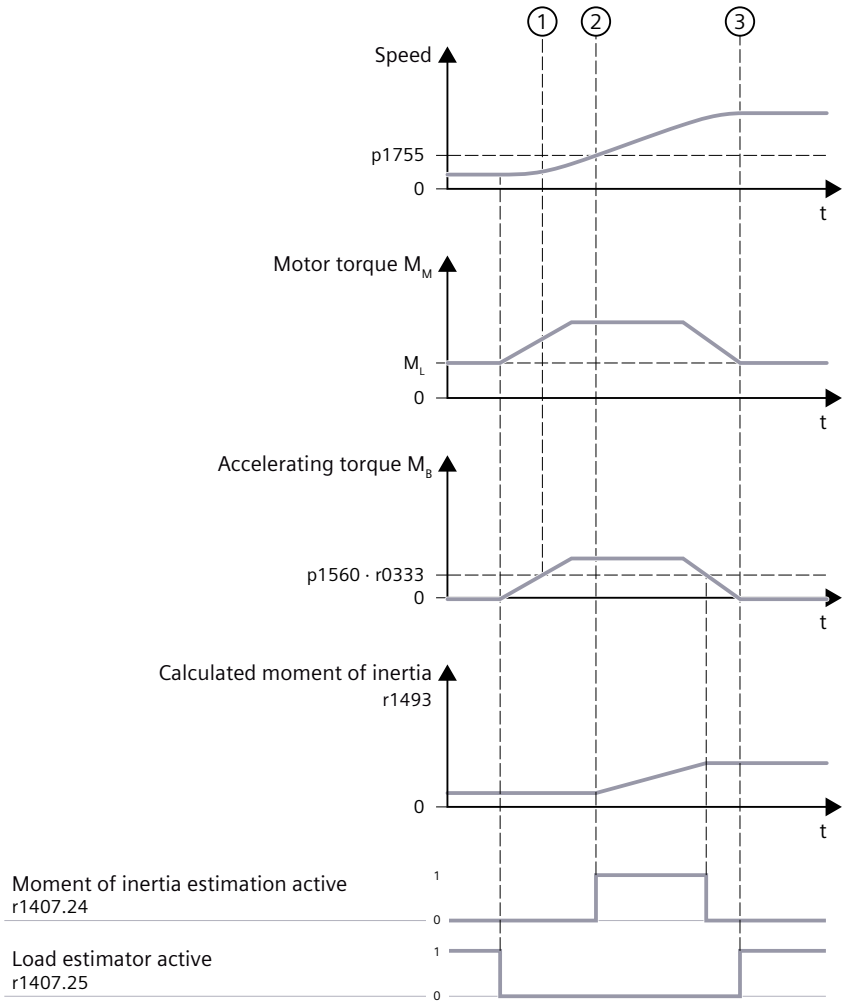


Figure 13-178 Calculation of the moment of inertia

For larger speed changes, the converter first calculates acceleration torque M_B as difference between the motor torque M_M, load torque M_L and friction torque M_R:

$M_B = M_M - M_L - M_R$

The moment of inertia J of the motor and load is then obtained from the acceleration torque M_B and angular acceleration α (α = rate of change of the speed):

$J = M_B / \alpha$

If all of the following conditions are met, the converter calculates the moment of inertia:

- ① The measured acceleration torque M_B must satisfy the following two conditions:
  - The sign of M_B is the same as the direction of the actual acceleration
  - M_B > p1560 · motor rated torque (r0333)
- ② Speed > p1755
- The converter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 1/s² (≙ speed change 480 r/min per s)

③ The converter calculates the load torque again after acceleration.

In applications where the motor predominantly operates with a constant speed, calculating the moment of inertia using the function described above is only rarely possible. Moment of inertia precontrol is available for situations such as these. The moment of inertia precontrol assumes that there is a linear relationship between the moment of inertia and the load torque.

Example: For a horizontal conveyor, in a first approximation, the moment of inertia depends on the load.

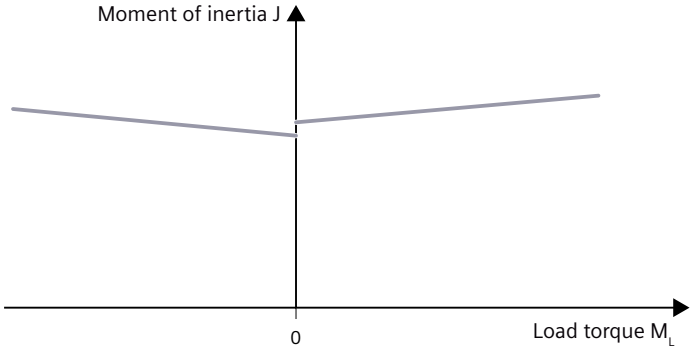


Figure 13-179 Moment of inertia precontrol

The relationship between load torque and torque is stored as a linear characteristic in the converter.

- In positive direction of rotation:
  Moment of inertia J = p5312 · load torque M_L + p5313
- In negative direction of rotation:
  Moment of inertia J = p5314 · load torque M_L + p5315

You have the following options to determine the characteristic:

- You already know the characteristic from other measurements. In this case, you must set the parameters to the known values when commissioning the system.
- The converter iteratively determines the characteristic by performing measurements during motor operation.

Parameters

The following list contains the parameters of the "Moment of inertia estimator" function.

Number	Name	Unit
r0333[0...n]	Rated motor torque	Nm
p0341[0...n]	Motor moment of inertia	kgm²
p0342[0...n]	Ratio between the total and motor moment of inertia	-
p1226[0...n]	Threshold for standstill detection	rpm
p1400[0...n].0...31	Speed control configuration	-
r1407.0...31	Status word speed controller	-
r1493	Moment of inertia total, scaled	kgm²
p1496[0...n]	Acceleration precontrol scaling	%

p1498[0...n]	Load moment of inertia	kgm²
c1502[0...n]	Freeze moment of inertia estimator	-
p1560[0...n]	Moment of inertia estimator accelerating torque threshold value	%
p1561[0...n]	Moment of inertia estimator change time moment of inertia	ms
p1562[0...n]	Moment of inertia estimator change time load	ms
p1755[0...n]	Motor model changeover speed encoderless operation	rpm
p5310[0...n].0...1	Moment of inertia precontrol configuration	-
r5311[0...n].0...5	Moment of inertia precontrol status word	-
p5312[0...n]	Moment of inertia precontrol linear positive	s²
p5313[0...n]	Moment of inertia precontrol constant positive	kgm²
p5314[0...n]	Moment of inertia precontrol linear negative	s²
p5315[0...n]	Moment of inertia precontrol constant negative	kgm²

13.12.25 Efficiency optimization

Overview

The efficiency optimization optimizes the flux of the motor depending on the operating point of the motor. This has the following advantages:

- Lower energy costs
- Lower motor temperature rise
- Lower motor noise levels

The advantages are countered by the disadvantage that the closed-loop speed control reacts less dynamically to load changes when the flux is reduced.

Requirement

The converter operates an induction motor.

Closed-loop speed control is active.

Function description

Efficiency optimization is deactivated in the converter factory setting (p1401.14 = 0 signal).

The driven machine requires a defined speed and, depending on the speed, a defined torque.

The efficiency of an induction motor is determined by speed, torque and flux.

As the driven machine defines the speed and torque, changing the flux is the only remaining possibility of optimizing the motor efficiency.

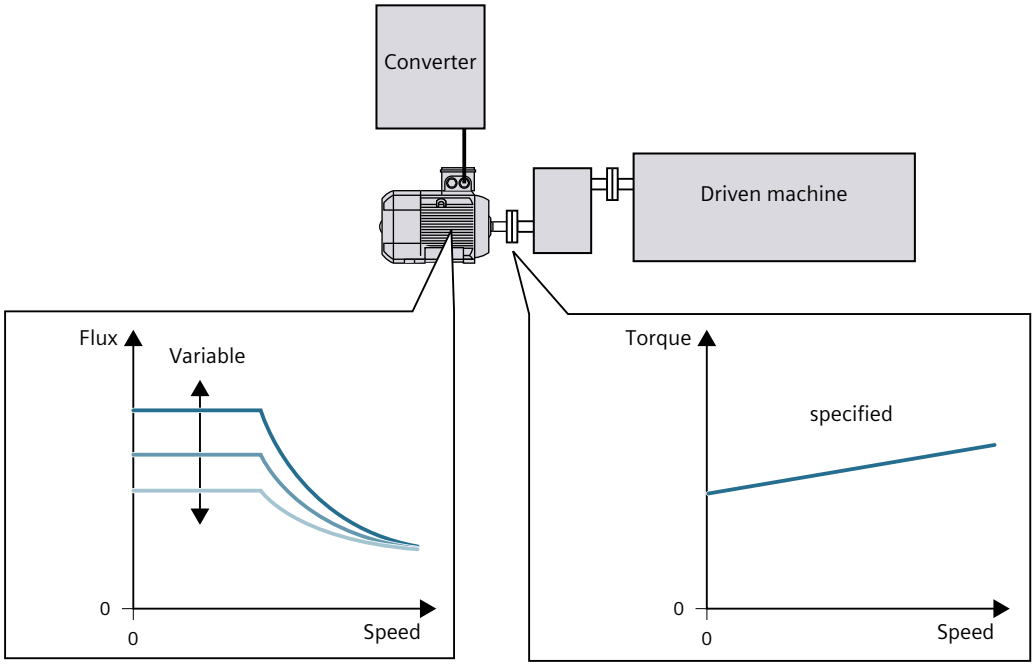


Figure 13-180 Predefined and variable quantities for motor efficiency

In partial load operation of the motor, efficiency optimization uses the thermal motor model to continuously determine the dependency between efficiency and flux, and from this it calculates the optimum flux.

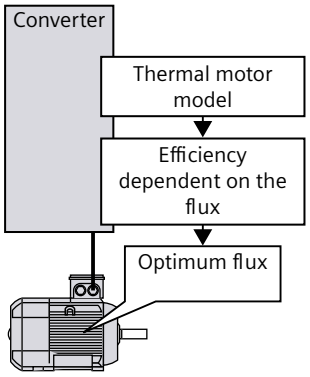


Figure 13-181 Calculating the optimum flux

Depending on the operating point of the motor, the efficiency optimization reduces or increases the flux of the motor.

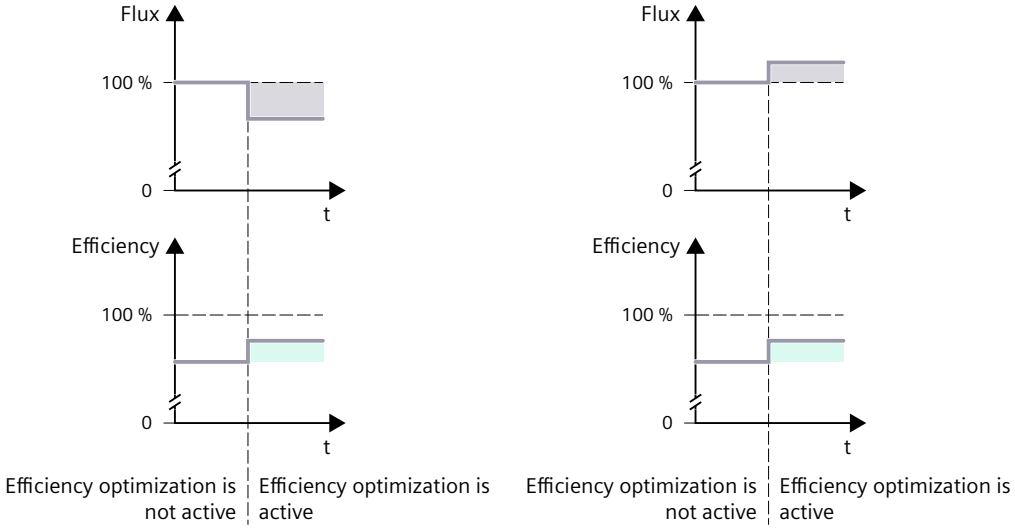


Figure 13-182 Increasing efficiency by optimizing the flux in the motor

Parameters

The following list contains the parameters of the "Efficiency optimization" function.

Number	Name	Unit
r0080[0...1]	Torque actual value	Nm
r0084[0...1]	Flux actual value	%
p1401[0...n].0...30	Flux control configuration	-
r3313	Efficiency optimization optimum flux	%
p3315[0...n]	Efficiency optimization minimum flux limit value	%
p3316[0...n]	Efficiency optimization maximum flux limit value	%

13.12.26 Flux control

Overview

After the ON command to switch on the motor, the flux control controls the magnetic flux in the motor.

Requirement

Flux control is only active with induction motors in closed-loop speed control mode.

The converter has determined the appropriate motor data for the motor using the motor identification.

Function description

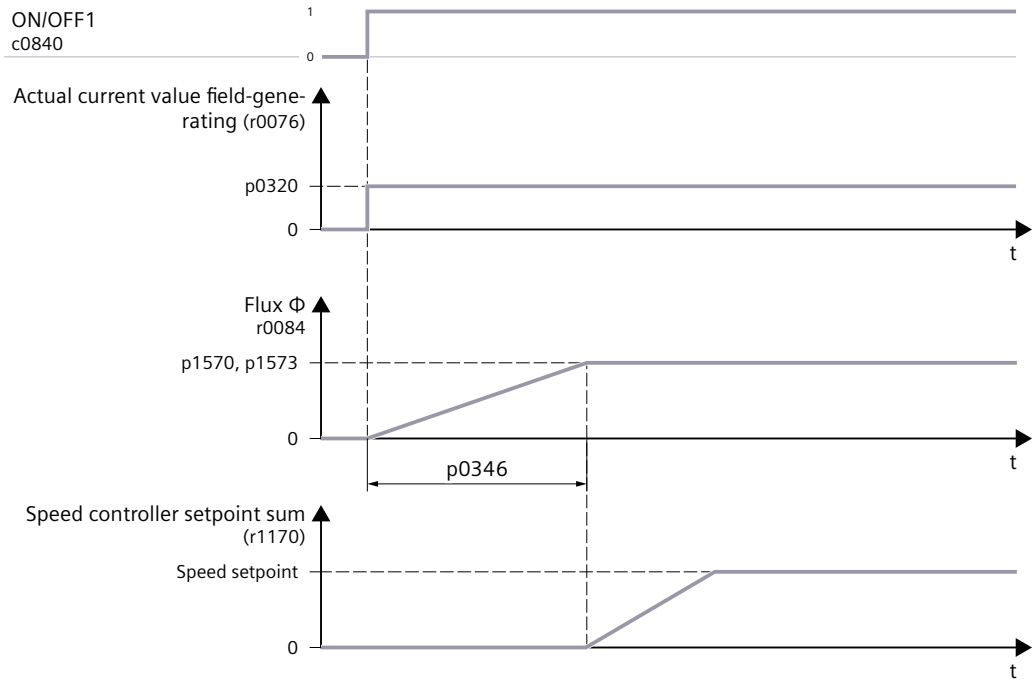


Figure 13-183 Magnetization of the induction motor

After the ON command, the converter impresses the field-generating current setpoint with the p0320 value.

This causes a magnetic flux to be established in the motor. The flux controller controls the flux to reach the flux setpoint p1570.

At the end of the motor excitation build-up time p0346, the converter enables the speed setpoint.

Reducing p0346 reduces the time until the speed setpoint is enabled. However, the motor does not provide its full torque until the flux has been built up fully.

Parameters

The following list contains the parameters of function "Flux control".

Number	Name	Unit
r0083	Flux setpoint	%
r0084[0...1]	Flux actual value	%
p0320[0...n]	Motor rated magnetizing current/short-circuit current	Arms
p0346[0...n]	Motor excitation build-up time	s
p0621[0...n]	Identification stator resistance after restart	-
p0640[0...n]	Motor current limit	Arms
p1570[0...n]	Flux setpoint	%
p1573[0...n]	Flux threshold value magnetizing	%

13.12.27 Flux control with fast magnetization

Overview

Fast magnetization speeds up the magnetization of an induction motor relative to the standard magnetization process. The disadvantages of fast magnetization are the higher thermal stress it places on the converter and potentially the brief alignment of the motor after the ON command.

Requirement

Fast magnetization is only possible with induction motors in closed-loop speed control mode.

The converter has determined the appropriate motor data for the motor using the motor identification.

Parameter p1401 enables fast magnetization.

Fast magnetization is not possible in the following situations:

- The "Stator resistance identification after restart" function is enabled (p0621 > 0).
- The "Flying restart" function is enabled (p1200 > 0).

Function description

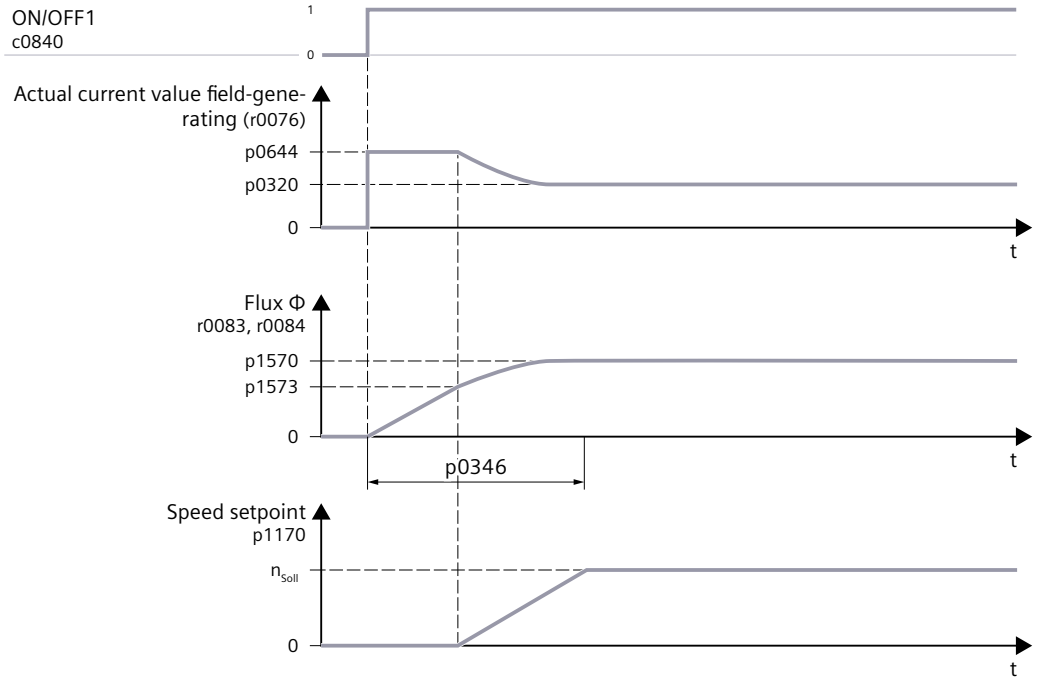


Figure 13-184 Fast magnetization of the induction motor

After the ON command, the field-generating current setpoint jumps to the maximum possible value 0.9 · r0067.

To reduce the thermal stress of the power unit, p0644 also reduces the field-generating current.

The converter enables the speed setpoint when the flux reaches the flux threshold value p1573.

Reducing p1573 reduces the time until the speed setpoint is enabled. However, the motor does not provide its full torque as long as the flux has not reached flux setpoint p1570.

The motor excitation build-up time p0346 is the latest possible time for the enabling of the speed setpoint.

After the speed setpoint has been enabled, the flux controller controls the flux to reach flux setpoint p1570.

Example

One application for fast magnetization is traction drives that have to be able to respond to a drive command with minimal delay, such as those used in operator-controlled crane trolleys, for example.

Parameters

The following list contains the parameters of function "Flux control with fast magnetization".

Number	Name	Unit
r0083	Flux setpoint	%
r0084[0...1]	Flux actual value	%
r0207[0...3]	Rated power unit current	Arms
p0320[0...n]	Motor rated magnetizing current/short-circuit current	Arms
p0346[0...n]	Motor excitation build-up time	s
p0621[0...n]	Identification stator resistance after restart	-
p0640[0...n]	Motor current limit	Arms
p0644[0...n]	Current limit excitation induction motor	%
p1401[0...n].0...30	Flux control configuration	-
p1570[0...n]	Flux setpoint	%
p1573[0...n]	Flux threshold value magnetizing	%

13.12.28 Vdc_min controller (kinetic buffering)

Overview

The Vdc_min controller (kinetic buffering) increases the drive availability because the kinetic energy of the load accommodates brief power dips or failures.

Requirement

The driven load has a sufficiently high inertia.

The application allows braking of the motor during a power failure.

Function description

The DC link voltage in the converter decreases when the line supply dips or fails. The Vdc_min controller intervenes starting from an adjustable threshold. With kinetic buffering active, the converter covers its power loss and the losses in the motor with the kinetic energy of the load. The speed of the load decreases but the DC link voltage remains constant with the Vdc_min controller active. After the line supply returns, the converter resumes normal operation.

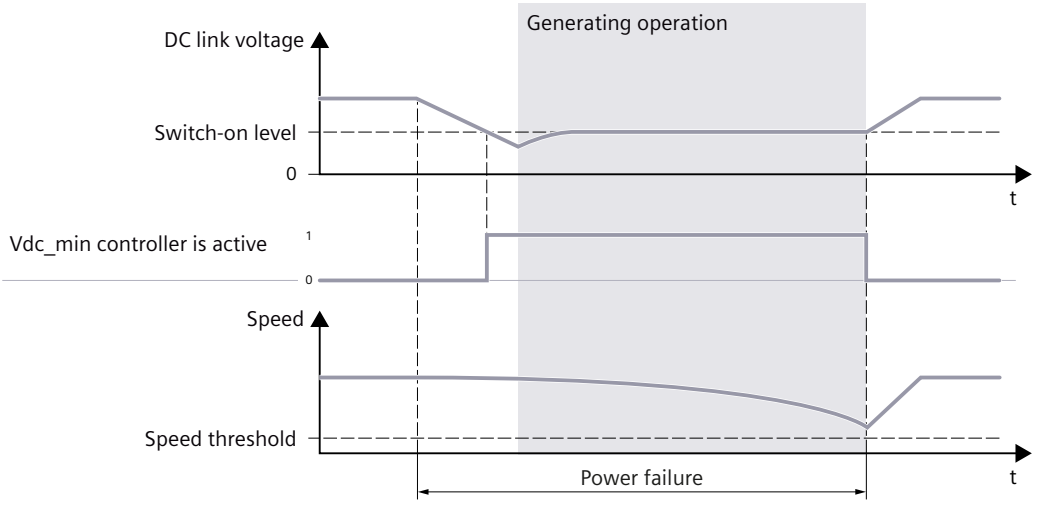


Figure 13-185 Principal mode of operation of the Vdc_min controller

Parameters

The following list contains the parameters of the "Vdc_min controller (Vdc_min control)" function for speed control.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
p0210	Device supply voltage	V
p1240[0...n]	Vdc controller or Vdc monitoring configuration	-
p1245[0...n]	Vdc_min controller switch-in level (kinetic buffering)	%
r1246	Vdc_min controller switch-in level (kinetic buffering)	V
p1247[0...n]	Vdc_min controller dynamic factor (kinetic buffering)	%
p1255[0...n]	Vdc_min controller time threshold	s
p1256[0...n]	Vdc_min controller response (kinetic buffering)	-
p1257[0...n]	Vdc_min controller speed threshold	rpm

13.12.29 Vdc_max controller (voltage limitation)

Overview

The Vdc_max control limits the DC link voltage in the converter and prevents unwanted switching off of the motor.

Precondition

The Vdc_max control is suitable for applications with short-time generator operation of the motor, e.g. pumps or fans.

The Vdc_max control is not suitable for applications where the motor is in continuous regenerative operation, e.g. as is the case for hoisting gear and centrifuges.

Function description

If the converter cannot transfer the electrical energy delivered by the motor during braking, e.g. to a braking resistor, the converter stores the energy in its DC link capacitors. This causes the DC link voltage Vdc in the converter to increase.

An excessively high DC link voltage damages the converter as well as the motor.

The Vdc_max control extends the ramp-down time of the motor when braking. Consequently, the motor feeds only so much energy back into the converter to cover the losses in the converter. The DC link voltage remains in the permissible range.

The following figure illustrates the motor and converter protection in the case of overvoltage.

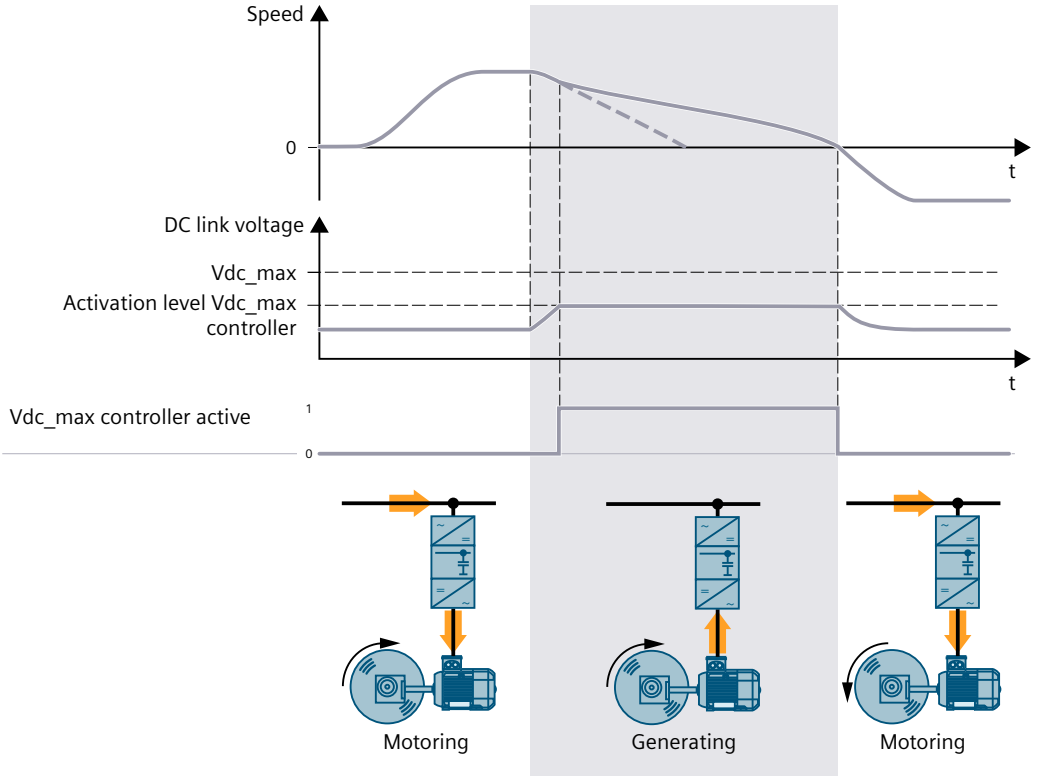


Figure 13-186 Simplified representation of the Vdc_max control

Parameters

The following list contains the parameters of the "Vdc_max controller" function for speed control.

Number	Name	Unit
p0210	Device supply voltage	V
p1240[0...n]	Vdc controller or Vdc monitoring configuration	-
p1241[0...n]	Vdc_max controller factor switch-on level	%
r1242	Vdc_max controller switch-in level	V
p1243[0...n]	Vdc_max controller dynamic factor	%
p1250[0...n]	Vdc_max controller proportional gain	-
p1251[0...n]	Vdc_max controller integral time	ms
p1252[0...n]	Vdc_max ctrl rate time	ms
p1254	Vdc_max controller automatic sensing of the switch-on level	-

13.13 Drive functions

13.13.1 Starting and stopping the motor

13.13.1.1 Sequence control when switching the motor on and off

Overview

The sequence control defines the rules for switching the motor on and off.

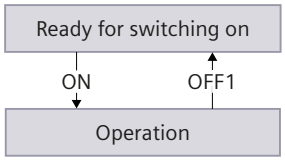


Figure 13-187 Sequence control

Description of function

After switching the supply voltage on, the converter goes into the "ready to start" state. In this state, the converter waits for the command to start the motor.

The converter starts the motor with the ON command. The converter changes to the "Operation" state.

After the OFF1 command, the converter brakes the motor down to standstill. The converter switches off the motor once standstill has been reached. The converter is again "ready to start".

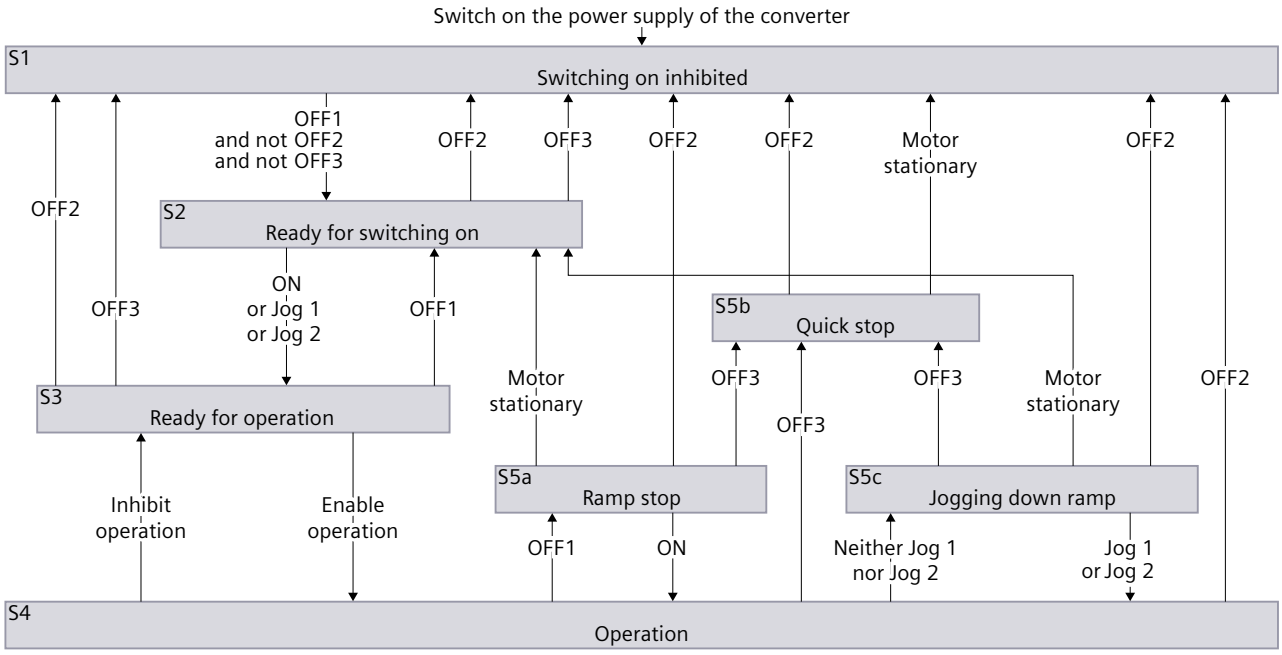


Figure 13-188 Sequence control of the converter when the motor is switched on and off

The converter states S1 ... S5c are defined in the PROFIdrive profile. The sequence control defines the transition from one state to another.

Table 13-108 Converter states

The motor is switched off		**The motor is switched on**	
Current does not flow in the motor and the motor does not generate any torque		Current flows in the motor and the motor generates a torque	
S1	The ON command and an OFF command are active at the same time. In order for the converter to exit the state, you must deactivate OFF2 and OFF3 and activate the ON command again.	S4	The motor is switched on.
S2	The converter waits for a command to start the motor.	S5a, S5c	The converter brakes the motor with the ramp-down time of the ramp-function generator.
S3	The converter waits for "Enable operation". The "Enable operation" command is always active in the converter factory setting.	S5b	The converter brakes the motor with the OFF3 ramp-down time.

Table 13-109 Commands for switching the motor on and off

Command	Description
ON Jog 1 Jog 2 Enable operation	The converter starts the motor.
OFF1, OFF3	1. The converter brakes the motor. 2. The converter switches off the motor once it comes to a standstill. The converter identifies that the motor is at a standstill when at least one of the following conditions is satisfied: • The speed actual value falls below the threshold in p1226, and the time started in p1228 has expired. • The speed setpoint falls below the threshold in p1226, and the time subsequently started in p1227 has expired.
OFF2 Inhibit operation	The converter immediately switches off the motor without actively braking it.

Parameters

The following list contains the parameters of the "Sequence control when switching the motor on and off" function.

Number	Name	Unit
r0046.0...31	Missing enable signals	-
p0857	Power unit monitoring time	ms
c0858[0...n]	Unconditionally close holding brake	-
c0860	Line contactor feedback signal	-
c0860	Line contactor feedback signal	-
p0861	Line contactor monitoring time	ms
p0861	Line contactor monitoring time	ms
p1226[0...n]	Threshold for standstill detection	rpm
p1227[0...n]	Standstill detection monitoring time	s
p1228[0...n]	Pulse cancellation delay time	s

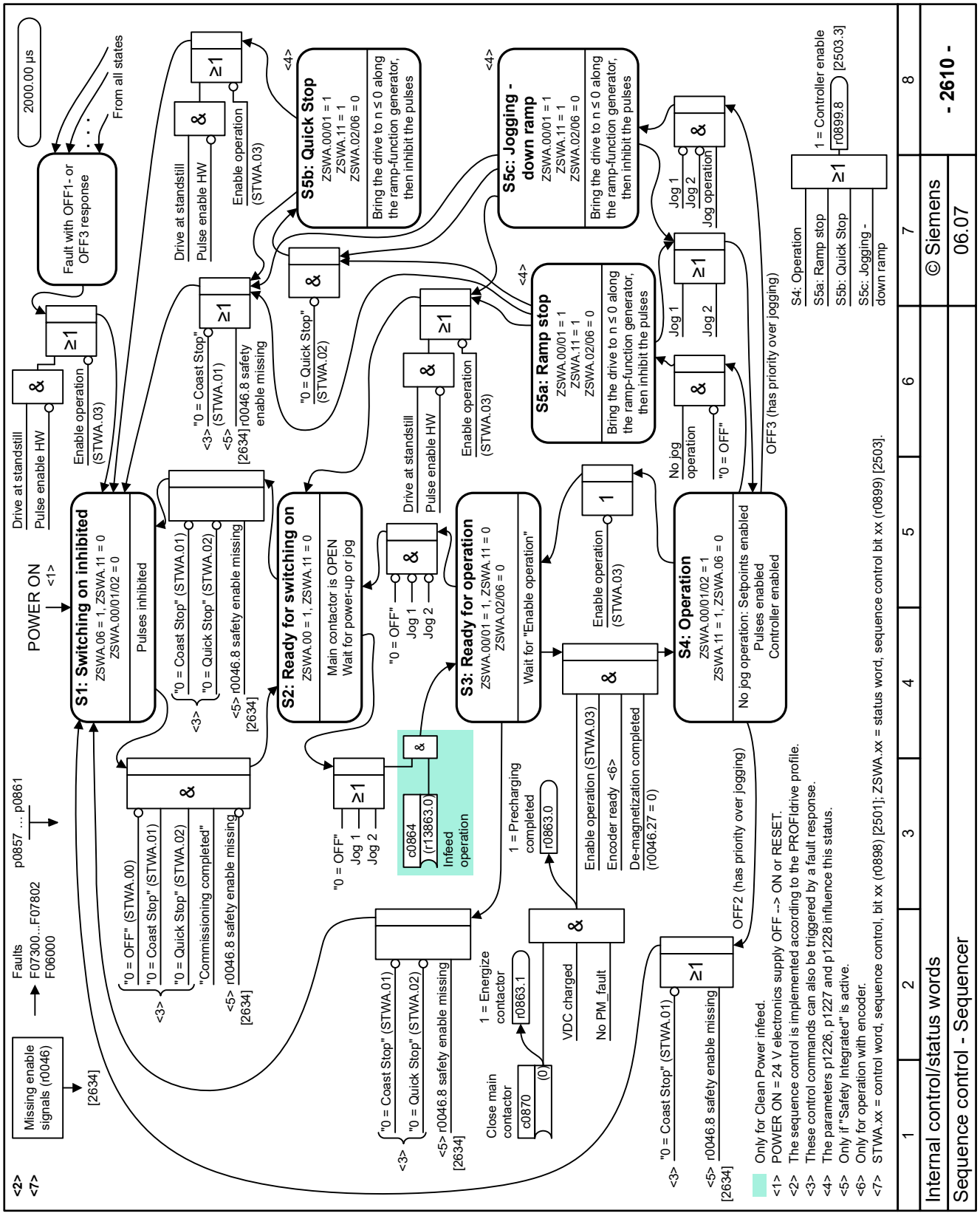


Figure 13-189 2610 - Sequence control - sequencer

13.13.1.2 Motor control with ON/reverse commands

Overview

The command "ON/OFF1" starts and stops the motor. The "Reverse" command reverses the direction of rotation of the motor.

Function description

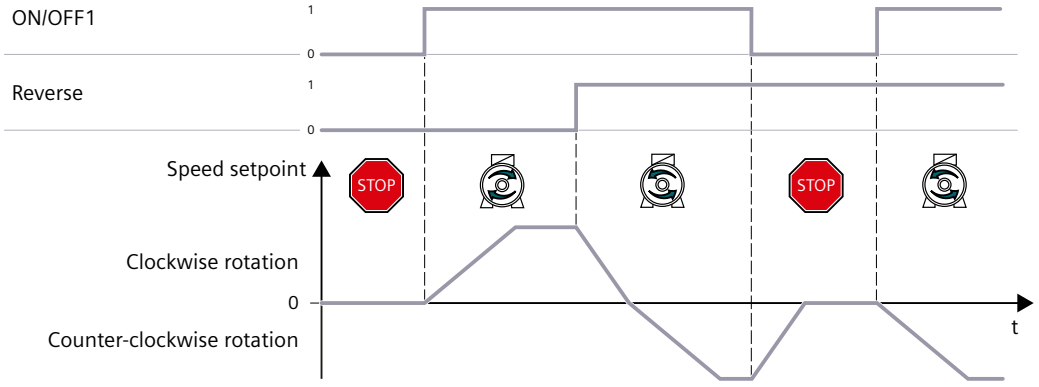


Figure 13-190 Two-wire control, ON/reverse

Table 13-110 Function table

ON/OFF1	Reverse	Function
0	0	The motor stops.
0	1	The converter brakes the motor to a standstill.
1	0	The motor starts. The converter accelerates the motor in the "clockwise" direction.
1	1	The motor starts. The converter accelerates the motor in the "counter-clockwise" direction.

Example

Table 13-111 Commands "ON/OFF1" and "Reverse" are interconnected with signals of the digital inputs

Parameters	Description
c0840[C] is interconnected with r0722.0	Digital input 0 enters command "ON/OFF"
c1113[C] is interconnected with r0722.1	Digital input 1 enters command "Reverse"

Parameters

The following list contains the parameters of the "Motor control with ON/reverse commands" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0840[0...n]	ON / OFF (OFF1)	-
c1113[0...n]	Setpoint inversion	-

13.13.1.3 Motor control with clockwise/counterclockwise commands

Overview

The commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" start the motor and also select a direction of rotation.

Function description

Two-wire control, clockwise/counter-clockwise rotation 1

p3334 = 1 activates the function.

The converter expects an unambiguous direction selection. The motor continues to rotate with the previous direction of rotation when clockwise and counterclockwise directions of rotation are simultaneously selected.

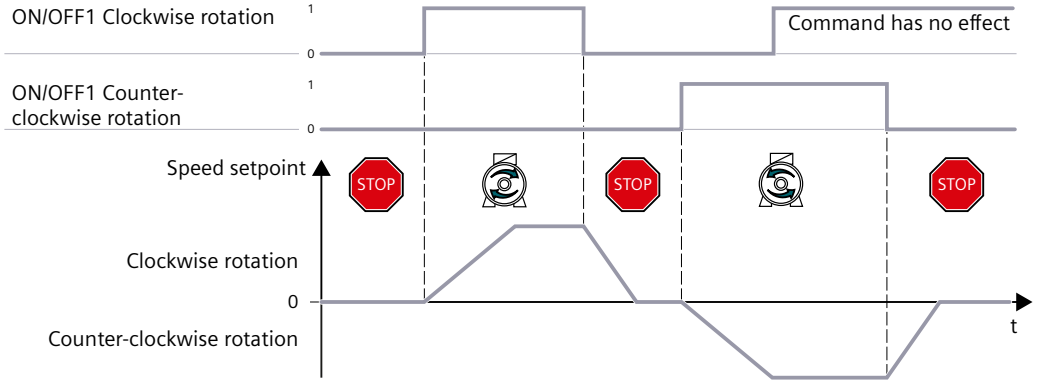


Figure 13-191 Two-wire control, clockwise/counter-clockwise rotation 1

Table 13-112 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	The motor stops. The converter brakes the motor to a standstill.
1	0	The motor starts. The converter accelerates the motor in the "clockwise" direction.
0	1	The motor starts. The converter accelerates the motor in the "counter-clockwise" direction.
1	1	The motor starts. The command that first enters the state "1" defines the direction. The other command has no effect.

Two-wire control, clockwise/counter-clockwise rotation 2

p3334 = 2 activates the function.

The converter expects an unambiguous direction selection. The motor stops when clockwise and counterclockwise directions of rotation are simultaneously selected.

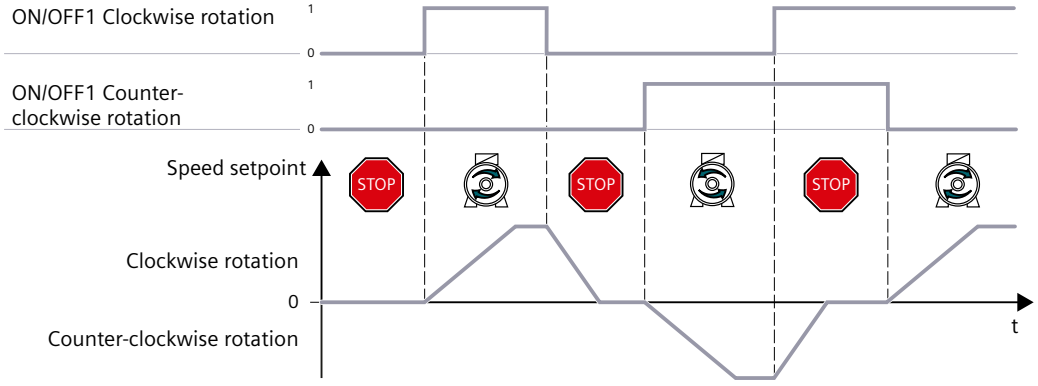


Figure 13-192 Two-wire control, clockwise/counter-clockwise rotation 2

Table 13-113 Function table

ON/OFF1 clockwise rotation	ON/OFF1 counter-clockwise rotation	Function
0	0	The motor stops. The converter brakes the motor to a standstill.
1	0	The motor starts. The converter accelerates the motor in the "clockwise" direction.
0	1	The motor starts. The converter accelerates the motor in the "counter-clockwise" direction.
1	1	The motor stops. The converter brakes the motor to a standstill.

Example

Table 13-114 Commands "ON/OFF1 clockwise rotation" and "ON/OFF1 counter-clockwise rotation" are interconnected with the signals of the digital inputs

Parameters	Description
p3334 = 2	"Two-wire control, clockwise/counter-clockwise rotation 2" is active
c3330[C] is interconnected with r0722.0	Digital input 0 enters command "ON/OFF1 clockwise direction of rotation"
c3331[C] is interconnected with r0722.1	Digital input 1 enters command "ON/OFF1 counterclockwise direction of rotation"

Parameters

The following list contains the parameters of the "Motor control with clockwise/ counterclockwise commands" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0840[0...n]	ON / OFF (OFF1)	-
c1113[0...n]	Setpoint inversion	-
c3330[0...n]	2/3 wire control command 1	-
c3331[0...n]	2/3 wire control command 2	-
r3333.0...3	2/3 wire control control word	-
p3334	2/3 wire control selection	-

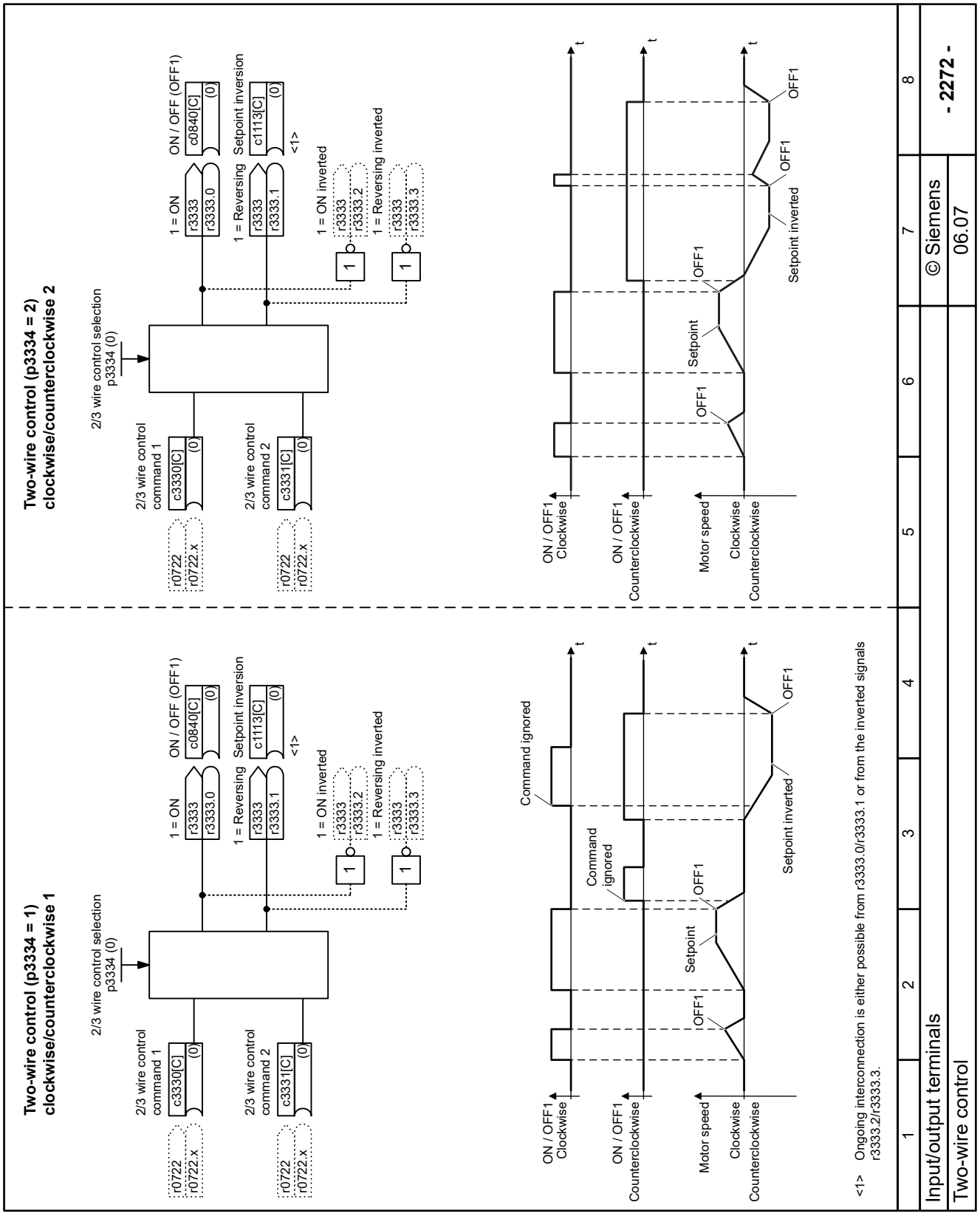


Figure 13-193 2272 - 2-wire control

13.13.1.4 Motor control with 3 commands

Overview

The converter offers various methods for starting and stopping the motor and reversing its direction of rotation using 3 signals.

Function description

Three-wire control, enable/clockwise/counter-clockwise rotation

p3334 = 3 activates the function.

The "Enable/OFF1" command is a precondition for starting the motor.

When commands "ON clockwise rotation" and "ON counterclockwise rotation "change from a 0 signal to a 1 signal, the motor starts and at the same time selects a direction of motion.

Without command "Enable/OFF1" the motor stops.

The motor stops when clockwise and counterclockwise directions of rotation are simultaneously selected.

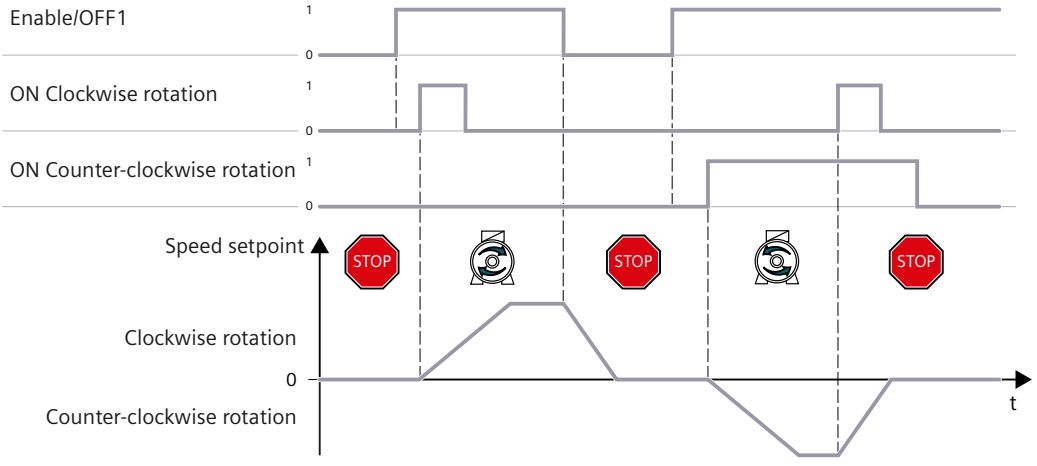


Figure 13-194 Three-wire control, enable/clockwise/counter-clockwise rotation

Table 13-115 Function table

Enable / OFF1	ON clockwise rotation	ON counter-clockwise rotation	Function
0	0 or 1	0 or 1	The motor stops. The converter brakes the motor to a standstill.
1	0→1	0	The motor starts. The converter accelerates the motor in the "clockwise" direction.

Enable / OFF1	ON clockwise rotation	ON counter-clockwise rotation	Function
1	0	0→1	The motor starts. The converter accelerates the motor in the "counter-clockwise" direction.
1	1	1	The motor stops. The converter brakes the motor to a standstill.

Three-wire control, enable/ON/reverse

p3334 = 4 activates the function.

The "Enable/OFF1" command is a precondition for starting the motor.

The "ON" command starts the motor. The "Reverse" command reverses the direction of rotation of the motor.

Without command "Enable/OFF1" the motor stops.

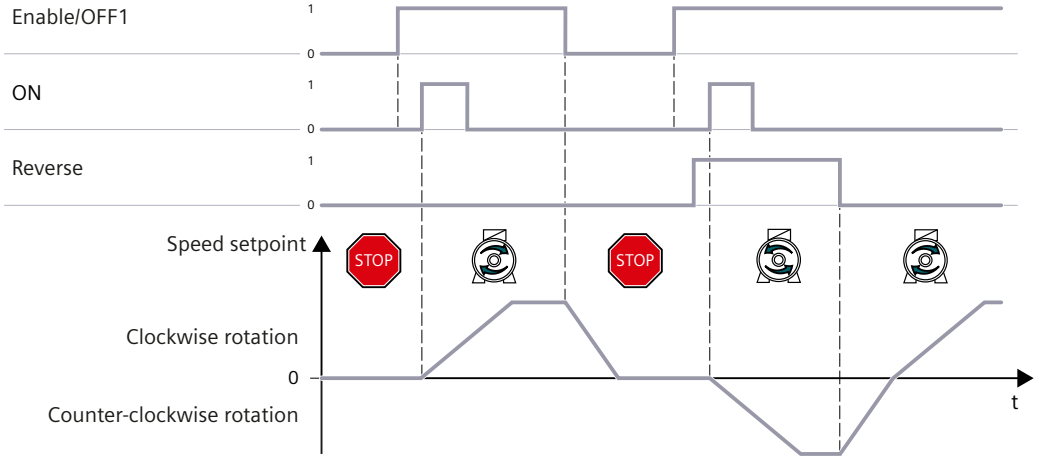


Figure 13-195 Three-wire control, enable/ON/reverse

Table 13-116 Function table

Enable / OFF1	ON	Reverse	Function
0	0 or 1	0 or 1	The motor stops. The converter brakes the motor to a standstill.
1	0→1	0	The motor starts. The converter accelerates the motor in the "clockwise" direction.
1	0→1	1	The motor starts. The converter accelerates the motor in the "counter-clockwise" direction.

Example

Table 13-117 Commands "Enable/OFF1", "ON" and "Reverse" are interconnected with the signals of the digital inputs

Parameters	Description
p3334 = 4	"Three-wire control enable/ON/reverse" is active
c3330[C] is interconnected with r0722.0	Digital input 0 enters command "Enable/OFF1"
c3331[C] is interconnected with r0722.1	Digital input 1 enters command "ON"
c3332[C] is interconnected with r0722.2	Digital input 2 enters command "Reverse"

Parameters

The following list contains the parameters of the "Motor control with 3 commands" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	-
c0840[0...n]	ON / OFF (OFF1)	-
c1113[0...n]	Setpoint inversion	-
c3330[0...n]	2/3 wire control command 1	-
c3331[0...n]	2/3 wire control command 2	-
c3332[0...n]	2/3 wire control command 3	-
r3333.0...3	2/3 wire control control word	-
p3334	2/3 wire control selection	-

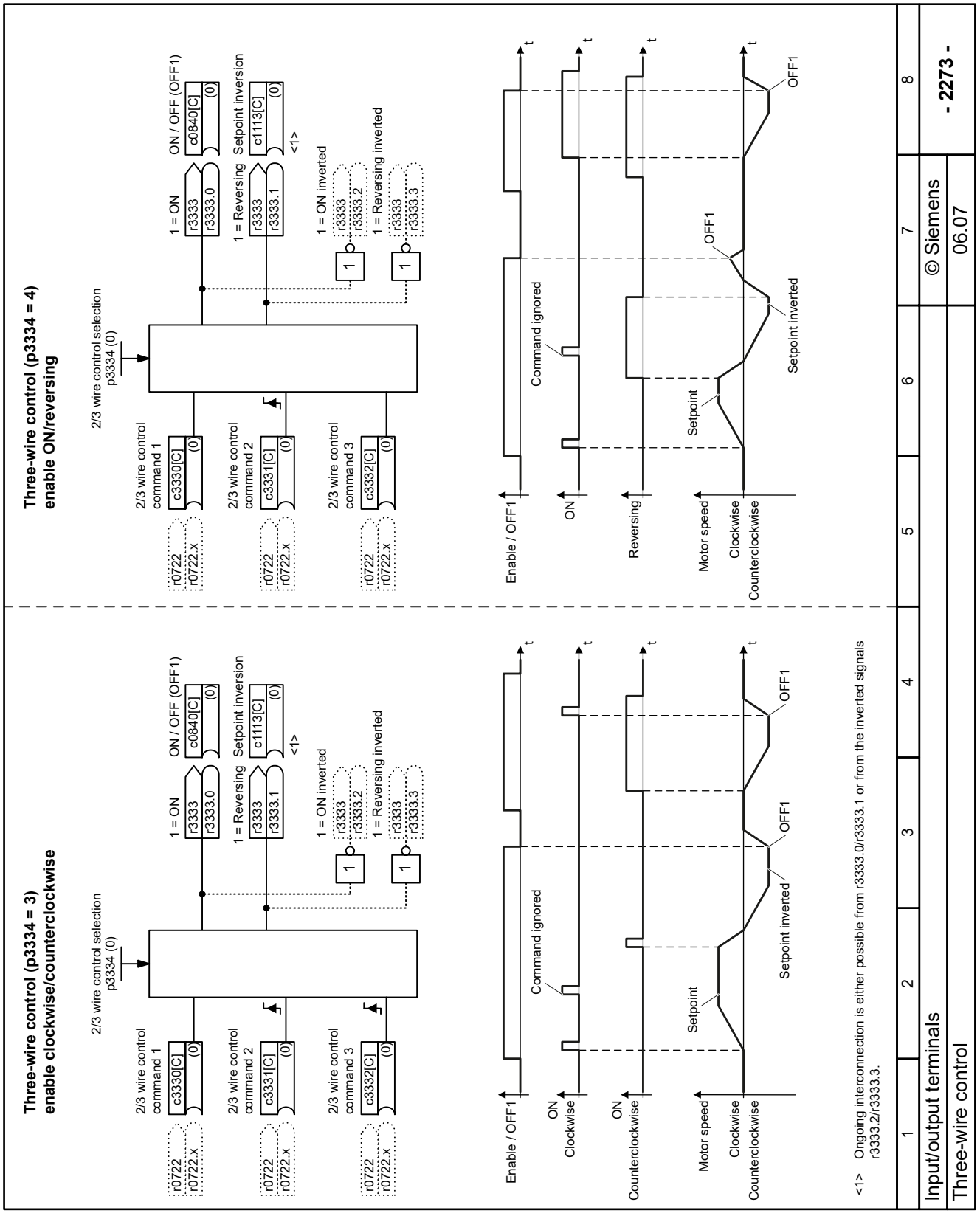


Figure 13-196 2273 - 3-wire control

13.13.2 Unit, unit group and unit selection

Overview

The physical units of parameters, which the converter calculates, e.g. for closed-loop control tasks, can be adapted to the specific application.

Function description

The converter calculates internally with referred variables as well as with physical variables. The physical variables are represented in parameters with the appropriate physical unit.

Parameters with the same unit are combined in a unit group.

In turn, several unit groups are assigned parameters for unit selection, which switch over the unit of the unit groups.

Example

Selecting units using parameter p0100, IEC/NEMA standard, switches over a series of unit groups, e.g.:

- Units group 7_4: Switchover Nm ↔ lbf ft
- Units group 14_6: Switchover kW ↔ HP

More information

The following information on this topic is provided in the List Manual:

- Which parameters have a physical unit?
- Which unit group is assigned to the parameter?
- Which parameter switches over the unit group?

Parameters

The following list contains the parameters of the "Motor standard" function.

Number	Name	Unit
p0100	IEC/NEMA Standards	-
p0349	System of units motor equivalent circuit diagram data	-
p0505	Selecting the system of units	-
p0595	Technological unit selection	-
p2496	LR measurement unit position	-
p2496	LR measurement unit position	-
p2497	LR measurement unit velocity	-
p2497	LR measurement unit velocity	-
p2498	LR measurement unit acceleration	-
p2498	LR measurement unit acceleration	-
p2499	LR measurement unit jerk	-

p2499	LR measurement unit jerk	-

13.13.3 Reference values

Overview

A reference value is a parameter that defines the scaling of parameters with physical unit.

Function description

Every numerical signal sink and every numerical signal source with physical unit is assigned a parameter as reference value.

If the reference value is changed, the significance of the scaled values also changes.

Example

Scaling with reference speed p2000:

- Reference speed p2000 = 1 500 r/min → fixed speed setpoint 1 (p1001) = 80 % corresponds to speed = 1 200 r/min
- Reference speed p2000 = 3 000 r/min → fixed speed setpoint 1 (p1001) = 80 % corresponds to speed = 2 400 r/min

Parameters

The following list contains the parameters of function "Reference values".

Number	Name	Unit
p2000	Reference speed reference frequency	rpm
p2001	Reference voltage	Vrms
p2002	Reference current	Arms
p2003	Reference torque	Nm
p2004	Reference power	kW
p2005	Reference angle	°
p2006	Reference temperature	°C
p2007	Reference acceleration	rev/s²

13.13.4 Data sets

13.13.4.1 Drive data set - managing different drive configurations

Overview

The converter saves different drive settings and activates the appropriate setting when requested by the higher-level control.

Function description

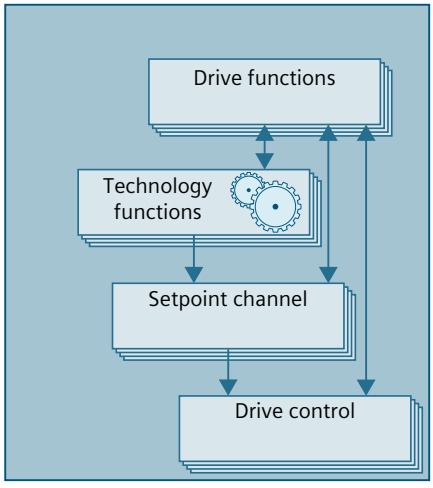


Figure 13-197 Different settings in the drive data sets

A drive data set contains the adjustable parameters of the following converter functions:

- Drive functions
- Technology functions
- Setpoint channel
- Drive control
- Closed-loop infeed control

Parameter p0180 specifies the number of drive data sets.

The parameters of drive data set are indexed. Selecting a certain parameter index activates the corresponding parameters of the drive data set.

Example

The converter operates 2 different motors. When required, the higher-level control switches between motor 1 and motor 2. The converter must operate with the settings that match the selected motor.

In this example, the number of drive data sets is p0180 = 2.

	Parameter name	Motor 1	Motor 2
Drive data set	---	0	1
Selecting the drive data set	Drive data set selection DDS bit 0	c0820 = 0	c0820 = 1
Active parameter index of the drive data set	---	[0]	[1]
Examples of parameters of the drive data set	Fixed speed setpoint 1	p1001[0]	p1001[1]
	Ramp-function generator ramp-up time	p1120[0]	p1120[1]
	Maximum speed	p1082[0]	p1082[1]
	Speed controller P gain	p1460[0]	p1460[1]

Parameters

The following list contains the parameters of the "Switching between different drive configurations" function.

Number	Name	Unit
r0051.0...3	Drive Data Set DDS effective	-
p0180	Number of Drive Data Sets (DDS)	-
p0186[0...n]	Motor Data Sets (MDS) number	-
p0187[0...n]	Motor encoder encoder data set number	-
p0188[0...n]	Encoder 2 encoder data set number	-
c0820[0...n]	Drive Data Set selection DDS bit 0	-
c0821[0...n]	Drive Data Set selection DDS bit 1	-
c0822[0...n]	Drive Data Set selection DDS bit 2	-
c0823[0...n]	Drive Data Set selection DDS bit 3	-
p0826[0...n]	Motor changeover motor number	-
c0828[0...n]	Motor changeover feedback signal	-

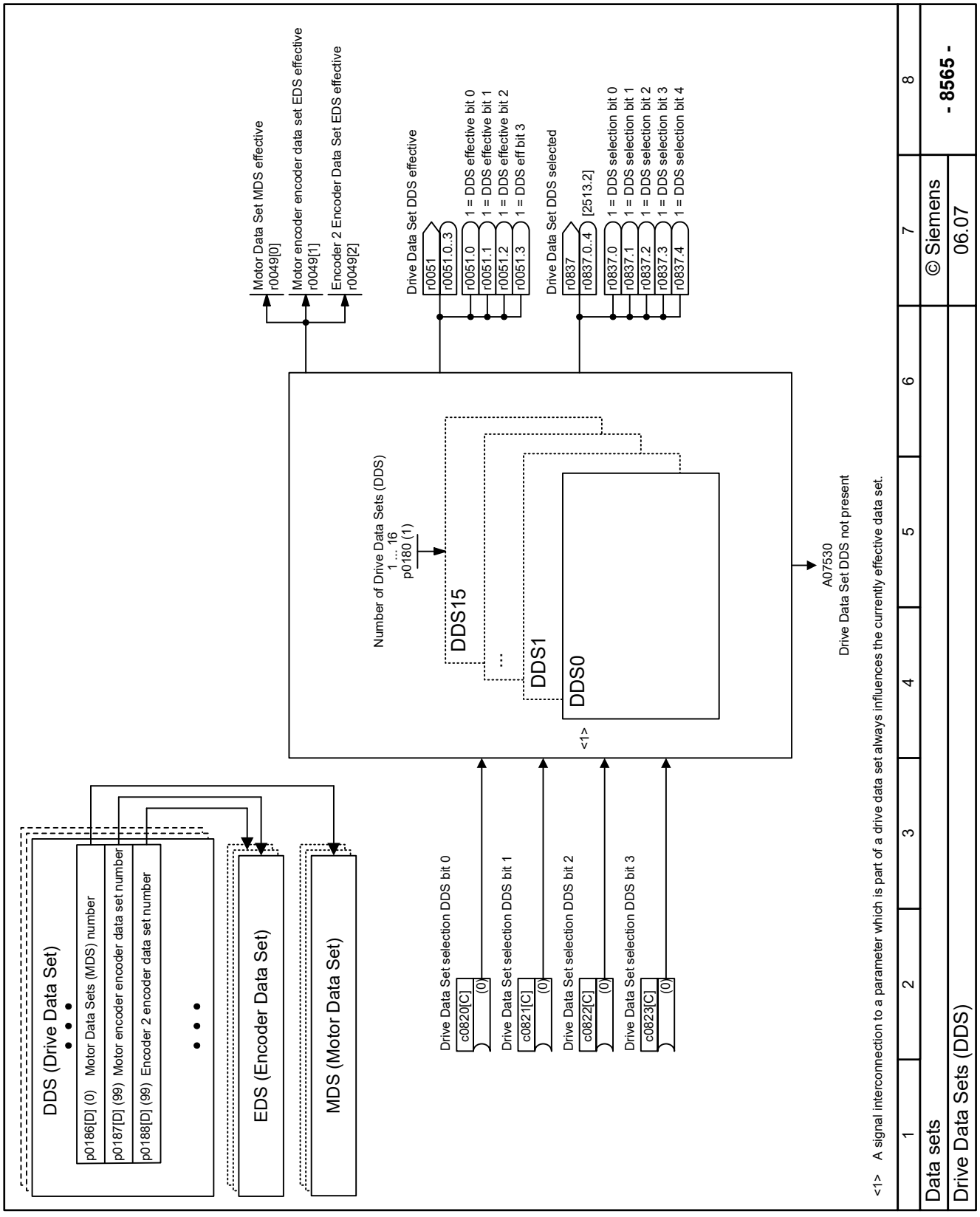


Figure 13-198 8565 - Drive Data Sets (DDS)

13.13.4.2 Motor data set - managing different motors

Overview

The converter saves the motor data of different motors in motor data sets. When requested by the higher-level control system, the converter switches over the closed-loop drive control with the appropriate motor data set.

Function description

A motor data set (MDS) contains the adjustable parameters of the connected motor and display parameters with calculated data.

A dedicated motor data set is required for every motor.

Several motor data sets are required for the following applications, for example:

- The converter alternately operates different motors.
- Motor windings can be changed over, e.g. for a star-delta changeover

Parameter p0130 defines the number of motor data sets.

Parameter p0186 assigns a motor data set to one or several drive data sets:

- The index of p0186 corresponds to the number of the drive data set.
- The parameter value corresponds to the number of the motor data set.

It is not possible to directly select a motor data set. When selecting a certain drive data set, the converter also uses the assigned motor data set.

Example

The converter alternately operates 2 different motors.

- Motor 1 drives the travel gear in a machine.
- Motor 2 drives the hoisting gear in a machine.

Drive data set	Motor data set	P0186 setting	Explanation
DDS0	MDS0	p0186[0] = 0	The motor data of motor 1 are in the MDS0. MDS0 is assigned to DDS0.
DDS1	MDS1	p0186[1] = 1	The motor data of motor 2 are in the MDS1. MDS1 is assigned to DDS1.

When operating the travel gear, the higher-level control selects drive data set DDS0. When selecting DDS0, then MDS0 is also active.

When operating the hoisting gear, the higher-level control selects drive data set DDS1. When selecting DDS1, then MDS1 is also active.

Parameters

The following list contains the parameters of function "Motor data set".

Number	Name	Unit
p0130	Number of Motor Data Sets (MDS)	-
p0186[0...n]	Motor Data Sets (MDS) number	-

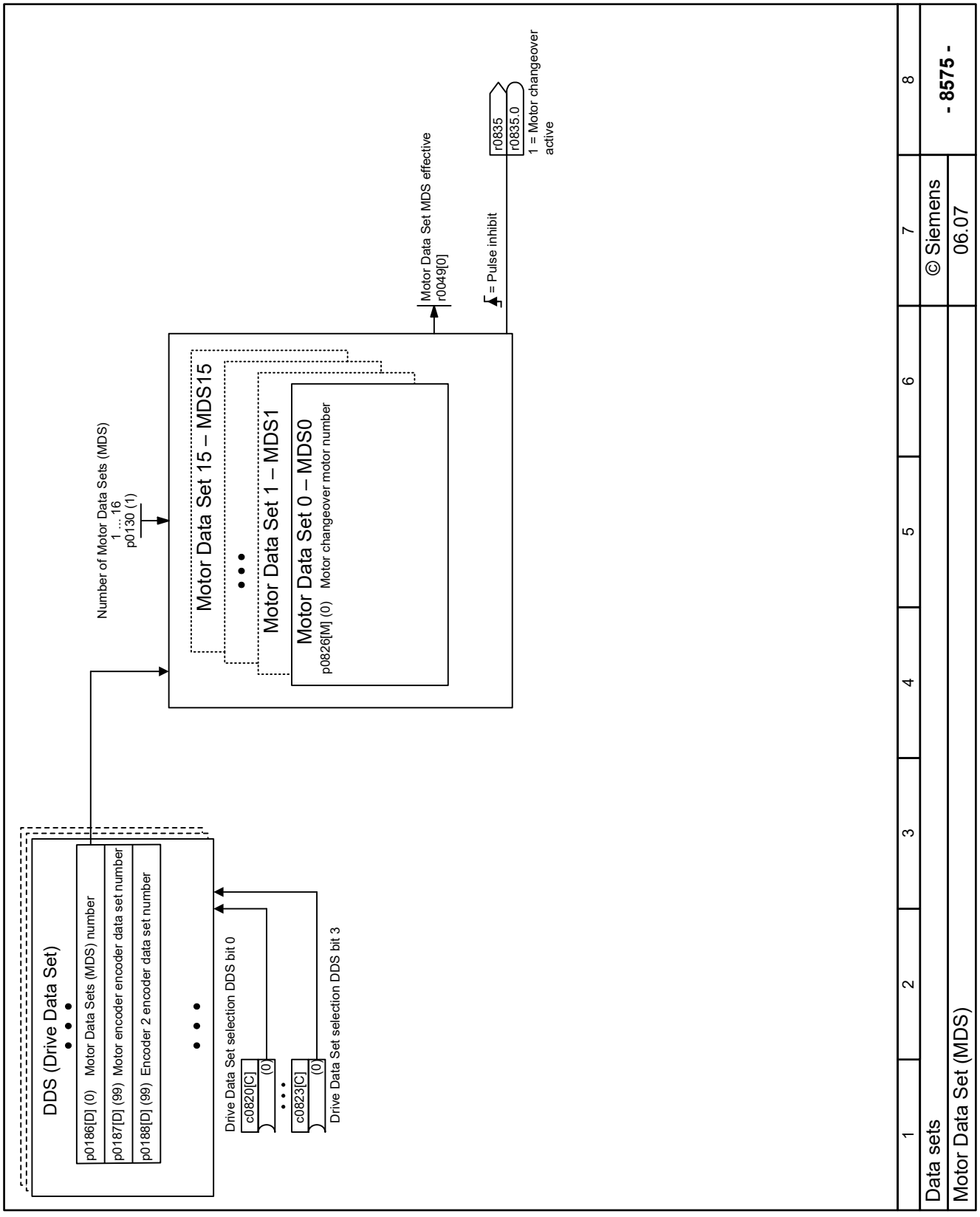


Figure 13-199 8575 - Motor Data Sets (MDS)

13.13.4.3 Encoder data set - managing different encoders

Overview

The converter saves the encoder data of different encoders in encoder data sets. When requested by the higher-level control system, the converter switches over the closed-loop drive control with the appropriate encoder data set.

Precondition

The safe actual value acquisition of Safety Integrated Functions only supports 1 encoder data set. As a consequence, changing over the encoder data set is not permissible for safe actual value acquisition.

Function description

An encoder data set (EDS) contains the adjustable parameters of the connected encoder.

A dedicated encoder data set is required for every encoder.

Several encoder data sets are required for the following applications, for example:

- The converter alternately operates different motors.
- Motor windings can be changed over, e.g. for a star-delta changeover

Parameter p0140 specifies the number of encoder data sets.

Parameters p0187 and p0188 assign an encoder data set to a drive data set:

- p0187 assigns the motor encoder.
- p0188 assigns encoder 2.
- Index of parameter p0187 ... p0188 corresponds to the number of the drive data set.
- The parameter value corresponds to the number of the encoder data set.

It is not possible to directly select an encoder data set. When selecting a certain drive data set, the converter uses all of the assigned encoder data sets.

Example

The converter operates a motor with different operating modes:

- In operating mode 1, the closed-loop drive control only evaluates the motor encoder.
- In operating mode 2, the closed-loop drive control evaluates the motor encoder and also encoder 2.

Drive data set	Motor data set	Encoder data set	P0186 setting	Explanation
DDS0	MDS0	EDS0	p0187[0] = 0	The encoder data of the motor encoder are in EDS0. EDS0 is assigned to DDS0.
DDS1	MDS0	EDS0 EDS1	p0187[1] = 0 p0188[1] = 1	The encoder data of the motor encoder are in EDS0. EDS0 is assigned to DDS0. The encoder data of encoder 2 are in EDS1. EDS1 is assigned to DDS1.

Parameters

The following list contains the parameters of function "Encoder data set".

Number	Name	Unit
p0140	Number of Encoder Data Sets (EDS)	-
p0187[0...n]	Motor encoder encoder data set number	-
p0188[0...n]	Encoder 2 encoder data set number	-

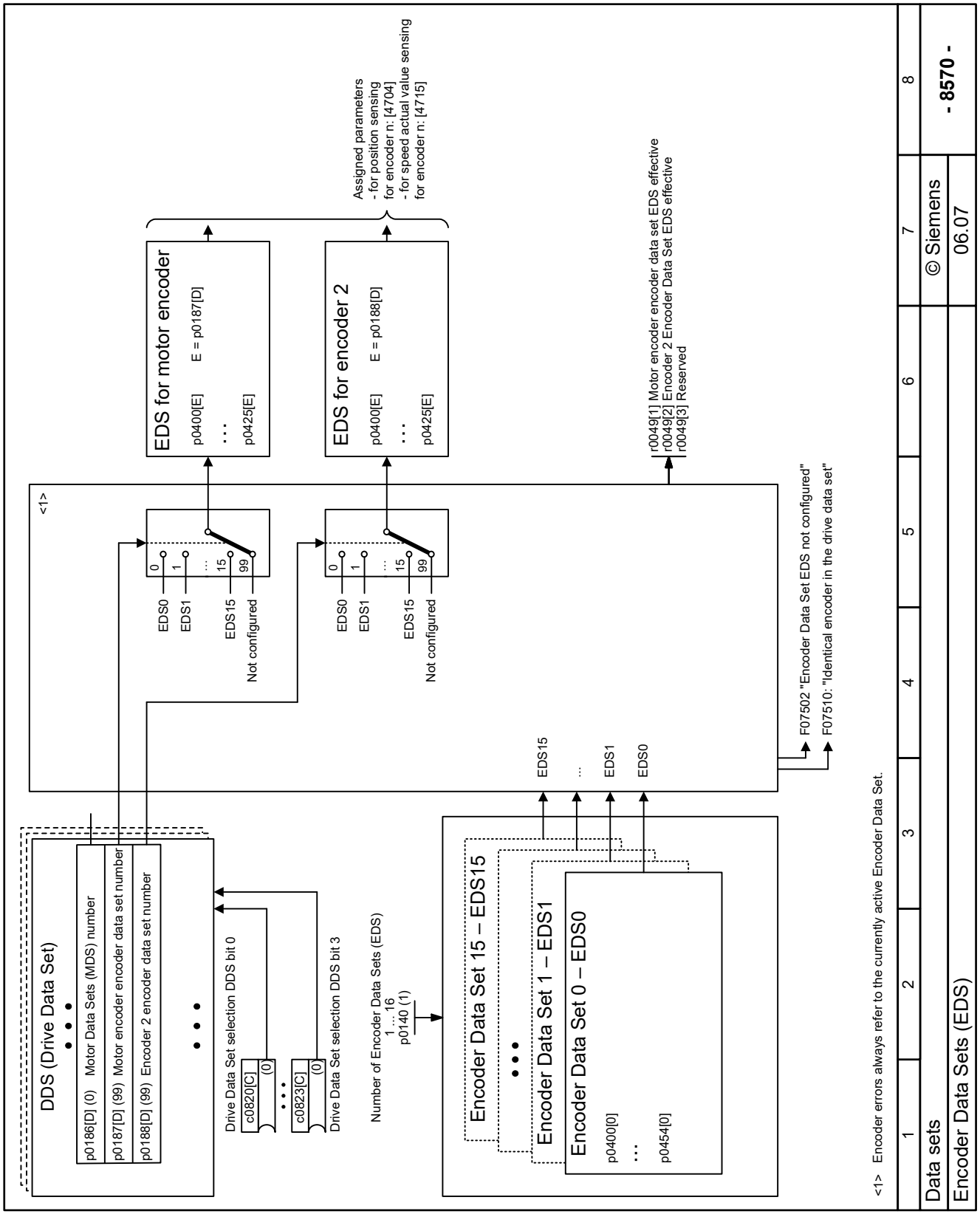


Figure 13-200 8570 - Encoder Data Sets (EDS)

13.13.4.4 Command data set - managing different controls

Overview

The command data set makes it possible to control the converter via different interfaces and to switch control system during operation.

Description of function

The converter has different interfaces via which it receives control signals and reports status signals.

The functions of the converter are interconnected with the control signals and status signals by means of interconnection parameters.

If the interconnection parameters are indexed, then it is possible to set a separate interconnection for each index.

A command data set contains all the signal interconnections assigned to a particular index.

The command data set selected thus also defines the interfaces and the nature of converter control.

Example

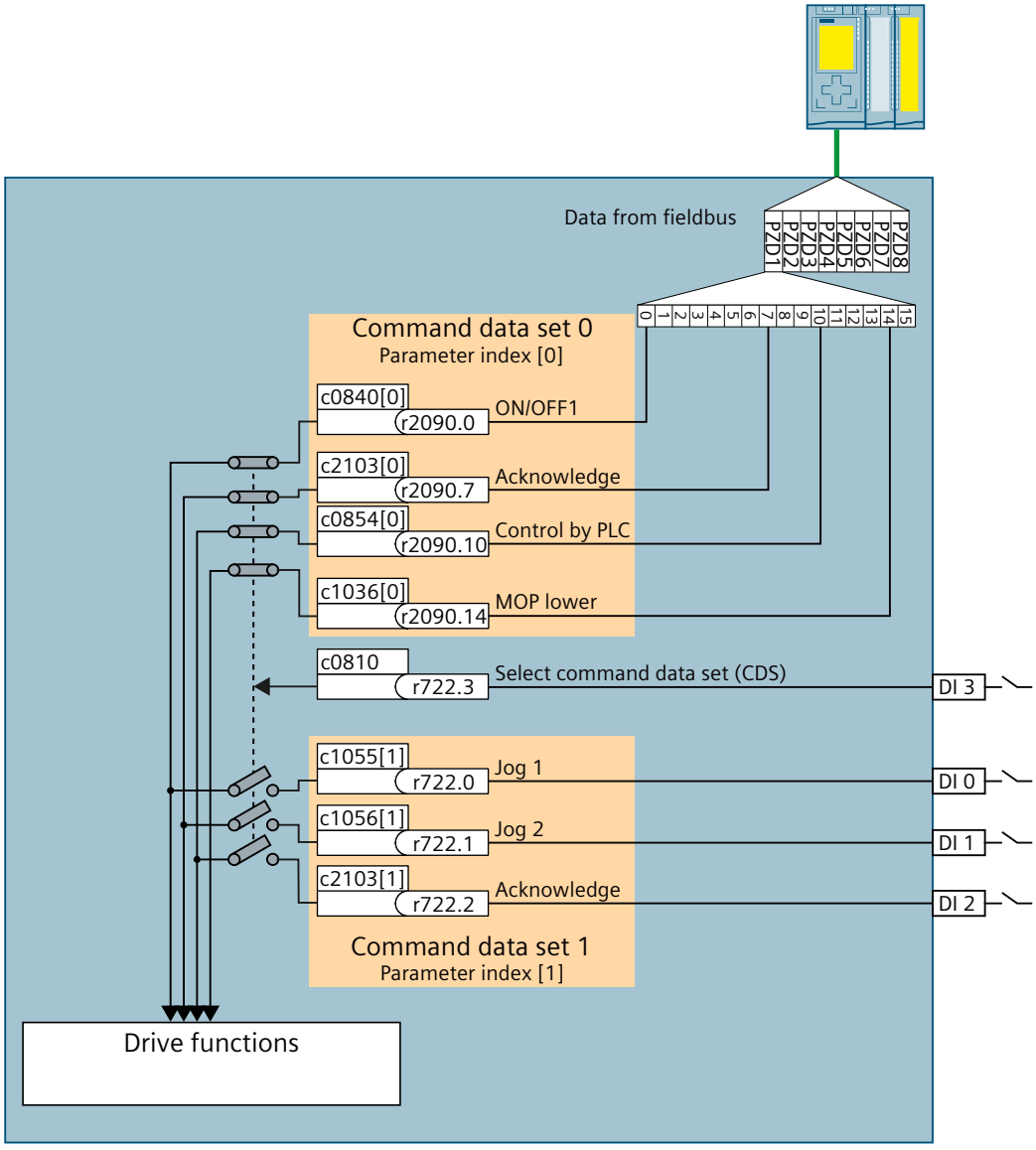


Figure 13-201 Switching command data sets

The motor should be controlled either from a central control via the fieldbus or locally via the digital inputs of the converter.

Digital input DI 3 switches the command data set and hence the control commands.

Parameters

The following list contains the parameters of the "Switching between drive controls" function.

Number	Name	Unit
r0050.0...1	Command Data Set CDS effective	-
p0170	Number of Command Data Sets (CDS)	-

c0810	Command data set selection CDS bit 0	-
c0811	Command data set selection CDS bit 1	-

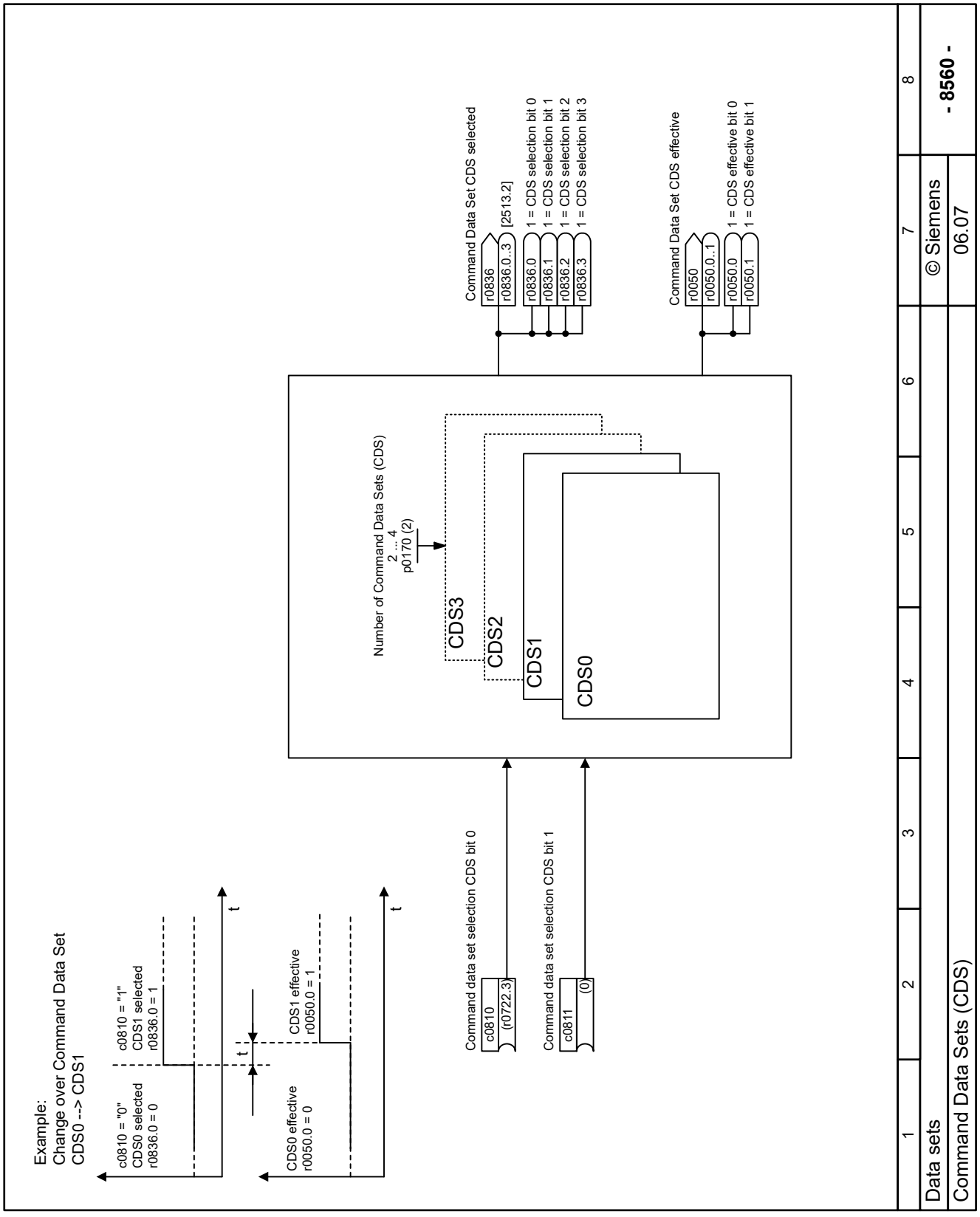


Figure 13-202 8560 - Command Data Sets (CDS)

13.13.5 Line contactor control

Overview

The optional line contactor electrically disconnects the converter from the line supply. Disconnection from the line supply increases the level of safety in the case of faults and saves energy in non-operational periods.

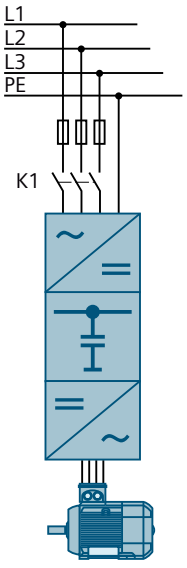


Figure 13-203 K1 line contactor

Precondition

The line contactor control requires a 24 V power supply of the converter.

The 24 V power supply must be maintained, even when the line contactor is open.

Function description

The converter controls its own line contactor using signal r0863.1 via a digital output.

The converter monitors the line contactor feedback signal in signal c0860.

When feedback signal is activated, parameter p0861 defines the monitoring time of the line contactor. If the feedback signal is not available for longer than the time set in p0861, then the converter issues a fault.

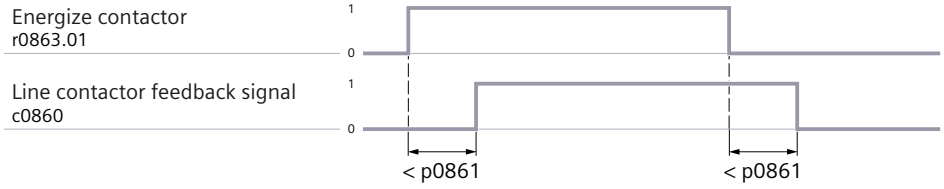


Figure 13-204 Monitoring of line contactor feedback signal

Example

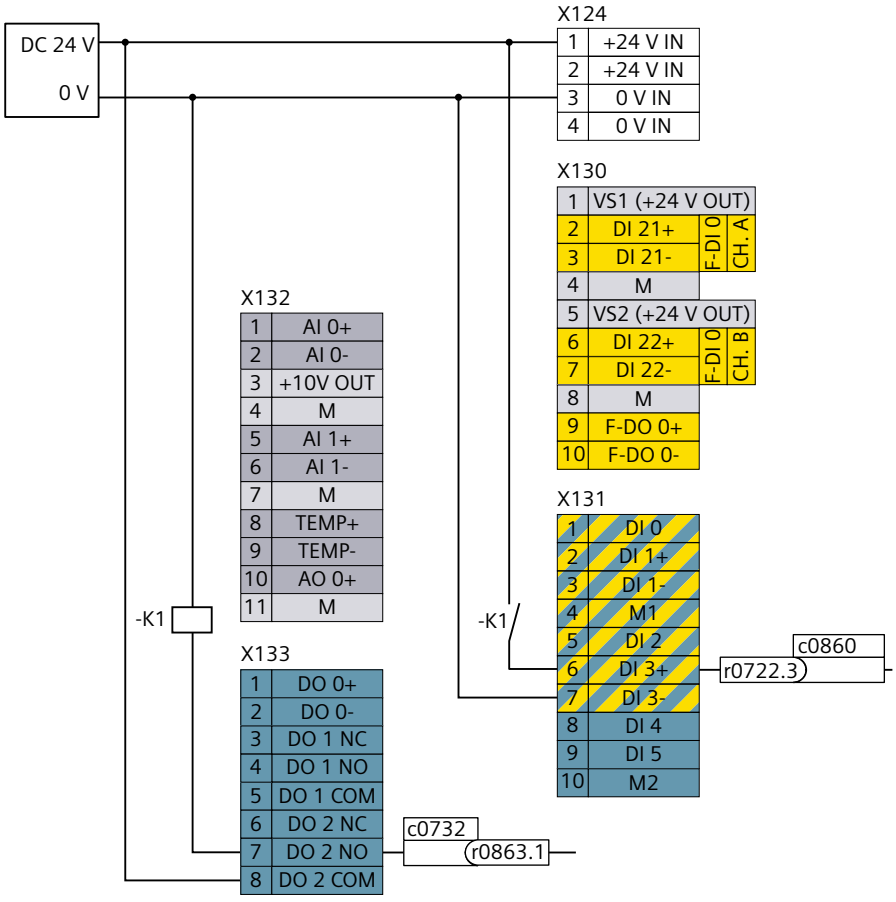


Figure 13-205 Line contactor control via DO 2, feedback signal via DI 3

Parameters

The following list contains the parameters of the "Line contactor control" function.

Number	Name	Unit
r0046.0...31	Missing enable signals	-
c0732	Signal for terminal DO 2	-
c0860	Line contactor feedback signal	-
c0860	Line contactor feedback signal	-
p0861	Line contactor monitoring time	ms
p0861	Line contactor monitoring time	ms
r0863.0...1	Drive coupling status word/control word	-
p0867	Power unit main contactor holding time after OFF1	ms
c0870	Close main contactor	-

13.13.6 Line contactor control for Clean Power converters

Overview

The optional line contactor disconnects the converter from the line supply and therefore reduces the converter losses when the motor is not in operation.

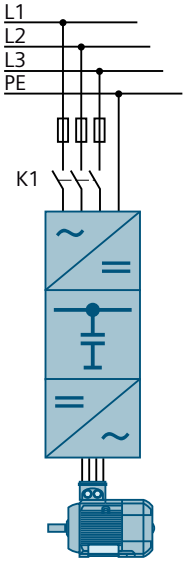


Figure 13-206 K1 line contactor

Requirement

The following requirements apply:

- The converter has an active Clean Power infeed.
- The line contactor control requires a 24 V power supply of the converter.
  The 24 V power supply must be maintained, even when the line contactor is open.

Description of function

The converter controls its own line contactor using signal r13863.1 via a digital output.

The converter evaluates the line contactor feedback signal in signal c0860.

When feedback signal is activated, parameter p0861 defines the monitoring time of the line contactor. If the line contactor feedback signal is not available for longer than the time set in p0861, then the converter issues a fault.

Example

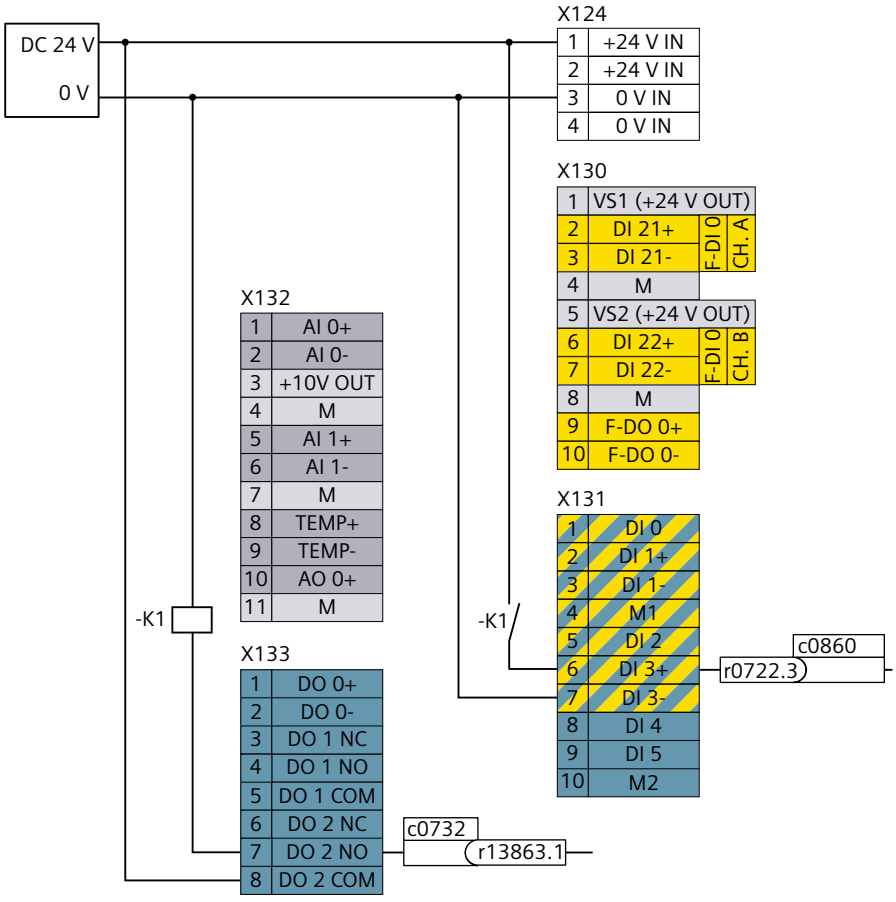


Figure 13-207 Converter with Clean Power infeed, line contactor control via DO 2, feedback signal via DI 3

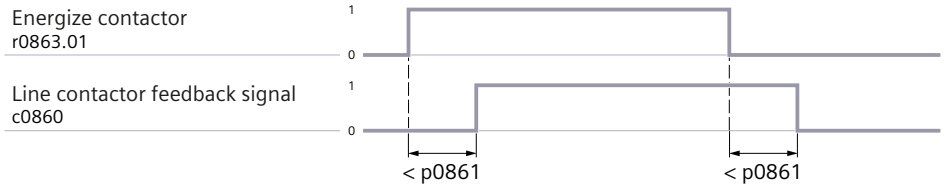


Figure 13-208 Monitoring of line contactor feedback signal

Parameters

The following list contains the parameters of function "Line contactor control for Clean Power converters".

Number	Name	Unit
c0860	Line contactor feedback signal	-
p0861	Line contactor monitoring time	ms
r13863.0...2	Infeed drive coupling status word/control word	-

13.13.7 DC braking

Overview

With DC braking, the motor brakes the load by converting the kinetic energy of the load into heat.

Precondition

DC braking is only possible with an induction motor.

Applications involving suspended loads, e.g. hoisting gear/cranes or vertical conveyors, are not permitted.

NOTICE
Motor overheating as a result of DC braking DC braking can subject the motor to thermal overload. A thermal overload damages the motor. • Monitor the motor temperature. • Allow the motor to cool down between braking operations.

Function description

The motor brakes the load without generator power flowing into the converter.

The motor converts braking energy of the load into heat.

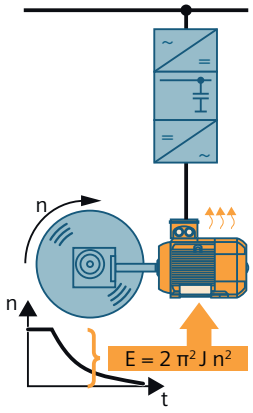


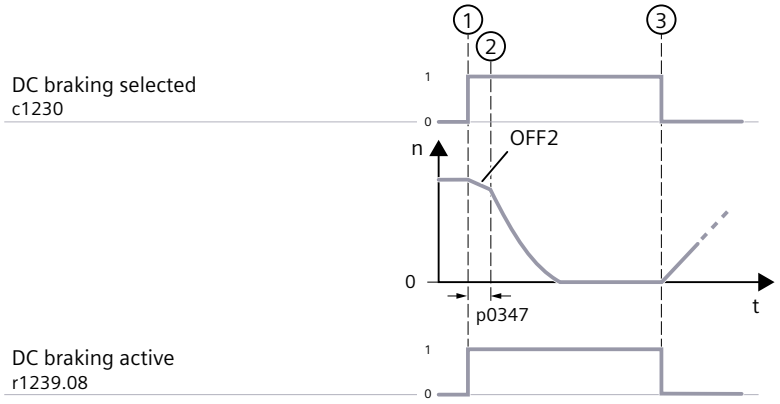
Figure 13-209 Energy flow during DC braking

Features of DC braking:

- No constant braking torque
- No braking torque at standstill

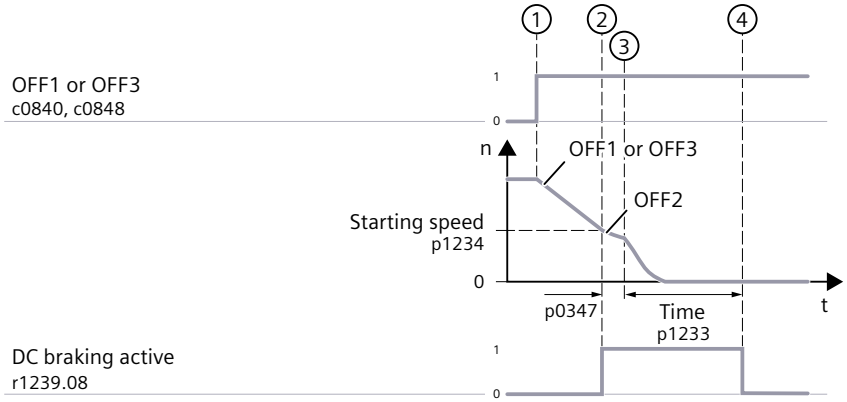
DC braking is available in 4 variants:

- Internal DC braking, p1231 = 4



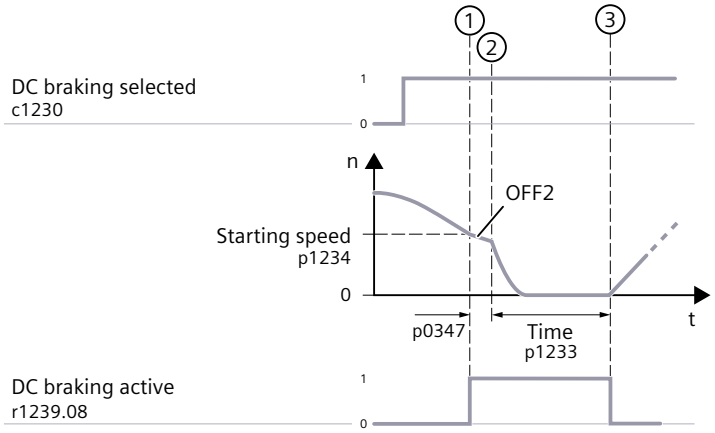
① If the binary signal sink c1230 has a 1 signal, then the converter switches off the motor current for the duration of the motor de-excitation time p0347. The drive behaves in the same way as it does in response to an OFF2 command.
② After the motor de-excitation time, the converter brakes the motor using DC braking.
③ When binary signal sink c1230 has a 0 signal, the converter exits DC braking.

- DC braking for OFF1/OFF3, p1231 = 5



① After an OFF1 or OFF3 command, the converter brakes the motor along the OFF1 or OFF3 down ramp to the speed to start DC braking.
② As soon as the motor speed falls below the speed to start DC braking, the converter switches off the motor current for the duration of the motor de-excitation time p0347. The drive behaves in the same way as it does in response to an OFF2 command.
③ After the motor de-excitation time, the converter brakes the motor using DC braking.
④ The converter exits DC braking after the DC braking time.

- DC braking when falling below a starting speed, p1231 = 14

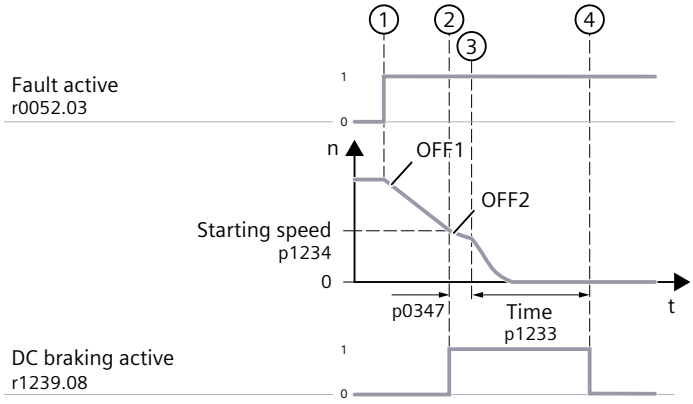


① If the binary signal sink c1230 has a 1 signal and the motor speed falls below the starting speed, then the converter switches off the motor current for the duration of the motor de-excitation time p0347. The drive behaves in the same way as it does in response to an OFF2 command.

② After the motor de-excitation time, the converter brakes the motor using DC braking.

③ The motor resumes normal operation after the DC braking time.

- DC braking as fault response, p2101[x] = 6



① After a fault, which is assigned the DC braking response, the converter brakes the motor along the OFF1 down ramp.

② As soon as the motor speed falls below the speed to start DC braking, the converter switches off the motor current for the duration of the motor de-excitation time p0347. The drive behaves in the same way as it does in response to an OFF2 command.

③ After the motor de-excitation time, the converter brakes the motor using DC braking.

④ The converter exits DC braking after the DC braking time.

If a speed encoder is being used, then DC braking ends as soon as the speed falls below standstill threshold p1226.

Example

Suitable for applications in which the motor must be braked electrically but neither a converter with energy recovery nor a braking resistor is available.

Typical applications for DC braking:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Parameters

The following list contains the parameters of the "DC braking" function.

Number	Name	Unit
p0347[0...n]	Motor de-excitation time	s
p1226[0...n]	Threshold for standstill detection	rpm
c1230[0...n]	DC braking/armature short circuit activation	-
p1231[0...n]	DC braking/armature short circuit configuration	-
p1232[0...n]	DC braking braking current	Arms
p1233[0...n]	DC braking time	s
p1234[0...n]	Speed at the start of DC braking	rpm
r1239.0...13	DC braking/armature short circuit status word	-
p2100[0...19]	Change fault response fault number	-
p2101[0...19]	Change fault response response	-

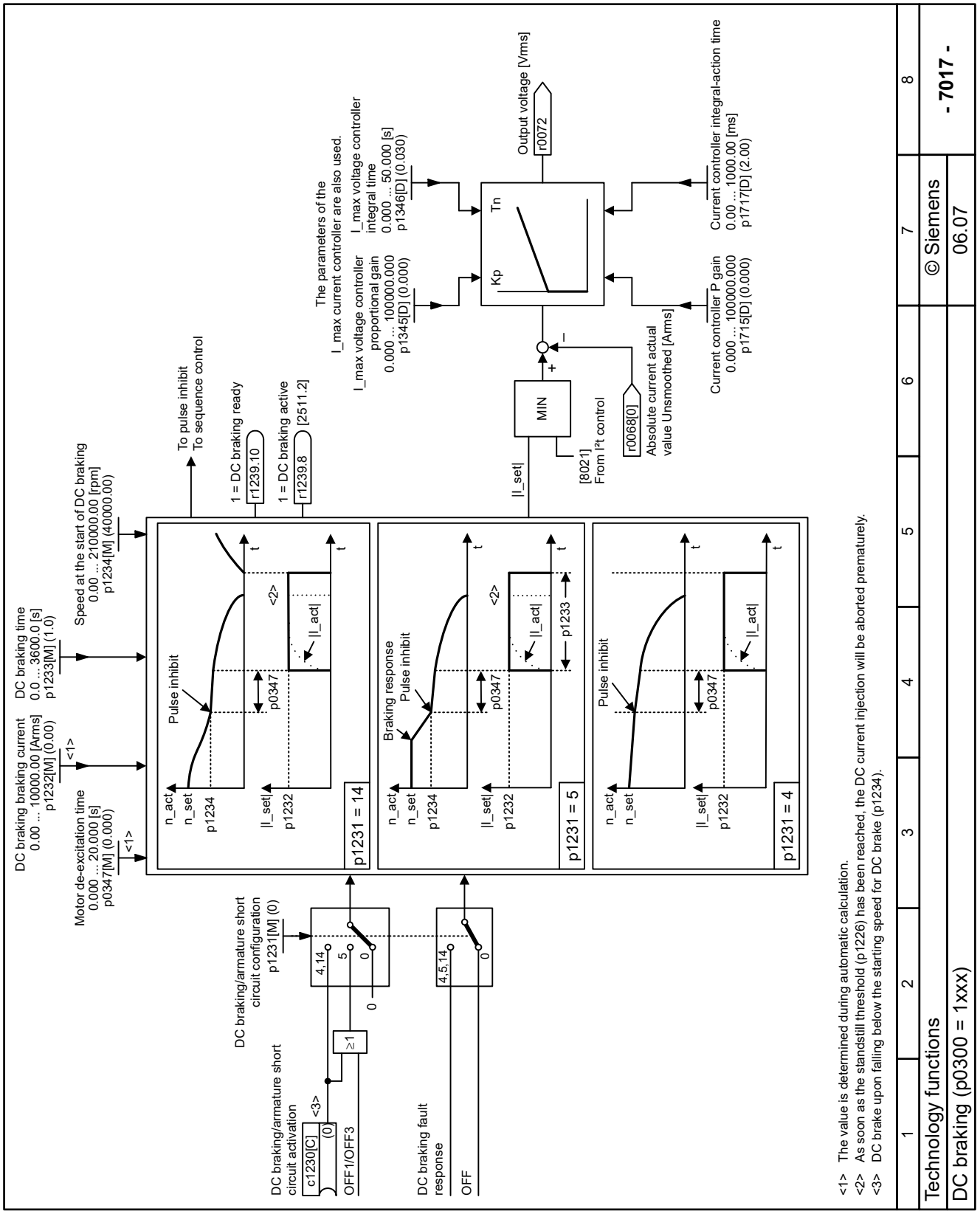


Figure 13-210 7017 - DC braking

13.13.8 Armature short-circuit braking

Overview

Armature short-circuit braking brakes the load. During braking, armature short-circuit braking converts the kinetic energy of the load in the motor into heat.

Requirement

Requirements:

- The armature short-circuit braking function is possible only for permanently excited synchronous motors.
- Motor rated short-circuit current p0320 < Maximum motor current p0323
- Additional requirement for internal armature short-circuit braking:
  Power unit maximum current r0209[0] ≥ 1.8 · rated short-circuit current r0331

⚠ WARNING

Motor acceleration by pulling load

A pulling load may accelerate the motor significantly even if armature short-circuit braking is active. An unexpectedly high speed can damage the machine or result in death or serious injury.

- If there is a pulling load, use a mechanical brake in addition to the armature short-circuit braking.

Description of function

A "1" signal of the binary signal sink p1230 activates the "Armature short-circuit braking" function.

A "0" signal of the binary signal sink p1230 deactivates the "Armature short-circuit braking" function.

The "Armature short-circuit braking" function briefly closes the stator windings of the synchronous motor. If the synchronous motor is rotating, a current flows that brakes the motor.

The "Armature short-circuit braking" function can be realized internally via the converter or externally using a contactor circuit with braking resistors.

- Internal armature short-circuit braking: p1231 = 4
  The response time of the internal armature short-circuit braking is just a few milliseconds, so it is much shorter than the response time of a mechanical brake.
  To maintain armature short-circuit braking despite a power failure, the 24 V power supply to the converter must continue even after the power failure.
- External armature short-circuit braking p1231 = 1 or p1231 = 2
  Via output terminals, the "External armature short-circuit braking" function controls an external contactor, which then short-circuits the motor windings through resistors.
  With p1231 = 1, the converter monitors the feedback signal of the external contactor. The motor can only be operated if the external contactor is open.
  The converter monitors contactor feedback signals "Contactor is open" and "Contactor is closed" using signals c1235[0] and c1235[1].
  To achieve the highest braking effect, calculate the resistance value R using the following formula:
  $R = 5.2882 \cdot 10^{-5} \cdot p0314 \cdot p0356 \cdot n_{max} - p0350$
  n_{max} = maximum speed used

When using NO contacts as main contacts for the contactor, then the drive is no longer protected against power failure. Protection against power failure is only guaranteed when using the NC contacts as the main contacts for the contactor. Inversion of the digital inputs and digital outputs may be necessary.

Example

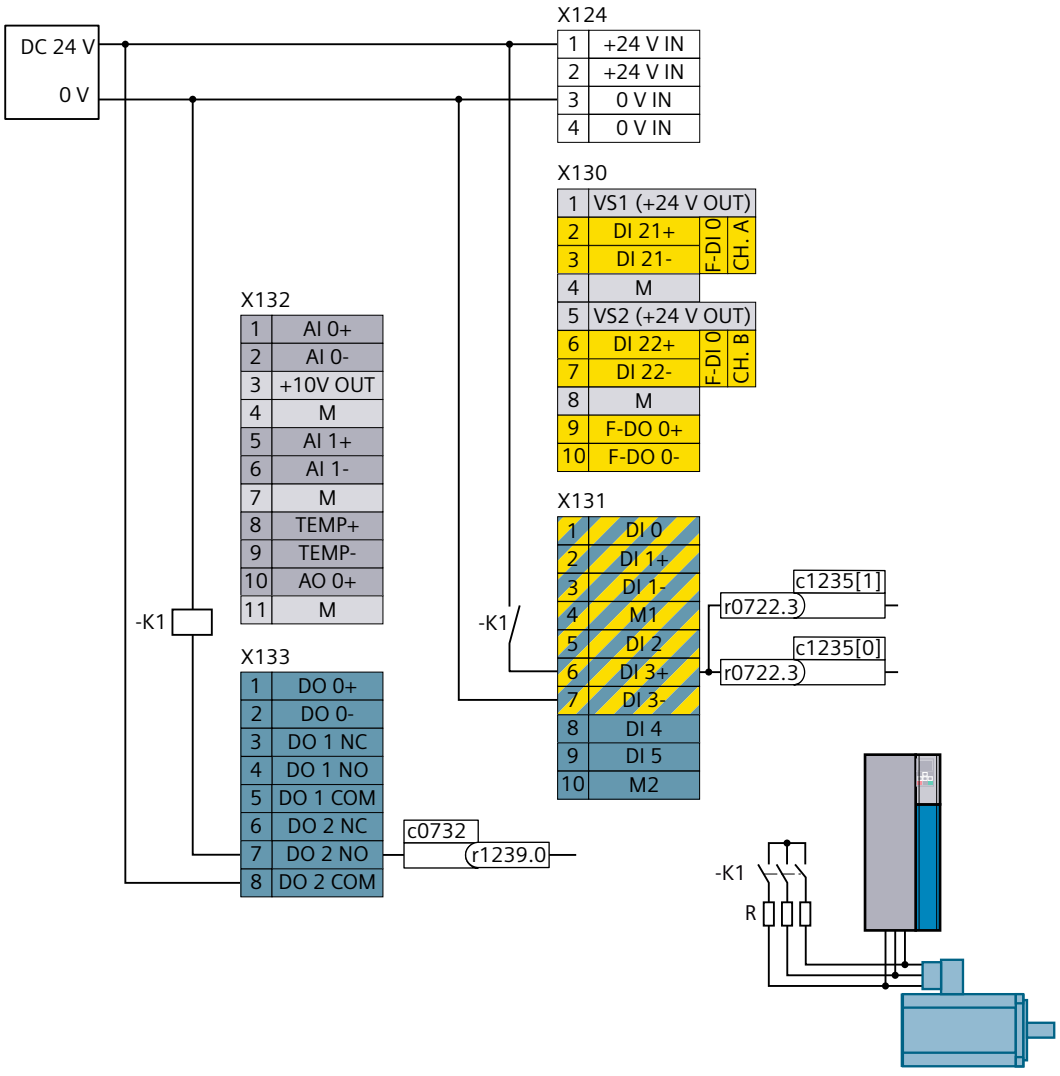


Figure 13-211 External armature short-circuit braking with feedback signal of the K1 contactor

Parameters

The following list contains the parameters of the "Armature short-circuit braking" function.

Number	Name	Unit
r0209[0...3]	Power unit maximum current	Arms
p0323[0...n]	Maximum motor current	Arms
r0331[0...n]	Actual motor magnetizing current/short-circuit current	Arms
c1230[0...n]	DC braking/armature short circuit activation	-
p1231[0...n]	DC braking/armature short circuit configuration	-
c1235[0...n]	External armature short-circuit contactor feedback signal	-
p1236[0...n]	Ext armature short-cct contactor feedback signal monit time	ms
p1237[0...n]	External armature short-circuit wait time when opening	ms

r1238	Armature short-circuit external state	-
r1239.0...13	DC braking/armature short circuit status word	-

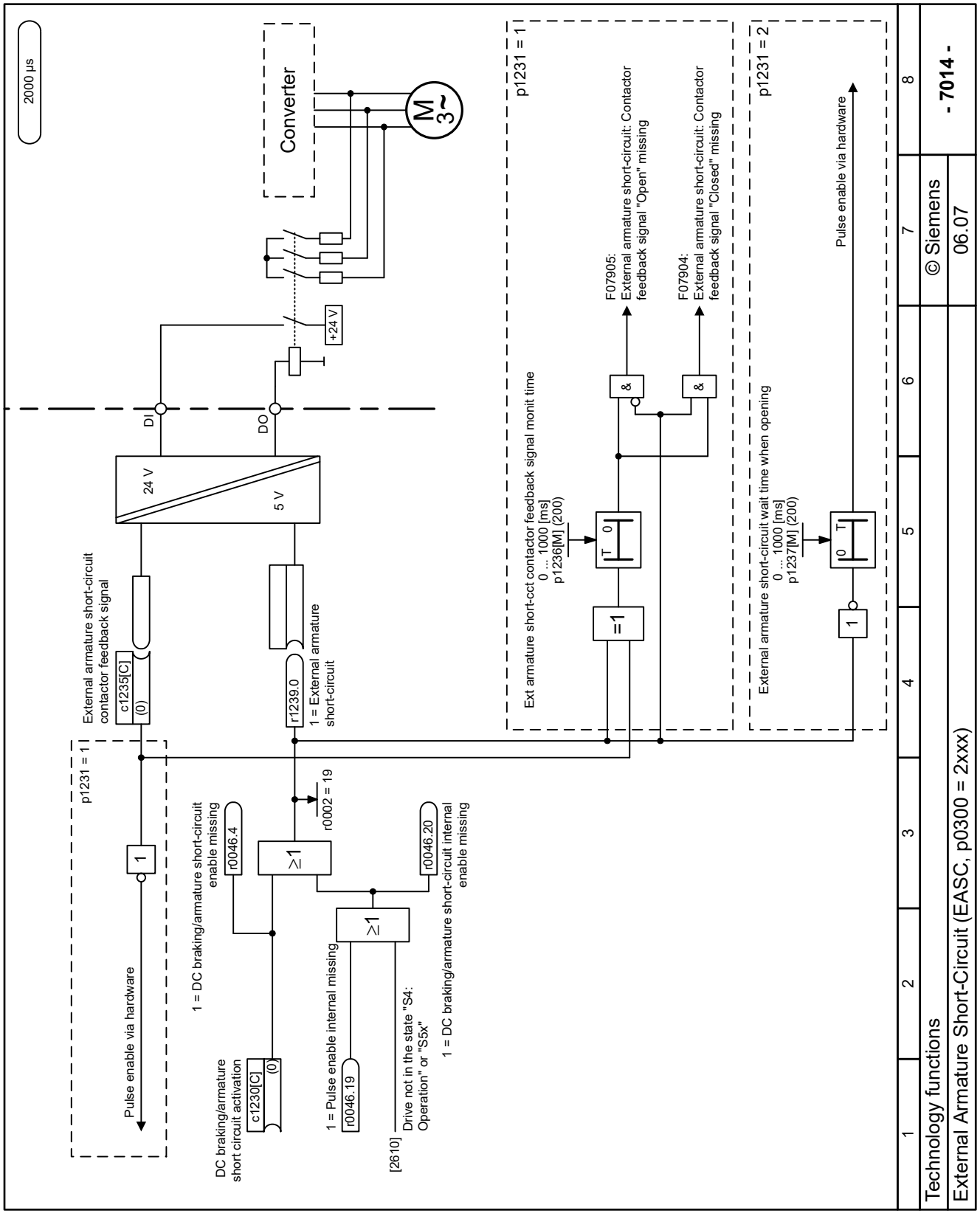


Figure 13-212 7014 – External armature short-circuit (EASC)

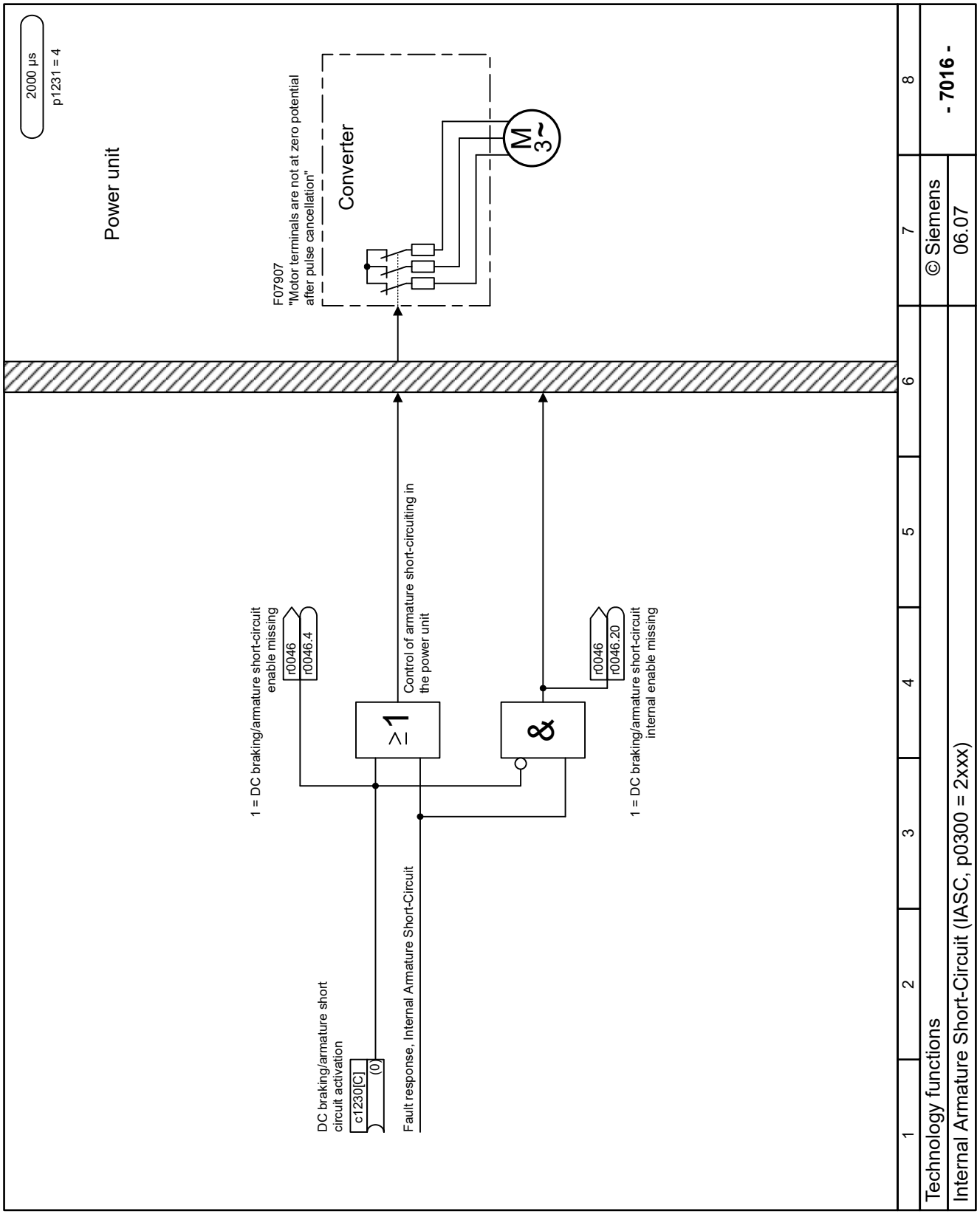


Figure 13-213 7016 – Internal armature short-circuit (IASC)

13.13.9 Loss braking

Overview

When the motor stops, loss braking creates additional magnetic losses in the motor, therefore increasing the braking power without requiring a braking resistor.

Precondition

Loss braking is only possible with an induction motor and closed-loop speed control.

Function description

In the flux control configuration, p1401.16 = 1 signal activates loss braking.

When loss braking is activated, after an OFF1 command or an OFF3 command the converter adds an oscillating signal with amplitude p1559 to the flux setpoint.

The oscillating field-generating current increases the motor losses. The increased motor losses compensate part of the braking energy of the load.

Before the motor comes to a standstill the converter deactivates loss braking.

The following diagram shows the timing sequence of loss braking after an OFF1 command with the Vdc_max controller simultaneously activated.

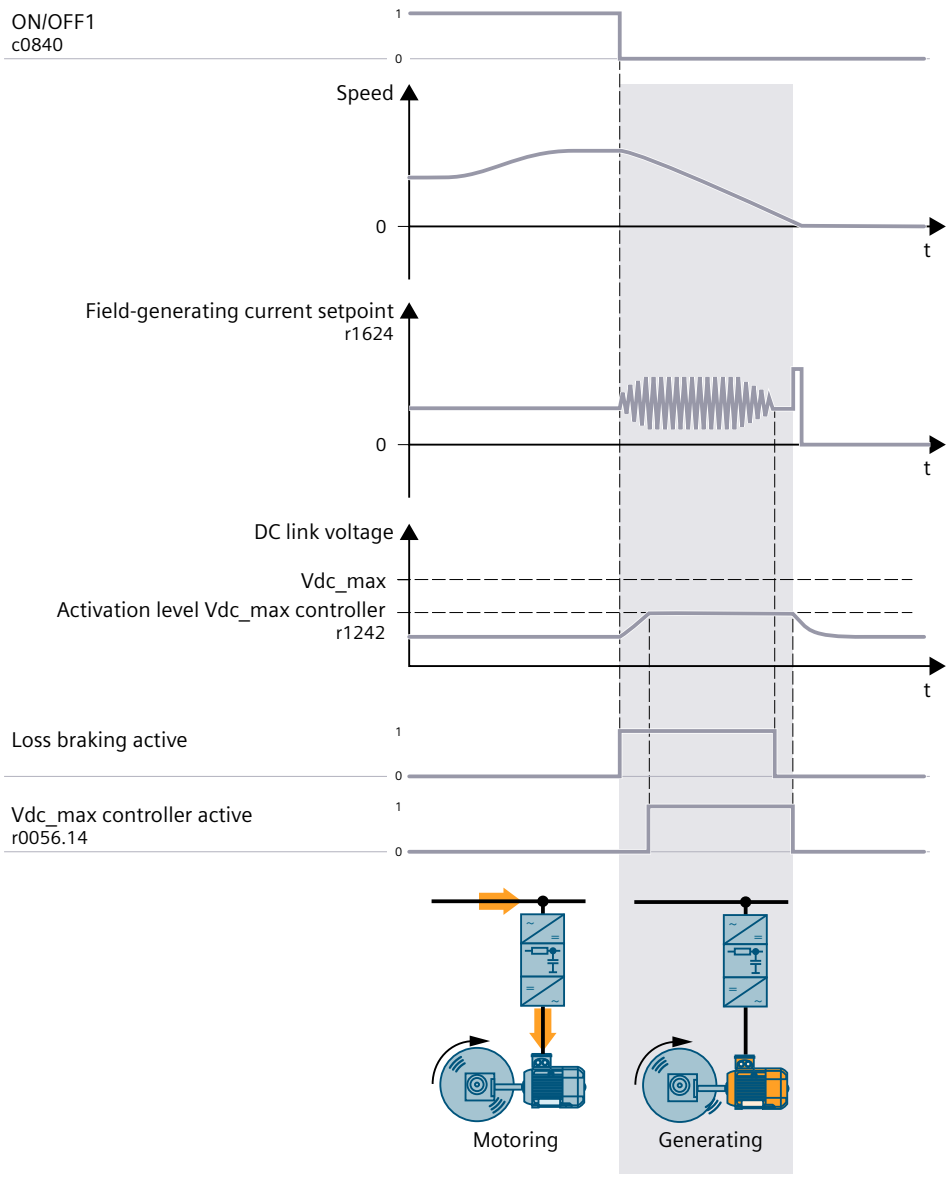


Figure 13-214 Loss braking for active Vdc_max controller

Parameter

The following list contains the parameters of function "Loss braking".

Number	Name	Unit
p1401[0...n].0...30	Flux control configuration	-
p1559[0...n]	Loss braking, braking current	%

13.13.10 Compound braking

Overview

The converter uses compound braking to brake the load along a defined ramp-down ramp without the need for a braking resistor or a converter with energy recovery.

Precondition

Compound braking is only possible with an induction motor and with V/f control. p1300 = 1 ... 7.

The "Flying restart" function is deactivated.

DC braking is deactivated.

The compound braking function is not possible for a power failure.

NOTICE
Overheating of the motor due to compound braking Compound braking can subject the motor to thermal overload. A thermal overload damages the motor. • Monitor the motor temperature. • Allow the motor to cool down between braking operations.

Function description

The motor converts braking energy of the load into heat.

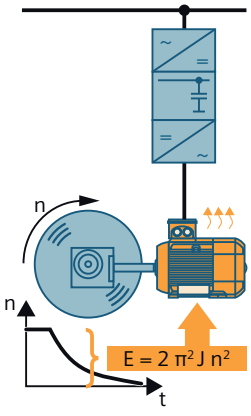


Figure 13-215 Energy flow during compound braking

Features of compound braking:

- No constant braking torque
- No braking torque at standstill

The converter activates the compound braking dependent on the DC link voltage. Above a DC link voltage threshold value (r1282), the converter adds a DC current to the motor current.

The DC current brakes the motor and prevents the DC link voltage from increasing above a critical value.

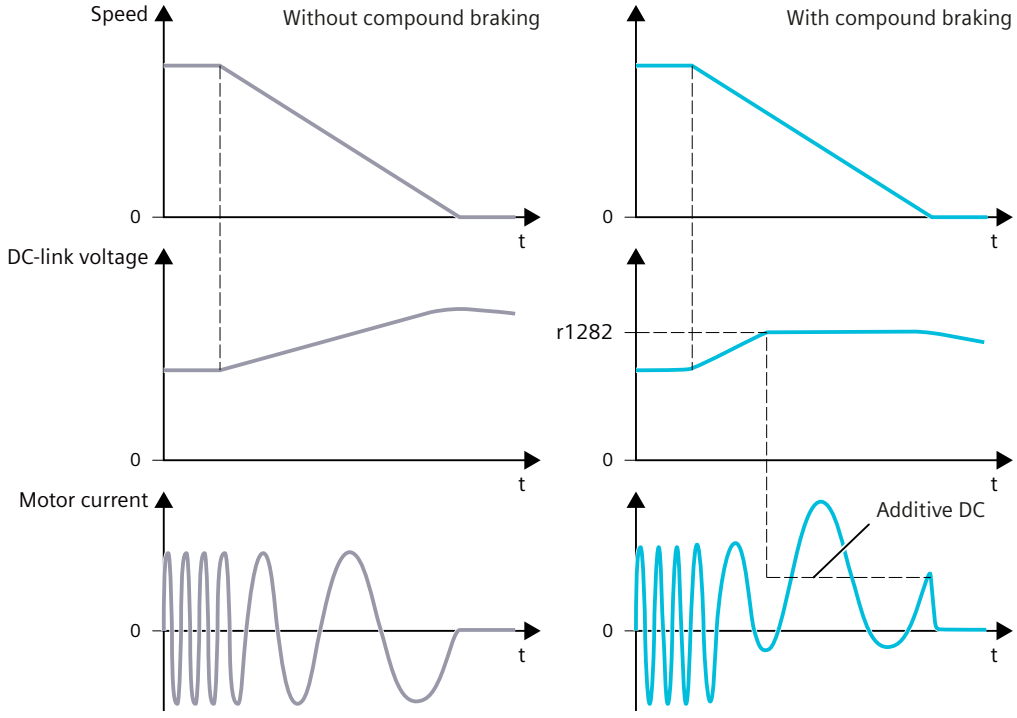


Figure 13-216 Braking of the motor with and without active compound braking

Example

Suitable for applications in which the motor must be braked electrically but neither a converter with energy recovery nor a braking resistor is available.

Typical applications for compound braking:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

Applications involving suspended loads, e.g. hoisting gear/cranes or vertical conveyors, are not permitted.

Parameters

The following list contains the parameters of the "Compound braking" function.

Number	Name	Unit
r1282	Vdc_max controller switch-in level (U/f)	V

r1282	Vdc_max controller switch-in level (U/f)	V
p3856[0...n]	Compound braking current	%
r3859.0...1	Compound braking/DC quantity control status word	-

13.13.11 Dynamic braking

Overview

With dynamic braking, the converter brakes the motor and converts the braking energy of the load into heat.

Precondition

The following requirements apply for dynamic braking:

- A braking resistor is connected to the converter.
- The parameters must be correctly set for a third-party braking resistor.

NOTICE
Converter damage due to incorrect settings
When the settings for a third-party braking resistor are not completely made, dynamic braking is deactivated or the converter can be damaged. • Correctly set parameters p0216, p0218 and p0219[0,1].

Function description

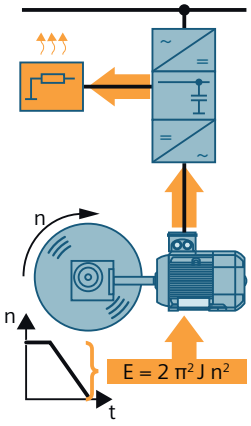


Figure 13-217 Power flow during dynamic braking

The braking resistor converts the regenerative energy E generated when the motor brakes into heat in a braking resistor.

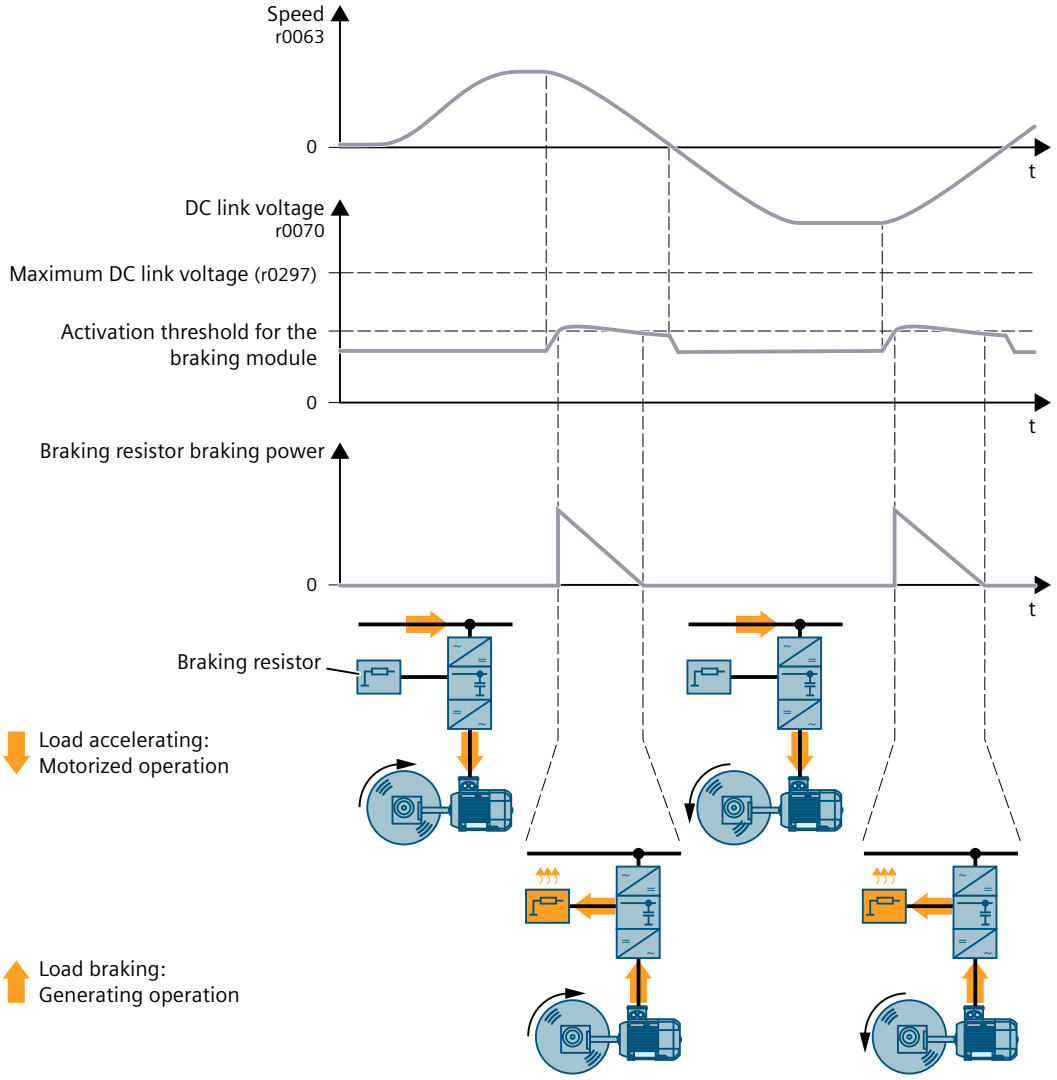


Figure 13-218 Simplified representation of dynamic braking with respect to time

The motor supplies regenerative energy to the converter when braking. The regenerative energy causes the DC link voltage in the converter to increase. Above the activation threshold for the braking chopper, the converter transfers the regenerative energy to the braking resistor.

There are two options available for temperature monitoring of the braking resistor:

1. Temperature monitoring with a temperature sensor
   Connect the temperature sensor of the braking resistor to a free digital input on the converter and assign the "External fault" function to the digital input used.
2. Temperature monitoring using a thermal model in the software
   – If the consumed energy of the braking resistor reaches 80% of the thermal model, the converter issues an alarm.
   – If the consumed energy of the braking resistor reaches the switch-off threshold, the converter issues an alarm and blocks the braking resistor.
     When the braking resistor has cooled down, the converter unblocks the braking resistor again.

Parameter setting p0215 defines the selection of braking resistors for dynamic braking as follows:

- p0215 = 1 Use braking resistor without temperature monitoring in the software
  We recommend temperature monitoring with a temperature sensor
- p0215 = 2 Siemens braking resistor
  All of the settings required to thermally monitor the braking resistor are saved in the converter.
- p0215 = 3 Third-party braking resistor
  Additional settings are required to thermally monitor the braking resistor.

Parameter p0219[0] defines the maximum braking power that the braking resistor is expected to absorb.

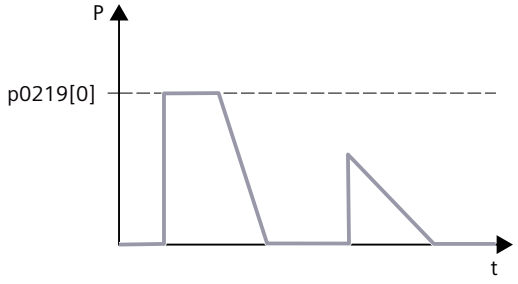


Figure 13-219 Example of maximum braking power in an application

Parameters

The following list contains the parameters of the "Dynamic braking" function.

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r0070	Actual DC link voltage	V
p0215	Braking resistor selection	-
p0216	Braking resistance value	ohm
p0218	Braking resistor duration at maximum power	s
p0219[0...1]	Braking resistor braking power	kW
r0297	DC link voltage overvoltage threshold	V

13.13.12 Dynamic braking for Clean Power converters

Overview

With dynamic braking, the converter brakes the motor and converts the braking energy of the load into heat.

Requirement

The following requirements apply for dynamic braking:

- A braking resistor is connected to the converter.
- The parameters must be correctly set for a third-party braking resistor.

NOTICE
Converter damage due to incorrect settings When the settings for a third-party braking resistor are not completely made, dynamic braking is deactivated or the converter can be damaged. • Correctly set parameters p0216, p0218 and p0219[0,1].

Function description

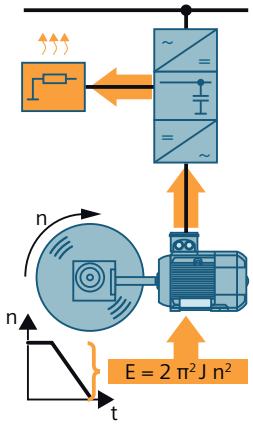


Figure 13-220 Power flow during dynamic braking

The braking resistor converts the regenerative energy E generated when the motor brakes into heat in a braking resistor.

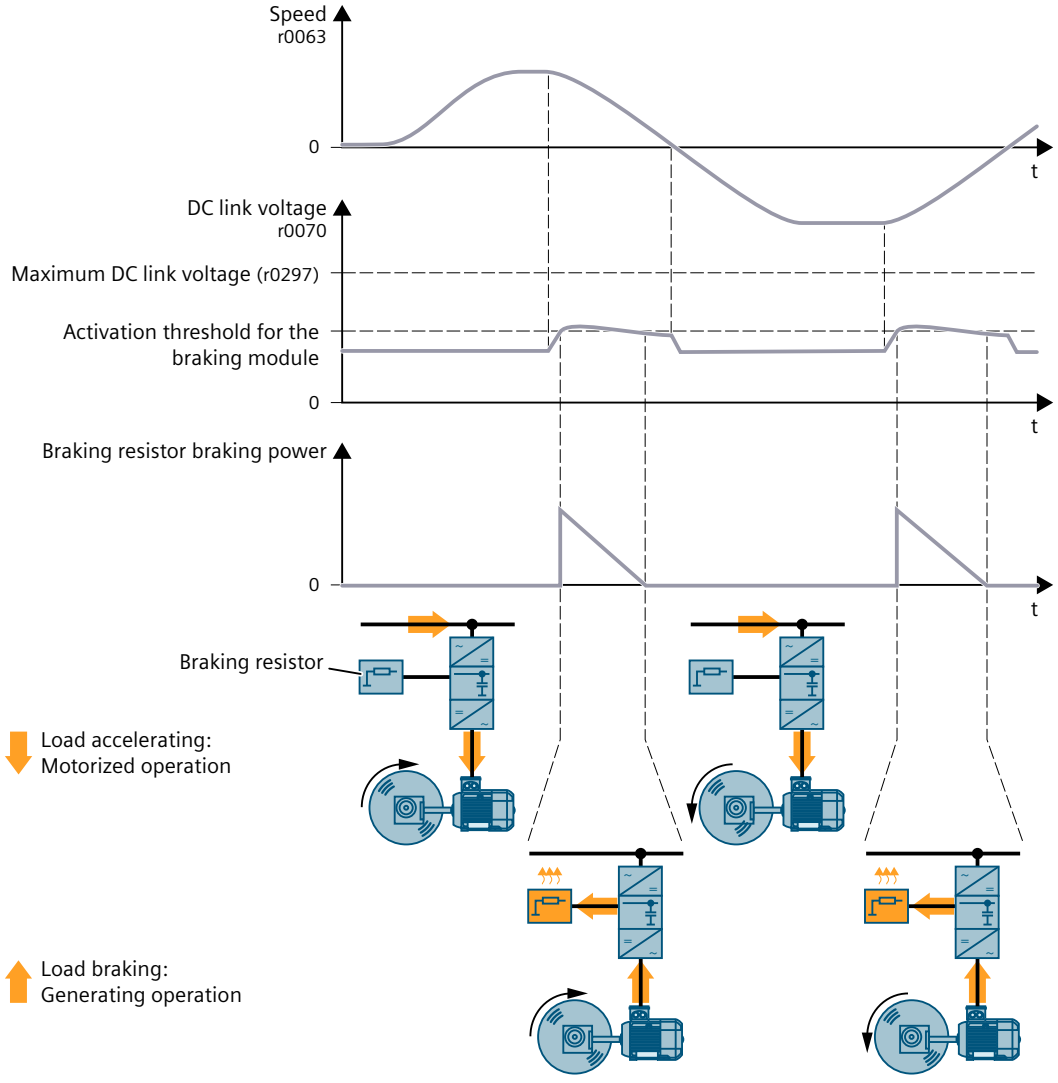


Figure 13-221 Simplified representation of dynamic braking with respect to time

The motor supplies regenerative energy to the converter when braking. The regenerative energy causes the DC link voltage in the converter to increase. If the DC link voltage exceeds the activation threshold for the braking chopper, then the braking chopper transfers the regenerative energy to the braking resistor.

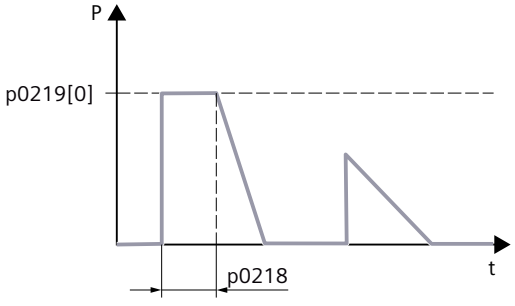
There are two upload options available for temperature monitoring of the braking resistor:

1. Temperature monitoring with a temperature sensor
   Connect the temperature sensor of the braking resistor to a free digital input on the converter and assign the "External fault" function to the digital input used.
2. Temperature monitoring using a thermal model in the software
   – If the consumed energy of the braking resistor reaches 80% of the thermal model, the converter issues an alarm.
   – If the consumed energy of the braking resistor reaches the switch-off threshold, the converter issues an alarm and blocks the braking resistor.
   When the braking resistor has cooled down, the converter unblocks the braking resistor again.

Parameter setting p0215 defines the selection of braking resistors for dynamic braking as follows:

- p0215 = 0 No braking resistor
- p0215 = 2 Siemens braking resistor
  All of the settings required to thermally monitor the braking resistor are saved in the converter.
- p0215 = 3 Third-party braking resistor
  Additional settings are required to thermally monitor the braking resistor.

Parameter p0219[0] defines the maximum braking power that the braking resistor is expected to absorb.



p0219[0] Maximum braking power of the braking resistor for a limited time p0218
p0218 Time that the braking resistor can absorb the maximum braking power

Figure 13-222 Example of maximum braking power in an application

Parameters

The following list contains the parameters of function "Dynamic braking for Clean Power converters".

Number	Name	Unit
r0063[0...2]	Speed actual value	rpm
r0070	Actual DC link voltage	V
p0215	Braking resistor selection	-
p0216	Braking resistance value	ohm
p0218	Braking resistor duration at maximum power	s

p0219[0...1]	Braking resistor braking power	kW
r0297	DC link voltage overvoltage threshold	V

13.13.13 Motor holding brake

Overview

A holding brake holds a switched-off motor in position.

Function "Holding brake" minimizes the wear of an electromechanical brake when controlled as follows:

- The brake opens once the motor is magnetized.
- The converter switches off the motor once the motor holding brake has closed.

Function description

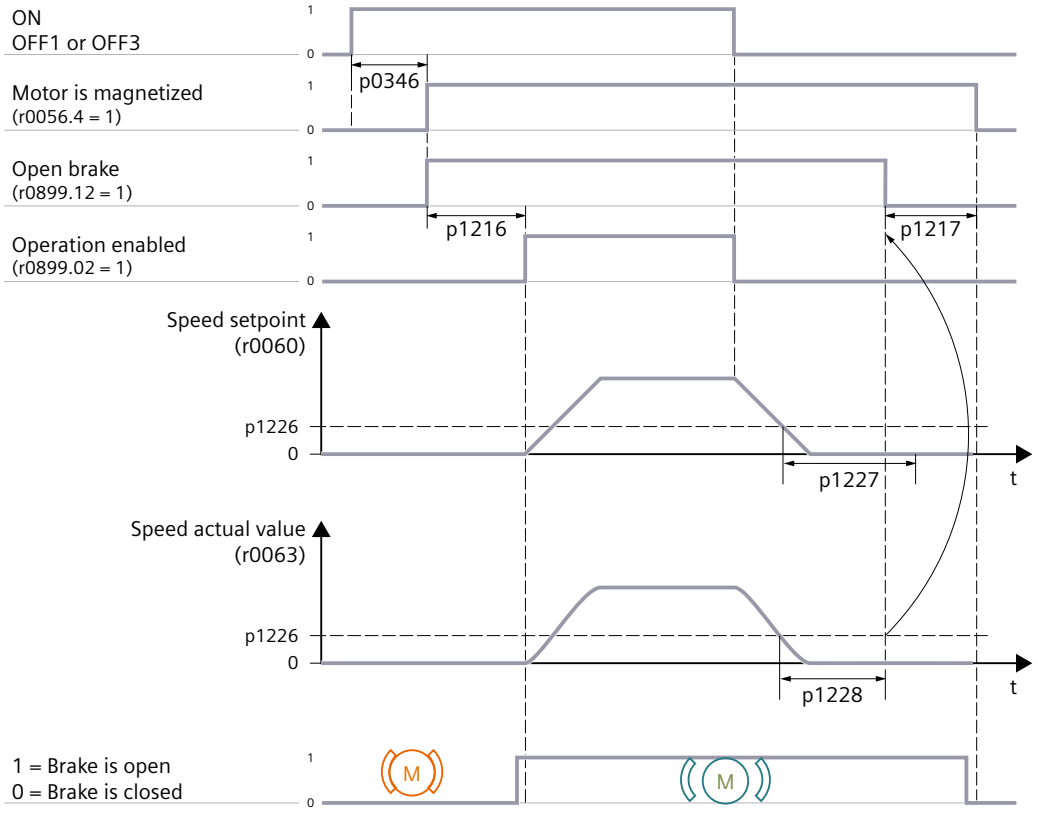


Figure 13-223 Function of the holding brake

The converter controls the holding brake as follows:

- After the ON command:
  - After the ON command, the converter switches on the motor.
  - At the end of the "motor excitation build-up time" p0346, the converter issues the command to open the brake.
  - The converter holds the motor at a standstill until the "Holding brake opening time" p1216 has ended.
    The holding brake must have opened within time p1216.
  - The converter accelerates the motor to the speed setpoint.
- After the OFF1 or OFF3 command:
  - After the OFF1 or OFF3 command, the converter brakes the motor to a standstill.
  - During braking, the converter compares the speed setpoint and the actual speed with the "Threshold for zero speed detection" p1226:
    Speed setpoint < p1226: The "Zero speed detection monitoring time" p1227 starts.
    Actual speed < p1226: The "Pulse cancellation delay time" p1228 starts.
  - When the first of the two times p1227 or p1228 has elapsed, the converter issues the command to close the brake.
  - The converter switches off the motor after the "Holding brake closing time" p1217.
    The holding brake must have closed within time p1217.
- After the OFF2 command
  The converter issues the command to immediately close the holding brake, irrespective of the motor speed.

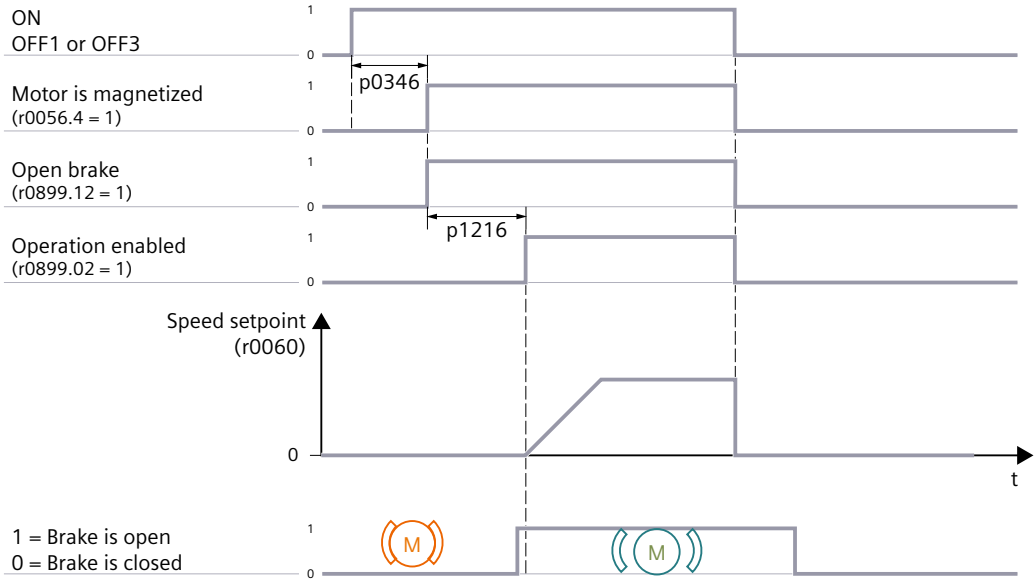
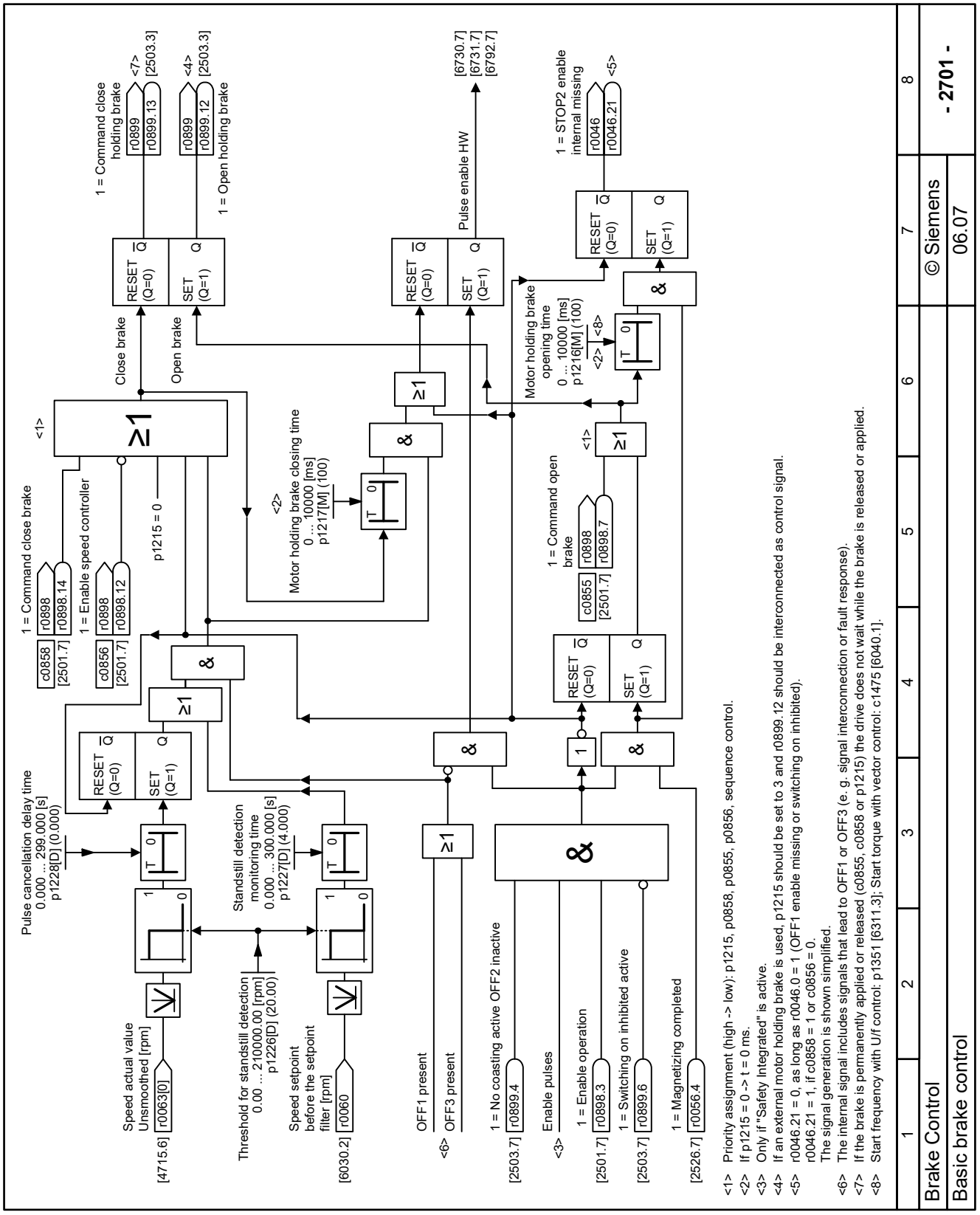


Figure 13-224 Control of the holding brake after OFF2

Parameters

The following list contains the parameters of the "Motor holding brake" function.

Number	Name	Unit
p0346[0...n]	Motor excitation build-up time	s
c0855[0...n]	Unconditionally release holding brake	-
c0858[0...n]	Unconditionally close holding brake	-
r0899.0...13	Status word sequence control	-
p1215[0...n]	Motor holding brake configuration	-
p1216[0...n]	Motor holding brake opening time	ms
p1217[0...n]	Motor holding brake closing time	ms
p1226[0...n]	Threshold for standstill detection	rpm
p1227[0...n]	Standstill detection monitoring time	s
p1228[0...n]	Pulse cancellation delay time	s
p1351[0...n]	Motor holding brake starting frequency	%
c1475[0...n]	Speed controller torque setting value for motor holding brake	Nm



<1> Priority assignment (high -> low): p1215, p0858, p0855, p0856, sequence control.
<2> If p1215 = 0 -> t = 0 ms.
<3> Only if "Safety Integrated" is active.
<4> If an external motor holding brake is used, p1215 should be set to 3 and r0899.12 should be interconnected as control signal.
<5> r0046.21 = 0, as long as r0046.0 = 1 (OFF1 enable missing or switching on inhibited).
r0046.21 = 1, if c0858 = 1 or c0856 = 0.
The signal generation is shown simplified.
<6> The internal signal includes signals that lead to OFF1 or OFF3 (e. g. signal interconnection or fault response).
<7> If the brake is permanently applied or released (c0855, c0858 or p1215) the drive does not wait while the brake is released or applied.
<8> Start frequency with U/f control: p1351 [6311.3]; Start torque with vector control: c1475 [6040.1].

Figure 13-225 2701 - Basic brake control

13.13.14 Automatic restart

Overview

When the automatic restart function is active, the converter acknowledges faults and automatically starts the motor.

Requirement

⚠ WARNING

Unexpected motion as a result of an automatic hot restart

An activated automatic restart can initiate unexpected machine motion that may result in death or sever injury.

- Only activate the automatic restart function if this cannot result in any dangerous situation.
- In the system or at the machine, clearly mark that the drive can automatically restart.

Description of function

p1210 activates the automatic restart function corresponding to the requirements of the specific application.

The automatic restart function includes 2 different subfunctions:

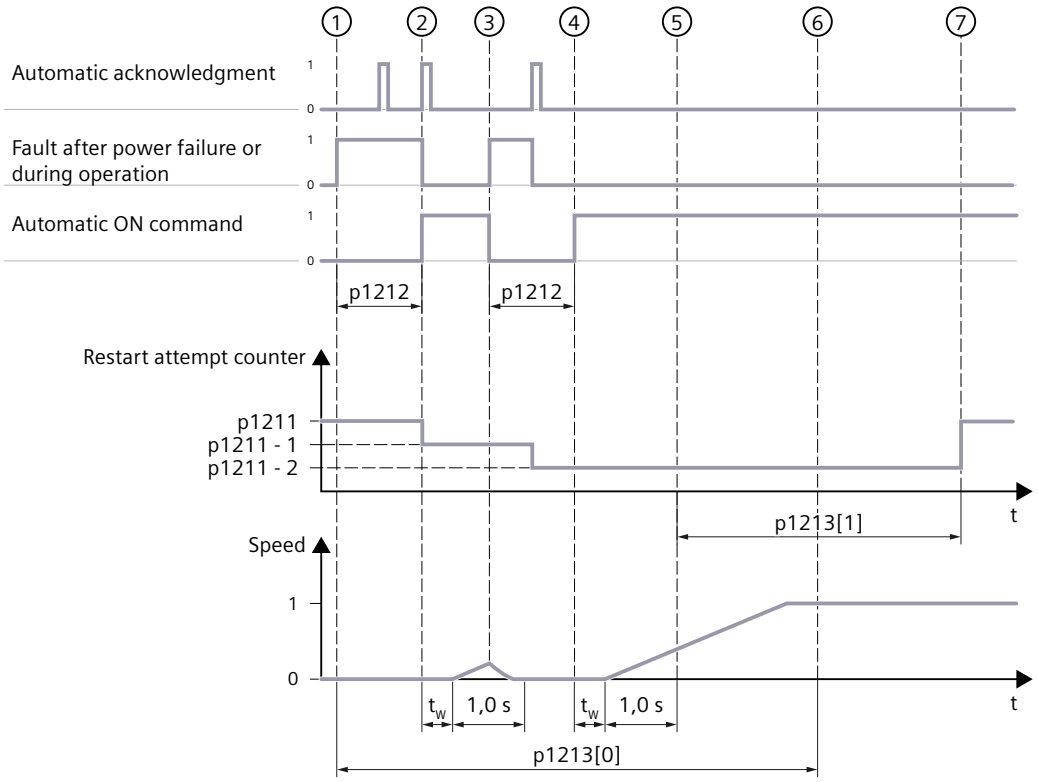
- The converter acknowledges faults automatically.
- After a fault or a power failure, the converter switches on the motor again automatically.

The converter interprets the following events as a power failure:

- The converter signals fault F30003 (undervoltage in the DC link) after the line voltage of the converter was briefly interrupted.
- All power supplies of the converter were interrupted and all the energy storage devices in the converter were discharged to such a level that the converter electronics failed.

For certain faults, p1206[0...9] suppresses the automatic restart.

The following diagram shows the principle of operation of the automatic restart function.



t_w Sum of the magnetizing time and the time for the flying restart of the motor

① A fault activates the automatic restart function.

② 1st attempt of the automatic restart starts.

The converter decrements the counter of the start attempts.

A fault is output if the start attempt counter < 0.

③ 1st attempt of the automatic restart fails as a result of a new fault.

④ 2nd attempt of the automatic restart starts.

⑤ 2nd attempt of the automatic restart is successful.

If no fault has occurred one second after the flying restart of the motor, then the automatic restart attempt was successful.

⑥ The automatic restart must be successful within p1213[0]. If not, then a fault is output.

⑦ After p1213[1], the converter resets the start attempt counter to p1211.

Figure 13-226 Time response of the automatic restart

Parameters

The following list contains the parameters of the "Automatic restart" function.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
p1206[0...9]	Automatic restart faults not active	-
p1210	Automatic restart mode	-
p1211	Automatic restart start attempts	-
p1212	Automatic restart wait time, acknowledgment and start attempt	s

p1213[0...1]	Automatic restart monitoring time	s

13.13.15 Flying restart

Overview

If the converter output frequency does not match the motor speed when an ON command is issued, then undesirable torque surges or an overcurrent fault occurs.

The "Flying restart" function allows the converter to be bumplessly connected to motor operating with an unknown speed.

Precondition

Flying restart is only possible for vector control, Dynamic Drive Control, Standard Drive Control and V/f control.

Permissible drives:

- 1 converter with 1 motor
- 1 converter with several mechanically coupled motors
  Several motors connected to 1 converter without a mechanical coupling is not permissible.

If an optional component is installed at the converter power output, e.g. a dv/dt filter, then the motor voltage can be acquired using a Voltage Sensing Module (VSM10) between the component and the motor or the speed can be acquired using an encoder.

The "Flying restart" function with search current is only possible for induction motors.

Function description

Parameter p1270 configures the "Flying restart" function:

Bit	Signal name	Comment
00	1 signal: Fast flying restart with voltage model	Activates a search method that uses an internal voltage model.
01	1 signal: PLL extension for fast flying restart with voltage model for induction motors	---
02	1 signal: Activate search with model	If flying restart with high speeds does not reliably function then bit 02 activates an alternative search technique.
03	1 signal: Activates current injection for low speeds	For an induction motor < 75 kW, activates an additional current injection for a flying restart with internal voltage measurement or voltage measurement using a VSM10.

Bit	Signal name	Comment
04	1 signal: Activating flying restart with voltage measurement by the VSM10	Activates the search where the voltage is measured using a VSM10.
05	1 signal: Activates a flying restart with voltage measurement	Activates the search with the internal voltage measurement of the converter.

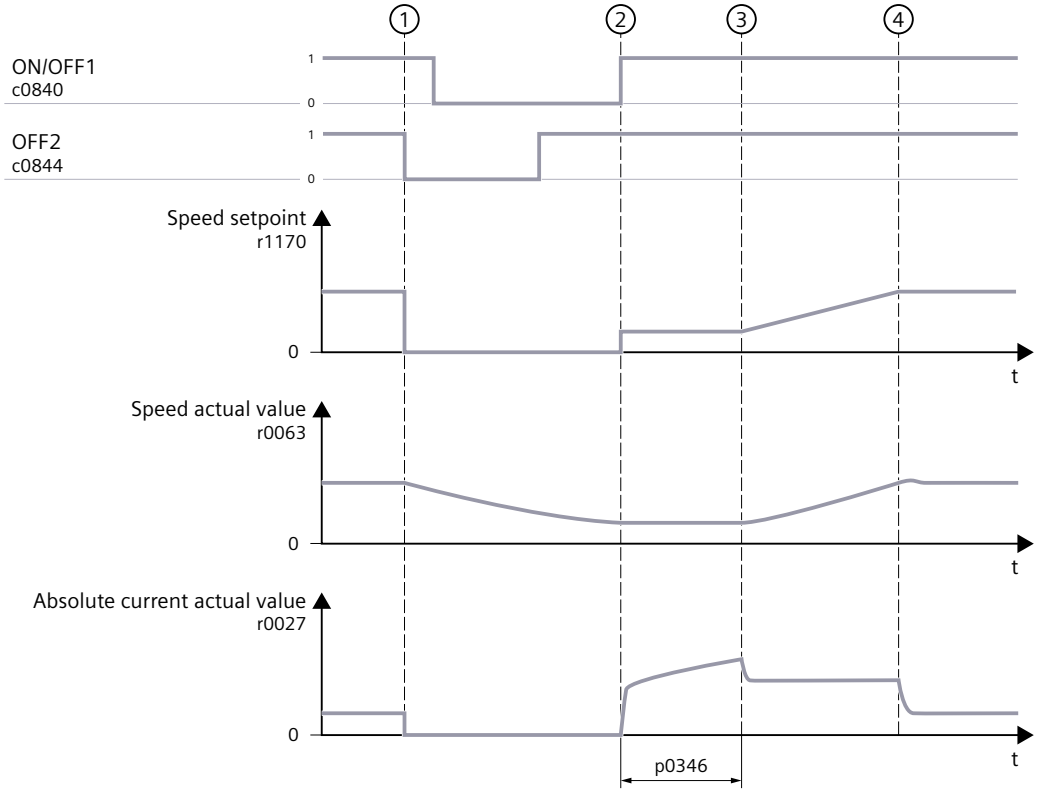


Figure 13-227 "Flying restart" function with voltage measurement

Action		Motor / converter response
①	Signal change at OFF2 from 1 to 0	• The motor coasts down. • The motor demagnetizes itself. • The converter senses the speed using its internal voltage measurement or using the voltage measurement of the VSM10.
②	Signal change at ON/OFF1 from 0 to 1	• The converter sets the ramp-function generator output to the actual speed value. • The converter magnetizes the motor for the time specified in p0346. • The converter sets its output frequency to 0 Hz for magnetization at motor speeds <10 % of the rated speed.
③	---	• The converter accelerates the motor to the actual speed setpoint.
④	---	• The "Flying restart" function is exited.

The "Flying restart" function uses a search current if all bits p1270.00 ... p1270.05 have a 0 signal.

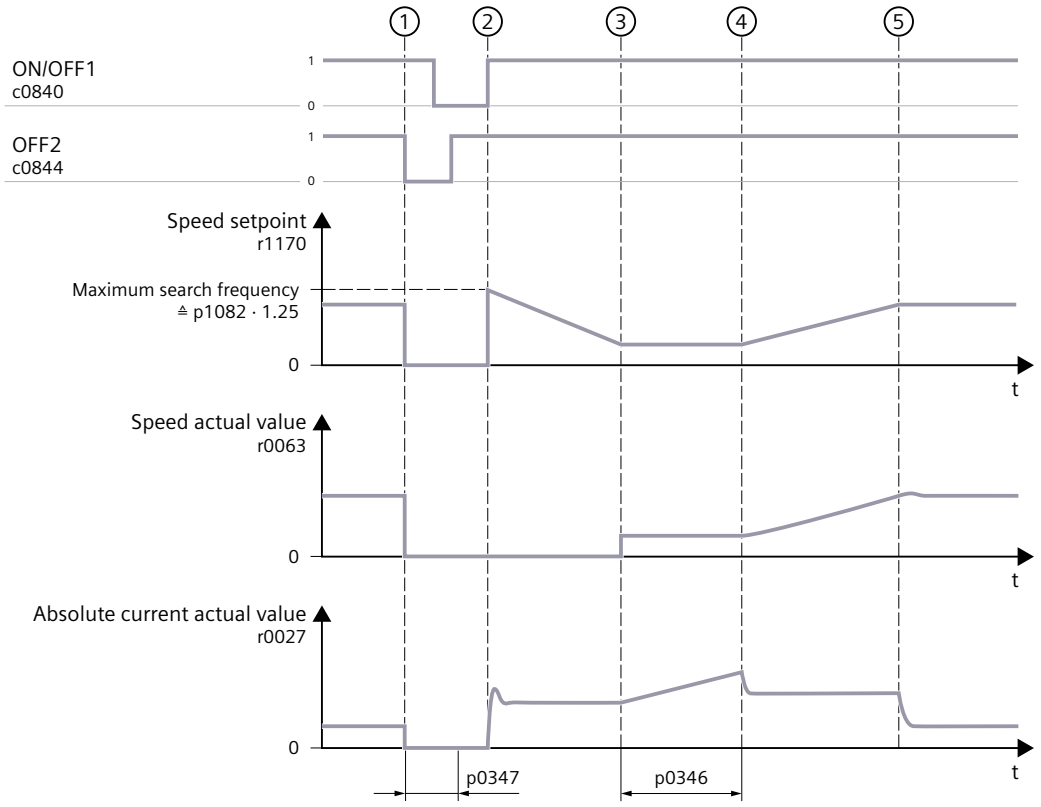


Figure 13-228 "Flying restart" function for an induction motor with search current

	Action	Motor / converter response
①	Signal change at OFF2 from 1 to 0	• The motor coasts down. • The motor demagnetizes itself.
②	Signal change at ON/ OFF1 from 0 to 1	• Response depends on the motor: – Applicable for an induction motor: As a minimum, the converter waits until the demagnetization time p0347 has elapsed. The converter injects the search current in the motor. The search current starts at a search frequency that approximately corresponds to the speed of p1082 · 1.25. The converter continuously reduces the search frequency until the search speed reaches the motor speed. – Applicable for a synchronous-reluctance motor Immediately after the ON command, the converter injects current pulses in the motor. • If the converter does not acquire the motor speed when performing a flying restart, e.g. if a filter is installed between the converter and motor then a higher search current p1202 and a longer search time p1203 are possibly required.

③	---	• The converter magnetizes the motor for the time specified in p0346. • The converter sets the ramp-function generator output to the actual speed value. • The converter sets its output frequency to 0 Hz for magnetization at motor speeds <10 % of the rated speed.
④	---	• The converter accelerates the motor to the actual speed setpoint.
⑤	---	• The "Flying restart" function is exited.

Example

Examples for using the "Flying restart" function:

- The motor is rotating after a brief power interruption.
- A flow of air is turning a fan impeller.
- A load with a high moment of inertia drives the motor.

Parameters

The following list contains the parameters of the "Flying restart" function.

Number	Name	Unit
p0247.0...9	Voltage measurement configuring	-
p0346[0...n]	Motor excitation build-up time	s
p0347[0...n]	Motor de-excitation time	s
p1082[0...n]	Maximum speed	rpm
p1200[0...n]	Flying restart operating mode	-
c1201[0...n]	Flying restart enable	-
p1202[0...n]	Flying restart search current	%
p1203[0...n]	Flying restart search rate factor	%
r1204.0...15	Flying restart U/f control status	-
r1205.0...25	Flying restart vector control status	-
p1270[0...n].0...6	Flying restart configuration	-

13.13.16 Friction characteristic

Overview

In many applications the friction torque of the load is not negligible.

With an activated friction characteristic, the converter precontrols the speed controller with the friction torque. The precontrol reduces overshooting of the speed after speed changes.

Requirement

The friction characteristic is recorded.

The friction characteristic is activated: p3842 = 1.

Description of function

The friction torque r3841 specifies a torque setpoint that bypasses the speed controller.

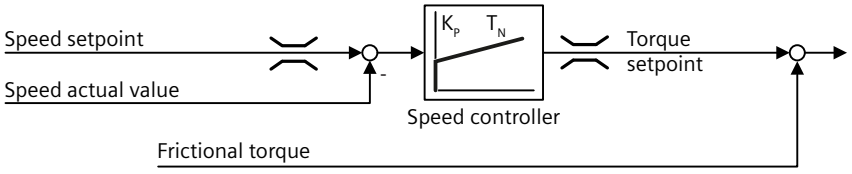


Figure 13-229 Precontrol of the speed controller with the friction torque

The converter calculates the current friction torque from a friction characteristic with 10 interpolation points.

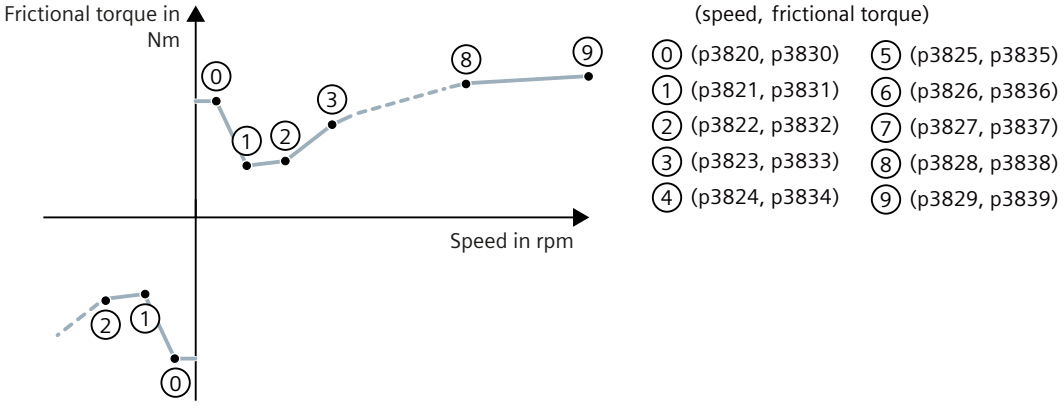


Figure 13-230 Friction characteristic

The interpolation points of the friction characteristic are defined for positive speeds. In the negative direction of rotation, the converter uses the interpolation points with negative sign.

Parameters

The following list contains the parameters of the "Friction characteristic" function.

Number	Name	Unit
p3820[0...n]	Friction characteristic value n0	rpm
p3821[0...n]	Friction characteristic value n1	rpm
p3822[0...n]	Friction characteristic value n2	rpm
p3823[0...n]	Friction characteristic value n3	rpm
p3824[0...n]	Friction characteristic value n4	rpm
p3825[0...n]	Friction characteristic value n5	rpm
p3826[0...n]	Friction characteristic value n6	rpm
p3827[0...n]	Friction characteristic value n7	rpm
p3828[0...n]	Friction characteristic value n8	rpm
p3829[0...n]	Friction characteristic value n9	rpm
p3830[0...n]	Friction characteristic value M0	Nm
p3831[0...n]	Friction characteristic value M1	Nm

p3832[0...n]	Friction characteristic value M2	Nm
p3833[0...n]	Friction characteristic value M3	Nm
p3834[0...n]	Friction characteristic value M4	Nm
p3835[0...n]	Friction characteristic value M5	Nm
p3836[0...n]	Friction characteristic value M6	Nm
p3837[0...n]	Friction characteristic value M7	Nm
p3838[0...n]	Friction characteristic value M8	Nm
p3839[0...n]	Friction characteristic value M9	Nm
r3840.0...9	Friction characteristic status word	-
r3841	Friction characteristic output	Nm
p3842	Friction characteristic activation	-
p3843[0...n]	Friction characteristic frictional torque diff. smoothing time	ms
p3844[0...n]	Friction characteristic number changeover point upper	-
p3845	Record friction characteristic activation	-
p3846[0...n]	Record friction characteristic ramp-up/ramp-down time	s
p3847[0...n]	Record friction characteristic time to warm up	s

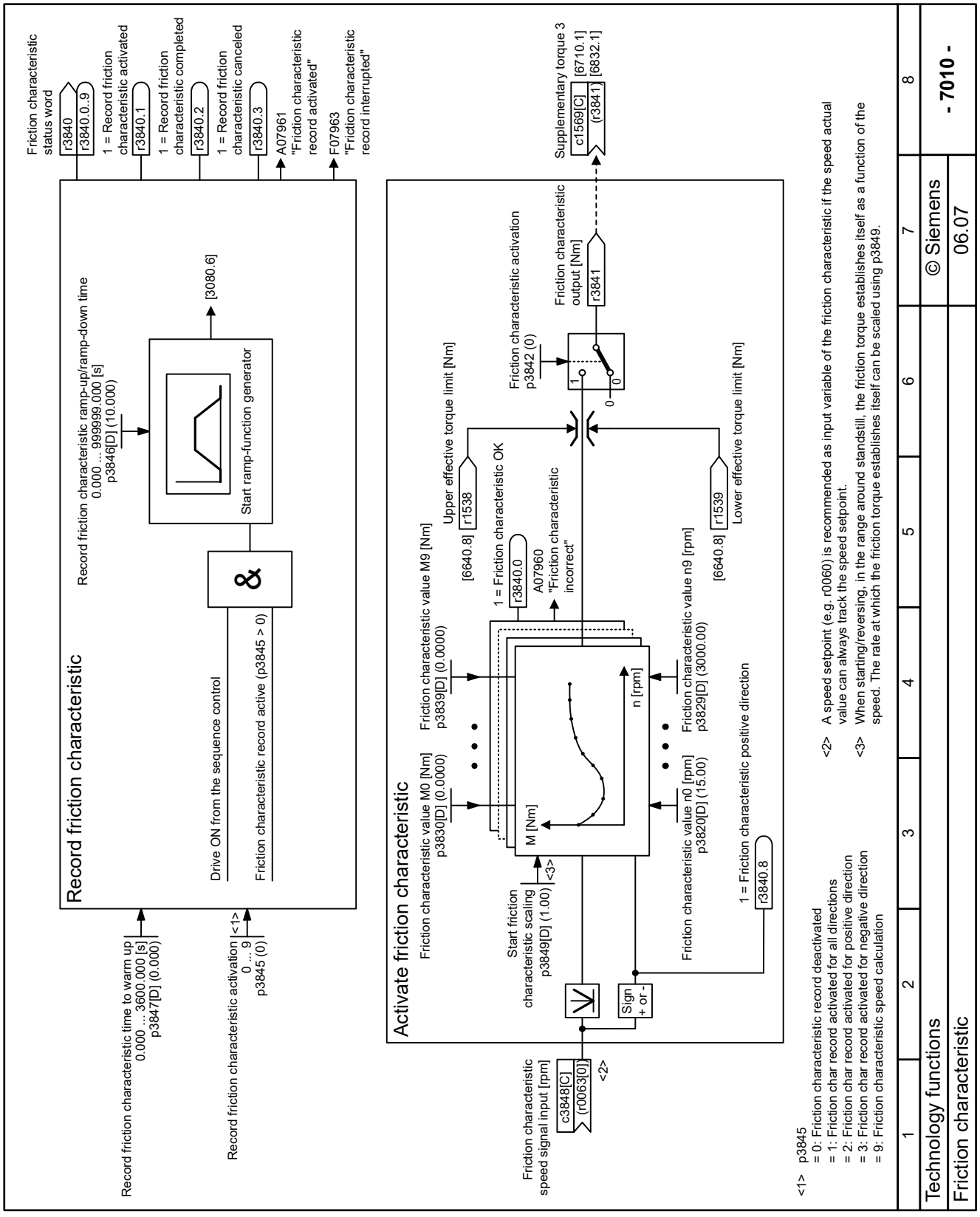


Figure 13-231 7010 - Friction characteristic

13.13.17 Recording a friction characteristic

Overview

On request, the converter records the friction characteristic. The converter accelerates the motor step by step to the rated speed, measures the friction torque and writes the friction torque to the interpolation points of the friction characteristic.

Requirement

The motor is permitted to accelerate up to the rated speed without endangering persons or property.

Procedure

Proceed as follows to record the friction characteristic:

1. Set p3845 to a value of your choice:
   - 1: Record the friction characteristic in both directions of the motor.
   - 2: Record the friction characteristic in the positive direction of the motor.
   - 3: Record the friction characteristic in the negative direction of the motor.
   - 9: Calculate speeds for the friction characteristic.
2. Switch on the motor (ON/OFF1 = 1).
3. The converter moves the motor in the selected direction or in both directions.
   During the measurement, the converter signals the alarm A07961.
4. When the converter has calculated all the interpolation points of the friction characteristic, the converter stops the motor.
   The converter averages the measurement results of the positive and negative directions of rotation.

13.13.18 Messages/Monitoring functions

13.13.18.1 Stall monitoring

Overview

The "Stall monitoring" function detects overload in standard induction motors.

Requirement

The "Stall monitoring" function is only active during closed-loop speed control and only at a speed of < p1755 · (100% - p1756).

Function description

If the load of a standard induction motor exceeds the stall torque of the motor, the motor can also stall during operation on the converter. A stalled motor is stationary and does not develop sufficient torque to accelerate the load.

The converter calculates the speed in the motor model.

When the fault signal r1746[0] in the motor model exceeds fault threshold value p1745, the converter sets r1408.12 to a 1 signal. After delay time p2178, the converter signals that the motor has stalled with an r2198.7 = 1 signal.

Parameters

The following list contains the parameters of the "Stall message" function.

Number	Name	Unit
r1408.0...31	Status word current controller	-
p1745[0...n]	Motor model error threshold stall detection	%
r1746[0...5]	Motor model error signal/threshold value stall detection	%
p2178[0...n]	Motor stalled delay time	s
r2198.0...13	Status word monitoring 2	-

13.13.18.2 Blocked monitoring

Overview

The "Blocked monitoring" function detects that a stuck load machine is preventing the motor from rotating.

Function description

If the speed lies below the speed threshold p2175 for time p2177 and the motor current simultaneously reaches the current limit, then the converter switches off the motor and signals a fault.

Parameters

The following list contains the parameters of the "Blocking message" function.

Number	Name	Unit
r0056.0...15	Status word, closed-loop control	-
p1300[0...n]	Open-loop/closed-loop control mode	-
r1406.4...15	Control word speed controller	-
r1407.0...31	Status word speed controller	-
c2144[0...n]	Motor stall monitoring enable (negated)	-
r2169	Actual speed smoothed signals	rpm
p2175[0...n]	Motor blocked speed threshold	rpm
p2177[0...n]	Motor blocked delay time	s

r2198.0...13	Status word monitoring 2	-
c3230[0...n]	Load monitoring speed actual value	rpm

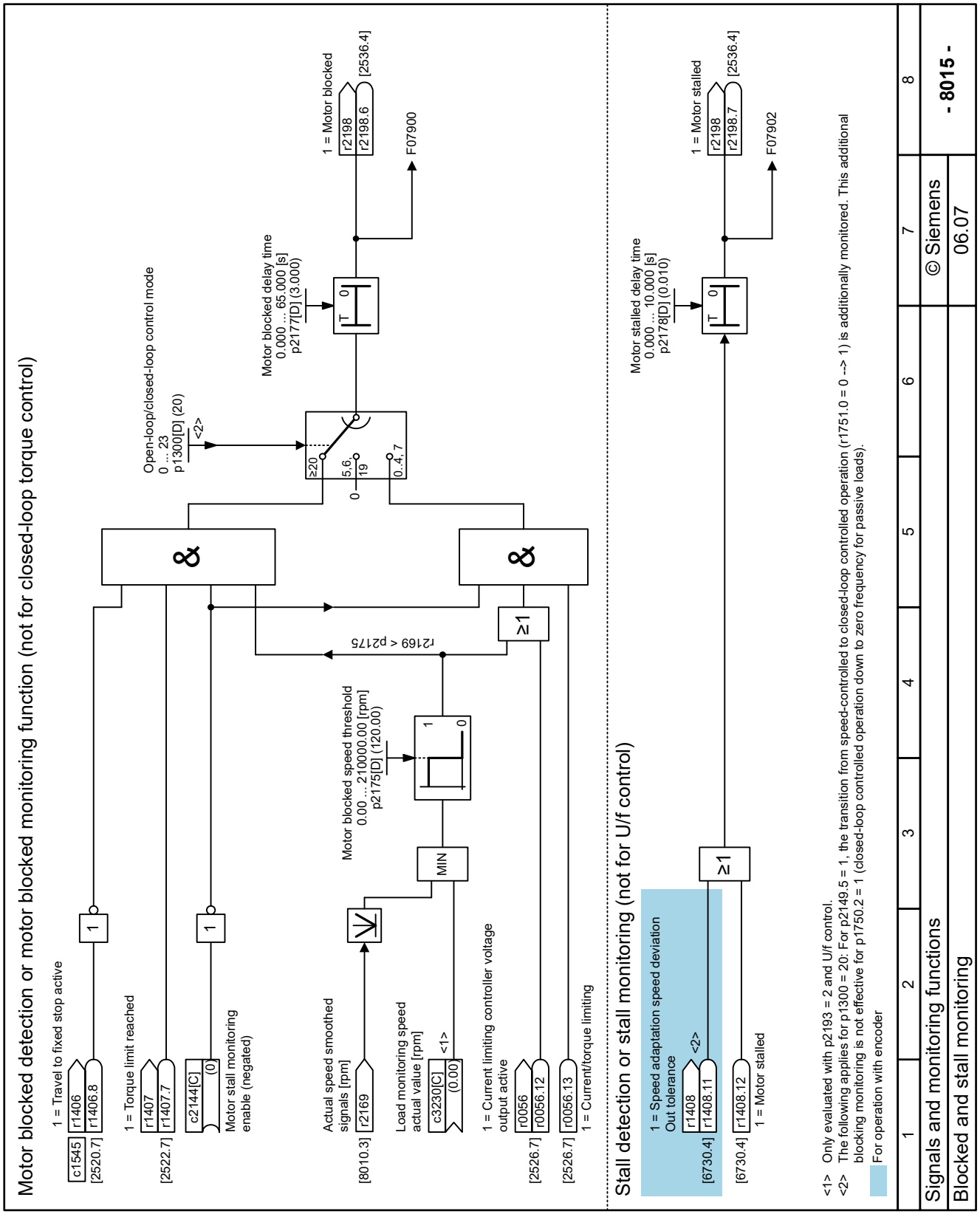


Figure 13-232 8015 – Blocking and stall monitoring

13.13.18.3 Speed deviation monitoring

Overview

The function monitors the speed or velocity of a machine component using a pulse signal at a digital input.

Function description

The converter compares speed r0586 with speed actual value r2169 and signals when the difference between the encoder signal and the motor speed is too high.

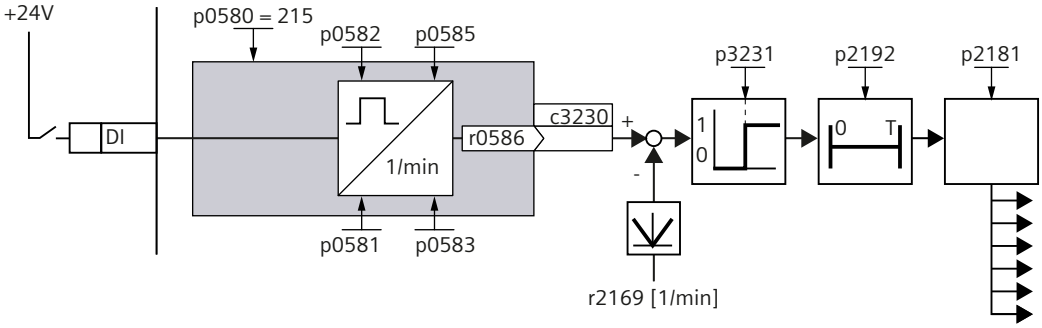
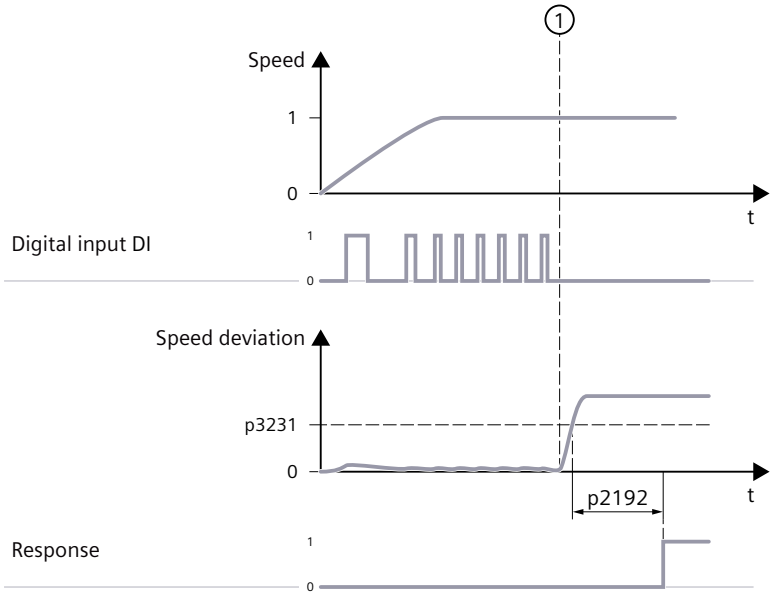


Figure 13-233 Speed deviation monitoring

p2181 defines the response of the converter to an excessive deviation.

The "Measuring probe" subfunction calculates the speed from the pulse signal of the digital input.



① Encoder signal fails

Figure 13-234 Time response of the speed monitoring

Example

Examples of how the function can be used:

- Gearbox monitoring for traction drives or hoisting gear
- Drive belt monitoring for fans or conveyor belts
- Blocking protection for conveyor belts

Parameters

The following list contains the parameters of the "Speed deviation monitoring" function.

Number	Name	Unit
p0490.5	Invert measuring probe or equivalent zero mark	-
p0580	Measuring probe input terminal	-
p0581	Measuring probe edge	-
p0582	Measuring probe pulses per revolution	-
p0583	Measuring probe maximum measuring time	s
r0586	Measuring probe speed actual value	rpm
r0587	Measuring probe measuring time measured	-
r0588	Measuring probe pulse counter	-
r0589	Measuring probe wait time	-
r2169	Actual speed smoothed signals	rpm
p2181[0...n]	Load monitoring response	-
p2192[0...n]	Load monitoring delay time	s
p2193[0...n]	Load monitoring configuration	-
c3230[0...n]	Load monitoring speed actual value	rpm
p3231[0...n]	Load monitoring speed deviation	rpm

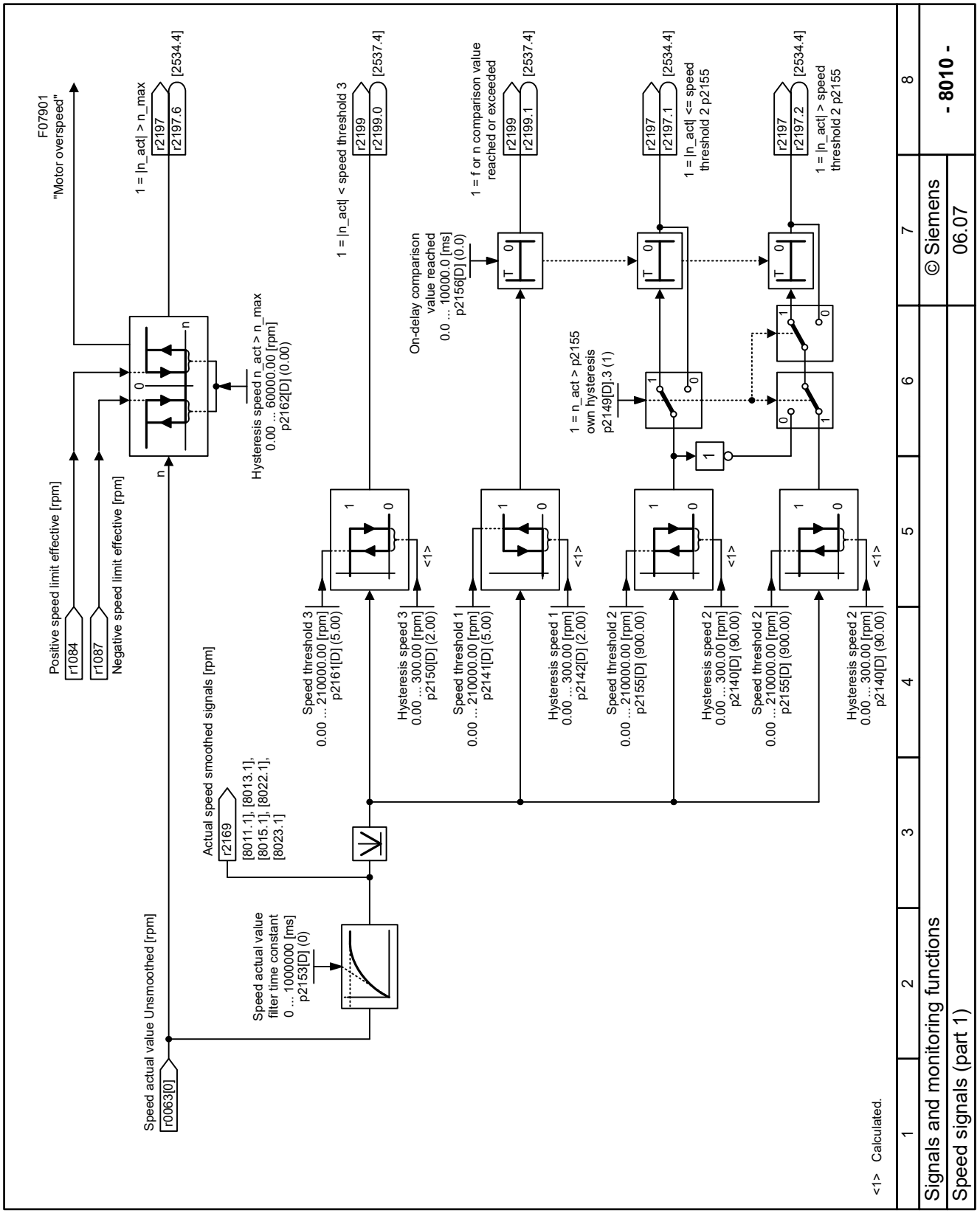


Figure 13-235 8010 – Speed messages (Part 1)

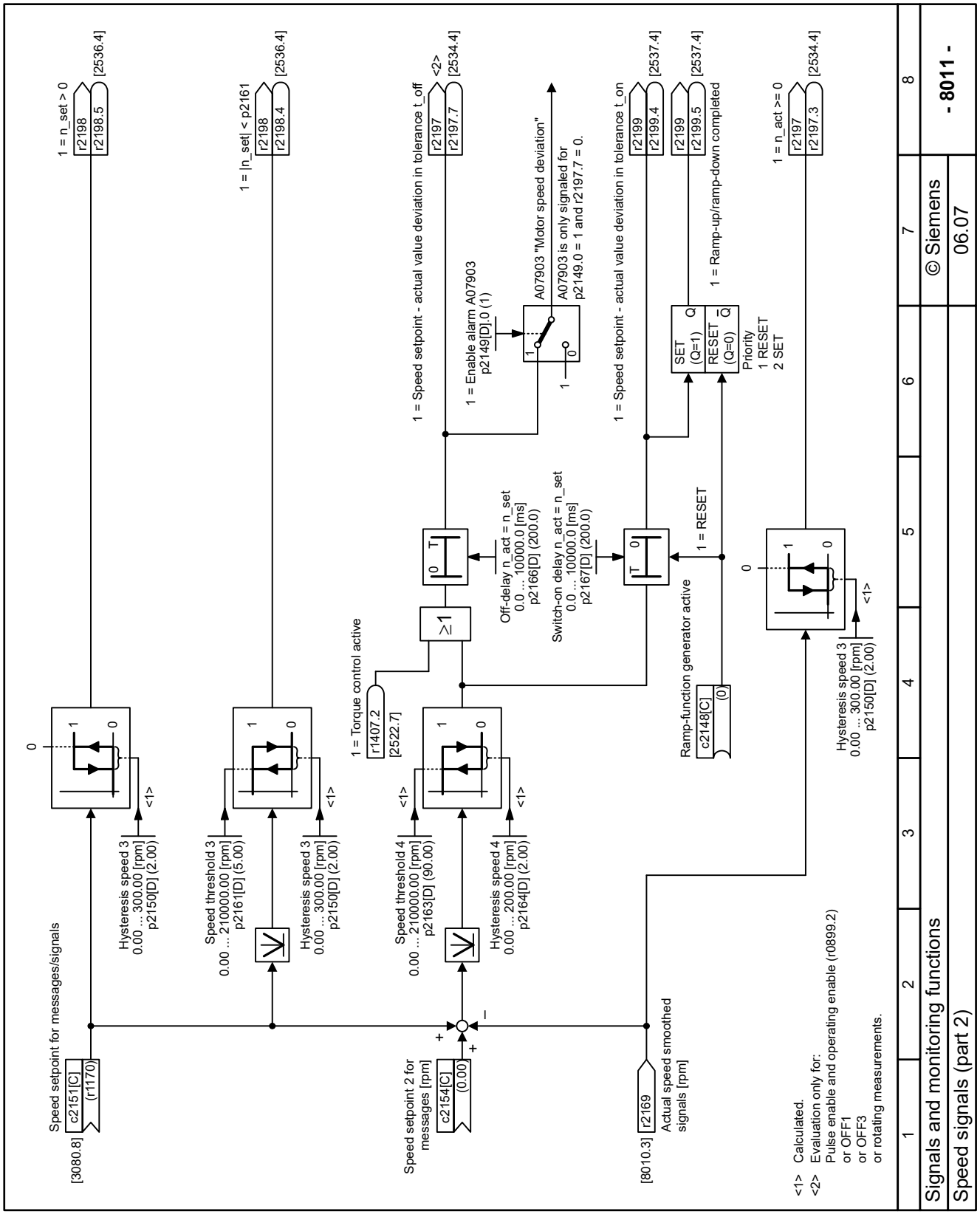


Figure 13-236 8011 – Speed messages (Part 2)

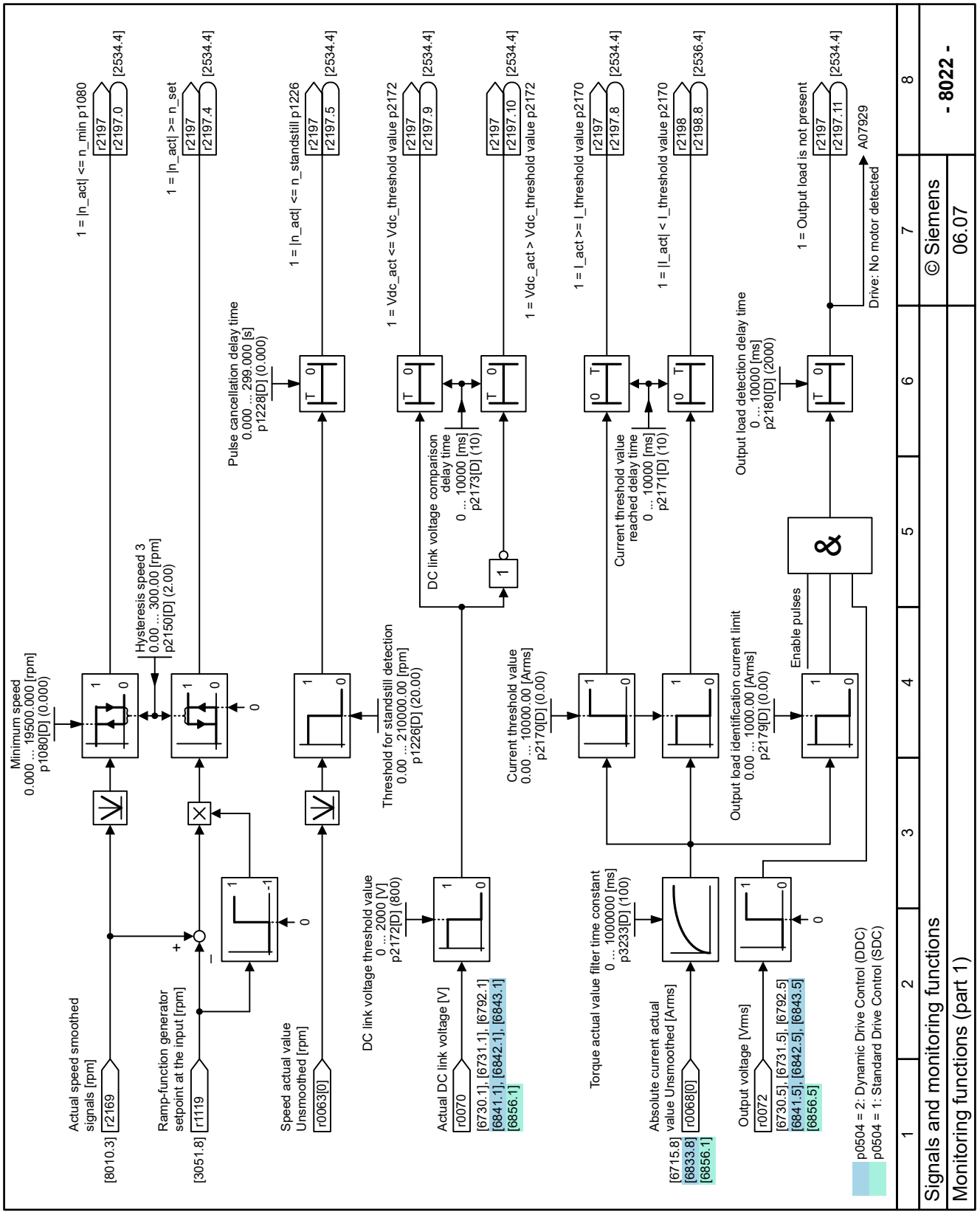


Figure 13-237 8022 – Monitoring functions (Part 1)

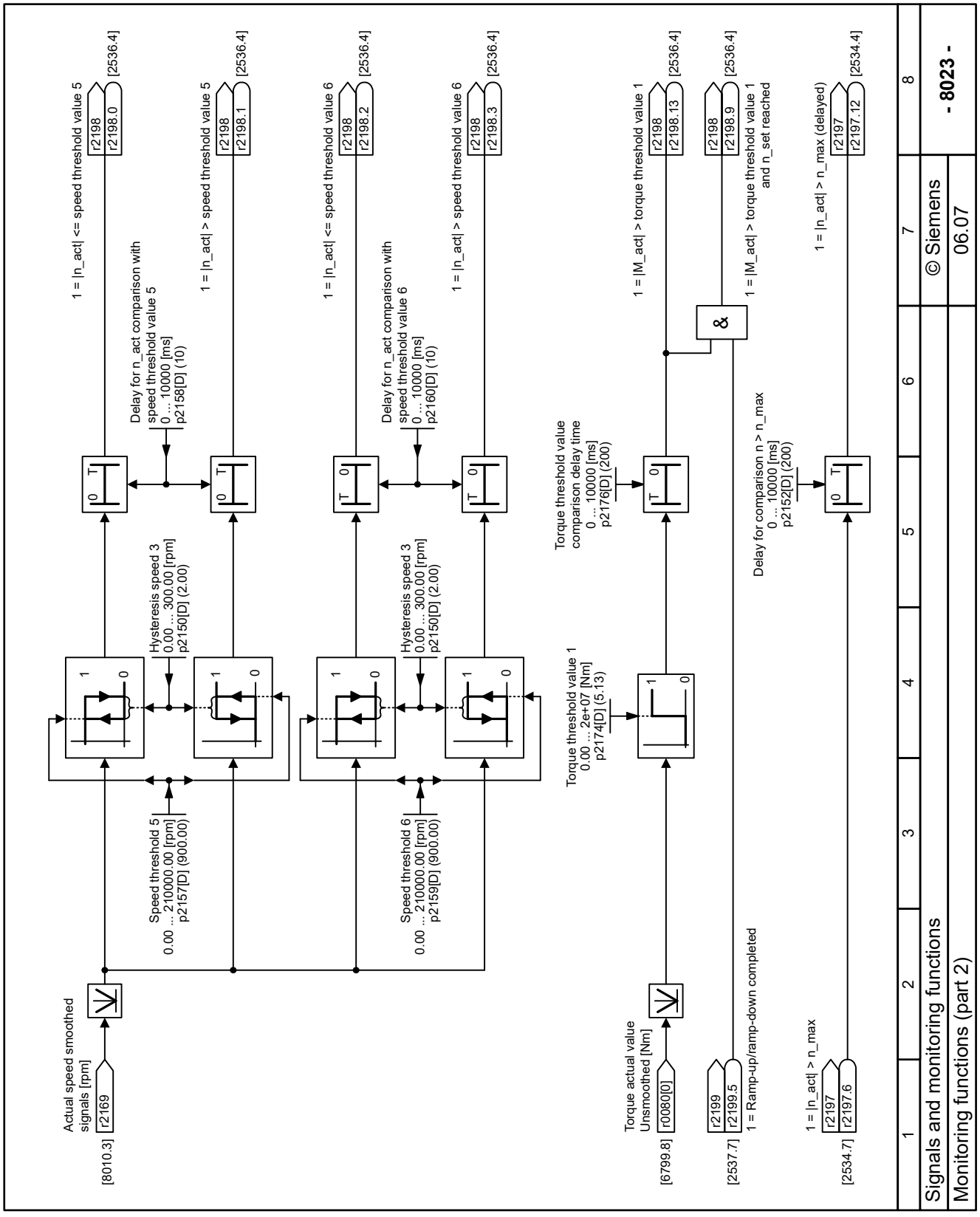


Figure 13-238 8023 – Monitoring functions (Part 2)

13.13.18.4 Load monitoring for torque

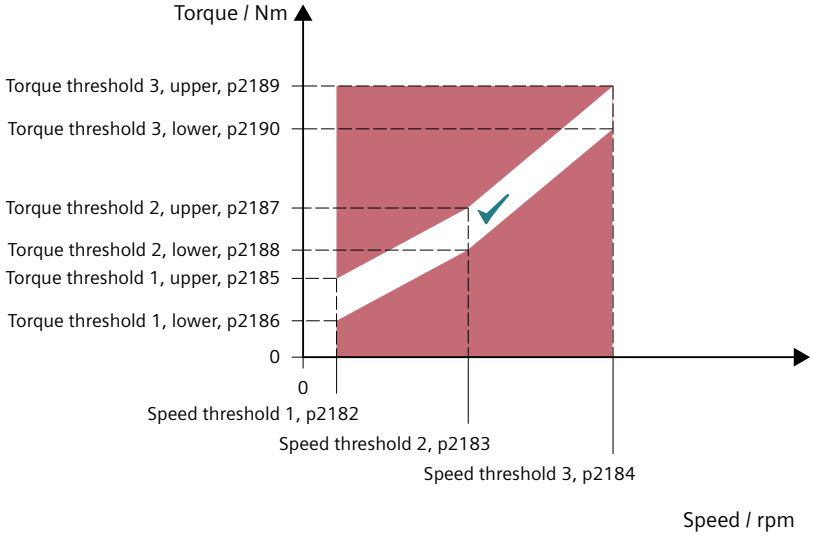
Overview

The "Load monitoring for torque" function compares the motor torque with an upper and lower torque threshold that is dependent on the speed.

Function description

In applications with fans, pumps or compressors with flow characteristic, the torque follows the speed according to a specific characteristic.

A torque that is too low indicates that the motor and load are no longer mechanically coupled. A torque that is too high can indicate problems in the mechanical system of the driven load.



If the torque lies outside the permissible range for longer than time p2192, then the converter responds as specified in p2181.

The monitoring is not active below speed threshold 1 and above speed threshold 3.

Example

In the following examples, a torque that is too high or too low indicates an error in the system:

- For pumps, a torque that is too low can indicate leakage or dry running of the pump.
- For fans, a torque that is too low indicates that the power transmission from the motor to the load has been interrupted by a broken drive belt.

Parameters

The following list contains the parameters of the "Load monitoring for torque" function.

Number	Name	Unit
r0031	Actual torque smoothed	Nm
p1082[0...n]	Maximum speed	rpm
p2181[0...n]	Load monitoring response	-
p2182[0...n]	Load monitoring speed threshold value 1	rpm
p2183[0...n]	Load monitoring speed threshold value 2	rpm
p2184[0...n]	Load monitoring speed threshold value 3	rpm
p2185[0...n]	Load monitoring torque threshold 1 upper	Nm
p2186[0...n]	Load monitoring torque threshold 1 lower	Nm
p2187[0...n]	Load monitoring torque threshold 2 upper	Nm
p2188[0...n]	Load monitoring torque threshold 2 lower	Nm
p2189[0...n]	Load monitoring torque threshold 3 upper	Nm
p2190[0...n]	Load monitoring torque threshold 3 lower	Nm
p2191[0...n]	Load monitoring torque threshold no load	Nm
p2192[0...n]	Load monitoring delay time	s
p2193[0...n]	Load monitoring configuration	-

13.13.18.5 Load monitoring failure detection

Overview

The "Load monitoring failure detection" function evaluates a binary signal and signals a signal failure.

Function description

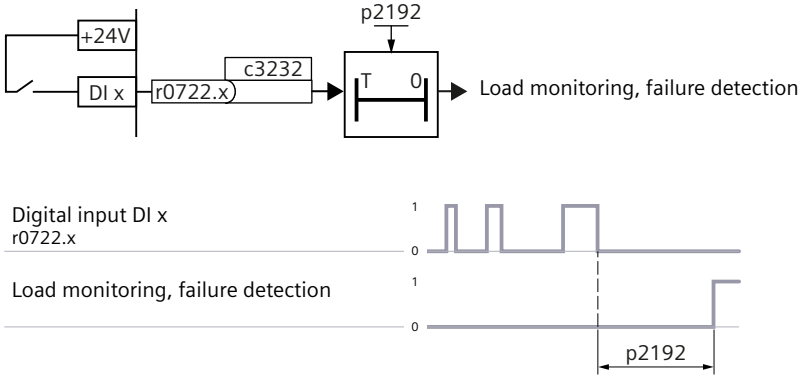


Figure 13-239 Function diagram and time response of the load monitoring failure detection

With the signal interconnection of a digital input and function "Load monitoring failure detection", the converter evaluates whether a sensor regularly provides a 24 V signal when the motor is operational. If the sensor signal fails for time p2192, the converter signals fault "Load monitoring failure detection".

Example

Examples of how the function can be used:

- Gearbox monitoring for traction drives or hoisting gear
- Monitoring the motion of a machine component using an electromechanical or electronic sensor, e.g. a proximity switch

Parameters

The following list contains the parameters of the "Load monitoring failure detection" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	-
p2192[0...n]	Load monitoring delay time	s
p2193[0...n]	Load monitoring configuration	-
c3232[0...n]	Load monitoring failure detection (external)	-

13.13.18.6 No-load monitoring

Overview

The no-load monitoring evaluates the motor current and detects an interrupted phase in the motor cable.

Function description

A motor current that is too low indicates that the motor cable is interrupted.

If the motor current is below the current limit p2179 for time p2180, the converter signals the alarm A07929.

Parameters

The following list contains the parameters of the "No-load monitoring" function.

Number	Name	Unit
r0068[0...1]	Absolute current actual value	Arms
p2179[0...n]	Output load identification current limit	Arms
p2180[0...n]	Output load detection delay time	ms
r2197.0...13	Status word monitoring 1	-

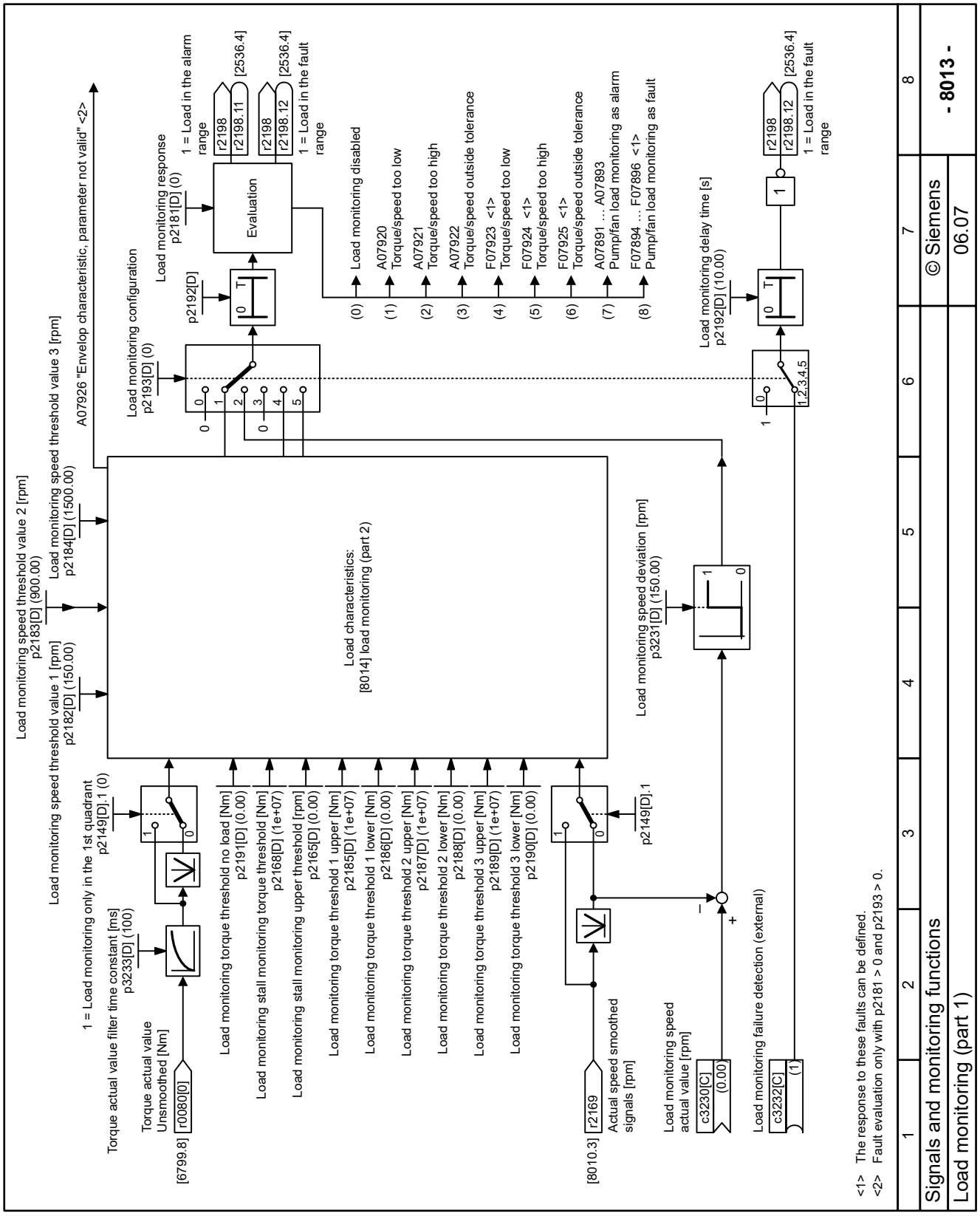


Figure 13-240 8013 - Load monitoring (Part 1)

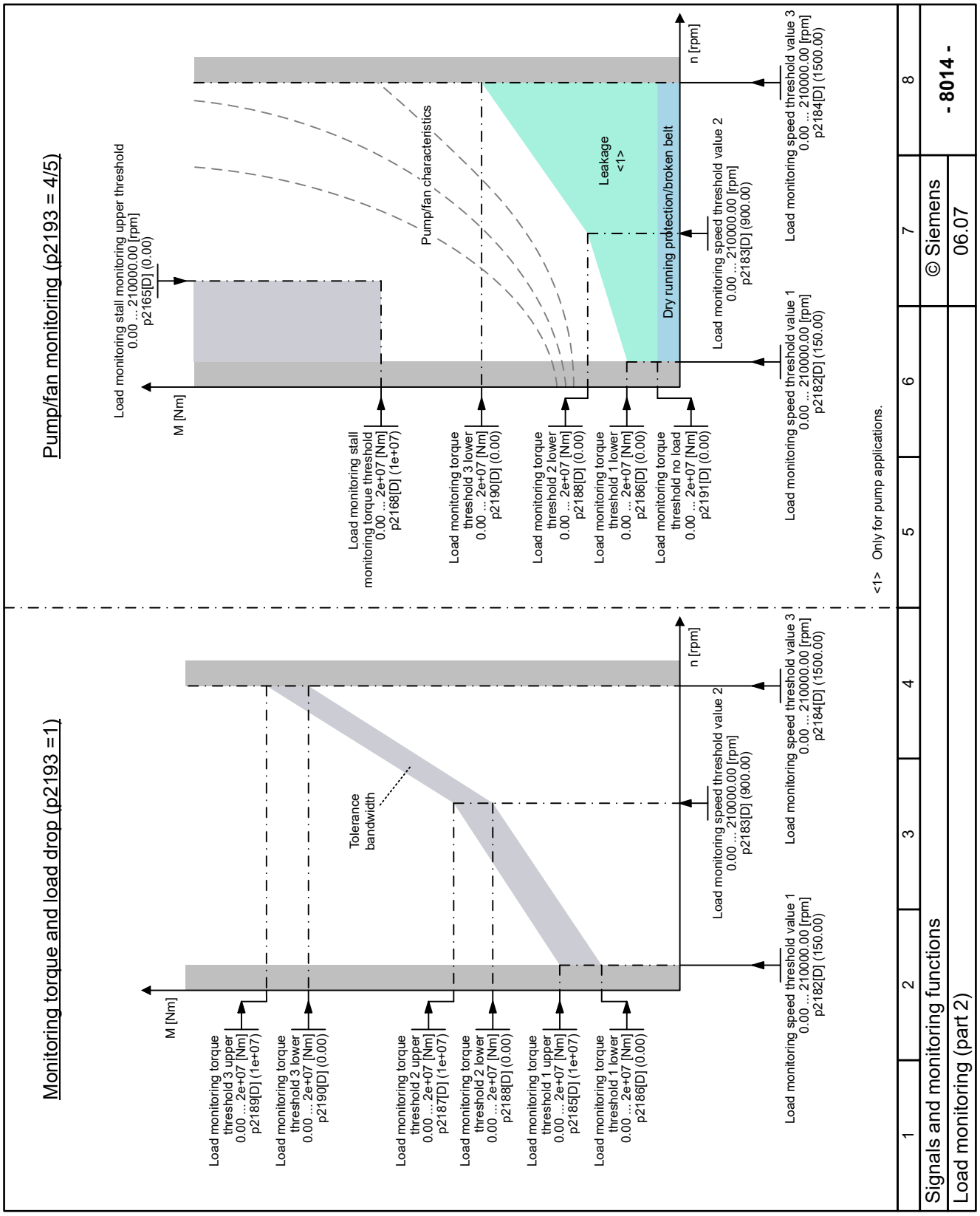


Figure 13-241 8014 - Load monitoring (Part 2)

13.13.18.7 Variable signaling function

Overview

Function "Variable signaling function" monitors 1 ... 3 interconnectable signals in the converter.

Function description

Numerical signal sink c3291 compares the interconnected signal with threshold value p3295 and signals the result in binary signal source r3294.

p3296 defines the hysteresis for the comparison:

- Monitored signal > Threshold value + hysteresis → r3294 = 1 signal
- Monitored signal < Threshold value - hysteresis → r3294 = 0 signal

Pickup delay p3297 and dropout delay p3298 delay the corresponding signal change.

Sampling time p3299 defines the resolution of the variable signaling function with respect to time.

Parameters

The following list contains the parameters of the function "Variable signaling function".

Number	Name	Unit
p3290.0...5	Variable signaling function start	-
c3291[0...2]	Variable signaling function input signal	-
r3294.0...6	Variable signaling function output signal	-
p3295[0...2]	Variable signaling function threshold value	-
p3296[0...2]	Variable signaling function hysteresis	-
p3297[0...2]	Variable signaling function pickup delay	ms
p3298[0...2]	Variable signaling function dropout delay	ms
p3299[0...2]	Variable signaling function sampling time	ms

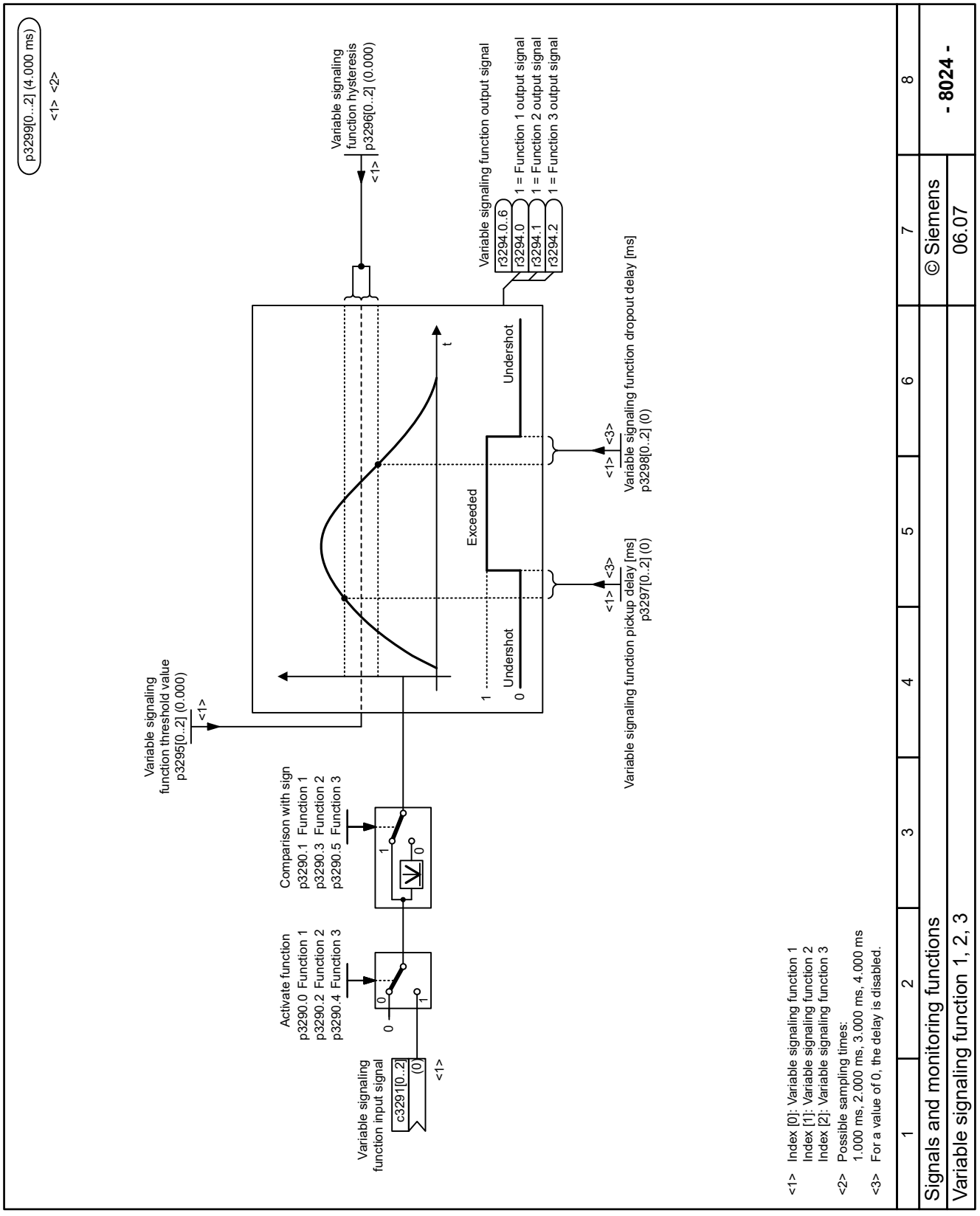


Figure 13-242 8024 – Variable message function 1, 2, 3

13.13.18.8 Overload response

Overview

To maintain operation for an impending thermal overload, with the appropriate setting, the converter reduces its losses.

Precondition

When reducing the pulse frequency, the pulse frequency setpoint p1800 in operation must be higher than the minimum pulse frequency.

Reducing the pulse frequency only makes sense for applications that are not critical from a control-related perspective, e.g. pump and fan drives.

When reducing the output current and the speed, a speed deviation and a reduced torque are permissible in the application for a limited time.

Function description

The following effects determine the thermal stress of the converter:

- The ambient temperature
- The increase of ohmic losses with increasing output current
- The increase of switching losses with pulse frequency

The converter monitors the following values to be able to respond to an impending overload condition:

- Motor current
- DC link current
- Active power
- Chip temperature of the power electronics
- Heat sink temperature

The converter signals an alarm for a pending overload condition.

The converter responds to an overload condition with a fault.

Depending on the setting of parameter p0290, when the alarm is active, the converter attempts to reduce its load by applying the following measures:

- Reducing the pulse frequency
  The converter reduces the pulse frequency starting from the pulse frequency setpoint p1800. A reduced pulse frequency results in lower converter switching losses.
  On the other hand, reducing the pulse frequency increases the current ripple of the motor. Depending on the load moment of inertia, the current ripple results in a higher torque ripple at the motor shaft and a higher motor noise level.
  Once the impending overload condition has been removed, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.
- Reduction of the output current
  For a drive with closed-loop speed control, reducing the output current reduces the converter load; however; it also reduces the motor torque and results in a deviation between the speed setpoint and speed actual value.
  Once the impending overload condition has been removed, the converter re-enables the output current.
- Reducing the output frequency
  For a drive with V/f control, reducing the output frequency reduces the converter load; however; it also results in a deviation between the speed setpoint and speed actual value.
  Once the impending overload condition has been removed, the converter re-enables the output frequency.

p0290 setting	**Overload response**		**Remark**
	Reducing the pulse frequency	**Reducing the output current or reducing the output frequency**	
p0290 = 0	No	Yes	---
p0290 = 1	No	No	---
p0290 = 2 p0290 = 12 p0290 = 22	Yes	Yes, if reducing the pulse frequency is not possible or was not successful	Contrary to "p0290 = 2", for "p0290 = 12" the converter evaluates the actual load and already reduces the pulse frequency before reaching the temperature alarm threshold. For "p0290 = 22" the converter suppresses the alarm.
p0290 = 3 p0290 = 13 p0290 = 23	Yes	No	We recommend setting p0290 = 13 for loads with high starting torque. Contrary to "p0290 = 3", for "p0290 = 13" the converter evaluates the actual load and already reduces the pulse frequency before reaching the temperature alarm threshold. For "p0290 = 23" the converter suppresses the alarm.
p0290 = 24	Yes	Yes	Loss-optimized reduction of the pulse frequency
p0290 = 25	Yes	No	

Parameters

The following list contains the parameters of function "Overload response".

Number	Name	Unit
r0036[0...2]	Power unit overload	%
r0037[0...10]	Power unit temperatures	°C
p0290	Power unit overload response	-
p0292[0...1]	Power unit temperature alarm threshold	°C
p1800[0...n]	Pulse frequency setpoint	kHz

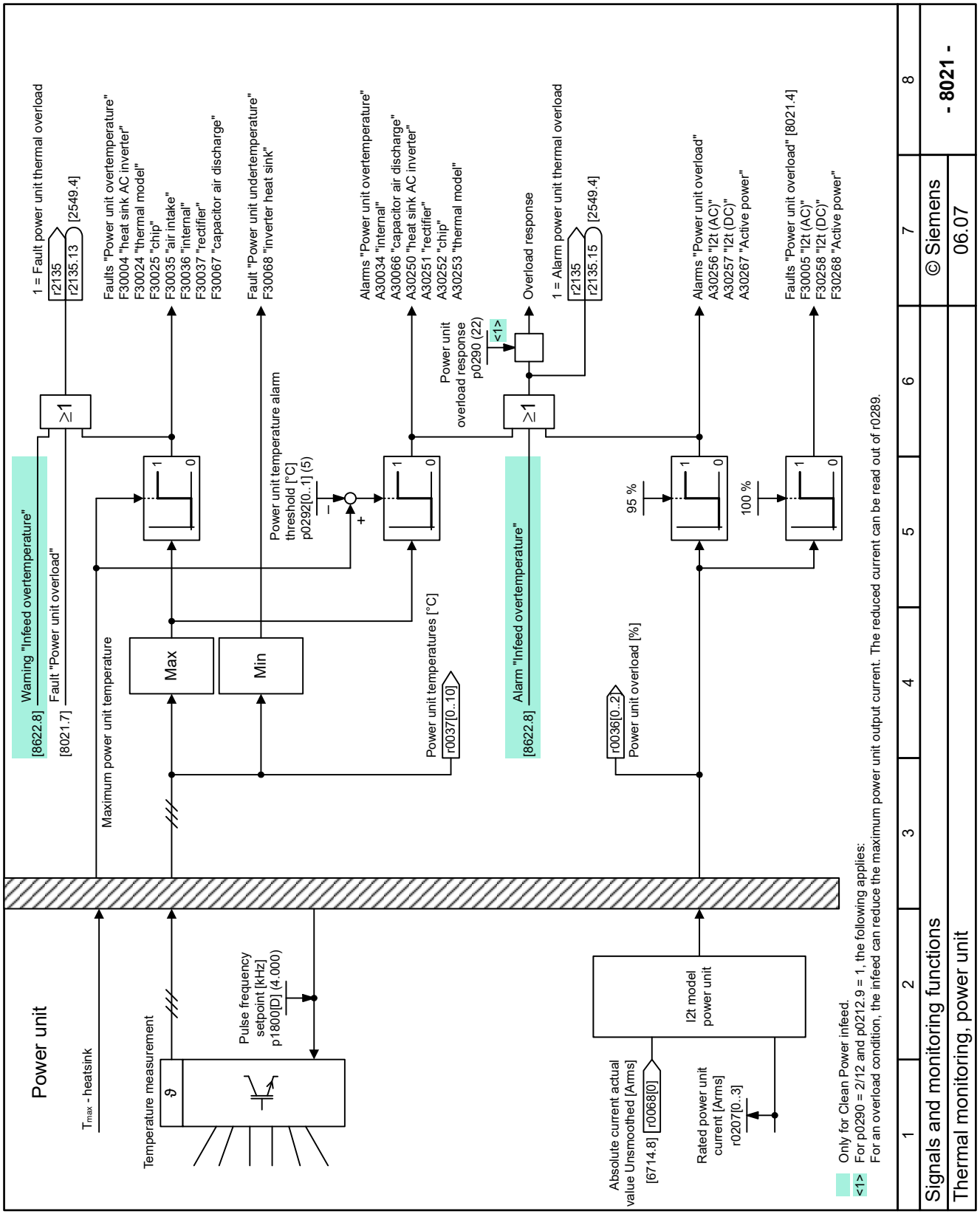


Figure 13-243 8021 - Thermal monitoring power unit

13.13.18.9 Motor protection with temperature sensor KTY84

Overview

The converter has a function to evaluate a KTY84 sensor to measure the motor temperature.

Requirement

NOTICE
Overheating of the motor due to connection of the KTY84 sensor with incorrect polarity
If a KTY84 sensor is connected with incorrect polarity, the motor can be damaged due to overheating, since the converter cannot detect the overtemperature. • Connect the KTY84 sensor with the correct polarity.

Function description

The converter evaluates the motor temperature in the range from -48 °C ... +248 °C.

Parameters p0604 or p0605 define the alarm threshold and fault threshold.

- Alarm threshold: Motor temperature > p0604 and p0610 = 0
- The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring:

- Wire break
  The converter signals a fault after 100 milliseconds.
- Short-circuit
  The converter signals a fault after 100 milliseconds.

Parameter p0607 defines the delay between the output of an alarm and fault when the sensor monitoring responds.

Parameters

The following list contains the parameters of the "Motor protection with temperature sensor KTY84" function.

Number	Name	Unit
p0335[0...n]	Motor cooling type	-
p0601[0...n]	Motor temperature sensor type	-
p0604[0...n]	Mot_temp_mod 2/sensor: alarm threshold	°C
p0605[0...n]	Mot_temp_mod 1/2 sensor threshold and temperature value	°C
p0610[0...n]	Motor overtemperature response	-
p0640[0...n]	Motor current limit	Arms

13.13.18.10 Motor protection with temperature sensor Pt100

Overview

The converter has a function to evaluate a Pt100 sensor to measure the motor temperature.

Requirement

You have set the temperature offset via parameter p0624.

With this setting, you correct a systematic temperature deviation, e.g. caused by the resistance of the measuring sensor connecting cable.

Function description

Using a Pt100 sensor, the converter evaluates the motor temperature in the range -48 °C to +248 °C.

You set the temperature for the alarm threshold and fault threshold using parameters p0604 and p0605:

- Alarm threshold: Motor temperature > p0604 and p0610 = 0
- The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring

- Wire break:
  The converter signals a fault after 100 milliseconds.
- Short-circuit:
  The converter signals a fault after 100 milliseconds.

Parameters

The following list contains the parameters of the "Motor protection with temperature sensor Pt100" function.

Number	Name	Unit
p0335[0...n]	Motor cooling type	-
p0601[0...n]	Motor temperature sensor type	-
p0604[0...n]	Mot_temp_mod 2/sensor: alarm threshold	°C
p0605[0...n]	Mot_temp_mod 1/2 sensor threshold and temperature value	°C
p0610[0...n]	Motor overtemperature response	-
p0624[0...n]	Motor temperature offset Pt100	K

13.13.18.11 Motor protection with temperature sensor Pt1000

Overview

To protect the motor against overtemperature, the converter can evaluate the Pt1000 sensor.

Function description

With a Pt1000 sensor, the converter evaluates the motor temperature in the range -48 °C ... +248 °C.

You set the temperature for the alarm threshold and fault threshold using parameters p0604 and p0605:

- Alarm threshold: Motor temperature > p0604 and p0610 = 0
- The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring

- Wire break:
  The converter signals a fault after 100 milliseconds.
- Short-circuit:
  The converter signals a fault after 100 milliseconds.

Parameters

The following list contains the parameters of the "Motor protection with temperature sensor Pt1000" function.

Number	Name	Unit
p0335[0...n]	Motor cooling type	-
p0601[0...n]	Motor temperature sensor type	-
p0604[0...n]	Mot_temp_mod 2/sensor: alarm threshold	°C
p0605[0...n]	Mot_temp_mod 1/2 sensor threshold and temperature value	°C
p0610[0...n]	Motor overtemperature response	-

13.13.18.12 Motor protection with temperature switch

Overview

To protect the motor against overtemperature, the converter can evaluate a temperature switch, such as a bimetal NC contact.

Function description

The converter interprets a resistance ≥ 100 Ω as an open bimetal NC contact and responds according to the setting of p0610.

Parameters

The following list contains the parameters of the "Motor protection with temperature switch" function.

Number	Name	Unit
p0335[0...n]	Motor cooling type	-
p0601[0...n]	Motor temperature sensor type	-
p0610[0...n]	Motor overtemperature response	-

13.13.18.13 Motor protection with temperature sensor PTC

Overview

To protect the motor against overtemperature, the converter can evaluate a PTC sensor.

Function description

The converter interprets the resistance as follows:

- Resistance > 1650 Ω: Overtemperature
  The converter responds according to the setting for p0610.
- Resistance < 20 Ω: Short-circuit
  The converter signals an alarm.
  The converter signals a fault if the alarm is active for longer than 100 milliseconds.

Parameters

The following list contains the parameters of the "Motor protection with temperature sensor PTC" function.

Number	Name	Unit
p0335[0...n]	Motor cooling type	-
p0601[0...n]	Motor temperature sensor type	-
p0610[0...n]	Motor overtemperature response	-
p0640[0...n]	Motor current limit	Arms

13.13.18.14 Motor protection for synchronous motors by means of temperature calculation, Model 1

Overview

Thermal motor model 1 responds faster to critical motor temperatures than a measurement using a temperature sensor.

Precondition

After commissioning, the converter sets the thermal motor model that is suitable for the motor.

The modification of p0612 after commissioning requires testing of the alarm and fault thresholds p5390 and p5391.

Function description

Thermal motor model 1 calculates the motor temperature of synchronous and synchronous-reluctance motors from the motor current and the thermal time constant of the motor.

If the converter evaluates a temperature sensor in the motor, the converter corrects the model based on the measured temperature.

For motors that do not have a temperature sensor in each winding phase, at standstill, the motor current can flow through a motor winding that is not monitored. In this case, the converter does not correct the thermal motor model with the measured temperature, which results in local overheating of the motor.

For this specific case, we recommend configuration p5399.00 = 1 signal so that the thermal motor model operates at speeds |n| < 1 [r/min] independent of the motor temperature measurement.

Parameters

The following list contains the parameters of function "Motor protection for synchronous motors using temperature calculation, model 1".

Number	Name	Unit
r0034	Motor utilization thermal	%
r0035	Motor temperature	°C
r0068[0...1]	Absolute current actual value	Arms
p0305[0...n]	Rated motor current	Arms
p0605[0...n]	Mot_temp_mod 1/2 sensor threshold and temperature value	°C
p0610[0...n]	Motor overtemperature response	-
p0611[0...n]	I2t motor model thermal time constant	s
p0612[0...n].0...2	Motor temperature model activation	-
p0613[0...n]	Mot_temp_mod 1/3 ambient temperature	°C
p0625[0...n]	Motor ambient temperature during commissioning	°C
p0627[0...n]	Motor overtemperature, stator winding	K
p5390[0...n]	Mot_temp_mod 1/3 alarm threshold	°C
p5391[0...n]	Mot_temp_mod 1/3 fault threshold	°C

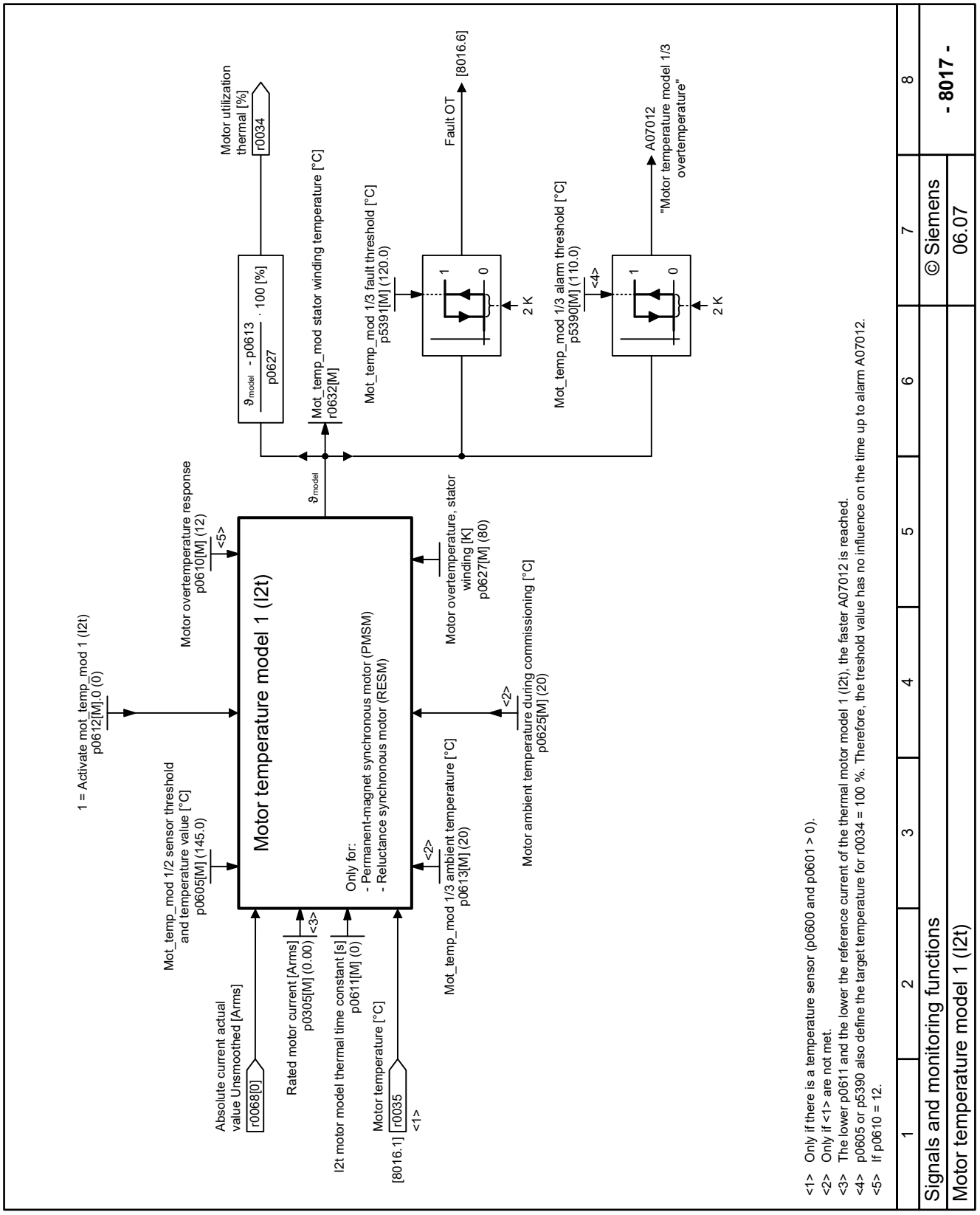


Figure 13-244 8017 - Motor temperature model 1 (I2t)

13.13.18.15 Motor protection for induction motors by means of temperature calculation, Model 2

Overview

The converter calculates the motor temperature based on a thermal motor model.

Description of function

The thermal motor model 2 for induction motors is a thermal 3-mass model, consisting of stator core, stator winding and rotor. Thermal motor model 2 calculates the temperatures in both the rotor and the stator winding.

The converter responds more quickly to a temperature change when the temperature is calculated based on the thermal motor model compared to when it is measured with a temperature sensor.

After commissioning, the converter sets the thermal motor type that is suitable for the motor.

If you use the thermal motor model together with a temperature sensor, e.g. a Pt1000, the converter corrects the model using the measured temperature.

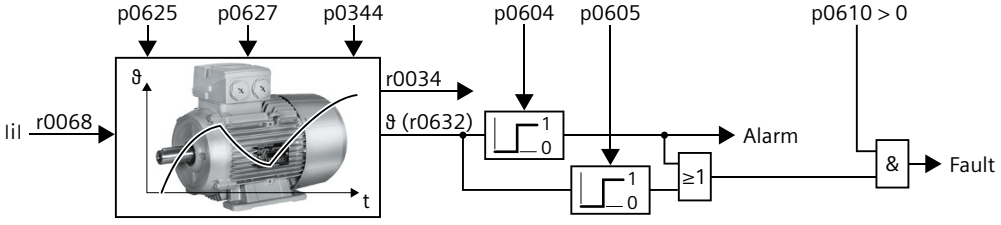


Figure 13-245 Thermal motor model 2 for induction motors

Parameters

The following list contains the parameters of function "Motor protection for induction motors using temperature calculation, model 2".

Number	Name	Unit
p0344[0...n]	Motor mass (for the thermal motor model)	kg
p0605[0...n]	Mot_temp_mod 1/2 sensor threshold and temperature value	°C
p0610[0...n]	Motor overtemperature response	-
p0612[0...n].0...2	Motor temperature model activation	-
p0617[0...n]	Stator thermally relevant iron component	%
p0618[0...n]	Stator thermally relevant copper component	%
p0619[0...n]	Rotor thermally relevant mass	%
p0625[0...n]	Motor ambient temperature during commissioning	°C
p0626[0...n]	Motor overtemperature, stator core	K
p0627[0...n]	Motor overtemperature, stator winding	K
p0628[0...n]	Motor overtemperature rotor	K
r0630[0...n]	Mot_temp_mod ambient temperature	°C
r0631[0...n]	Mot_temp_mod 2/3 stator iron temperature	°C

r0632[0...n]	Mot_temp_mod stator winding temperature	°C
r0633[0...n]	Mot_temp_mod 2/3 rotor temperature	°C

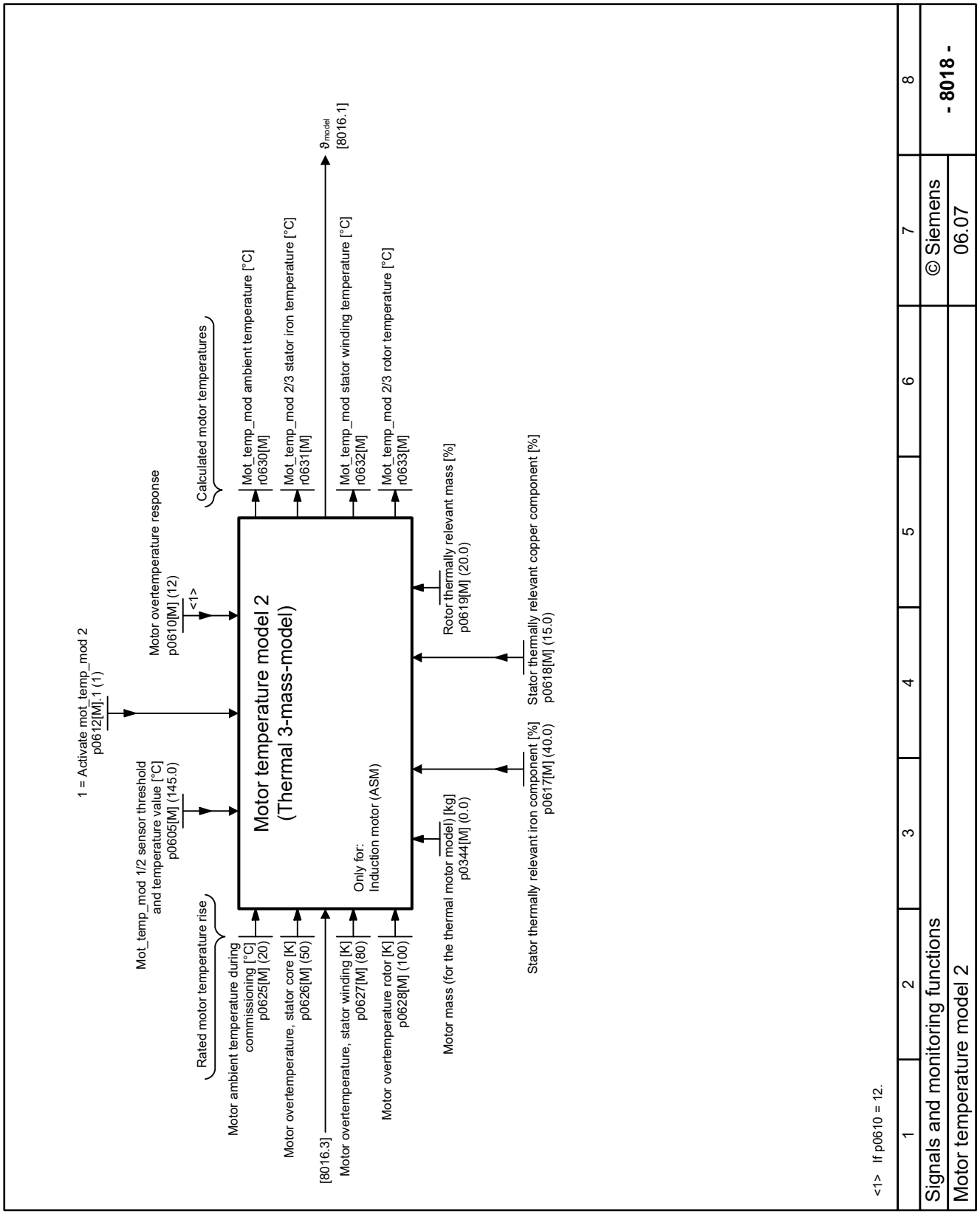


Figure 13-246 8018 - Motor temperature model 2

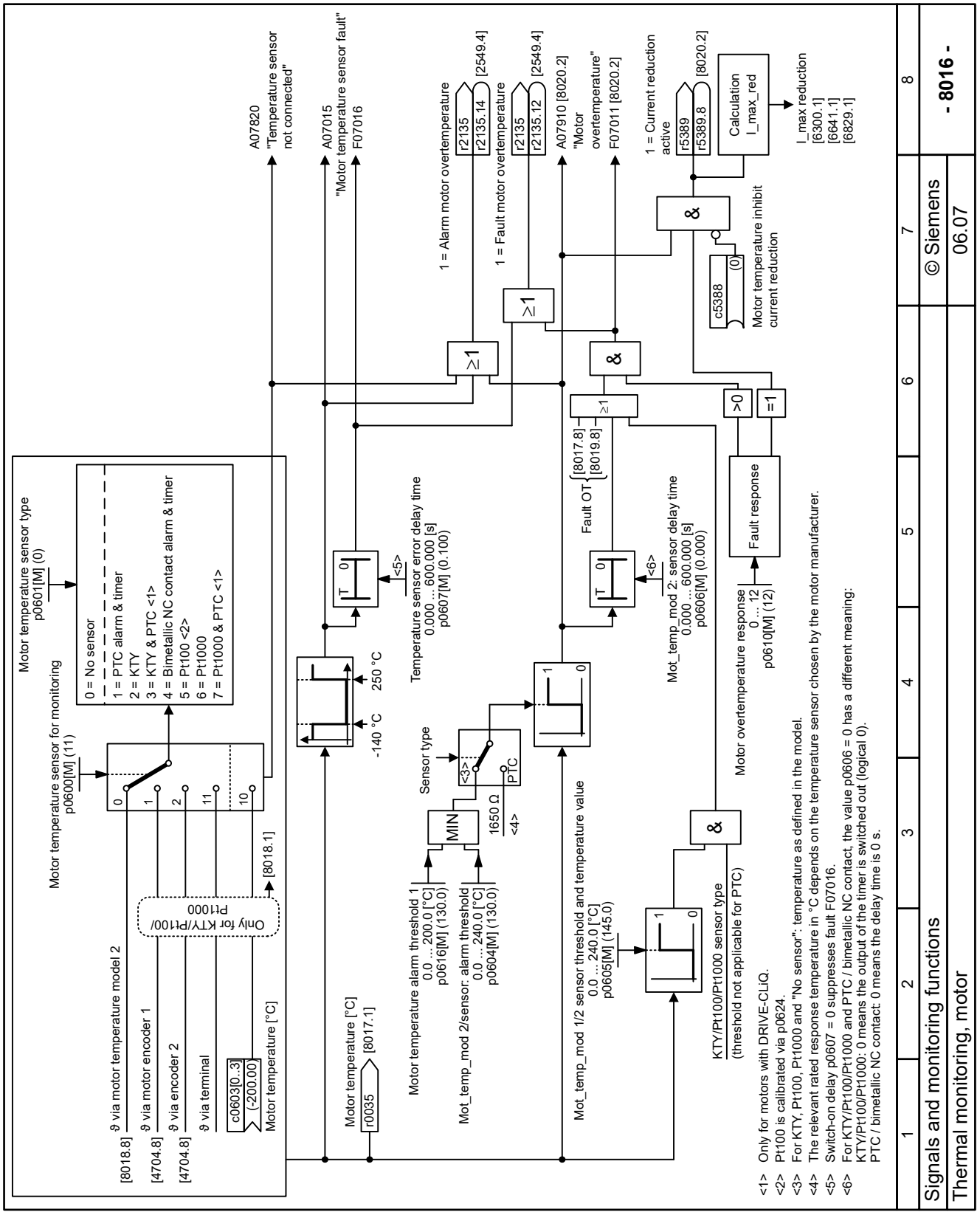


Figure 13-247 8016 - Thermal monitoring motor

13.13.18.16 Motor protection for synchronous motors by means of temperature calculation, Model 3

Overview

The converter calculates the motor temperature at different points on the motor based on a thermal motor model.

Description of function

Thermal motor model 3 for synchronous motors is a thermal 3-mass model, consisting of stator core, stator winding and rotor. Thermal motor model 3 calculates the temperatures in the stator core, rotor and stator winding.

Thermal motor model 3 works without temperature measurement support.

Parameters

The following list contains the parameters of function "Motor protection for synchronous motors using temperature calculation, model 3".

Number	Name	Unit
p5350[0...n]	Mot_temp_mod 1/3 boost factor at standstill	-
p5351[0...n]	Mot_temp_mod 3 stator power loss offset	W
p5352[0...n]	Mot_temp_mod 3 stator power loss linear n-dependent	W min/1000
p5353[0...n]	Mot_temp_mod 3 stator power loss square law n-dependent	W min²/1000²
p5354[0...n]	Mot_temp_mod 3 stator power loss stator linear n-dependent	W/A
p5355[0...n]	Mot_temp_mod 3 stator power loss stator square law I-dependent	W/A²
p5356[0...n]	Mot_temp_mod 3 gearbox thermally relevant surface motor	m²
p5357[0...n]	Mot_temp_mod 3 gearbox thermally relevant surface gearbox	m²
p5358[0...n]	Mot_temp_mod 3 gearbox emission coefficient motor	-
p5359[0...n]	Mot_temp_mod 3 gearbox emission coefficient gearbox	-
r5360[0...n]	Mot_temp_mod 3 gearbox temperature	°C
p5361[0...n]	Mot_temp_mod 3 gearbox alarm threshold	°C
p5362[0...n]	Mot_temp_mod 3 gearbox fault threshold	°C
r5363[0...n]	Mot_temp_mod 3 gearbox delay time	s
p5365[0...n]	Mot_temp_mod 3 grbx therm conductivity coeff stator/end shield	W/K
p5366[0...n]	Mot_temp_mod 3 grbx therm conductivity coeff end shield/ gearbox	W/K
p5367[0...n]	Mot_temp_mod 3 grbx therm conductivity coeff gearbox/flange	W/K
p5368[0...n]	Mot_temp_mod 3 grbx therm conductivity coeff flange/ environment	W/K
p5370[0...n]	Mot_temp_mod 3 stator thermal capacity	kW sec/K
p5371[0...n]	Mot_temp_mod 3 stator winding thermal capacity	kW sec/K
p5372[0...n]	Mot_temp_mod 3 rotor thermal capacity	kW sec/K
p5373[0...n]	Mot_temp_mod 3 gearbox thermal capacitance	kW sec/K
p5375[0...n].0...1	Additional motor overload protection configuration	-

p5380[0...n]	Mot_temp_mod 3 stator/ambient thermal conductivity (standstill)	W/K
p5381[0...n]	Mot_temp_mod 3 stator/stator winding therm. conduct. coefficient	W/K
p5382[0...n]	Mot_temp_mod 3 stator/rotor coefficient of thermal conductivity	W/K
p5383[0...n]	Mot_temp_mod 3 stator/surrounding therm. cond. coeff. lin. n-dep	W min/(1000 K)
p5384[0...n]	Mot_temp_mod 3 stator/surrounding therm cond. coeff sq-law n-dep	W min²/(1000² K)
p5385[0...n]	Mot temp mod 1 current limit characteristic gradient	Arms min
r5386[0...7]	Mot_temp remaining time until fault	s
r5387[0...n]	Mot_temp_mod 3 delay time	s
c5388	Motor temperature inhibit current reduction	-
r5389.0...13	Mot_temp status word faults/alarms	-
p5390[0...n]	Mot_temp_mod 1/3 alarm threshold	°C
p5391[0...n]	Mot_temp_mod 1/3 fault threshold	°C

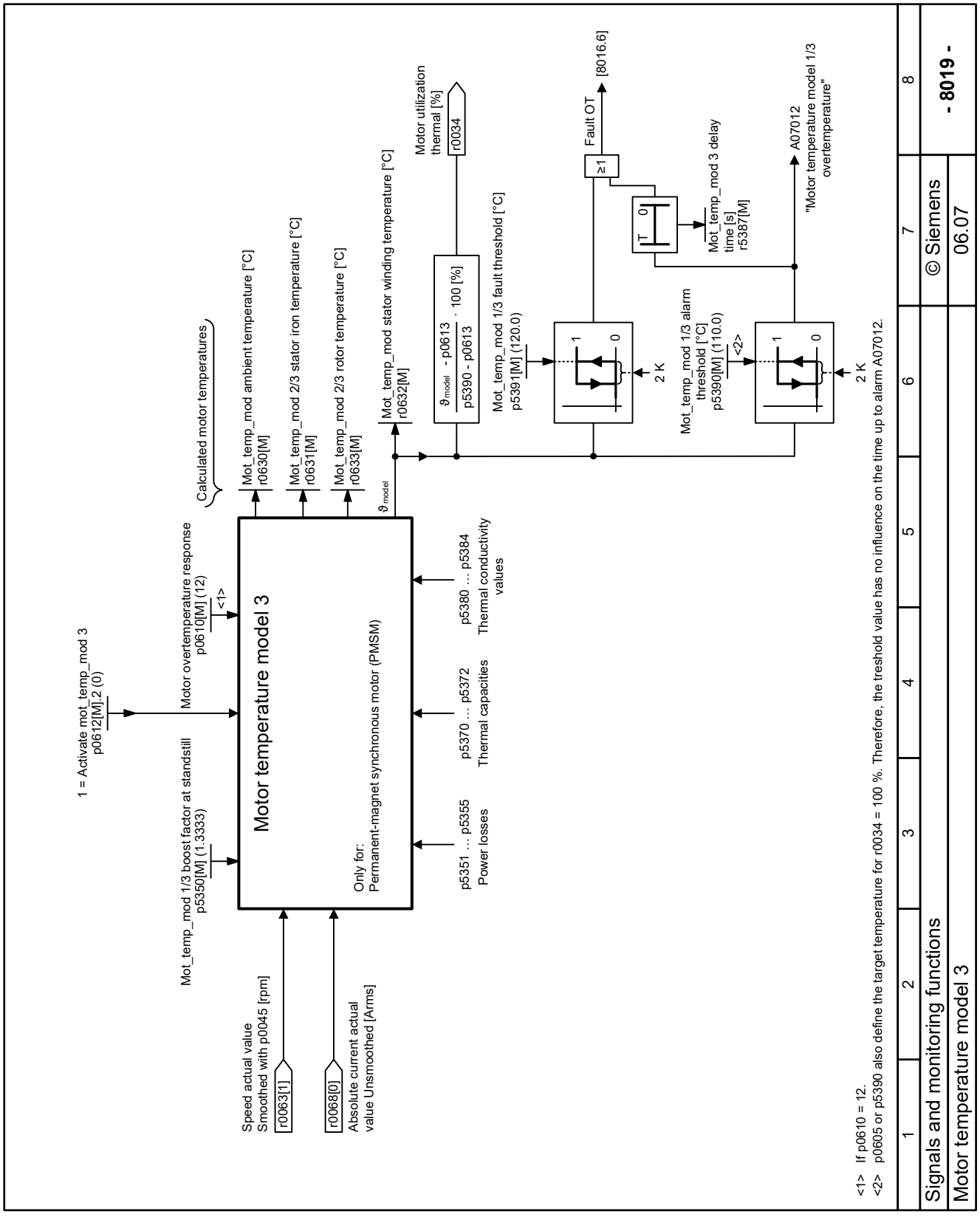


Figure 13-248 8019 – Motor temperature model 3

13.13.18.17 Remaining time up to fault due to motor overtemperature

Overview

When the motor is overloaded, the converter calculates the remaining time until the motor is shut down.

Function description

Display parameter r5386[0] supplies the value for the remaining time during which a motor can still be operated with the actual overload. If the actual motor load remains the same, then after the remaining time elapses, the converter switches off the motor with a fault.

Calculating the remaining time is independent of the configured motor and thermal motor model.

For diagnostics, display parameters r5386[1] ... r5386[5] indicate the relevant source for calculating the remaining time. Display parameters r5386[1] ... r5386[5] contain the values for different motor temperature measurements and motor temperature models. A value of -1 means that a prediction is not possible.

r5386[0] is limited to a maximum of 120 s. The displayed maximum value is applicable for a real remaining time ≤ 120 s.

The remaining time is applicable for the currently selected motor data set. After switching over the motor data set, after 2 s the remaining time calculation provides a definitive value.

Parameters

The following list contains the parameters of function "Remaining time up to fault due to overtemperature".

Number	Name	Unit
r5386[0...7]	Mot_temp remaining time until fault	s

13.13.18.18 Setting motor overload protection in accordance with IEC/UL 61800-5-1

Overview

The drive complies with motor overload protection according to IEC 61800-5-1 Ed. 3 and UL 61800-5-1 Ed. 2 by activating function "Motor overload protection".

Precondition

You are operating the motor without a temperature sensor.

You have commissioned the drive with the correct motor data.

Procedure

To activate the motor overload protection according to IEC 61800-5-1 Ed. 3 and UL 61800-5-1 Ed. 2, proceed as follows:

1. Set p5375.00 to a 1 signal.
2. Set p5375.01 to a 1 signal.

Result

Bit p5375.00 = 1 signal activates electronic motor overload protection with emulation of an electronic overload relay, Class 20.

The motor overload protection has a "thermal memory":

- If the converter supply voltage is switched off, the converter saves the calculated motor temperature.
- After the supply voltage returns, the converter continues to calculate the motor temperature based on the last saved temperature.

For p5375.00 = 1 signal, bit p5375.01 is also effective.

Bit p5375.01 = 1 signal activates the speed dependency of the electronic motor overload protection. When speed dependency is activated, the motor overload protection emulates a self-ventilated motor. The self-ventilated motor cools itself using the fan impeller located on the motor shaft.

13.13.19 Bypass

13.13.19.1 Bypass without line synchronization

Overview

The "Bypass without line synchronization" function switches the motor between converter and line (DOL) operation. In certain applications, the "Bypass without line synchronization" function can save energy or temporarily ensure continued operation in spite of a converter fault.

Precondition

NOTICE
Mechanical damage caused by reversal of the direction of rotation When switching over from converter to line (DOL) operation, if the phase sequence at the converter power output and the phase sequence of the line supply do not match, then the motor reverses in the opposite direction of rotation when connected directly to the line supply. When connected to the line supply, the high torques when reversing and the possible inadmissible direction of rotation can result in mechanical damage to the plant or machine. • Check that the same phase sequence is present on the motor both when breaker K1 is closed and when breaker K2 is closed.

NOTICE
Material damage caused by switching over too early If a feedback signal from either of the two breakers "Motor - power unit" (K1) and "Motor - line supply " (K2) does not always match the state of the corresponding breaker, then a breaker may close prematurely. Premature closing can damage the breaker or damage the system or machine. • Only use breakers whose feedback signals always correctly reflect the status of the breaker. • Wire the feedback signal with a digital input of the converter. • Interconnect the feedback signal with binary signal sink c1269.

The "Bypass without line synchronization " function has the following requirements:

- The converter operates an induction motor.
- The induction motor can be operated directly on the line supply.
- The "flying restart" function is active (p1200 = 1 or 4).

Function description

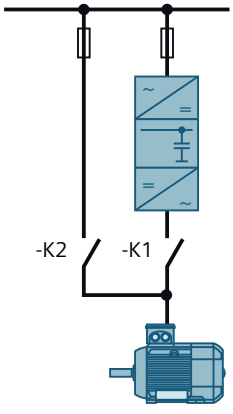


Figure 13-249 Converter bypassed by the motor - line supply breaker (K2)

Under a settable switchover condition, the converter opens the motor - power unit breaker (K1) and closes motor - line supply breaker (K2). As a consequence, the converter switches the motor from converter operation to line (DOL) operation.

There are 2 options for the switching condition:

- The converter switches the motor between converter operation and line (DOL) operation depending on the "Bypass control command" c1266.

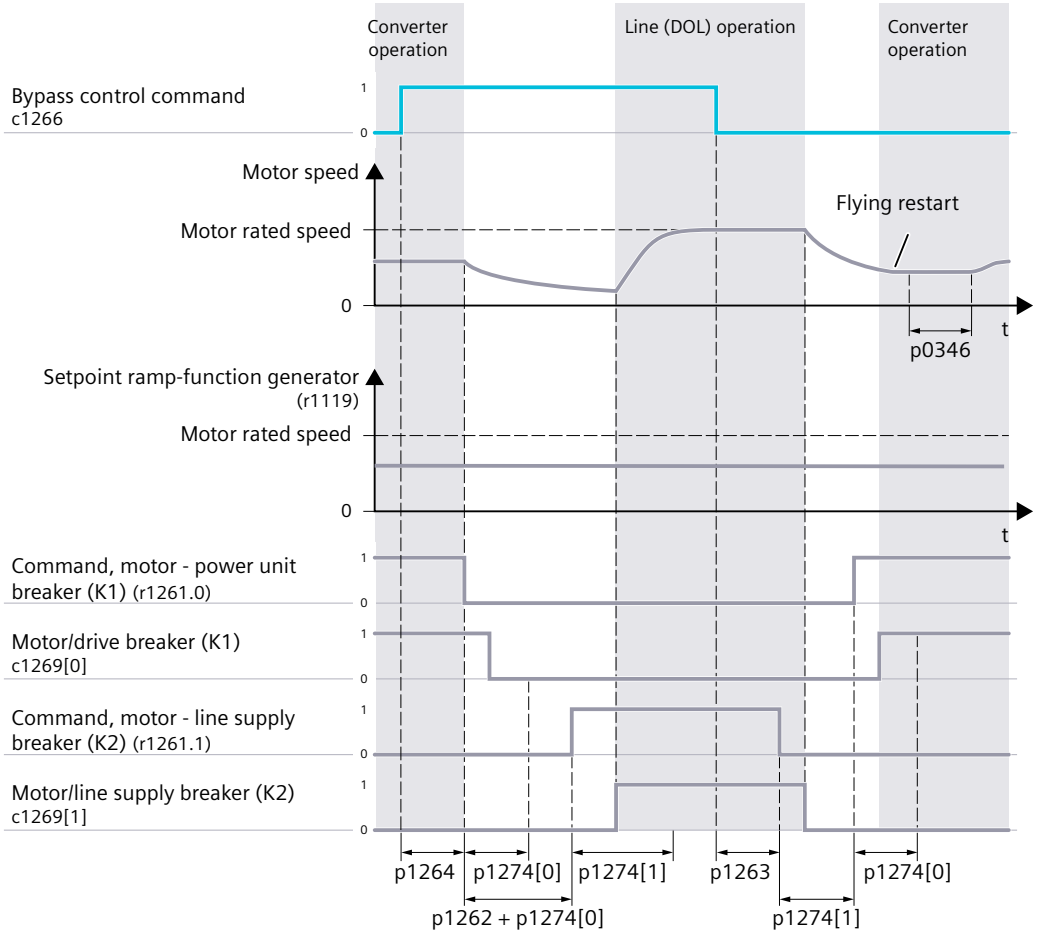


Figure 13-250 Switching over using the "Bypass control command" (p1267.0 = 1)

- The converter switches the motor between converter operation and line (DOL) operation depending on the speed:
  - If the motor speed r0063 is above the "Bypass speed threshold" p1265, then the converter switches the motor to line (DOL) operation.
  - If the speed setpoint r1119 falls below the "Bypass speed threshold", then the converter switches the motor to converter operation.

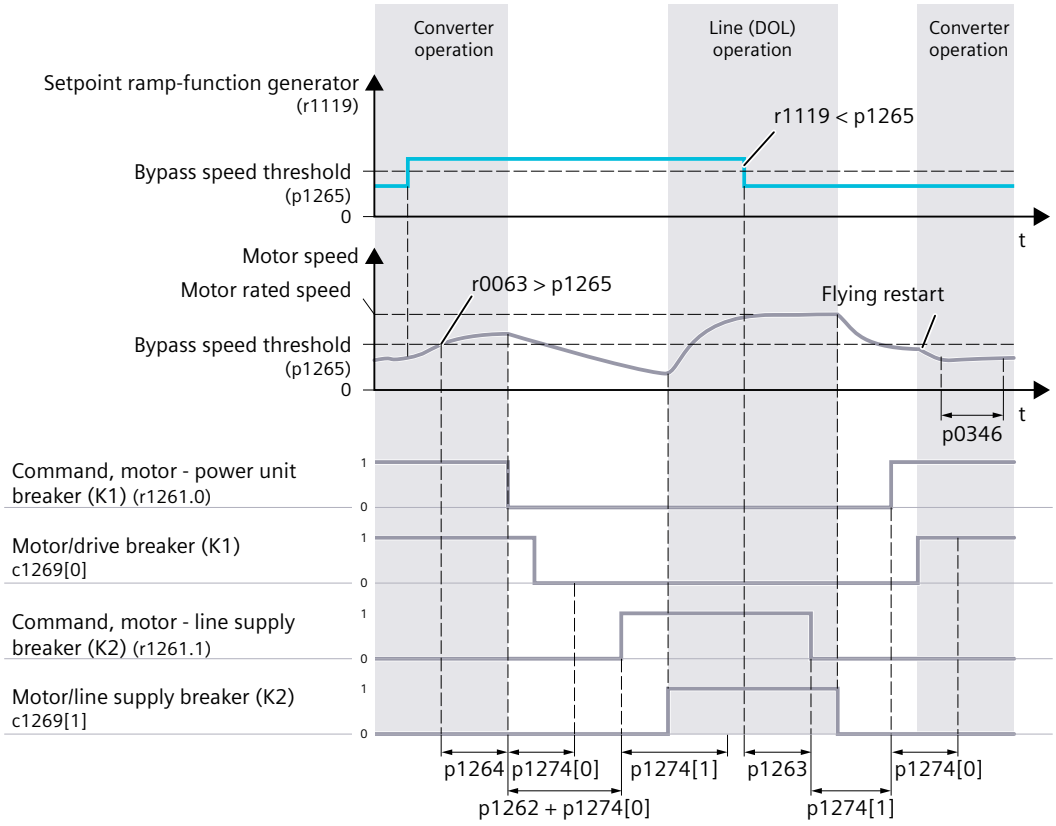


Figure 13-251 Switching over using the "Bypass speed threshold" (p1267.1 = 1)

Switchover phase from converter operation to line (DOL) operation:

1. The converter waits for the time p1264 to expire.
2. The converter switches off its power unit and opens the motor - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is open.
3. The converter waits for the de-excitation time of the motor.
4. The converter closes the motor - line supply breaker (K2).
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is closed.
5. The motor accelerates on the line supply.
   The motor accelerates to its rated speed if it is operating with its rated voltage and frequency.

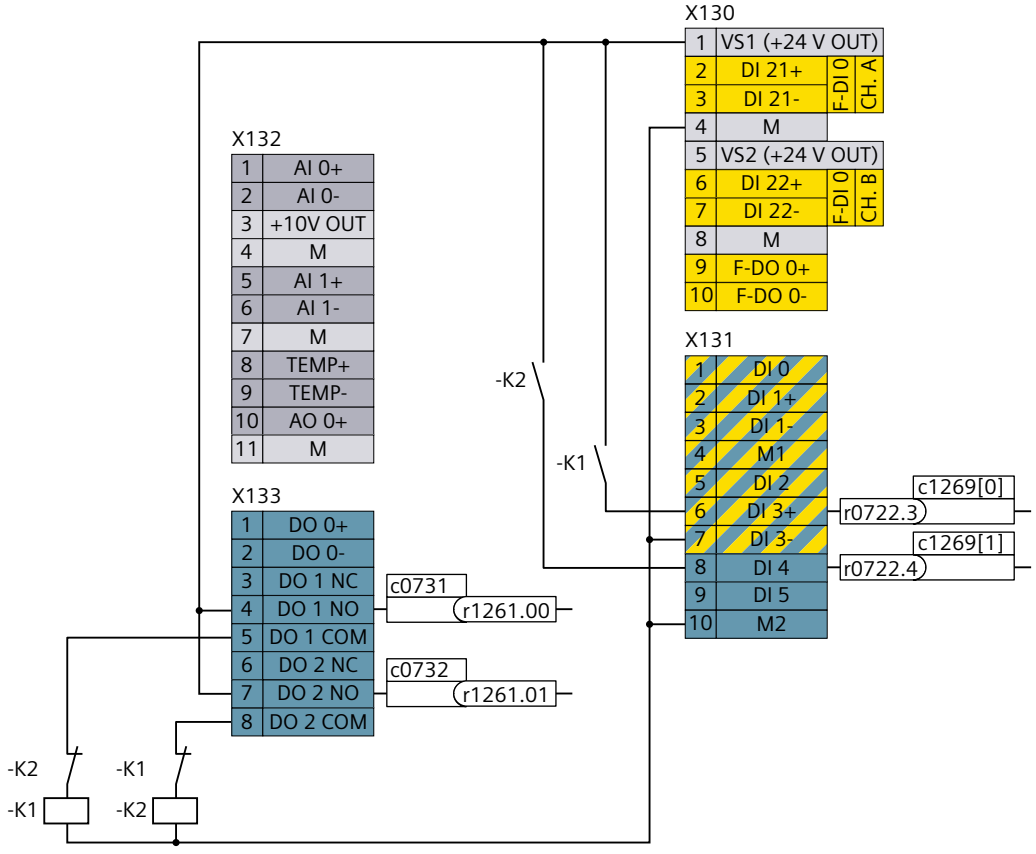
Switchover phase from line (DOL) operation to converter operation:

1. The converter waits for the time p1263 to expire.
2. The converter opens the motor - line supply breaker (K2)
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is open.
3. If voltage measurement is selected with p1270.5 = 1, the converter waits for the time p1274[1].
   If voltage measurement is deselected with p1270.5 = 0, the converter waits for the time p1274[1] + the motor de-excitation time p1262.

4. The converter closes the switch - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is closed.
5. The converter performs a flying restart of the motor. The output frequency of the converter synchronizes with the motor speed.
   If the "Flying restart" function is deactivated, the motor coasts down and the converter outputs alarm A07314.

Example

The figure below shows an example of the wiring of the converter and the internal interconnections of the inputs and outputs.



K1 Motor - power unit breaker
K2 Motor - line supply breaker

Figure 13-252 Wiring for the "Bypass without line synchronization" function

Parameters

The following list contains the parameters of function "Bypass without line synchronization".

Number	Name	Unit
p1260	Bypass configuration	-

r1261.0...17	Bypass control/status word	-
p1262[0...n]	Bypass dead time	s
p1263	Debypass delay time	s
p1264	Bypass delay time	s
p1265	Bypass speed threshold	rpm
c1266	Bypass control command	-
p1267.0...1	Bypass changeover source configuration	-
c1268	Bypass feedback synchronization completed	-
c1269[0...1]	Bypass switch feedback signal	-
p1274[0...1]	Bypass switch monitoring time	ms

13.13.19.2 Bypass with line synchronization without overlap

Overview

The "Bypass with line synchronization without overlap " function switches the motor between converter and line (DOL) operation. The line synchronization before switching minimizes the torque-free time of the motor and the torque surges to the load machine.

Precondition

NOTICE

Mechanical damage caused by reversal of the direction of rotation

When switching over from converter operation to line (DOL) operation, if the phase sequence at the converter power output and the phase sequence of the line supply do not match, then the motor reverses in the opposite direction of rotation when connected directly to the line supply. When connected to the line supply, the high torques when reversing and the possible inadmissible direction of rotation can result in mechanical damage to the plant or machine.

- Check that the same phase sequence is present at the motor both when breaker K1 is closed and when breaker K2 is closed.
- Check that at the Voltage Sensing Module (VSM10) (X521/X522: U, V, W) the same phase sequence is available as at the motor.
  For Clean Power converters, the phase sequence must be the same at the line connection X1:L1 ... L3 and the motor.

NOTICE

Material damage caused by switching over too early

If a feedback signal from either of the two breakers "Motor - power unit" (K1) and "Motor - line supply " (K2) does not always match the state of the corresponding breaker, then a breaker may close prematurely. Premature closing can damage the breaker or damage the system or machine.

- Only use breakers whose feedback signals always correctly reflect the status of the breaker.
- Wire the feedback signal with a digital input of the converter.
- Interconnect the feedback signal with binary signal sink c1269.

The "Bypass with line synchronization without overlap" function has the following preconditions:

- The converter contains an OM-DQ that establishes a DRIVE-CLiQ connection to a Voltage Sensing Module (VSM10).
  For Clean Power converters, neither OM-DQ nor a VSM10 is required.
- The converter operates an induction motor.
- The induction motor can be operated directly on the line supply.
- Even for line (DOL) operation of the motor, the converter remains connected to the line supply.
- Parameter p0112 "Sampling times presetting p0115" has the factory setting.
- Parameter p1800 "Pulse frequency setpoint" is in the factory setting.
- Function "Sync-line-drive" is active (p3800 = 1).
- It is recommended that the "Flying restart" function be enabled (p1200 = 1 or 4).
  Function "Flying restart" minimizes no-torque pauses during switchover phases

Function description

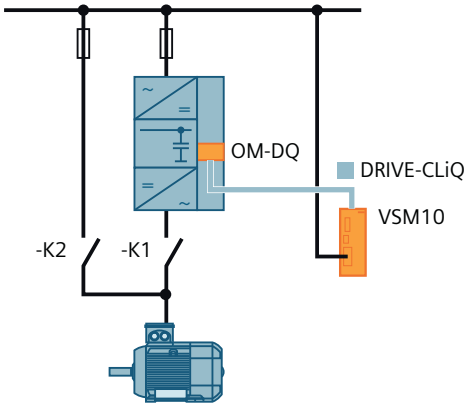


Figure 13-253 Converter bypassed by the motor - line supply breaker (K2)

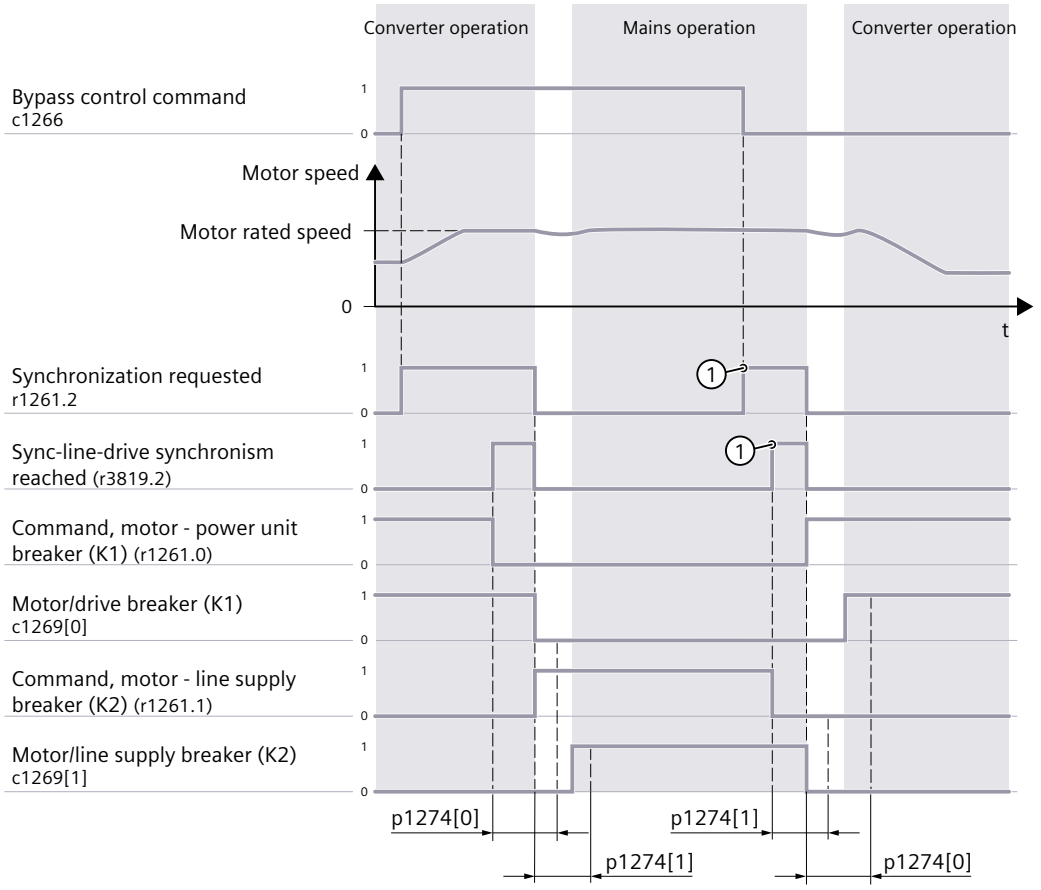
With the binary signal sink "Bypass control command" c1266 = 1 signal, the converter synchronizes its power output with the line and switches the motor from converter operation to line (DOL) operation:

- The motor - power unit breaker (K1) opens.
- The motor - line supply breaker (K2) closes.

With the binary signal sink "Bypass control command" c1266 = 0 signal, the converter synchronizes its power output with the line and switches the motor from line (DOL) operation to converter operation:

- The motor - line supply breaker (K2) opens.
- The motor - power unit breaker (K1) closes.

An active "Flying restart" function allows a switch to be made to converter operation even if line synchronization is possibly defective.



① Only when function "Flying restart" is activated: p1200 = 1 or 4

Figure 13-254 Bypass with line synchronization without overlap

Switchover phase from converter operation to line (DOL) operation:

1. c1266 changes from 0 signal to 1 signal.
2. The converter synchronizes the motor with the line supply.
   If a synchronization error occurs, an insufficient motor voltage can be the cause.
   A reduced flux, e.g. as the efficiency optimization is active, results in a reduced motor voltage. As a consequence, depending on the load, it is possible that the motor voltage is not sufficient to accelerate the motor up to the line frequency. The following functions influence the available motor voltage:
   - Efficiency optimization
     p1401.14 = 0 signal deactivates efficiency optimization.
   - Speed-dependent flux
     p1401.30 = 0 signal deactivates the speed-dependent flux.
3. When synchronism is reached, the converter switches off its power unit and opens the motor - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is open.

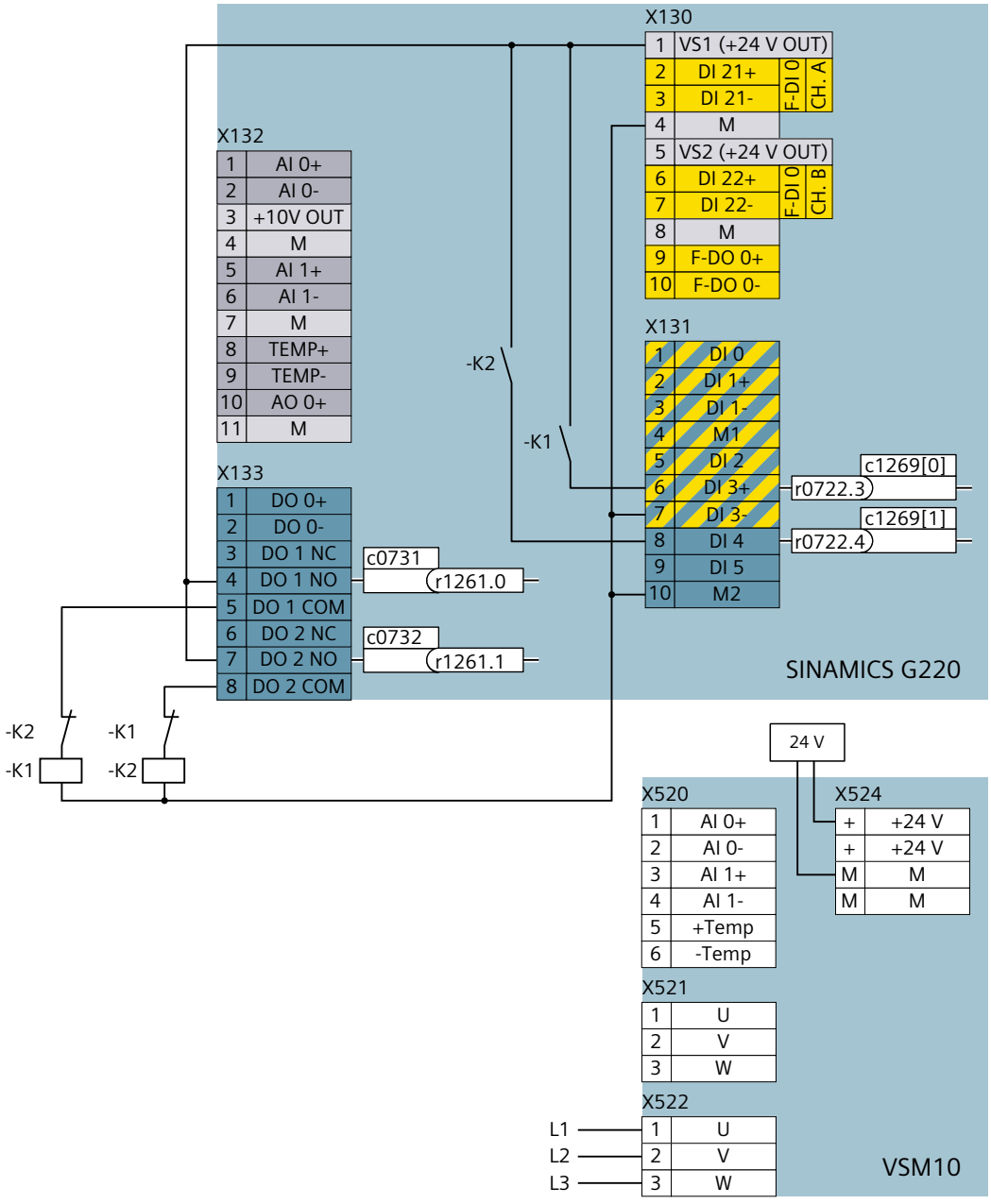
4. When the motor - power unit breaker (K1) is opened, the converter closes the motor - line supply breaker (K2).
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is closed.
5. The motor is in line (DOL) operation.

Switchover phase from line (DOL) operation to converter operation:

1. c1266 changes from 1 signal to 0 signal.
2. The converter synchronizes the power output with the line.
3. When synchronism is reached, the converter opens the motor - line supply breaker (K2).
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is open.
4. When the motor - line supply breaker (K2) is opened, the converter closes the motor - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is closed.
5. The motor is in converter operation.

Example

The figure below shows an example of the wiring of the Voltage Sensing Module, the converter and the internal interconnections of the inputs and outputs.



K1	Motor - power unit breaker
K2	Motor - line supply breaker
VSM10	Voltage Sensing Module for determining the line voltage. Not required for Clean Power converters

Figure 13-255 Wiring for the "Bypass with line synchronization without overlap" function

13.13.19.3 Bypass with line synchronization and overlap

Overview

The "Bypass with line synchronization and overlap" function switches the motor between converter and line (DOL) operation without any interruption. Switching without interruption prevents a speed fluctuation regardless of the moment of inertia of the load machine.

Precondition

NOTICE

Mechanical damage caused by reversal of the direction of rotation

When switching over from converter operation to line (DOL) operation, if the phase sequence at the converter power output and the phase sequence of the line supply do not match, then the motor reverses in the opposite direction of rotation when connected directly to the line supply. When connected to the line supply, the high torques when reversing and the possible inadmissible direction of rotation can result in mechanical damage to the plant or machine.

- Check that the same phase sequence is present at the motor both when breaker K1 is closed and when breaker K2 is closed.
- Check that at the Voltage Sensing Module (VSM10) (X521/X522: U, V, W) the same phase sequence is available as at the motor.
  For Clean Power converters, the phase sequence must be the same at the line connection X1:L1 ... L3 and the motor.

NOTICE

Material damage caused by switching over too early

If a feedback signal from either of the two breakers "Motor - power unit" (K1) and "Motor - line supply " (K2) does not always match the state of the corresponding breaker, then a breaker may close prematurely. Premature closing can damage the breaker or damage the system or machine.

- Only use breakers whose feedback signals always correctly reflect the status of the breaker.
- Wire the feedback signal with a digital input of the converter.
- Interconnect the feedback signal with binary signal sink c1269.

NOTICE

Drive system overload as a result of an excessively tolerant ground-fault monitoring

If a synchronization error occurs in the switchover phase from converter operation to line (DOL) operation, it can be helpful to increase the shutdown threshold of function "Ground-fault monitoring". For an excessively high shutdown threshold, it is possible that the converter does not detect a ground fault. An undetected ground fault can overload the converter and the motor, therefore causing damage.

- Before you increase the shutdown threshold of function "Ground-fault monitoring", carefully evaluate the risk and the effects of a fault to ground in your system or machine.

The "Bypass with line synchronization and overlap" function has the following preconditions:

- The converter contains an OM-DQ that is connected to a Voltage Sensing Module (VSM10) via DRIVE-CLiQ.
  For Clean Power converters, neither OM-DQ nor a VSM10 is required.
- A reactor with uk = 8% ... 10%, referred to the rated value of the converter output current is installed between the power output and the motor.
  The reactor is dimensioned for the highest occurring current.
- The converter operates an induction motor.
- The induction motor can be operated directly on the line supply.
- Even for line (DOL) operation of the motor, the converter remains connected to the line supply.
- Parameter p0112 "Sampling times presetting p0115" has the factory setting.
- Parameter p1800 "Pulse frequency setpoint" is in the factory setting.
- The "Sync-line-drive" function is enabled (p3800 = 1).
- It is recommended that the "Flying restart" function be enabled (p1200 = 1 or 4).
  Function "Flying restart" increases operational ruggedness in switchover phases.

Function description

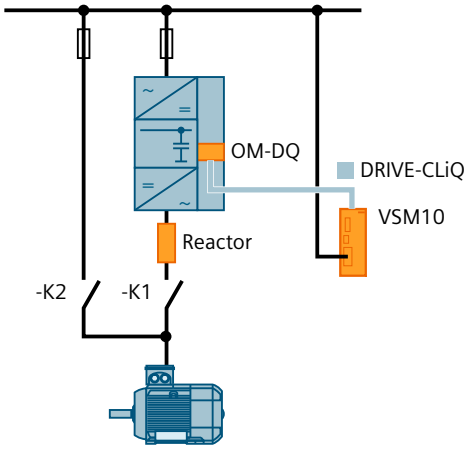


Figure 13-256 Converter bypassed by the motor - line supply breaker (K2)

With the binary signal sink "Bypass control command" c1266 = 1 signal, the converter synchronizes its power output with the line and switches the motor from converter operation to line (DOL) operation:

- The motor - power unit breaker (K1) opens.
- The motor - line supply breaker (K2) closes.

With the binary signal sink "Bypass control command" c1266 = 0 signal, the converter synchronizes its power output with the line and switches the motor from line (DOL) operation to converter operation:

- The motor - power unit breaker (K1) closes.
- The motor - line supply breaker (K2) opens.

An active "Flying restart" function allows a switch to be made to converter operation even if line synchronization is possibly defective.

When function "Flying restart" is active, a no-torque pause can occur in the switchover phase.

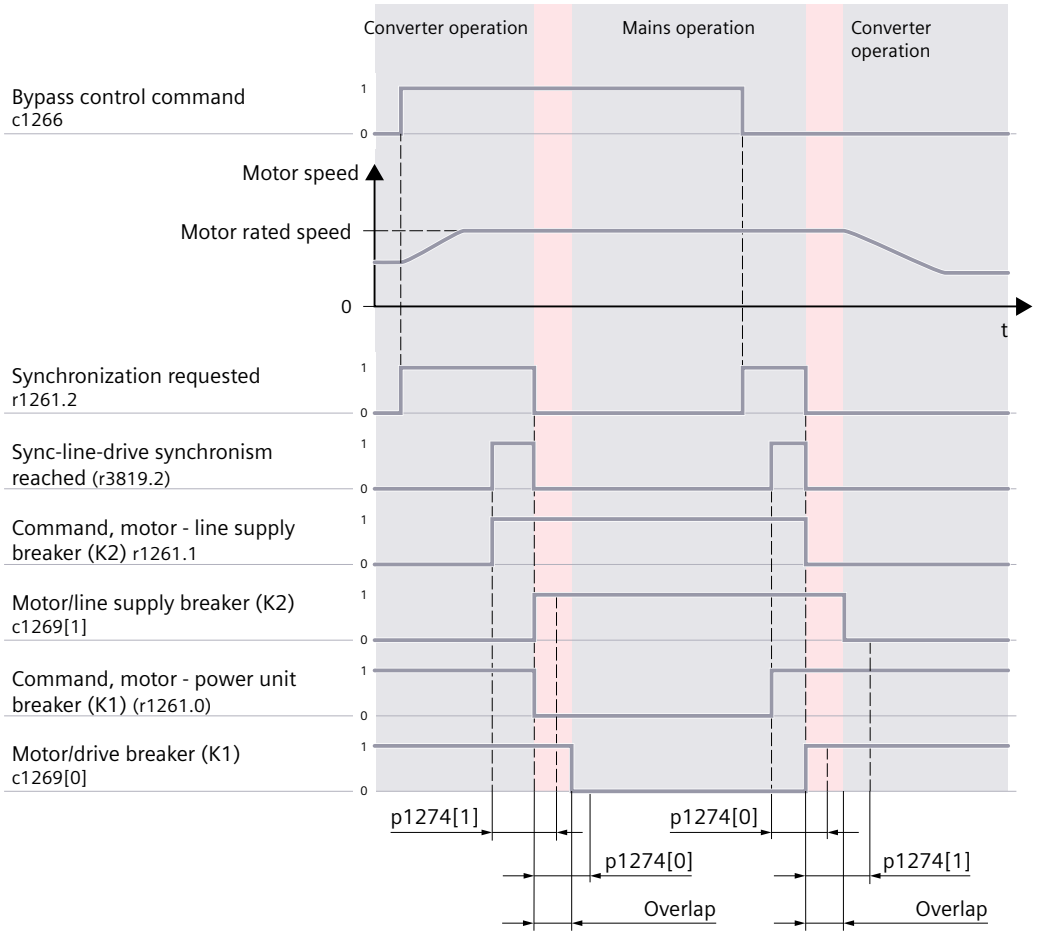


Figure 13-257 Bypass with line synchronization and overlap

Switchover phase from converter operation to line (DOL) operation:

1. c1266 changes from 0 signal to 1 signal.
2. The converter synchronizes the motor with the line supply.
   If a synchronization error occurs, an insufficient motor voltage can be the cause.
   A reduced flux, e.g. as the efficiency optimization is active, results in a reduced motor voltage. As a consequence, depending on the load, it is possible that the motor voltage is not sufficient to accelerate the motor up to the line frequency. The following functions influence the available motor voltage:
   - Efficiency optimization
     p1401.14 = 0 signal deactivates efficiency optimization.
   - Speed-dependent flux
     p1401.30 = 0 signal deactivates the speed-dependent flux.

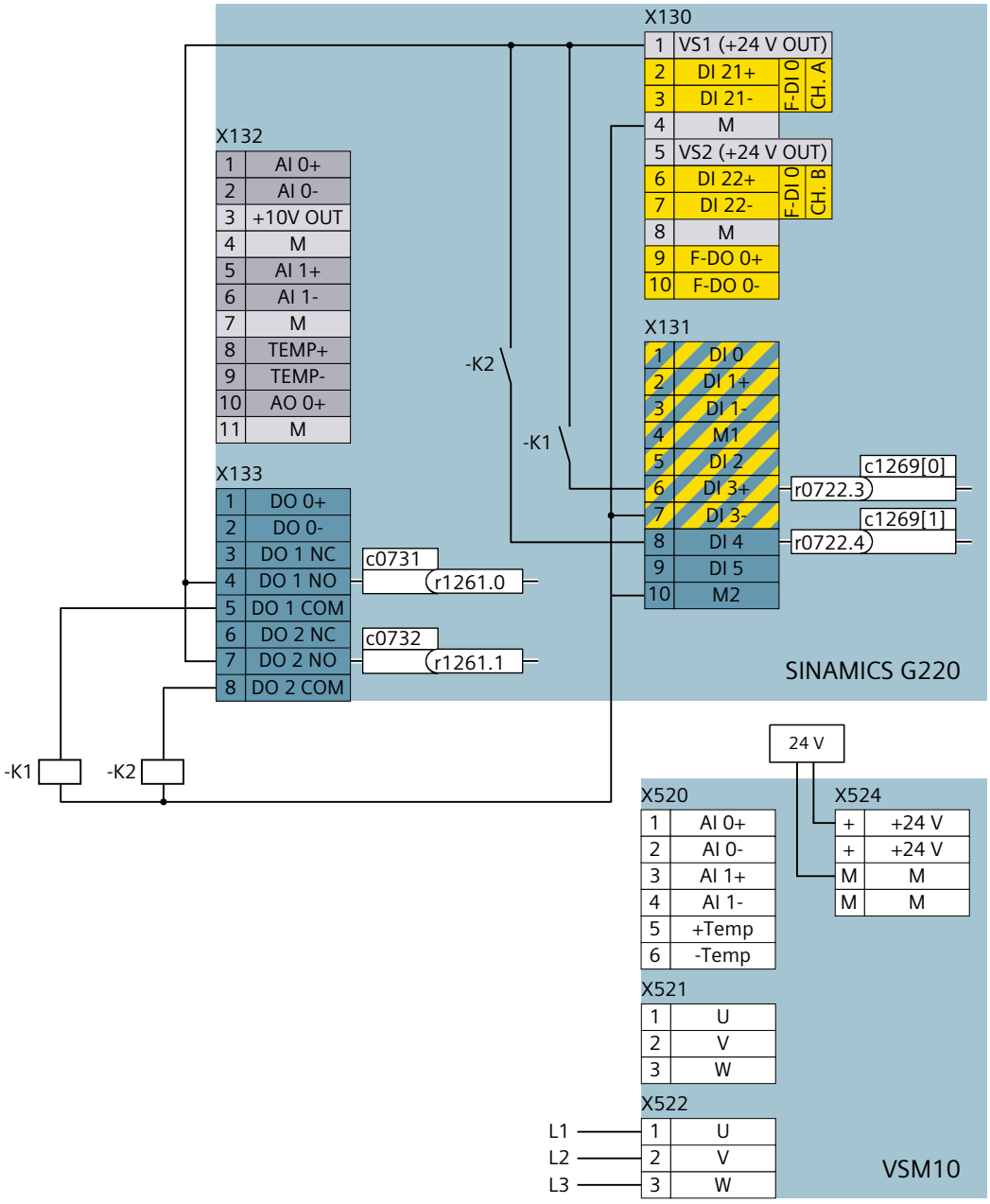
3. When synchronism is reached, the converter closes the motor - line supply breaker (K2).
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is closed.
   The motor - line supply breaker (K2) and also the motor - power unit breaker (K1) are closed.
   Converter operation and line (DOL) operation overlap.
   The equalizing current when switching K2 can cause the ground-fault monitoring to respond and result in a fault. In this case, a fault can be avoided by carefully increasing shutdown threshold. The following parameters define the shutdown threshold of the ground fault monitoring:
   - p0287[1]
   - For Clean Power converters p0287[1] and p13287[1]
4. When the motor - line supply breaker (K2) is closed, the converter switches off its power unit and opens the motor - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is open.
5. The motor is in line (DOL) operation.

Switchover phase from line (DOL) operation to converter operation:

1. c1266 changes from 1 signal to 0 signal.
2. The converter synchronizes the power output with the line.
3. When synchronism is reached, the converter closes the motor - power unit breaker (K1).
   p1274[0] is the maximum time for the feedback signal indicating that the motor - power unit breaker (K1) is closed.
   The motor - line supply breaker (K2) and also the motor - power unit breaker (K1) are closed.
   Converter operation and line (DOL) operation overlap.
4. When the motor - power unit breaker (K1) is closed, the converter opens the motor - line supply breaker (K2).
   p1274[1] is the maximum time for the feedback signal indicating that the motor - line supply breaker (K2) is open.
5. The motor is in converter operation.

Example

The figure below shows an example of the wiring of the Voltage Sensing Module, the converter and the internal interconnections of the inputs and outputs.



K1	Motor - power unit breaker
K2	Motor - line supply breaker
VSM10	Voltage Sensing Module for determining the line voltage. Not required for Clean Power converters

Figure 13-258 Wiring for the "Bypass with line synchronization and overlap" function

Parameters

The following list contains the parameters of the "Bypass with line synchronization with and without overlap" function.

Number	Name	Unit
p0287[0...1]	Ground fault monitoring shutdown threshold	%
p1260	Bypass configuration	-
r1261.0...17	Bypass control/status word	-
c1266	Bypass control command	-
c1268	Bypass feedback synchronization completed	-
c1269[0...1]	Bypass switch feedback signal	-
p1274[0...1]	Bypass switch monitoring time	ms
p1401[0...n].0...30	Flux control configuration	-
r3661[0]	VSM input line voltage u1 - u2	V
r3662[0]	VSM input line voltage u2 - u3	V
p3800[0...n]	Motor-line synchronization activation	-
p3800[0...n]	Motor-line synchronization activation	-
c3802[0...n]	Motor-line synchronization enable	-
r3803.0	Motor-line synchronization control word	-
r3804	Motor-line synchronization target frequency	Hz
r3805	Motor-line synchronization frequency difference	Hz
p3806[0...n]	Motor-line synchronization frequency difference threshold value	Hz
r3808	Motor-line synchronization phase difference	°
p3809[0...n]	Motor-line synchronization phase setpoint	°
p3811[0...n]	Motor-line synchronization frequency limiting	Hz
r3812	Motor-line synchronization correction frequency	Hz
p3813[0...n]	Motor-line synchronization phase synchronism threshold value	°
r3814	Motor-line synchronization voltage difference	Vrms
p3815[0...n]	Motor-line synchronization voltage difference threshold value	%
p3818[0...n]	Motor-line synchronization time limiting	s
r3819.0...8	Motor-line synchronization status word	-
r6319[0...1]	Infeed line supply voltage phase-to-phase	V
p13287[0...1]	Infeed ground fault monitoring shutdown threshold	%

13.13.20 Pulse frequency wobble

Overview

Function "Pulse frequency wobbulation" avoids mechanical resonance in the motor and therefore reduces the noise emitted by the motor.

In addition, the function reduces conducted electromagnetic interference by distributing the energy of pulse frequency over a wide spectrum.

Precondition

No sine-wave filter is installed at the converter output: Drive, filter type on the motor side p0230 < 3.

The setpoint of the pulse frequency is ≤ the frequency, which is obtained from the current controller sampling time: p1800 ≤ 1 000 / p0115[0].

Function description

The converter activates pulse frequency wobbulation with p1810.02 = 1 signal.

When pulse frequency wobbulation is activated, a noise generator varies the pulse frequency of the power unit around the average value of the setpoint pulse frequency p1800.

The converter automatically corrects the current measurement fault, which occurs as a result of asynchronous pulse and control sampling times.

Parameter p1811[0...n] specifies the amplitude of the pulse frequency wobbulation.

When pulse frequency wobbulation is deactivated, the converter sets parameter p1811 = 0.

Example

The following applications are typically suitable for pulse frequency wobbulation:

- Systems for heating, ventilation or climate control
- Pumps and fans

Parameters

The following list contains the parameters of function "Pulse frequency wobbulation".

Number	Name	Unit
p0115[0...6]	Sampling times for internal control loops	µs
p1800[0...n]	Pulse frequency setpoint	kHz
p1810.0...15	Modulator configuration	-
p1811[0...n]	Pulse frequency wobbulation amplitude	%

13.14 Safety Integrated

13.14.1 Machinery directive

Overview

The basic safety and health requirements specified in Annex I of the Directive must be fulfilled for the safety of machines.

Description

The protective goals must be implemented responsibly to ensure compliance with the Directive.

Manufacturers of a machine must verify that their machine complies with the basic requirements. This verification is facilitated by means of harmonized standards.

IEC 61800-5-2 Adjustable-speed electrical power drive systems Part 5-2 is relevant for the Machinery Directive: Safety requirements - Functional safety.

Within the context of EN 61508, IEC 61800-5-2 considers adjustable-speed electrical power drive systems (PDS), which are suitable for use in safety-related applications (PDS(SR)).

IEC 61800-5-2 places requirements on PDS(SR) as subsystems of a safety-related system. This therefore permits the implementation of the electrical/electronic/programmable electronic elements of a PDS(SR) taking into account the safety-relevant performance of the safety function(s) of a PDS.

Manufacturers and suppliers of PDS(SR) can prove to users (e.g. integrators of control systems, developers of machines and plants etc.) the safety-relevant performance of their equipment by implementing the specifications stipulated in standard IEC 61800-5-2.

In the machinery directive, a drive system is designated as power drive system (PDS).

13.14.2 Functional safety

Overview

A system or machine is considered functionally safe if the safety-relevant parts of the protection and control equipment function correctly.

Description

Safety, from the perspective of the object to be protected, cannot be split-up. The causes of danger and therefore also the technical measures to prevent them can vary widely. This is why a differentiation is made between different types of safety (e.g. by specifying the cause of possible hazards). "Functional safety" is involved if safety depends on the correct function.

To ensure the functional safety of a system or machine, the safety-related parts of the protection and control devices must function correctly. In the case of a fault, systems must respond in such a way that either the plant remains in a safe state or it is brought into a safe state. In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to implement functional safety are based on the following basic objectives:

- Avoiding systematic faults
- Controlling random faults or failures

Determining whether an adequate level of functional safety has been achieved is based on the following criteria:

- The probability of hazardous failures
- The fault tolerance
- The quality by avoiding systematic faults

As a consequence, specific classifications are included in the standards:

- Standards IEC 61800-5-2 and IEC 62061 define the "Safety Integrity Level" (SIL).
- Standard ISO 13849-1 defines "Category" and "Performance Level" (PL).

13.14.3 Safety Integrated Functions

Overview

Safety Integrated Functions are used to reduce risk in safety-related applications.

Precondition

⚠ WARNING

Unsafe operation as a result of inadequate measures applied to minimize risk

Safety Integrated can reduce the level of risk associated with systems and machines. If the machine OEM complies with the following, then the system or machine can be safely operated with Safety Integrated:

- The machine OEM precisely knows the safety instructions and residual risks specified in the technical user documentation and complies with the documented constraints for Safety Integrated.
- Correctly designs and engineers the system or machine. A careful and thorough acceptance test must then be performed by qualified personnel and the results documented.
- Implements and validates all the measures required in accordance with the system or machine risk analysis using programmed and configured Safety Integrated Functions or in other ways.
- The use of Safety Integrated does not replace the risk assessment of the system or machine by the machine manufacturer as specified by the EU Machinery Directive.
  In addition to using Safety Integrated Functions, additional risk reduction measures must be implemented.

⚠ WARNING

Unsafe machine operation due to unsafe parameterization of the stop functions

Death or severe injuries can occur if stop functions are inappropriately configured.

- Configure the time stages of the stops corresponding to the application with the lowest possible value.

⚠ WARNING

Uncontrolled acceleration as a result of a fault in the closed-loop control

The following closed-loop control faults cause the spindle or axis to accelerate in an uncontrolled fashion:

- Fault in the absolute track (C-D track)
- Interchanged phases of the motor connections (V-W-U instead of U-V-W).
- Interchanged control sense
- Missing pole position identification

Closed-loop control faults prevent stop functions, categories 1 and 2 according to EN 60204 1, and can therefore result in death or severe injuries.

- Ensure that the closed-loop control functions correctly.

⚠ WARNING

Extended stopping distances due to stop response faults

After the set transition or delay time has elapsed, the converter initiates stop function category 0 according to EN 60204 1. If SBR/SAM is active, the converter detects this fault and initiates stop function category 0 according to EN 60204 1 at the earliest possible opportunity independent of the delay time. Electrical faults (e.g. defective components) may also lead to the faults listed above. The extended stopping distances can result in death or serious injuries as a result of unsuitable protective clearances.

- Check the parameterization.

⚠ WARNING

Movement within the tolerances of the protective functions

When a protective function is active, movement takes place within the parameterized tolerance. Stopping is initiated as a result of the tolerance being exceeded. SS1 does not guarantee controlled stopping in each state of the machine, which means that uncontrolled movement can occur that can result in death or severe injuries.

- Increase the safety clearances.

⚠ WARNING

Unexpected automatic start of the motor

An EMERGENCY STOP must stop the motor involved according to stop category 0 or 1 according to EN 60204-1 using Safety Integrated Functions STO or SS1.

Dangerous operating states can occur if the motor automatically starts when the EMERGENCY STOP is reset.

- After stopping according to stop Category 0 or 1, avoid that the motor automatically starts again.
- If the risk analysis permits it, the motor may automatically start after deselecting a Safety Integrated Function for motion monitoring. An automatic start is possible when a protective door is closed, for example.

⚠ WARNING

Undesirable motor motion after changing the hardware or software

Unsafe operating states can occur after changing or replacing hardware or software components. Persons must not be present in the hazardous area.

- Close all protective devices after changing or replacing.
- Depending on whether a change or replacement was carried out, perform either a reduced or a complete acceptance test.
- Before you enter the hazardous area, test all drives by briefly moving them in both directions of motion to ensure that the closed-loop response is stable.

⚠ WARNING

Unexpected machine movement after switching on the supply voltage

When the supply voltage is switched on, the Safety Integrated Functions cannot be selected immediately afterwards. The Safety Integrated Functions can only be selected after the system has completely run-up. As a consequence, there is an increased risk of an accident while the system runs-up. Persons must not be present in the hazardous area. Accidents can result in death or severe injuries.

- Close all protective devices before the system runs up.

⚠ WARNING

Unsafe operation as encoder monitoring is deactivated

Deactivated or incorrectly parameterized hardware and software monitoring functions of the encoder can result in unsafe operating states.

- Activate the encoder monitoring functions in the Sensor Module.
- Carefully parameterize the encoder monitoring functions.
- Depending on the fault type and the responding monitoring function, activate stop function category 0 or 1 according to EN 60204-1.

⚠ WARNING

Unexpected motor movements due to manipulated connecting cables

The manipulation of the connecting cables can cause unexpected motor movements in a machine or plant. Particularly in machines or plants in which Safety Integrated Functions are used to minimize risks, manipulation can result in serious personal injury or death.

- Prevent unauthorized access to the converter, for example by using a lockable control cabinet.
- Protect the cables inside and outside the control cabinet against manipulation by taking one of the following measures:
  - Sheathe the cables to the motors, encoders and sensors.
  - Route the cables in empty conduits.

⚠ WARNING

Unexpected machine movement after inserting a memory card

If a memory card without Safety Integrated Functions is inserted in the converter instead of a memory card with active Safety Integrated Functions, then deactivate the Safety Integrated Functions when the supply voltage is switched on the next time. Deactivated Safety Integrated Functions or Safety Integrated Functions that have not been adapted can trigger unexpected machine movements that may result in serious injury or death.

- Only insert a memory card with the required settings into the converter.
- Prevent unauthorized persons from accessing the converter.
- Protect configurations with active Safety Integrated Functions against changes by assigning roles using user management (UMAC).

⚠ WARNING

Speed or position overshoot for short-term upper limit violation

When the upper limit is violated, between detection and response, higher speeds than are set can briefly occur. Depending on the drive dynamic performance and the entered parameters, the specified position may be overshot by a smaller or larger amount.

- Design your machine appropriately.

⚠ WARNING

Stopping if a pole position identification has not been performed

Without performing a pole position identification, controlled stopping cannot be ensured, e.g. via OFF3 or as stop request initiated by a drive safety function, which can result in severe injuries or death.

- Perform a PollD.
- When protection equipment is open and pole position identification has not been performed, carefully ensure that the pulses are canceled.

⚠ WARNING

Additional residual risks

Safety Integrated is only activated if all of the system components are switched on and have been run-up.

Faults in the absolute track (C-D track), cyclically interchanged phases of motor connections (V-W-U instead of U-V-W), reversal in the control or direction or missing pole position ID can cause the spindle speed to accelerate or the axis to move. Category 1 and 2 stop functions according to EN 60204-1 (defined as STOP B to E in Safety Integrated) that are provided, are however not effective due to the fault. Uncontrolled movement of machine parts can result in severe injury or death.

- Wait until the converter has completely run out before going into operation.

Note

Fault of Safety Integrated Functions in the case of non-EMC-compliant installation

A non-EMC-compliant installation of your machine/system can result in sporadic faults in Safety Integrated Functions.

- Install the drive so that it is EMC-compliant.

Note

Protection against manipulation by unauthorized third parties

Safety Integrated Functions protect against hardware and software faults, but not against manipulation by unauthorized third parties.

Protective measures against unauthorized manipulation are described in the Startdrive Operating Instructions and online help. The measures address the following issues:

- Parameter configuration of Safety Integrated Functions
- Connection
- Hardware components

Note

Resetting safety messages

Withdrawing and inserting components in operation can result in a reset of safety messages.

Description

In comparison to standard converter functions, Safety Integrated Functions have an especially high degree of fail-safety. The Performance Level (PL) and Safety Integrity Level (SIL) of the corresponding standards are a measure of fail-safety.

Safety Integrated Functions are accordingly suitable for reducing risk in safety-related applications. If the risk analysis of the machine or the system indicates a special hazard potential in the application, an application is safety-related.

Safety Integrated means that the functions are integrated into the converter and can be executed without need of external components.

The converter performs a cyclic data comparison of the monitoring channels and identifies limit value violations of Safety Integrated Functions. Faults that are detected result in a safety message with a subsequent stop response.

The Safety Integrated Functions are in conformance with the following standards:

- Safety Integrity Level (SIL) 2 or 3 according to IEC 61800-5-2
- Performance Level (PL) e acc. to ISO 13849-1

13.14.4 Certification

Description

Safety Integrated Functions correspond to the functions according to IEC 61800-5-2.

Table 13-118 Certifications of Safety Integrated components

Converter	SIL	PL	Category
Control via PROFIsafe	SIL 3	PL e	Category 4
Control via F-DI	SIL 3	PL e	Category 3 or 4 [1]
Stop functions	SIL 3	PL e	Category 4
Motion monitoring	SIL 3	PL e	Category 3
Safe Motor Temperature (SMT)	SIL 2	PL d	Category 3

[1] depending on the parameterized self-test of the fail-safe digital input

Safety properties when using an encoder

All safety functions that require an encoder, only achieve the safety properties (SIL, PL, Cat), that the encoder actually supports.

13.14.5 PFH values

Description

The probability of failure for Safety Integrated Functions must be specified in the form of a PFH value (probability of failure per hour) according to IEC 61800-5-2, IEC 62061 and ISO 13849-1. The PFH value of a Safety Integrated Function depends on the safety concept of the converter and its hardware configuration, as well as on the PFH values of other components used for this Safety Integrated Function.

More information

The PFH values can be found under: PFH values (https://support.industry.siemens.com/cs/ww/en/view/76254308)

You can map the PFH values of all Safety Integrated components from Siemens using the "Safety evaluation" function in the TIA selection tool: Safety evaluation (www.siemens.com/tia)

13.14.6 Usage time when using Safety Integrated Functions

Requirement

⚠ WARNING

Unexpected motor response when the service life is exceeded

If the service life is exceeded, the probability of failure of the Safety Integrated Functions increases. This can result in unexpected motor movement and as a consequence can cause accidents involving death or severe injury.

- Take the converter out of service once the service life has been exceeded.

Description

The safety parameters of Safety Integrated Functions are applicable for a usage time of 20 years.

13.14.7 EMERGENCY OFF and EMERGENCY STOP

Overview

In plants, systems and machines a distinction must be made between EMERGENCY OFF and EMERGENCY STOP.

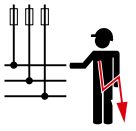
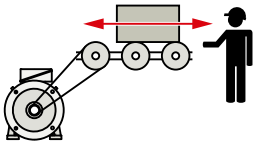
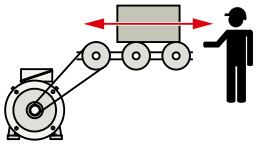
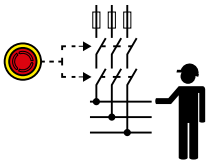
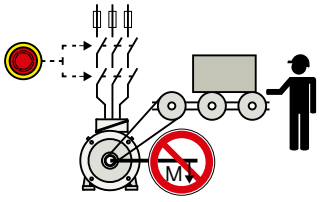
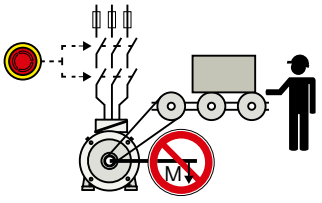
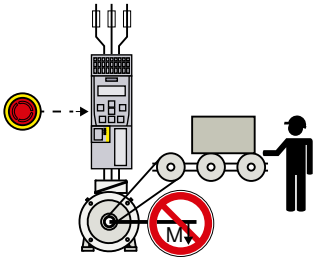
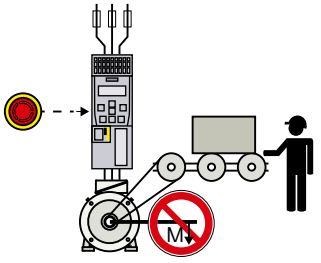
The Safe Torque Off (STO) and Safe Stop 1 (SS1) Safety Integrated Functions are suitable for implementing an EMERGENCY STOP, but are not suitable for implementing an EMERGENCY OFF.

Function description

IEC 60204-1 defines EMERGENCY OFF and EMERGENCY STOP:

- EMERGENCY OFF and EMERGENCY STOP are actions taken in an emergency.
- EMERGENCY OFF and EMERGENCY STOP reduce different risks in a system or machine:
  - EMERGENCY OFF reduces the risk of electric shock.
  - EMERGENCY STOP reduces the risk of unexpected movement.

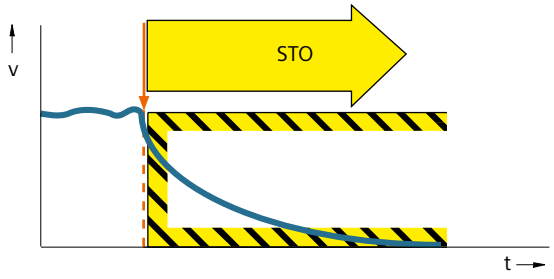
Table 13-119 The distinction between EMERGENCY OFF and EMERGENCY STOP

Action:	**EMERGENCY OFF**	**EMERGENCY STOP** **Stop category 0 according to IEC 60204-1**	**EMERGENCY STOP** **Stop category 1 according to IEC 60204-1**
Risk:	 Electric shock	 Unexpected motion	 Motion
Measure to minimize risk:	**Switch off voltage** Switch off hazardous voltages completely or in part	**Prevent movement** Prevent any hazardous movement	**Stop movement** Stop hazardous movement and prevent any restart.
Classic solution:	Switch off the voltage: 	Switch off the power supply of the drive: 	 Brake the motor and switch off the drive power supply
Solution with the STO or SS1 Safety Integrated Function integrated in the drive:	STO and SS1 are not suitable for switching off an electric voltage.	Select STO: 	Select SS1: 
		If the motor is stationary, then you may also switch off the converter power supply. However, switching off the voltage is not required as a risk-reduction measurement.	

13.14.8 Stop functions

13.14.8.1 Safe Torque Off (STO)

Overview



The Safe Torque Off (STO) function prevents the torque-generating supply of energy to the motor and prevents the motor from unexpectedly starting.

Precondition

STO is enabled in the function selection.

⚠ WARNING

Unexpected motor movement through active Safe Torque Off

When the Safe Torque Off (STO) function is active, then the motor can move unexpectedly, e.g. a suspended load can accelerate the motor. Unexpected movements can lead to damage to material damage, risk to persons, severe injury, and death.

- Take account of the way the Safe Torque Off (STO) function works when you perform risk assessments of the machine or system.
- Prevent movements of the motor, for example by using a holding brake.

Function description

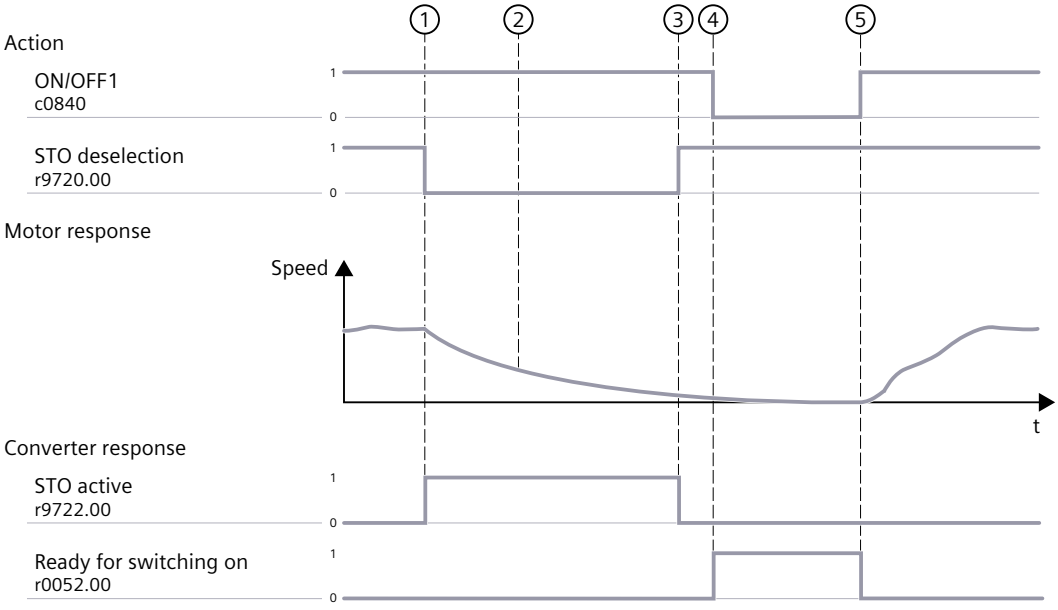


Figure 13-259 Flow diagram STO

Action		Motor / converter response
①	Selection of STO	• The converter detects selection of STO and signals the status "STO active" (r9722.00). • The converter interrupts the torque-generating energy feed to the motor. • The power unit and motor are not electrically isolated. • The "switching on inhibited" status prevents the motor from restarting automatically.
②	Coast down	• The motor coasts down to a standstill.
③	Deselection of STO	• The converter detects deselection of STO.
④	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.
⑤	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

Example

Applications include all machines and systems with moving axes (for example, conveyor technology, handling).

With STO, maintenance work on the machine with an open protective door is possible, for example. An EMERGENCY STOP with electromechanical disconnection is not required.

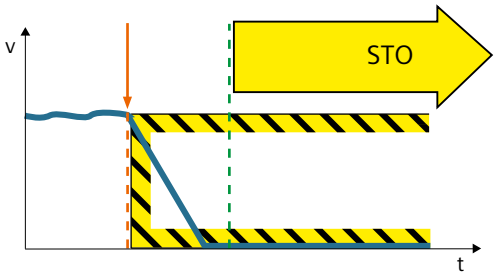
Parameters

The following list contains the parameters of the "Safe Torque Off (STO)" function.

Number	Name	Unit
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10352.0...17	SI STO select cause	-

13.14.8.2 Safe Stop 1 (SS1)

Overview



Safe Stop 1 (SS1) stops a dangerous movement of a machine component.

Precondition

SS1 is released in the function selection.

⚠ WARNING

Unexpected motor movement through active Safe Torque Off

There may be unexpected motor movements if the Safe Torque Off (STO) function is active. For instance, the motor can coast down to a standstill or a hanging load may accelerate the motor. Unexpected movements can lead to damage to property, risk to persons, severe injury and death.

- Consider the functionality of the SS1 function in the risk assessment of the machine or plant.
- Prevent movements of the motor, for example by using a holding brake.

Function description

With Safe Stop 1 (SS1), the converter stops a dangerous movement of an electrically driven machine component. After stopping, the Safe Torque Off (STO) function prevents the machine component from restarting.

Table 13-120 Function variants

Abbreviation	Brief description
SS1-t	Safe Stop 1 with time control
SS1-a	Safe Stop 1 with acceleration monitoring (SAM)
SS1-r	Safe Stop 1 with braking ramp monitoring (SBR)

Example

Table 13-121 SS1 application example

Example	Possible solution
A converter must brake a motor as quickly as possible after the EMERGENCY STOP pushbutton has been actuated. It is not permissible that the stationary motor undesirably restarts.	Select SS1 via a fail-safe signal or via PROFIsafe.

13.14.8.3 Safe Stop 1 with time control (SS1-t)

Overview

With SS1-t, the converter stops the motor along the parameterized OFF3 down ramp. After a delay time elapses, irrespective of the actual speed, the converter activates the Safe Torque Off (STO) function.

Function description

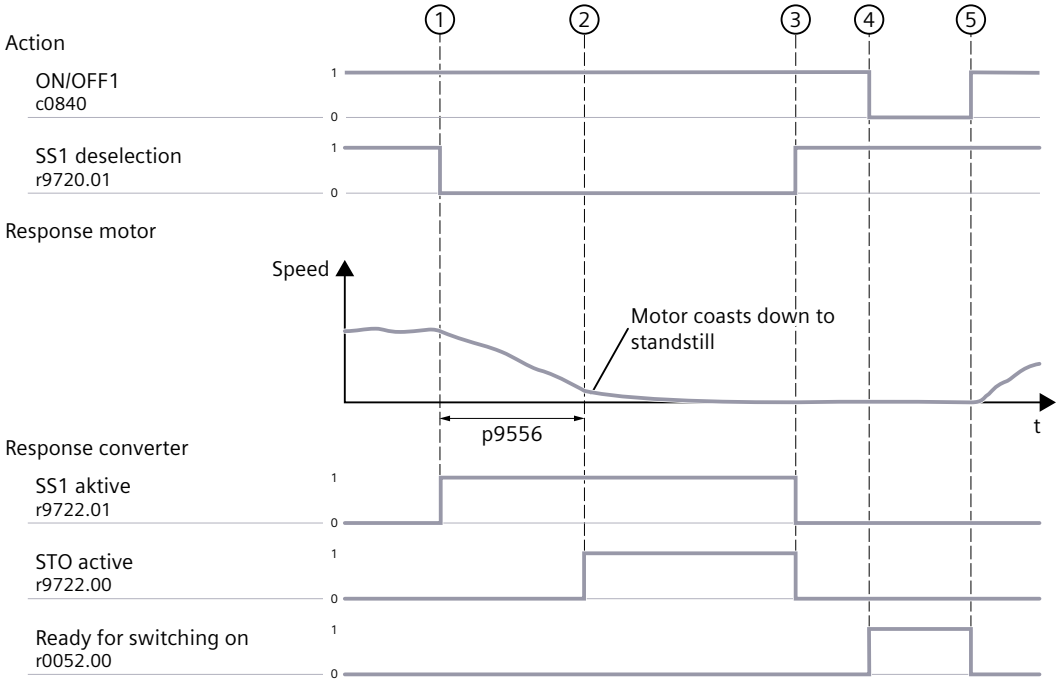


Figure 13-260 Flow diagram Safe Stop 1 with time control (SS1-t)

Action		Motor / converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.01). • The converter starts the transition time SS1 to STO (p9556). • The converter stops the motor with the OFF3 ramp-down time. Stopping with the OFF3 ramp-down time is not monitored. • Deselecting SS1 after the time ① does not interrupt the stopping of the motor.
②	Transition to STO	• The transition time from SS1 to STO (p9556) has elapsed. • The converter activates STO and signals status "STO active" (r9722.00) and status "SS1 active". • The converter activates STO even if SS1 is deselected in the meantime. • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from restarting. • The motor coasts down to a standstill.
③	Deselection of SS1	• The converter detects when SS1 is deselected. • The converter deactivates STO.
④	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.
⑤	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

Parameters

The following list contains the parameters of the "Safe Stop 1 with time control (SS1-t)" function.

Number	Name	Unit
p9556	SI transition time SS1 to STO	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10353.0...17	SI SS1 select cause	-

13.14.8.4 Setting the SS1 transition time for SS1-t and SS1-a

Description

Select the SS1 transition time so that the higher-level control stops the motor before the torque is shut down with STO, and if parameterized, the motor holding brake can close. The OFF3 ramp-down time must be oriented to the actual braking capacity of the system or machine.

Set the SS1 transition time as follows:

With parameterized motor holding brake

SS1 transition time (p9556) ≥ OFF3 ramp-down time (p1135) + pulse cancellation delay time (p1228) + motor holding brake closing time (r1217)

Without parameterized motor holding brake

SS1 transition time (p9556) ≥ OFF3 ramp-down time (p1135) + pulse cancellation delay time (p1228)

13.14.8.5 Safe Stop 1 with acceleration monitoring (SS1-a)

Overview

SS1-a with Safe Acceleration Monitor (SAM) monitors whether or not the motor inadmissibly accelerates when braking. After the defined time interval has elapsed or the speed falls below the defined shutdown velocity, Safe Torque Off (STO) becomes active.

Function description

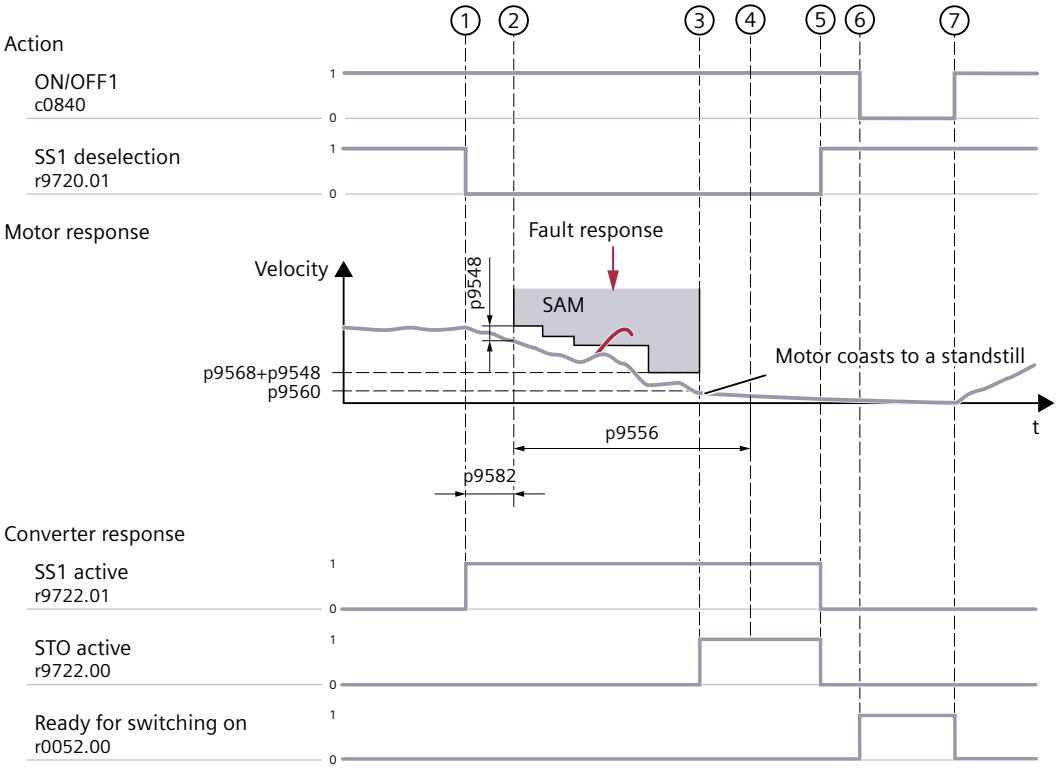


Figure 13-261 Flow diagram Safe Stop 1 with acceleration monitoring (SS1-a)

Action		Motor / converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.01). • The converter starts the transition time SS1 to STO (p9556) and the SAM delay time (p9582). • The converter stops the motor with the OFF3 ramp-down time. • Deselecting SS1 after the time ① does not interrupt the stopping of the motor.
②	Braking with the OFF3 ramp-down time with SAM monitoring	• The SAM delay time elapses. With SAM, the converter monitors whether the motor impermissibly accelerates. • The SAM monitoring follows the motor velocity as it decreases: The converter reduces the SAM monitoring step-by-step when the following applies: Absolute value of the motor velocity + p9548 < previous SAM monitoring It is not possible to increase the SAM monitoring. • If the motor velocity exceeds the SAM monitoring, then the converter signals a fault and activates STO. • If the motor velocity reaches the SAM limit value (p9568), then the converter limits the value for the SAM monitoring to p9568 + p9548.

③	Transition to STO	• The SAM monitoring is exited if the transition time from SS1 to STO (p9556) elapses or if the following applies: Motor velocity < STO shutdown velocity (p9560) • The converter activates STO. • The converter activates STO even if SS1 is deselected in the meantime. • The converter signals status "STO active" (r9722.00). • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from unexpectedly restarting. • The motor coasts down to a standstill.
④	Latest possible transition to STO	• The drive now activates STO if the motor velocity has still not fallen below the STO shutdown velocity (p9560).
⑤	Deselection of SS1	• The converter detects when SS1 is deselected. • The converter deactivates STO.
⑥	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.
⑦	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

Parameters

The following list contains the parameters of the "Safe Stop 1 with acceleration monitoring (SS1-a)" function.

Number	Name	Unit
p9548	SI SAM velocity tolerance	mm/min
p9548	SI SAM velocity tolerance	rpm
p9556	SI transition time SS1 to STO	ms
p9560	SI STO shutdown velocity	mm/min
p9560	SI STO shutdown velocity	rpm
p9568	SI SAM velocity limit	mm/min
p9568	SI SAM velocity limit	rpm
p9582	SI SAM/SBR delay time for SS1 and SS2	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10353.0...17	SI SS1 select cause	-

13.14.8.6 Safe Stop 1 with braking ramp monitoring (SS1-r)

Overview

With SS1-r, while braking, the converter monitors whether the speed of the motor remains below a defined ramp using Safe Brake Ramp monitoring (SBR). The converter activates Safe Torque Off (STO) after a defined shut down speed has been fallen below.

Function description

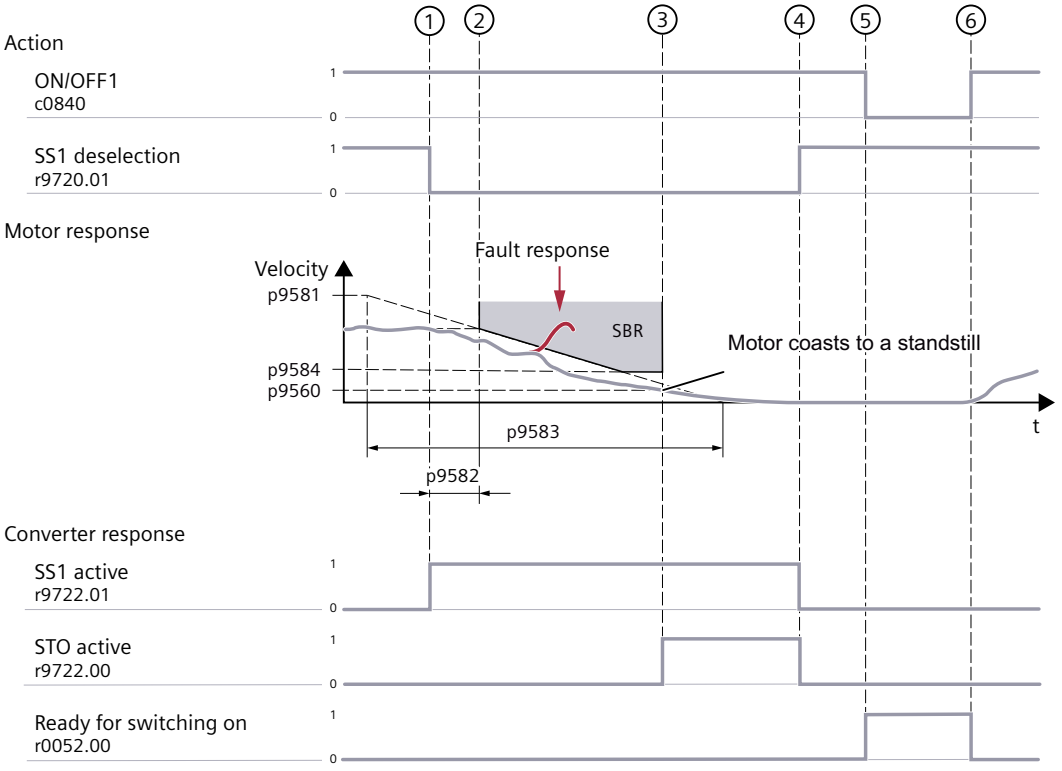


Figure 13-262 Flow diagram Safe Stop 1 with braking ramp monitoring (SS1-r)

Action		Motor / converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.01). • The converter stops the motor with the OFF3 ramp-down time. • Deselecting SS1 after the time ① does not interrupt the stopping of the motor. • The converter starts the SBR delay time p9582.
②	Braking with SBR monitoring	• The SBR delay time has elapsed. • The converter starts the SBR monitoring. SBR monitoring starts with the velocity actual value at time ①. p9583 and p9581 define the gradient of the SBR monitoring. • The SBR velocity limit (p9584) defines the minimum value of the SBR monitoring. Braking continues. • The converter monitors whether the motor exceeds the set safe OFF3 ramp-down time when braking. • The converter signals a fault if the motor speed violates the SBR monitoring.

③	Transition to STO	• SBR ends as soon as the speed actual value is below the STO shutdown speed (p9560) or the SBR monitoring was violated. • The converter activates STO. • The converter activates STO even if SS1 is deselected in the meantime. • The converter signals status "STO active" (r9722.00). • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from unexpectedly restarting. • The motor coasts down to a standstill.
④	Deselection of SS1	• The converter detects when SS1 is deselected. • The converter deactivates STO.
⑤	Signal change at ON/ OFF1 from 1 to 0	• The converter is ready to start again.
⑥	Signal change at ON/ OFF1 from 0 to 1	• The motor starts again.

Parameters

The following list contains the parameters of the "Safe Stop 1 with braking ramp monitoring (SS1-r)" function.

Number	Name	Unit
p9560	SI STO shutdown velocity	mm/min
p9560	SI STO shutdown velocity	rpm
p9581	SI SBR reference velocity for SS1 and SS2	mm/min
p9581	SI SBR reference velocity for SS1 and SS2	rpm
p9582	SI SAM/SBR delay time for SS1 and SS2	ms
p9583	SI SBR reference time for SS1 and SS2	s
p9584	SI SBR velocity limit	mm/min
p9584	SI SBR velocity limit	rpm
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10353.0...17	SI SS1 select cause	-

13.14.8.7 Safe Stop 1 with external stop

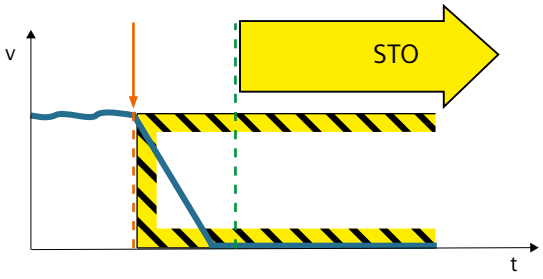
Overview

⚠ WARNING

Unexpected motor movement through active Safe Torque Off

There may be unexpected motor movements if the Safe Torque Off (STO) function is active. For instance, the motor can coast down to a standstill or a hanging load may accelerate the motor. Unexpected movements can lead to damage to property, risk to persons, severe injury and death.

- Consider the functionality of the SS1 function in the risk assessment of the machine or plant.
- Prevent movements of the motor, for example by using a holding brake.



Function description

The function "Safe Stop 1 with external stop" (SS1E) initiates the function "Safe Torque Off" (STO) after a predefined time interval has elapsed. The higher-level controller determines the braking reaction. A higher-level fail-safe controller detects the selection of SS1E via PROFIsafe. A higher-level non-fail-safe controller detects the selection of SS1E from the Safety Info Channel (SIC). During the delay time, SS1E cannot be deselected by withdrawing the control command, therefore fulfilling the requirements of EN 60204-1 relating to an EMERGENCY-STOP function in stop Category 1.

Table 13-122 Function variants

Abbreviation	Brief description
SS1E-t	Safe Stop 1 with external stop with time control
SS1E-a	Safe Stop 1 with external stop with acceleration monitoring (SAM)
SS1E-r	Safe Stop 1 with external stop with brake ramp monitoring (SBR)

Applications

Safe Stop 1 with external stop (SS1E) is suitable for use with drive line-ups where drives independently brake with the OFF3 ramp-down time detrimental to the application.

Drive groups are drives that are coupled through material, for example.

13.14.8.8 Safe Stop 1 with external stop with time control (SS1E-t)

Overview

When safety function SS1E-t is used, the motor is stopped by the user program of a higher-level control system. When selecting SS1E-t, the converter starts a safety-relevant delay time. Using an appropriate user program, the higher-level control system must stop the motors involved within the safety-relevant delay time. After the safety-relevant delay time has elapsed, the converter activates the STO function and safely interrupts the energy supply to the motor (independent of the actual speed).

Description of function

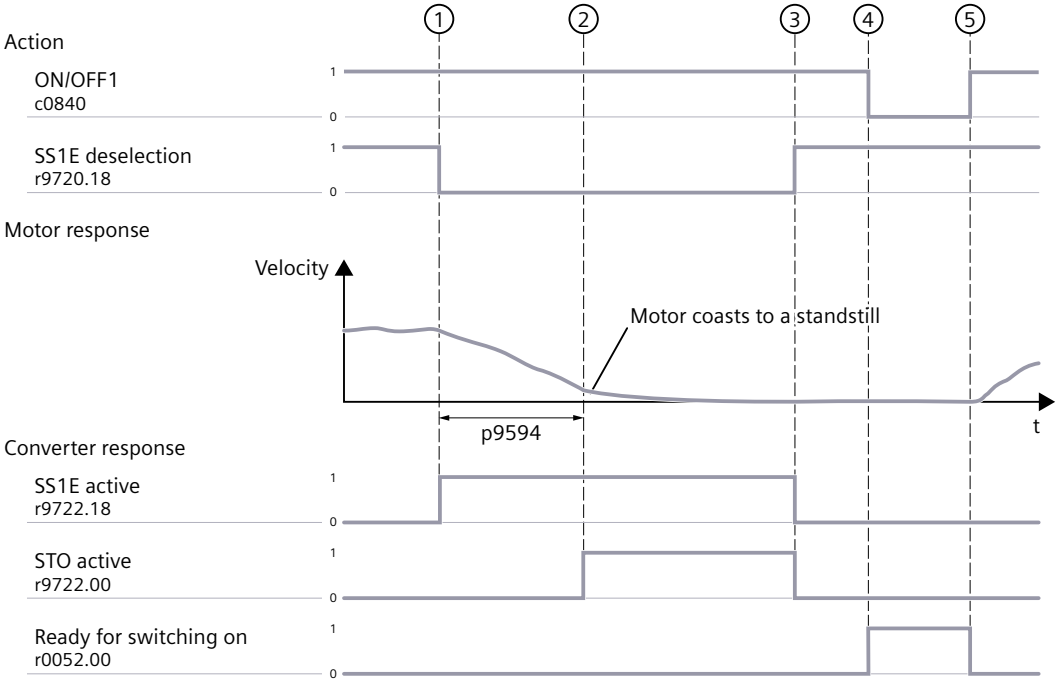


Figure 13-263 Description of function: SS1 with external stop (SS1E-t)

	Action	Response motor / controller
1	Selection of SS1E	• The converter detects when SS1E is selected and signals status "SS1E active" (r9722.18 and r9743.03). • The converter starts the transition time SS1E to STO (p9594). • The control system initiates stopping using the external setpoint input. • If SS1E is deselected within the delay time, the drive selects and deselects the STO function after the delay time has elapsed or after falling below the switch-off speed. • SS1E is terminated normally and cannot be interrupted.

②	Transition to STO	• The transition time SS1E to STO (p9594) elapses. • The converter activates STO and signals status "STO active" (r9722.00 and r9734.00). SS1E active remains active. • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from restarting. • The motor coasts down to a standstill.
③	Deselection of SS1E	• The converter detects when SS1E is deselected. • The converter deactivates STO.
④	Signal change at ON/ OFF1 from 1 to 0	• The converter is ready to start again.
⑤	Signal change at ON/ OFF1 from 0 to 1	• The motor starts again.

Parameters

The following list contains the parameters of the "Safe Stop 1 with external time control (SS1E-t)" function.

Number	Name	Unit
p9594	SI transition time SS1E to STO	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-
r9743.3...9	SI Safety Information Channel status word S_ZSW2B	-
r10370.0...13	SI SS1E select cause	-

13.14.8.9 Setting the SS1E transition time for SS1E-t and SS1E-a

Description

Select the SS1E transition time so that the higher-level control stops the motor before the torque is shut down with STO, and if parameterized, the motor holding brake can close. The braking time must be oriented to the actual braking capacity of the system or machine.

Set the SS1E transition time as follows:

With parameterized motor holding brake

SS1E delay time (p9594) ≥ braking time + pulse cancellation delay time (p1228) + motor holding brake closing time (r1217)

Without parameterized motor holding brake

SS1E transition time (p9594) ≥ braking time + pulse cancellation delay time (p1228)

13.14.8.10 Safe Stop 1 with external stop with acceleration monitoring (SS1E-a)

Overview

With SS1E-a, the higher-level control stops the motor via the user program. With Safe Acceleration Monitor (SAM) the converter monitors whether or not the motor inadmissibly accelerates when braking. After the delay time elapses or the defined shutdown velocity is fallen below, the converter activates the Safe Torque Off (STO) function.

Function description

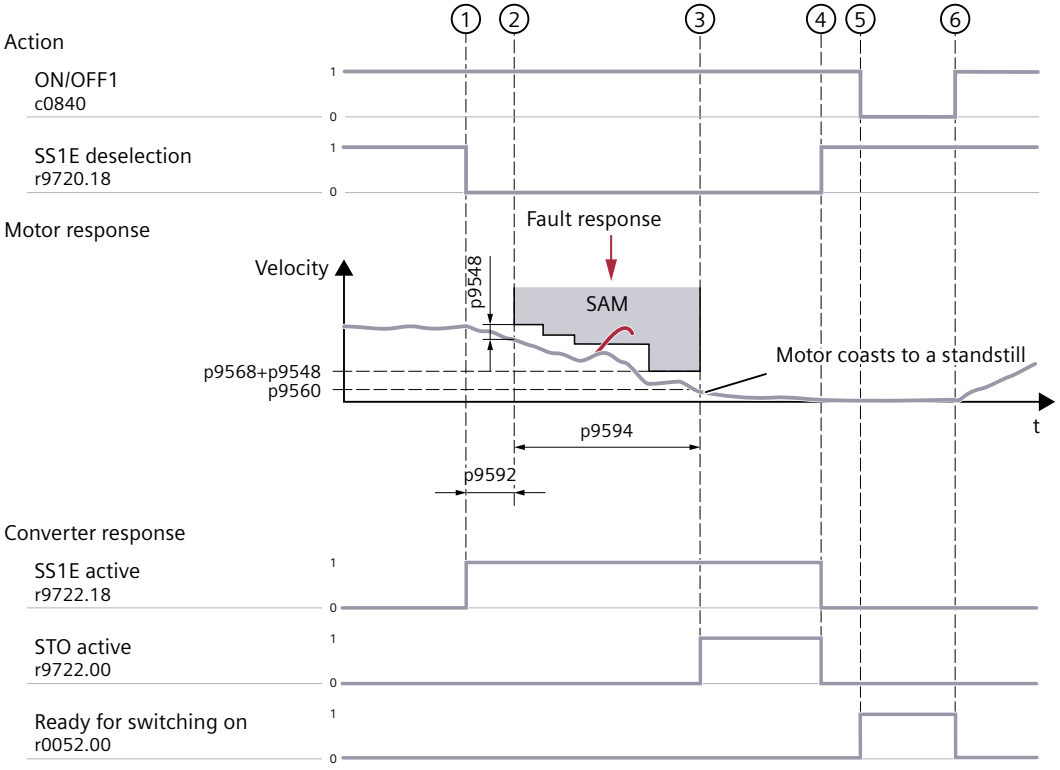


Figure 13-264 Function description: SS1E with SAM

Action		Motor / drive response
①	Selection of SS1E	• The converter detects when SS1E is selected and signals status "SS1E active" (r9722.18 and r9743.03). • The drive starts the transition time SS1E to STO (p9594) and the SAM delay time (p9592). • The higher-level control initiates the stopping process via the external setpoint input.

②	Braking with OFF3 ramp-down time with SAM monitoring	• The SAM delay time elapses. With SAM, the converter monitors whether the motor impermissibly accelerates. • The SAM monitoring follows the motor velocity as it decreases: The converter reduces the SAM monitoring step-by-step when the following applies: Absolute value of the motor velocity + p9548 < previous SAM monitoring It is not possible to increase the SAM monitoring. • If the motor velocity exceeds the SAM monitoring, then the converter signals a fault and activates STO. • If the motor velocity reaches the SAM limit value (p9568), then the converter limits the value for the SAM monitoring to p9568 + p9548.
③	Transition to STO	• SAM ends when the motor velocity falls below the STO shutdown velocity (p9560) or the SS1E to STO (p9594) transition time expires. STO is then activated. • The drive identifies when STO is selected and signals status "STO active" (r9722.00 and r9734.00). SS1E still remains active. • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from unexpectedly restarting. • The motor coasts down to a standstill.
④	Deselection of SS1E	• The converter detects when SS1E is deselected. STO is simultaneously deactivated.
⑤	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.
⑥	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

Parameters

The following list contains the parameters of function "Safe Stop 1 with external stop with acceleration monitoring (SS1E-a)".

Number	Name	Unit
p9548	SI SAM velocity tolerance	mm/min
p9548	SI SAM velocity tolerance	rpm
p9560	SI STO shutdown velocity	mm/min
p9560	SI STO shutdown velocity	rpm
p9568	SI SAM velocity limit	mm/min
p9568	SI SAM velocity limit	rpm
p9592	SI SAM/SBR delay time for SS1E and SS2E	ms
p9594	SI transition time SS1E to STO	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9743.3...9	SI Safety Information Channel status word S_ZSW2B	-
r10370.0...13	SI SS1E select cause	-

13.14.8.11 Safe Stop 1 with external stop with brake ramp monitoring (SS1E-r)

Overview

When function SS1E-r is active, the motor is stopped via the user program of a higher-level control system. The converter monitors whether the motor velocity remains below the Safe Brake Ramp monitoring (SBR). The converter activates the Safe Torque Off (STO) function after the specified shutdown velocity is fallen below.

Function description

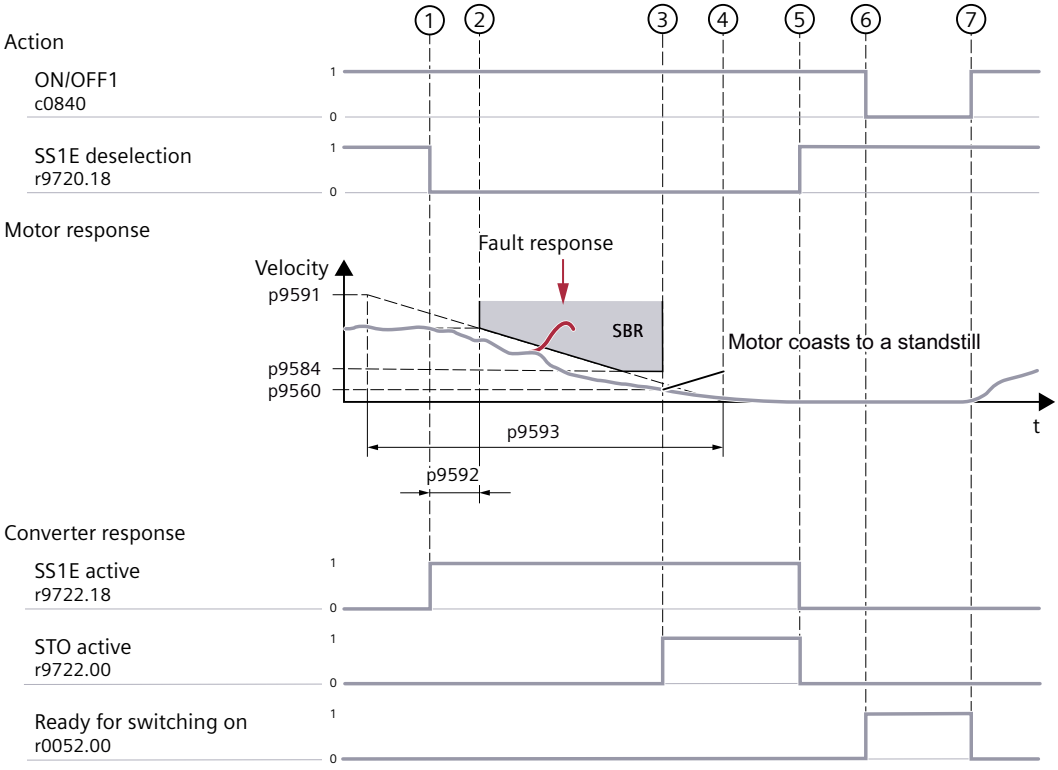


Figure 13-265 Function description: SS1E with SBR

Action		Motor/drive response
(1)	Selection of SS1E	• The drive identifies when SS1E is selected and signals status "SS1E active" (r9722.18 and r9743.03). • The higher-level control issues the setpoint to stop the motor. • The drive starts the SBR delay time (p9592).

②	Braking with SBR monitoring	• The SBR delay time elapses. • The drive initiates monitoring of motor velocity with SBR. • If the velocity of the motor is greater than the SBR monitoring, the converter reacts with a stop. • The SBR velocity limit (p9584) defines the minimum value of the SBR monitoring. Braking continues. • The converter signals a fault if the motor speed violates the SBR monitoring.
③	Transition to STO	• SBR ends as soon as the speed actual value is below the STO shutdown speed (p9560) or the SBR monitoring was violated. • The converter activates STO and signals status "STO active" (r9722.00 and r9734.00). SS1E still remains active. • STO interrupts the torque-generating supply of energy to the motor and prevents the motor from unexpectedly restarting. • The motor coasts down to a standstill.
④	Latest possible transition to STO	• The drive now activates STO if the motor velocity has still not fallen below the STO shutdown velocity (p9560).
⑤	Deselection of SS1E	• The drive detects when SS1E is deselected and activates STO.
⑥	Signal change at ON/OFF1 from 1 to 0	• The drive is again ready to start.
⑦	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

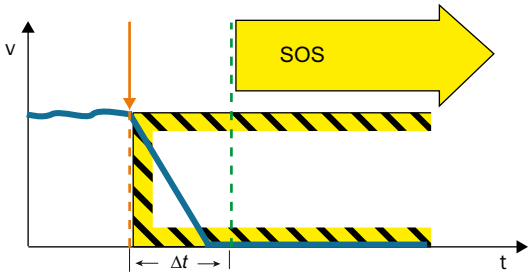
Parameters

The following list contains the parameters of function "Safe Stop 1 with external stop with brake ramp monitoring (SS1E-r)".

Number	Name	Unit
p9560	SI STO shutdown velocity	mm/min
p9560	SI STO shutdown velocity	rpm
p9584	SI SBR velocity limit	mm/min
p9584	SI SBR velocity limit	rpm
p9591	SI SBR reference velocity for SS1E and SS2E	mm/min
p9591	SI SBR reference velocity for SS1E and SS2E	rpm
p9592	SI SAM/SBR delay time for SS1E and SS2E	ms
p9593	SI SBR reference time for SS1E and SS2E	s
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-
r9743.3...9	SI Safety Information Channel status word S_ZSW2B	-
r10370.0...13	SI SS1E select cause	-

13.14.8.12 Safe Stop 2 (SS2) - overview

Overview



Function "Safe Stop 2 (SS2)" brings the motor to a standstill, keeps the motor active at the standstill position and monitors the standstill position using function "Safe Operating Stop (SOS)". SS2 corresponds to stop category 2 according to EN 60204-1.

The following function variants are available:

Abbreviation	Brief description
SS2-t	Safe Stop 2 with time-controlled activation of SOS
SS2-a	Safe Stop 2 with safe acceleration monitoring (SAM)
SS2-r	Safe Stop 2 with safe brake ramp monitoring (SBR)

If the higher-level control issues the speed setpoint, when function SS2 is active, then the specified speed setpoint and the actual speed value of the motor differ. The speed difference must not lead to a fault response of the higher-level control, which would interrupt function SS2 and, as a consequence, the independent braking process of the motor.

13.14.8.13 Safe Stop 2 with time control (SS2-t)

Overview

When function SS2-t is selected, the converter stops the motor along the OFF3 ramp. After the delay time elapses, irrespective of the actual velocity, the converter activates the Safe Operating Stop (SOS) function.

Function description

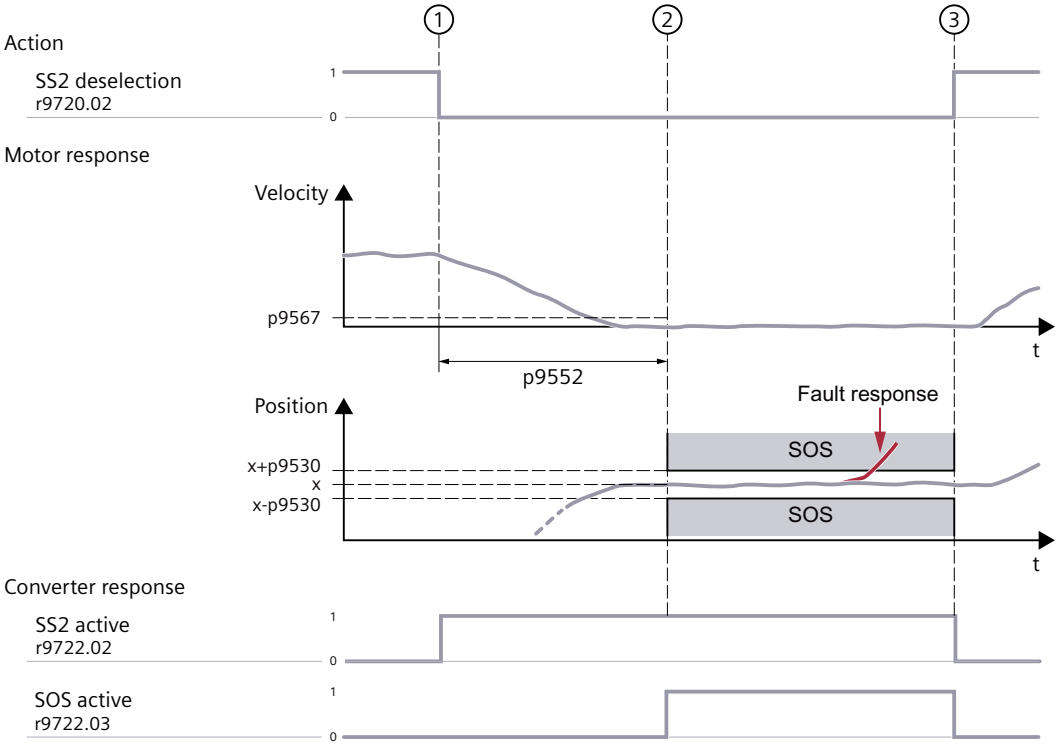


Figure 13-266 Function description: SS2 with time control

	Action	Motor / converter response
1	Selection of SS2	• The converter detects selection of SS2 and signals status "SS2 active" (r9722.02). • The converter starts the transition time SS2 to SOS (p9552). • The converter stops the motor along the OFF3 ramp. Stopping along the OFF3 ramp is not monitored. • The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567). The converter activates SOS if one of the transition times (p9569 or p9552) has elapsed.
2	Transition to SOS	• The transition time SS2 to SOS (p9552) elapses. • The converter activates SOS and signals status "SOS active" (r9722.03) and status "SS2 active" (r9722.02). • Function SOS safely monitors standstill of the motor using the standstill tolerance (p9530). The motor closed-loop control remains active. • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
3	Selection of SS2	• The converter detects when SS2 is deselected and signals status "SS2 not active" and "SOS not active". • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of the "Safe Stop 2 with time control (SS2-t)" function.

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9552	SI transition time SS2 to SOS	ms
r9722.0...28	SI status signals	-
r10354.0...13	SI SS2 select cause	-
r10472.0...13	SI SS2E select cause channel B	-

13.14.8.14 Setting the SS2 transition time

Description

Select the SS2 transition time so that before SOS is activated, the motor can completely ramp down along the OFF3 ramp. The OFF3 ramp-down time must be oriented to the actual braking capacity of the system or machine.

Set the SS2 transition time as follows:

SS2 transition time (p9552) ≥ OFF3 ramp-down time (p1135)

13.14.8.15 Safe Stop 2 with acceleration monitoring (SS2-a)

Overview

When function SS2-a is selected, the converter stops the motor along the OFF3 ramp. With Safe Acceleration Monitor (SAM) the converter monitors whether or not the motor inadmissibly accelerates when braking. When the switchover velocity is fallen below or after the delay time elapses, the converter activates the Safe Operating Stop (SOS) function.

Function description

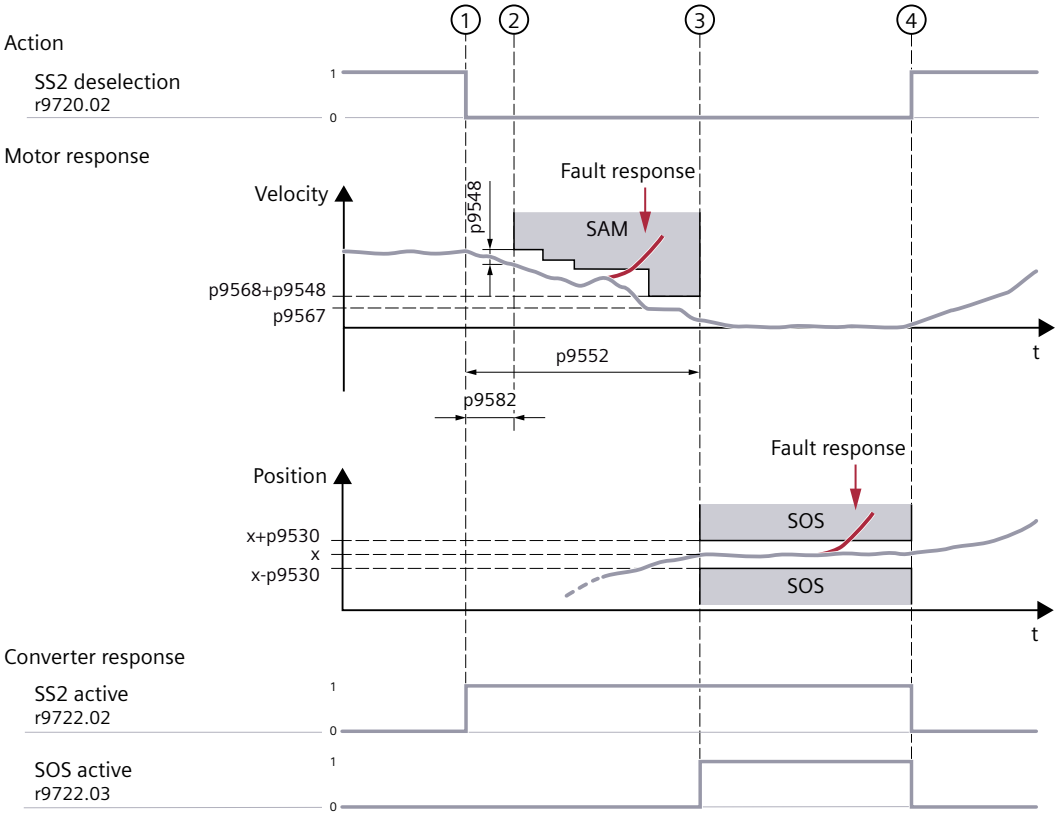


Figure 13-267 Function description: SS2 with SAM

Action		Motor / converter response
①	Selection of SS2	• The converter detects when SS2 is selected and signals status "SS2 active" (r9722.02). • The converter starts the SAM delay time (p9582). • The converter starts the SS2 delay time (p9552). • The converter brakes the motor along the OFF3 ramp.
②	Braking along the OFF3 ramp with SAM monitoring	• The SAM delay time elapses. With SAM, the converter monitors whether the motor impermissibly accelerates. • The SAM monitoring follows the motor velocity as it decreases: The converter reduces the SAM monitoring step-by-step when the following applies: Absolute value of the motor velocity + p9548 < previous SAM monitoring It is not possible to increase the SAM monitoring. • If the motor velocity exceeds the SAM monitoring, then the converter signals a fault and activates STO. • If the motor velocity reaches the SAM limit value (p9568), then the converter limits the value for the SAM monitoring to p9568 + p9548.

③	Transition to SOS	• The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567). The converter activates SOS if one of the transition times (p9569 or p9552) has elapsed. • The SS2 delay time (p9552) elapses. The SS2 delay time must be dimensioned to allow the motor to brake down to standstill from every speed of the operating process within this time. • The converter activates SOS and signals status "SOS active" (r9722.03) and status "SS2 active" (r9722.02). • The converter safely monitors standstill of the motor using the SOS function. The motor remains in closed-loop control and monitors the standstill tolerance (p9530). • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
④	Selection of SS2	• The converter detects when SS2 is deselected and signals status "SS2 not active" and "SOS not active". • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of function "Safe Stop 2 with acceleration monitoring (SS2-a)".

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9548	SI SAM velocity tolerance	mm/min
p9548	SI SAM velocity tolerance	rpm
p9552	SI transition time SS2 to SOS	ms
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9568	SI SAM velocity limit	mm/min
p9568	SI SAM velocity limit	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
p9582	SI SAM/SBR delay time for SS1 and SS2	ms
r9720.0...28	SI control word	-
r10354.0...13	SI SS2 select cause	-
r10472.0...13	SI SS2E select cause channel B	-

13.14.8.16 Safe Stop 2 with brake ramp monitoring (SS2-r)

Overview

When function SS2-r is selected, the converter stops the motor along the OFF3 ramp. With Safe Brake Ramp monitoring (SBR), the converter monitors whether the speed of the motor remains below a defined braking ramp. When the shutdown speed is fallen below or after the delay time elapses, the converter activates the Safe Operating Stop (SOS) function.

Function description

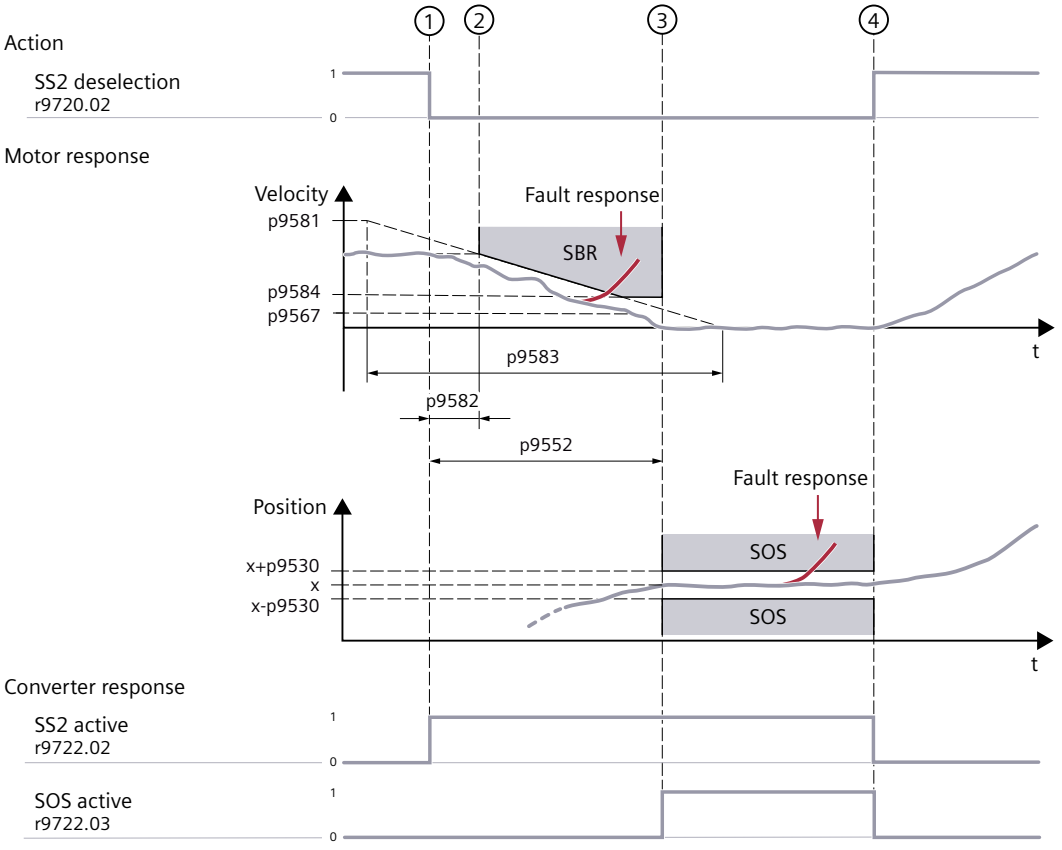


Figure 13-268 Function description: SS2 with SBR

	Action	Motor / converter response
①	Selection of SS2	• The converter detects selection of SS2 and signals status "SS2 active" (r9722.02). • The converter starts the SBR delay time (p9582). • The converter starts the SS2 delay time (p9552). • The converter brakes the motor along the OFF3 ramp.
②	Braking along an OFF3 ramp with SBR monitoring	• The SBR delay time elapses. • The reference velocity (p9581) and the SBR monitoring time (p9583) define the gradient of the SBR monitoring. • When the motor brakes, the converter monitors that the motor does not exceed the SBR monitoring. • When reaching the SBR velocity limit (p9584), then SBR monitoring is frozen. Braking continues. • The converter signals a fault if the motor speed violates the SBR monitoring.

③	Transition to SOS	• SBR ends as soon as the speed actual value is below the STO shutdown speed (p9560) or the SBR monitoring was violated. • The transition time (p9569) starts when function "Stop time shortening" is enabled (p9567 > 0). The converter activates SOS if one of the transition times (p9569 or p9552) has elapsed. • The SS2 delay time (p9552) elapses. The SS2 delay time must be dimensioned to allow the motor to brake down to standstill from every speed of the operating process within this time. • The converter activates SOS and signals status "SOS active" (r9722.03) and status "SS2 active" (r9722.02). • The converter safely monitors standstill of the motor using the SOS function. The motor remains in closed-loop control and monitors the standstill tolerance (p9530). • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
④	Selection of SS2	• The converter detects when SS2 is deselected and signals status "SS2 not active" and "SOS not active". • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of function "Safe Stop 2 with brake ramp monitoring (SS2-r)".

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9552	SI transition time SS2 to SOS	ms
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
p9581	SI SBR reference velocity for SS1 and SS2	mm/min
p9581	SI SBR reference velocity for SS1 and SS2	rpm
p9582	SI SAM/SBR delay time for SS1 and SS2	ms
p9583	SI SBR reference time for SS1 and SS2	s
p9584	SI SBR velocity limit	mm/min
p9584	SI SBR velocity limit	rpm
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10354.0...13	SI SS2 select cause	-

13.14.8.17 Safe Stop 2 with external stop (SS2E) - overview

Overview

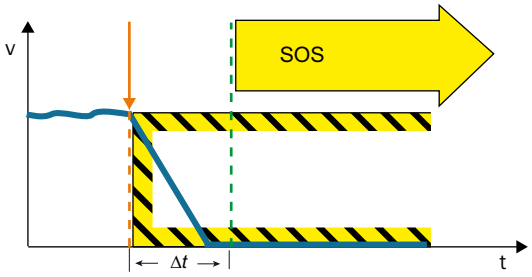


Figure 13-269 SS2E overview

When function "Safe Stop 2 with external stop (SS2E)" is active, then the higher-level control brings the motor to a standstill by using a suitable setpoint input. The converter monitors stopping using function SS2E and monitors the standstill position using function "Safe Operating Stop (SOS)". SS2E corresponds to stop category 2 according to EN 60204-1.

The following function variants are available:

Abbreviation	Brief description
SS2E-t	Safe Stop 2 with external stop and time control (time until SOS enabled)
SS2E-a	Safe Stop 2 with external stop and safe acceleration monitoring (SAM)
SS2E-r	Safe Stop 2 with external stop and safe brake ramp monitoring (SBR)

Example

Safe Stop 2 with external stop (SS2E) is suitable for a group of drives. Although they can be stopped together, they have different acceleration rates or are stopped in a specified sequence with respect to time.

These are drives that are mechanically connected to each other through a material web, for example.

13.14.8.18 Safe Stop 2 with external stop with time control (SS2E-t)

Overview

When function SS2E-t is activated, the higher-level control stops the motor. When function SS2E-t is selected, the converter starts the safe delay time. After the delay time elapses, the converter activates the Safe Operating Stop (SOS) function.

Function description

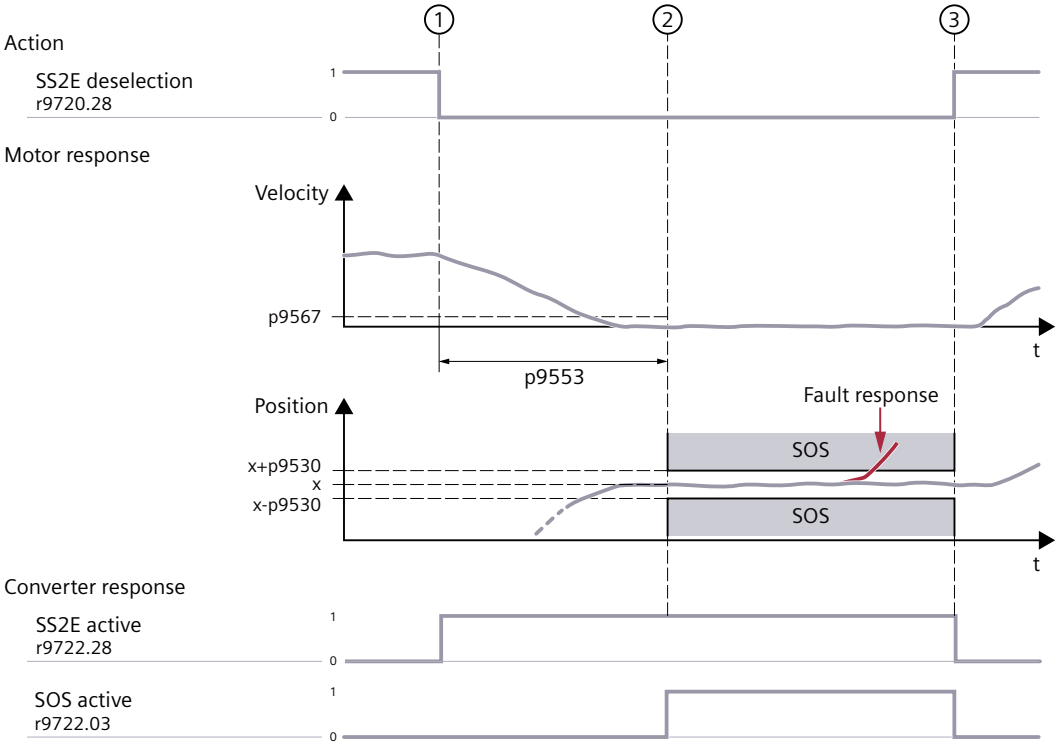


Figure 13-270 Function description: SS2E with time control

	Action	Motor / converter response
①	Selection of SS2E	• The converter detects when SS2E is selected and signals status "SS2E active" (r9722.28 and r10234.11). • The converter starts the transition time SS2E to SOS (p9553). • The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567) and S_STW1B.12 = 1 signal. The converter activates SOS if one of the transition times (p9569 or p9552) has elapsed.
②	Transition to SOS	• The transition time SS2E to SOS (p9553) elapses. • The converter activates SOS and signals status "SOS active" (r9722.03 and 9734.05). Status SS2E active remains active. • Function SOS safely monitors standstill of the motor using the standstill tolerance (p9530). The motor closed-loop control remains active. • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
③	Deselection of SS2E	• The converter detects when SS2E is deselected and signals status "SS2E not active" and "SOS not active". • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of function "Safe Stop 2 with external stop with time control (SS2E-t)".

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9553	SI transition time SS2E to SOS	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-
r10234.11...15	SI Safety Information Channel status word S_ZSW3B	-

13.14.8.19 Setting the SS2E transition time

Description

Select the SS2E transition time so that before SOS is activated, the motor can completely ramp down along the OFF3 ramp. The braking time must be oriented to the actual braking capacity of the system or machine.

Set the SS2E transition time as follows:

SS2E transition time (p9553) ≥ braking time

13.14.8.20 Safe Stop 2 with external stop with acceleration monitoring (SS2E-a)

Overview

When function SS2E-a is activated, the higher-level control stops the motor. When function SS2E-a is selected, using the Safe Acceleration Monitor (SAM), the converter monitors whether or not the motor inadmissibly accelerates when braking. After the delay time elapses, the converter activates the Safe Operating Stop (SOS) function.

Function description

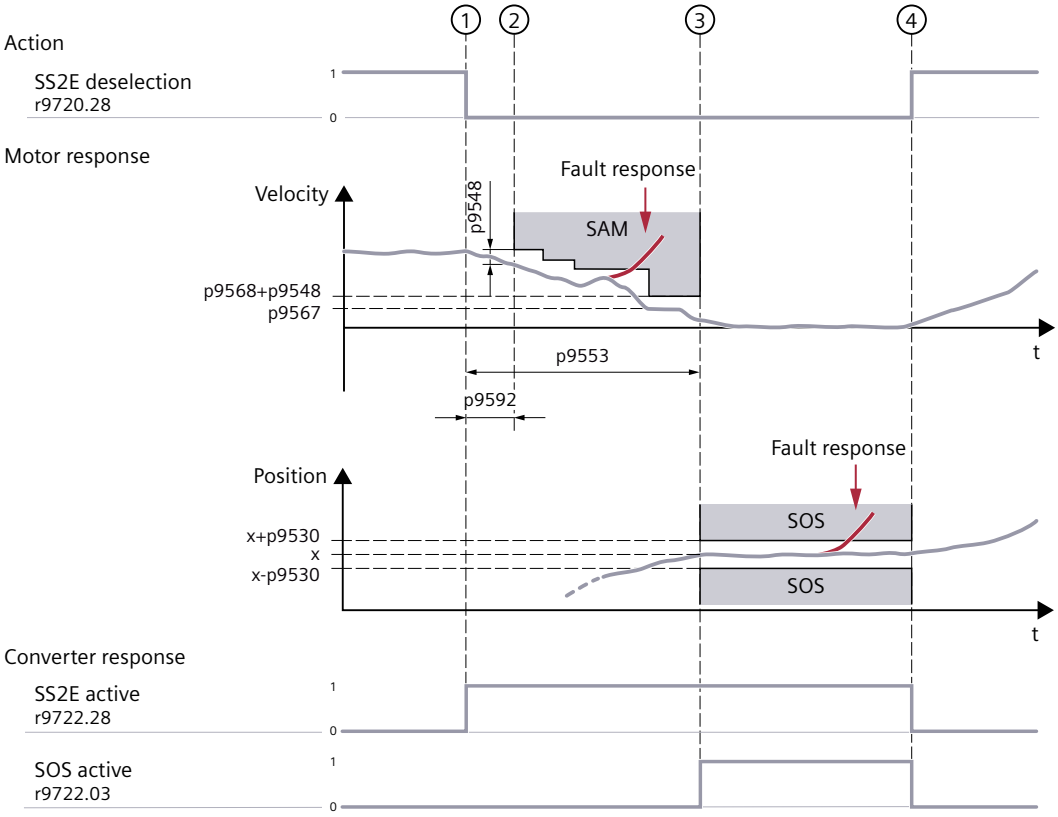


Figure 13-271 Function description: SS2E with SAM

Action		Motor / converter response
(1)	Selection of SS2E	• The converter detects when SS2E is selected and signals status "SS2E active" (r9722.28 and r10234.11). • The converter starts the SAM delay time (p9592). • The converter starts the SS2E delay time (p9553). • The higher-level control initiates the stopping process via the external setpoint input. • The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567) and S_STW1B.12 = 1 signal. The converter activates SOS if one of the transition times (p9569 or p9552) has elapsed.

②	Braking with SAM monitoring	• The SAM delay time elapses. With SAM, the converter monitors whether the motor impermissibly accelerates. • The SAM monitoring follows the motor velocity as it decreases: The converter reduces the SAM monitoring step-by-step when the following applies: Absolute value of the motor velocity + p9548 < previous SAM monitoring It is not possible to increase the SAM monitoring. • If the motor velocity exceeds the SAM monitoring, then the converter signals a fault and activates STO. • If the motor velocity reaches the SAM limit value (p9568), then the converter limits the value for the SAM monitoring to p9568 + p9548.
③	Transition to SOS	• The SS2E delay time (p9553) elapses. The SS2E delay time must be dimensioned to allow the converter to brake the motor to a standstill from every speed of the operating process within this time. • The converter activates SOS and signals status "SOS active" (r9722.03 and 9734.05) and status "SS2 active" (r9722.02 and r9734.02). • The converter safely monitors standstill of the motor using the SOS function. The motor remains in closed-loop control and monitors the standstill tolerance (p9530). • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
④	Deselection of SS2E	• The converter detects when SS2E is deselected and signals status "SS2E not active" (9722.28) and "SOS not active" (9722.03). • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of function "Safe Stop 2 with external stop with acceleration monitoring (SS2E-a)".

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9548	SI SAM velocity tolerance	mm/min
p9548	SI SAM velocity tolerance	rpm
p9553	SI transition time SS2E to SOS	ms
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9568	SI SAM velocity limit	mm/min
p9568	SI SAM velocity limit	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
p9592	SI SAM/SBR delay time for SS1E and SS2E	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	-
r10234.11...15	SI Safety Information Channel status word S_ZSW3B	-

13.14.8.21 Safe Stop 2 with external stop with brake ramp monitoring (SS2E-r)

Overview

When function SS2E-r is activated, the higher-level control stops the motor. When function SS2E-1 is selected, using safe brake ramp monitoring (SBR), the converter monitors whether the velocity of the motor remains below a defined braking ramp. After the delay time elapses, the converter activates the Safe Operating Stop (SOS) function.

Function description

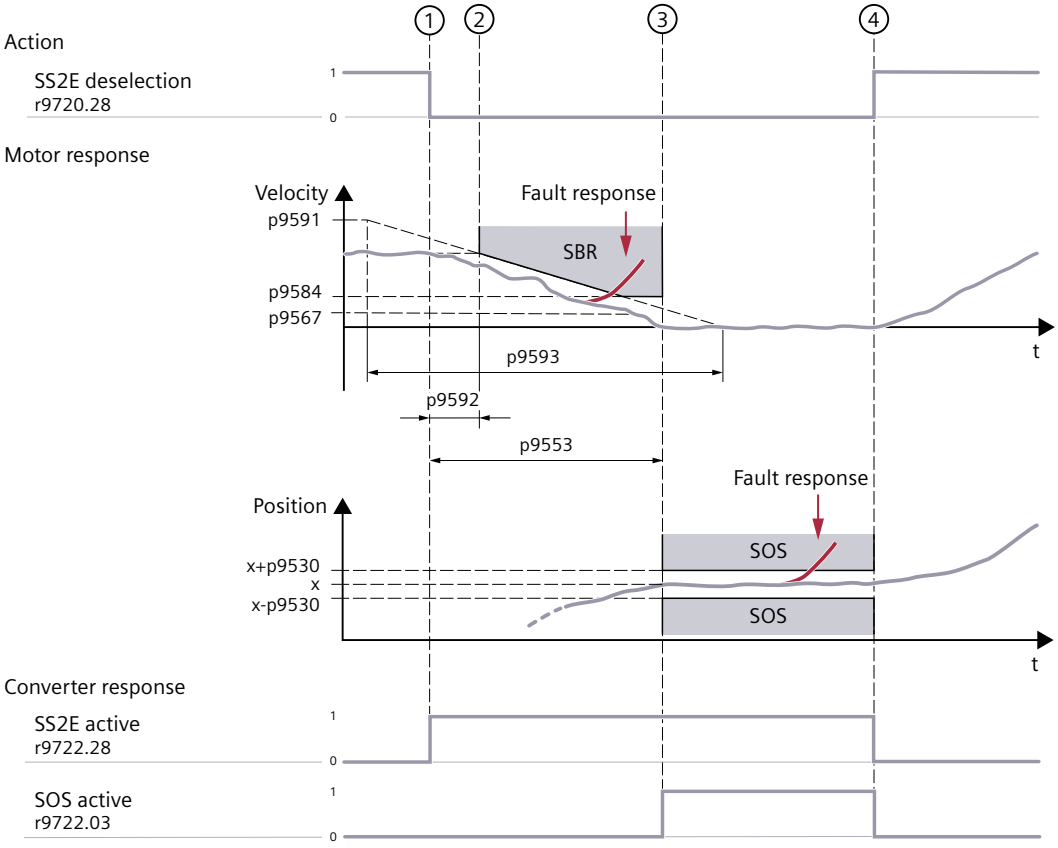


Figure 13-272 Function description: SS2E SBR

Action		Motor / converter response
①	Selection of SS2E	• The converter starts the SS2E delay time (p9553). • The converter starts the SBR delay time (p9592). • The higher-level control initiates the stopping process via the external setpoint input. • The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567) and S_STW1B.12 = 1 signal. The converter activates SOS after the transition time elapses. • The converter signals a fault if the motor velocity violates the SBR monitoring.
②	Braking with SBR monitoring	• SBR ends as soon as the velocity actual value is below the STO shutdown velocity (p9560) or the SBR monitoring was violated. • The converter activates STO. • The reference velocity (p9591) and the SBR monitoring time (p9593) define the gradient of the SBR monitoring. • When the motor brakes, the converter monitors that the motor does not exceed the SBR monitoring. • The SBR velocity limit (p9584) defines the minimum value of the SBR monitoring. Braking continues. • The converter signals a fault if the motor velocity violates the SBR monitoring.
③	Transition to SOS	• SBR ends as soon as the velocity actual value is below the STO shutdown velocity (p9560) or the SBR monitoring was violated. • The converter signals STO. • The SS2E delay time (p9553) elapses. The SS2E delay time must be dimensioned to allow the motor to brake down to standstill from every speed of the operating process within this time. • The converter activates SOS and signals status "SOS active" (r9722.03 and r9734.05) and status "SS2E active" (r9722.28 and 10234.11). • The converter safely monitors standstill of the motor using the SOS function. The motor remains in closed-loop control and monitors the standstill tolerance (p9530). • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO.
④	Deselection of SS2E	• The converter drive detects when SS2E is deselected and signals status "SS2E not enabled" and "SOS not enabled". • The motor closed-loop control follows the actual setpoint.

Parameters

The following list contains the parameters of function "Safe Stop 2 with external stop with brake ramp monitoring (SS2E-r)".

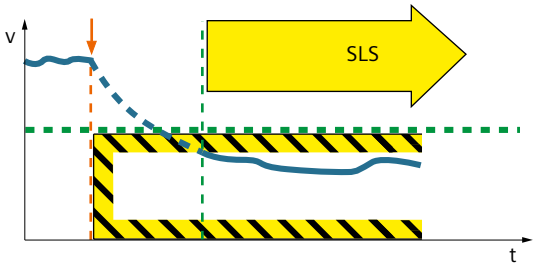
Number	Name	Unit
p9530	SI SOS standstill tolerance	mm

p9530	SI SOS standstill tolerance	°
p9553	SI transition time SS2E to SOS	ms
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
p9584	SI SBR velocity limit	mm/min
p9584	SI SBR velocity limit	rpm
p9591	SI SBR reference velocity for SS1E and SS2E	mm/min
p9591	SI SBR reference velocity for SS1E and SS2E	rpm
p9592	SI SAM/SBR delay time for SS1E and SS2E	ms
p9593	SI SBR reference time for SS1E and SS2E	s
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r10372.0...13	SI SS2E select cause	-

13.14.9 Motion monitoring

13.14.9.1 Safely-Limited Speed (SLS)

Overview



When function Safely-Limited Speed (SLS) is selected the converter monitors the motor speed. The converter stops the motor if the motor speed is higher than an SLS limit value. In operation, the higher-level control system can switch over between 4 independent SLS limit values.

Function description

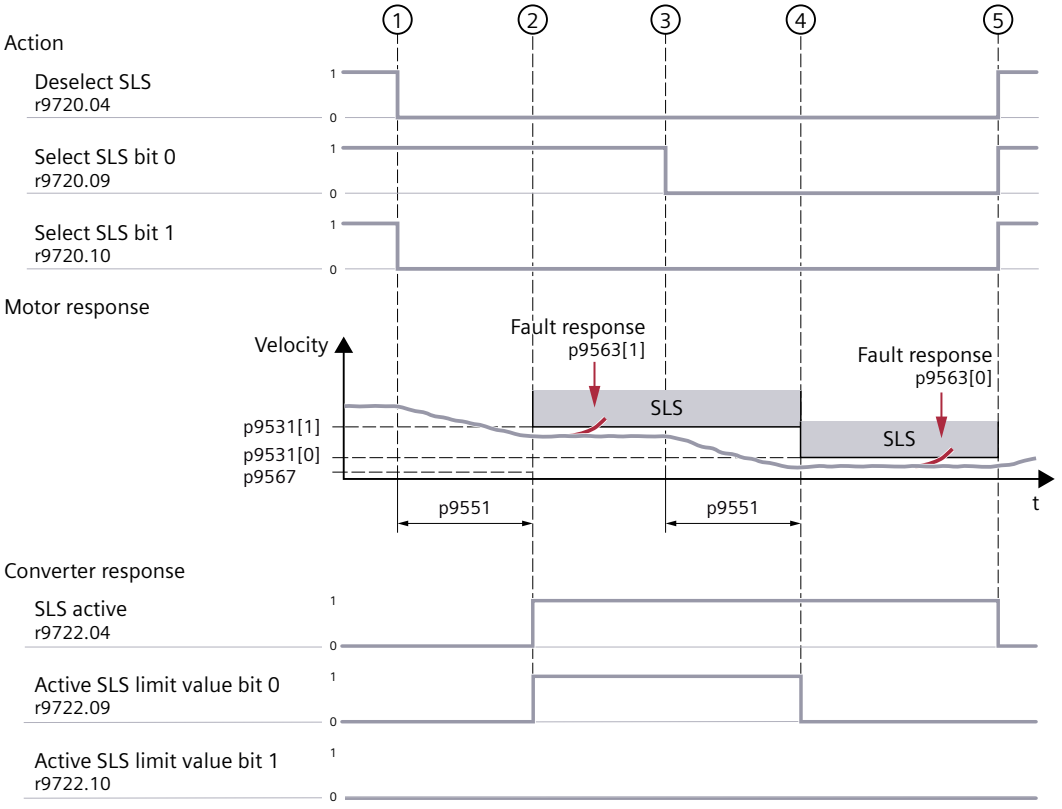


Figure 13-273 SLS with change between two SLS limit values

Action		Motor / converter response
①	Selection of SLS	• The converter detects the selection of SLS. • The converter detects when limit value SLS2 is selected (p9531[1]). • The converter starts the SLS delay time (p9551). • The motor follows the setpoint of the higher-level control and brakes. [1)] The actual speed must remain below the SLS2 limit value until the SLS delay time has elapsed.
②	Activating the SLS limit value	• The transition time (p9569) starts as soon as the speed falls below the switchover speed (p9567) and S_STW1B.12 = 1 signal. • The converter activates the SLS limit value after the transition time (9569) elapses. The SLS delay time (p9551) is only still relevant if it elapses before the transition time (p9569). • The converter signals status "SLS active" (r9722.04) and active SLS level (r9722.09 = 1, r9722.10 = 0). • If the motor speed violates the SLS2 limit value, the converter initiates the set stop response p9563[1].

③	Change to SLS1 limit value	• The converter detects when limit value SLS1 is selected (p9531[0]). [2)] • This diagram illustrates the switchover from a higher to a lower SLS limit value. In this case, the converter starts the SLS delay time (p9551). The SLS2 limit value remains while the SLS delay time is active. When switching over from a lower to a higher SLS limit value, the SLS delay time is not applied and the new SLS limit value becomes active immediately. • The motor follows the setpoint of the higher-level control and brakes. [1)] The actual speed must remain below the SLS1 limit value until the SLS delay time has elapsed.
④	Activating the SLS limit value	• Monitoring of the SLS1 limit value (p9531[0]) is effective once the SLS delay time (p9551) has elapsed. • The converter signals the active SLS level (r9722.09 = 0, r9722.10 = 0). • If the motor speed violates the SLS1 limit value, the converter initiates the set stop response p9563[0].
⑤	Deselection of SLS	• The converter detects deselection of SLS. • The motor follows the setpoint issued by the higher-level control.

1) The converter automatically brakes the motor if the following signals are interconnected:

- c1051 is interconnected with r9733[0]

- c1052 is interconnected with r9733[1]

2) Recommendation for setting the SLS limit values: SLS1 limit value < SLS2 limit value < ... < SLS3 limit value.

This diagram illustrates the switchover from a higher to a lower SLS limit value. In this case, the converter starts the SLS delay time (p9551). The SLS2 limit value remains while the SLS delay time is active.

When switching over from a lower to a higher SLS limit value, the SLS delay time is not applied and the new SLS limit value becomes active immediately.

Example

SLS is suitable for machines where hazards due to excessive speeds are possible. Using SLS makes sense when performing the following work:

- During commissioning
- During setup
- For maintenance work

Table 13-123 Application examples SLS

Example	Solution
Setup mode: The machine operator must enter the dangerous area of a machine and manually introduce material into a machine part.	With SLS, the converter monitors the velocity of the machine component.
To protect the drill chuck from destruction, a turning machine must not exceed a certain maximum velocity of the machine part.	

Parameters

The following list contains the parameters of the "SLS with switchover of speed levels" function.

Number	Name	Unit
p9531[0...3]	SI SLS limit values	mm/min
p9531[0...3]	SI SLS limit values	rpm
p9551	SI SLS delay time for limit value change	ms
p9563[0...3]	SI SLS stop response	-
p9569	SI transition time to SOS/SLS level after standstill	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.9.2 SLS with variable speed limit value

Overview

The SLS1 limit value is scalable during operation via PROFIsafe.

Requirement

The SLS1 limit value is selected via PROFIsafe.

p9604.9 is set: Transfer of the SLS limit value via PROFIsafe is enabled.

Function description

The signal S_SLS_LIMIT_A in the PROFIsafe telegram scales the SLS1 limit value.

The S_SLS_LIMIT_A scaling has the value range 1 ... 32767.

The scaled SLS1 limit value is calculated as follows: Scaled SLS1 limit value = S_SLS_LIMIT_A / 32767 · p9531[0]

Before the higher-level control (F-CPU) selects an SLS limit value or changes the SLS1 limit value, the control must reduce the motor speed after the delay time (p9551) elapses according to the changed SLS limit value.

Also for the scaled SLS1 limit value, the SLS2, SLS3 and SLS4 limit values can be selected using r9720.09 and r9720.10.

An invalid value in S_SLS_LIMIT_A results in the stop response parameterized in p9563[0].

Parameters

The following list contains the parameters of the "SLS with switchover of speed levels" function.

Number	Name	Unit
p9531[0...3]	SI SLS limit values	mm/min
p9531[0...3]	SI SLS limit values	rpm
p9551	SI SLS delay time for limit value change	ms
p9563[0...3]	SI SLS stop response	-
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.9.3 Limitation of the speed setpoint for SLS

Overview

Based on the setpoint limit, the control identifies the currently possible speed in the converter and avoids unnecessary shutdowns, e.g. by entering a speed setpoint that cannot be reached as a result of an active SLS.

Function description

The higher-level control receives the value for the required limitation of the speed setpoint from the Safety Info Channel (SIC) in telegram 700.

With SLS active, the converter sends the required setpoint limit r9733 in the S_V_LIMIT_B signal of telegram 700.

The converter calculates r9733 as follows:

- r9733[0] = p9531[x] · p9533 (converted from the load to the motor side)
- r9733[1] = -p9531[x] · p9533 (converted from the load to the motor side)
  [x] = selected SLS limit value

p9533 is the weighting factor to determine the setpoint limit from the selected actual speed limit in percent.

Conversion factor from the motor to the load side:

- Motor type = rotary and axis type = linear: p9522/(p9521 · p9520)
- Otherwise: p9522/p9521

Parameters

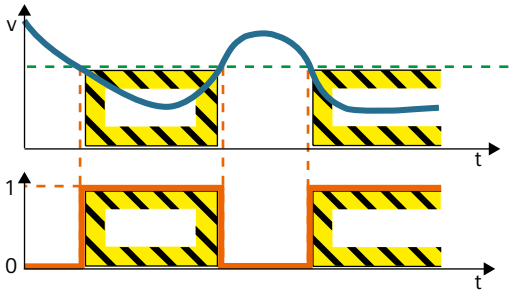
The following list contains the parameters of the "SLS with a speed level" function.

Number	Name	Unit
p9531[0...3]	SI SLS limit values	mm/min

p9531[0...3]	SI SLS limit values	rpm
p9551	SI SLS delay time for limit value change	ms
p9563[0...3]	SI SLS stop response	-
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9733[0...2]	SI effective setpoint velocity limiting	rpm

13.14.9.4 Safe Speed Monitor (SSM)

Overview



Safe Speed Monitor (SSM) detects when the velocity falls below a velocity limit in both directions of motion.

If the velocity of the motor exceeds the SSM limit, a message is output but no stop response.

The converter provides a safety-related signal for further processing.

Function description

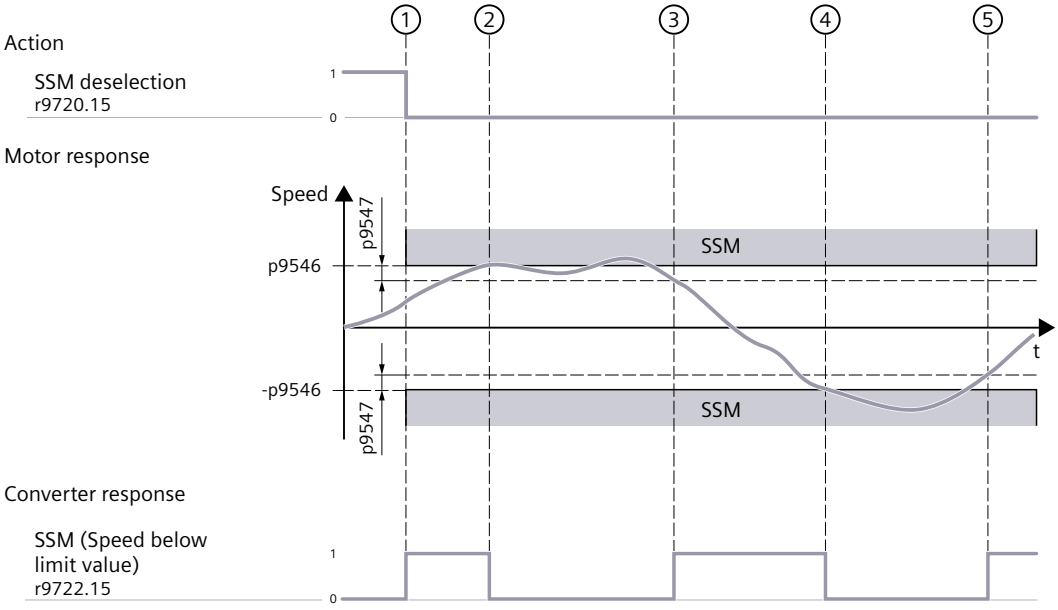


Figure 13-274 SSM

Action		Motor / converter response
①	Selection of SSM	• The converter detects when SSM is selected. • If the speed of the motor is between the speed limit and the negative speed limit, the converter sets the signal "Speed below limit value" (p9722.15 = 1). • p9507.09 defines the initial value of the SSM signal after switching on the supply voltage: – p9507.09 = 0 means "SSM status signal when running up initialized to '1'". – p9507.09 = 1 means "SSM status signal when running up initialized to '0'".
②	Exceeding the velocity limit	• If the velocity of the motor exceeds the velocity limit, then the converter resets signal "Speed below limit value" = 0 (p9722.15).
③	Falling below the velocity limit	• If the velocity of the motor falls below the velocity limit minus the hysteresis, then the converter sets signal "Speed below limit value" = 1 (p9722.15).
④	Falling below the negative velocity limit	• If the velocity of the motor falls below the negative velocity limit, then the converter resets signal "Speed below limit value" = 0 (p9722.15).
⑤	Exceeding the negative velocity limit	• If the velocity of the motor exceeds the negative speed limit plus the hysteresis, then the converter sets signal "Speed below limit value" = 1 (p9722.15).

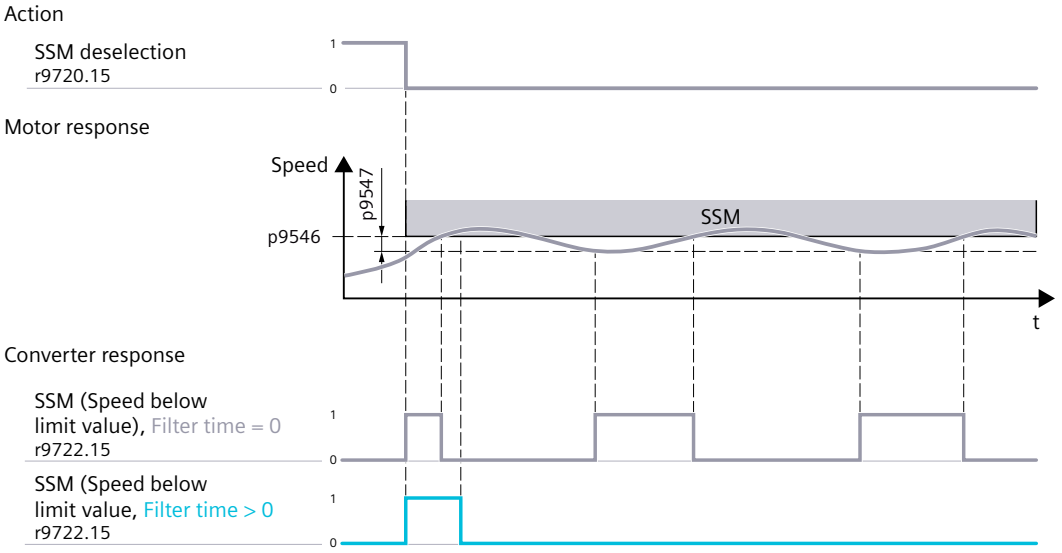


Figure 13-275 Principle of operation of the signal filter

The signal filter with filter time (p9545) smooths the speed measured value.

The filter reduces signal changes of the SSM feedback when monitoring speeds that lie just below the speed limit.

A filter time > 0 results in the SSM feedback signal being delayed.

For an encoder fault or communications failure, the system set status bit "SSM" to value "0".

Example

SSM is suitable for enabling access to the machine by way of safe SSM feedback. The safe state of the SSM feedback means that r9722.15 = 1. For example, it is possible to unlock safety doors only when the speed falls below critical levels.

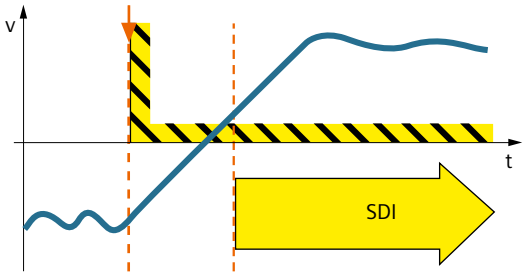
Parameters

The following list contains the parameters of the "Safe Speed Monitor (SSM)" function.

Number	Name	Unit
p9507.8...9	SI function configuration	-
p9545	SI SSM filter time	ms
p9546	SI SSM velocity limit	mm/min
p9546	SI SSM velocity limit	rpm
p9547	SI SSM velocity hysteresis	mm/min
p9547	SI SSM velocity hysteresis	rpm
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.9.5 Safe Direction (SDI)

Overview



With Safe Direction (SDI), the converter monitors the direction of motion of the motor. If the motor moves in the inhibited direction, then the converter stops the motor with a stop response that can be set using SDI.

The following SDI variants are available, depending on the direction of motion:

- SDI positive (SDI+)
- SDI negative (SDI-)

Function description

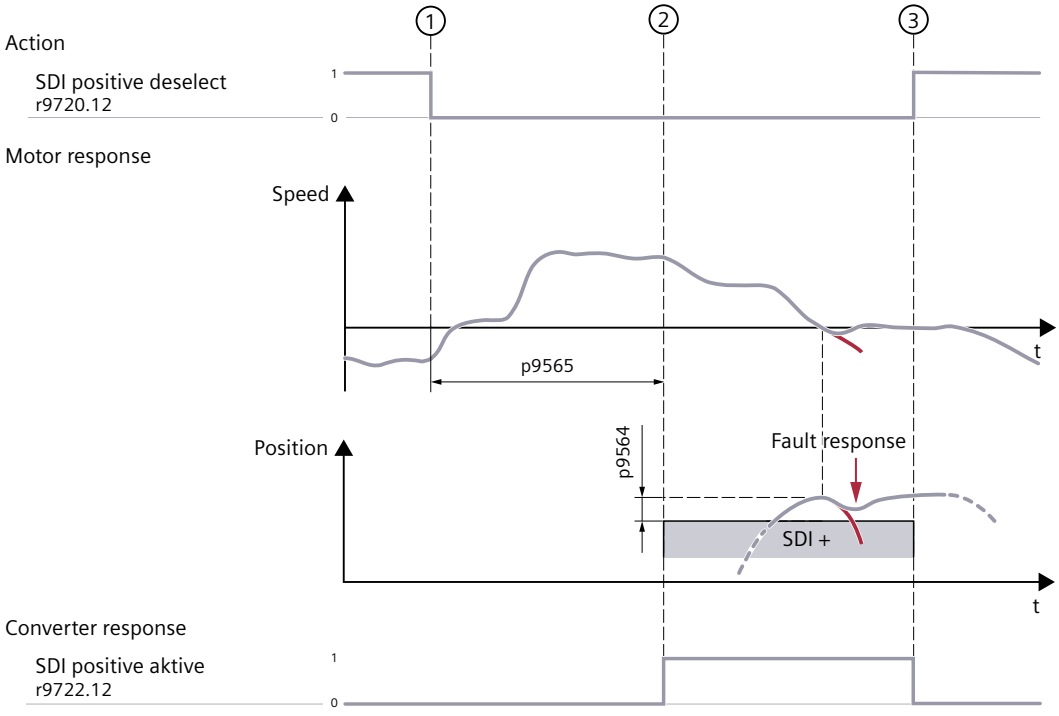


Figure 13-276 SDI+ with tolerance violation and direction of movement monitoring

Action		Motor / converter response
①	Selection of SDI+	• The converter detects the selection of SDI+. • The converter starts the SDI delay time (p9565).
②	Activation of SDI+	• After the SDI delay time has expired, the converter monitors the direction of motion of the motor. • The converter reports the status "SDI positive active" (r9722.12). • The converter continuously calculates the position of the motor. • As soon as the motor moves in the inhibited direction, the converter stores the current position and monitors the discrepancy between the current position and the stored position. • The converter sets r9733[1] = 0 (setpoint speed limitation negative).[2)] • If the discrepancy between the current position and the stored position is greater than the SDI tolerance p9564, the converter brakes the motor with the set stop response (p9566) and outputs a safety message [1)].
③	Deselection of SDI+	• The converter detects when SDI+ is deselected. • The converter stops monitoring the motion direction. • The motor can now be moved in both directions.

1) The following steps are required to acknowledge the safety message:

- Deselect SDI and select it again
- Safe acknowledgment

2) The converter automatically brakes the motor if the following signals are interconnected:

- c1051 is interconnected with r9733[0]
- c1052 is interconnected with r9733[1]

Parameters

The following list contains the parameters of the "Safe Direction (SDI)" function.

Number	Name	Unit
p9564	SI SDI tolerance	mm
p9564	SI SDI tolerance	°
p9565	SI SDI delay time	ms
p9566	SI SDI stop response	-
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9733[0...2]	SI effective setpoint velocity limiting	rpm

13.14.9.6 Limitation of the speed setpoint for SDI

Overview

Based on the setpoint limit, the control identifies the currently possible speed in the converter and avoids unnecessary shutdowns, e.g. by entering a speed setpoint that cannot be reached as a result of an active SDI.

Function description

The higher-level control receives the value for the required limitation of the speed setpoint from the Safety Info Channel (SIC) in telegram 700.

With SDI active, the converter sends the required setpoint limit r9733 in the S_V_LIMIT_B signal of telegram 700.

The converter calculates r9733 as follows:

- For SDI negative (SDI-): r9733[0] = 0
- For SDI positive (SDI+): r9733[1] = 0

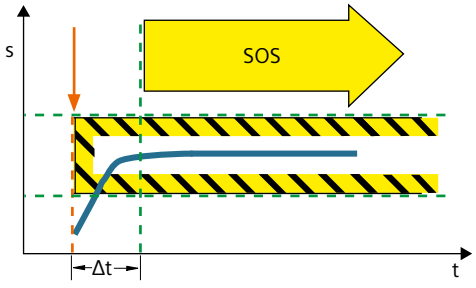
Parameters

The following list contains the parameters of function "Limiting the velocity setpoint for SDI".

Number	Name	Unit
p9564	SI SDI tolerance	mm
p9564	SI SDI tolerance	°
p9565	SI SDI delay time	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9733[0...2]	SI effective setpoint velocity limiting	rpm

13.14.9.7 Safe Operating Stop (SOS)

Overview



When safety function "Safe Operating Stop" (SOS) is active, the higher-level control stops the motor and the converter safely monitors the motor position for standstill.

Precondition

WARNING

Unexpected motor movement as a result of mechanical forces

When function "Safe Operating Stop (SOS)" is active, mechanical forces, which are higher than the maximum motor torque, result in a fault response. As a consequence of fault response "Safe Stop 1 (SS1)" (stop category 1 according to EN 60204-1), it is possible that the motor unexpectedly moves, which can result in death and severe injury.

- Take appropriate measures to prevent undesirable motion and use, e.g. a brake with safety-relevant monitoring.

Function "Safe Operating Stop" (SOS) always requires safe actual value acquisition with encoder.

Function description

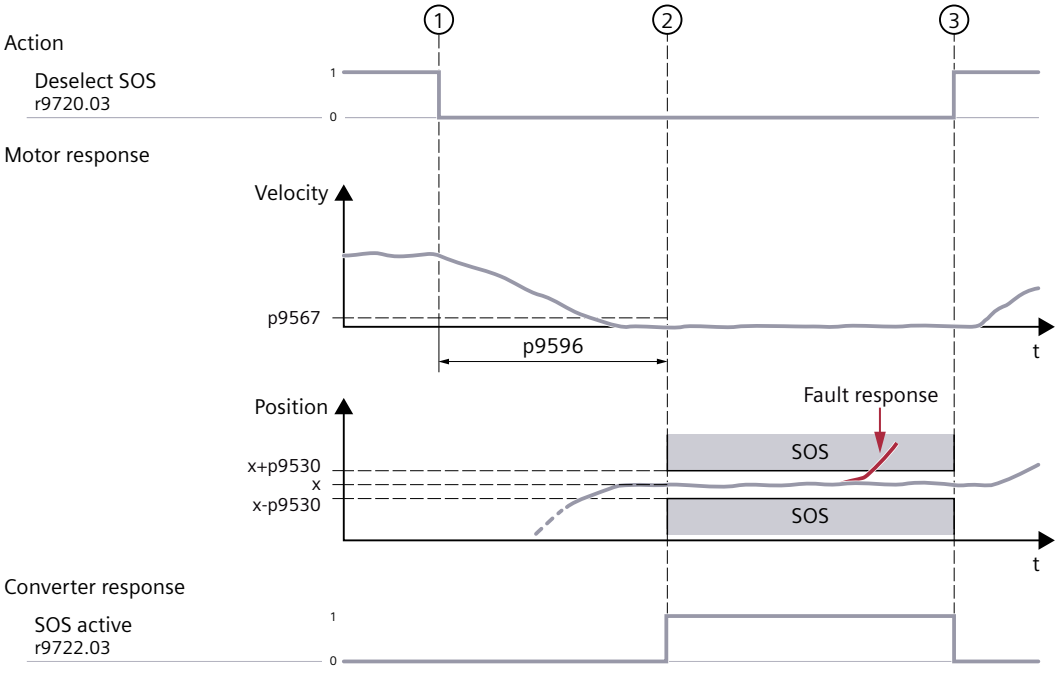


Figure 13-277 Function description: SOS

	Action	Motor / converter response
①	Selection of SOS	• The converter detects when SOS is selected and signals status "SOS active" (r9722.03). • The higher-level control stops the motor.

②	Start SOS	• The converter starts the SOS delay time (p9596). • The transition time (p9569) starts as soon as the velocity falls below the switchover velocity (p9567) and S_STW1B.12 = 1 signal. The converter activates SOS after the transition time elapses. • The SOS delay time (p9596) elapses. The SOS delay time must be dimensioned to allow the motor to brake down to standstill from every speed of the operating process within this time. • The converter activates SOS and signals status "SOS active" (r9722.03). • Function SOS safely monitors standstill of the motor using the standstill tolerance (p9530). The closed-loop motor control remains active. Parameter p9731 indicates the Safe Position accuracy (on the load side) that can be achieved as a maximum, based on the actual value acquisition for the safe motion monitoring functions. • If the standstill tolerance is violated, then the converter responds with SS1 and then transitions into STO. The standstill tolerance must be set suitable for the application in order not to influence additional drive monitoring functions.
③	Deselection of SOS	• The converter detects when SOS is deselected and signals status "SOS not active". • The closed-loop motor control follows the actual setpoint.

Example

SOS is suitable for the following applications:

- Machine parts must be safely monitored that they actually are at a standstill.

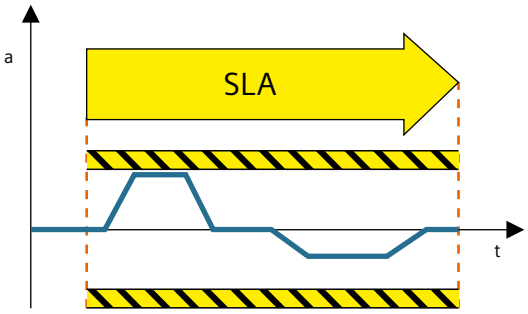
Parameters

The following list contains the parameters of function "Safe Operating Stop (SOS)".

Number	Name	Unit
p9530	SI SOS standstill tolerance	mm
p9530	SI SOS standstill tolerance	°
p9567	SI switchover velocity to SOS/SLS level	mm/min
p9567	SI switchover velocity to SOS/SLS level	rpm
p9569	SI transition time to SOS/SLS level after standstill	ms
p9596	SI SOS delay time	ms
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.9.8 Safely-Limited Acceleration (SLA)

Overview



Safety Integrated Function "Safely-Limited Acceleration" (SLA) monitors that a converter does exceed a preset acceleration limit.

Precondition

Function "Safely-Limited Acceleration" (SLA) always requires safe actual value acquisition with encoder.

The acceleration limit must be set as follows:

- p9578 ≥ 10 · r9790[1]
- p9578 ≥ 3 · r9790[0]

The acceleration threshold depends on:

- Type of actual value acquisition
- Gearbox ratios
- Quality of the encoder used
- Safety monitoring cycle p9500 (see the description for parameter r9790).

Function description

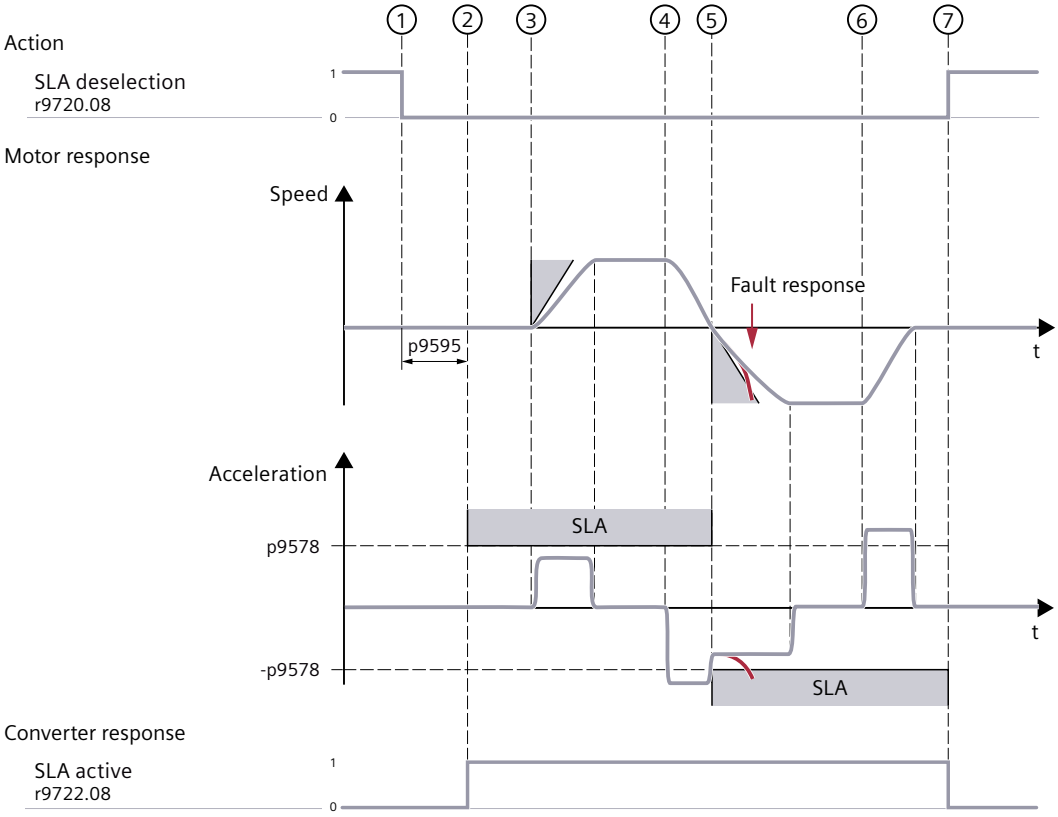


Figure 13-278 SLA

Action		Motor / drive response
①	Selection of SLA	• The converter detects when SLA is selected. • The converter starts the SLA delay time (p9595).
②	Activation of SLA	• Once the SLA delay time (p9595) elapses, monitoring of the SLA limit value (p9578) becomes active. • The converter signals status "SLA active" (r9722.08). • The signal filter (p9576) smooths the measured acceleration value. An active filter causes the SLA stop response to be initiated later.
③	The motor accelerates in the positive direction	• When accelerating, the converter monitors that the defined SLA limit is not exceeded. • r9789 allows the finer resolution acceleration monitoring to be diagnosed. Index 0 indicates the actual acceleration determined. Index 1 and 2 indicate the current limit values of the SLA monitoring. • If SLA detects that the acceleration limit has been exceeded, the converter initiates the configured stop response (p9579).
④	The motor brakes	• The acceleration of the braking operation is not monitored.

⑤	The motor accelerates in the negative direction	• When accelerating, the converter monitors that the defined SLA limit is not exceeded. • r9789 allows the finer resolution acceleration monitoring to be diagnosed. Index 0 indicates the actual acceleration determined. Index 1 and 2 indicate the current limit values of the SLA monitoring. • If SLA detects that the acceleration limit has been exceeded, the converter initiates the configured stop response (p9579).
⑥	The motor brakes	• The acceleration of the braking operation is not monitored.
⑦	Deselection of SLA	• The converter detects when SLA is deselected. • The converter stops monitoring the acceleration.

Example

SLA is suitable for machines for which the permissible acceleration may not be exceeded, for example in the setup mode.

Parameters

The following list contains the parameters of the "Safe Limited Acceleration (SLA)" function.

Number	Name	Unit
p9576	SI SLA filter time	ms
p9578	SI SLA acceleration limit	m/s²
p9578	SI SLA acceleration limit	rev/s²
p9579	SI SLA stop response	-
p9595	SI SLA delay time	ms
r9714[0...7]	SI diagnostics velocity	mm/min
r9714[0...7]	SI diagnostics velocity	rpm
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
r9789[0...2]	SI SLA acceleration diagnostics	m/s²
r9789[0...2]	SI SLA acceleration diagnostics	rev/s²
r9790[0...1]	SI SLA acceleration resolution	m/s²
r9790[0...1]	SI SLA acceleration resolution	rev/s²

13.14.10 Safe Motor Temperature (SMT)

Overview

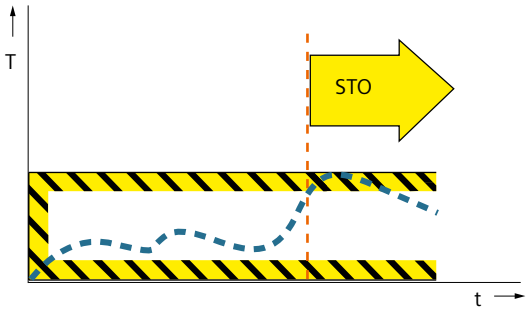


Figure 13-279 Overview SMT

Safe Motor Temperature (SMT) prevents the motor temperature from exceeding a specified limit. SMT protects motors against overtemperature in potentially explosive atmospheres.

SMT is a safety function in accordance with IEC 61800-5-2.

Requirement

Option module OM-SMT is connected to the converter.

Option module OM-SMT is configured with a commissioning tool.

A permissible PTC thermistor is connected at the input of the OM_SMT for the overtemperature shutdown.

Function description

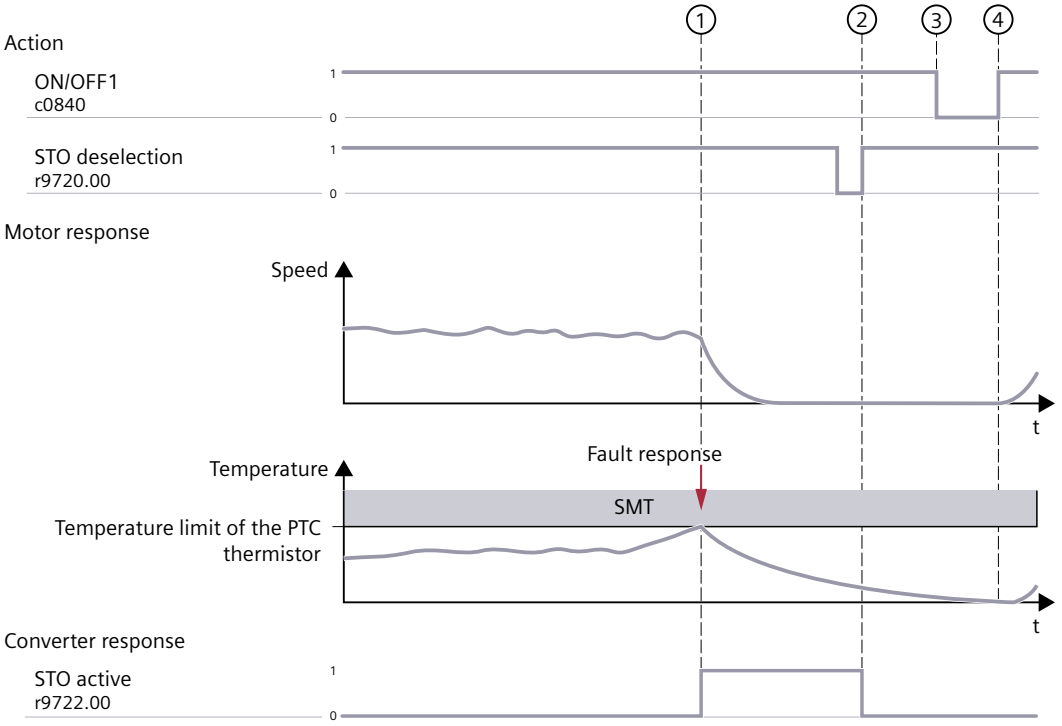


Figure 13-280 Flow diagram SMT

Action		Converter/motor response
①	OM-SMT detects an overtemperature	• The electrical resistance in the PTC thermistor increases above the switch-off limit. • The OM-SMT identifies when a temperature is exceeded. • The converter activates Safe Torque Off (STO) as a stop response and signals "STO active" (r9722.0). • STO prevents torque-generating energy from being fed to the motor. The motor coasts down. • The motor cools down.
②	Secure acknowledgment, e.g. via PROFIsafe, or by selecting and deselecting STO	• The converter acknowledges the fault under the following conditions: – At least one minute has elapsed since the fault occurred. – The resistance in the PTC thermistor has fallen below the temperature limit.
③	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.
④	Signal change at ON/OFF1 from 0 to 1	• The motor starts again.

Example

SMT protects motors against overtemperature in hazardous environments, e.g. in the chemical industry, in paper mills or in paint shops.

Parameters

The following list contains the parameters of the "Safe Motor Temperature (SMT)" function.

Number	Name	Unit
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.11 Safe actual value acquisition with encoder/mechanical system

Overview

Safe actual value acquisition using an encoder makes the actual value of the motor encoder available to the Safety Integrated Functions. The encoder or the Sensor Module generates the actual value and transfers it to the converter.

Requirement

The safe actual value acquisition of the converter requires a suitable motor encoder for Safety Integrated. Use incremental or absolute encoders to safely acquire the position values.

Settings

The safe actual value acquisition can be configured for linear and rotary axis types.

Rules for the setting:

- The monitoring cycle must be an integral multiple of the actual value acquisition cycle.
- For motion monitoring with encoder, the actual value acquisition cycle must be an integer multiple of the current controller cycle p0115[0].

More information

Information on suitable motors and encoders for Safety Integrated is provided on the Internet:

Suitable motors and encoders (https://support.industry.siemens.com/cs/ww/en/view/33512621)

Parameters

The following list contains the parameters of function "Actual value acquisition/mechanical system".

Number	Name	Unit
r9502	SI axis type	-
p9516.1	SI encoder configuration, safety functions	-
p9520	SI leadscrew pitch	mm
p9521[0...7]	SI gearbox encoder (motor)/load denominator	-
p9522[0...7]	SI gearbox encoder (motor)/load numerator	-
p9533	SI SLS setpoint speed limiting	%
p9539[0...7]	SI gearbox rotation reversal	-
p9630	SI safe maximum speed encoder (rotary)	rpm
p9631	SI safe position accuracy encoder (rotary)	°
p9632	SI safe maximum velocity encoder (linear)	m/min
p9633	SI safe position accuracy encoder (linear)	µm
r9634	SI safe maximum speed encoder detected (rotary)	rpm
r9635	SI safe position accuracy encoder detected (rotary)	°
r9636	SI safe maximum velocity encoder detected (linear)	m/min
r9637	SI safe position accuracy encoder detected (linear)	µm
p9674	SI module identifier Sensor Module	-
p9675	SI module identifier encoder	-
p9676	SI identifier encoder properties	-
p9677	SI offset POS1 POS2 encoder	-
r9708	SI diagnostics safe position	mm
r9708	SI diagnostics safe position	°
r9714[0...7]	SI diagnostics velocity	mm/min
r9714[0...7]	SI diagnostics velocity	rpm
r9730	SI Safe maximum velocity	mm/min
r9730	SI Safe maximum velocity	rpm
r9731	SI safe position accuracy	mm
r9731	SI safe position accuracy	°
r9732[0...1]	SI velocity resolution	mm/min
r9732[0...1]	SI velocity resolution	rpm
r9733[0...2]	SI effective setpoint velocity limiting	rpm

13.14.12 Safety Integrated encoderless

13.14.12.1 Safe encoderless actual value acquisition/mechanical system

Overview

With safe encoderless actual value acquisition, the converter calculates the motion of the motor rotor from the current and voltage.

Precondition

The following preconditions apply regarding safe actual value acquisition without encoder:

Note

Duration of the pole position identification for delay time

For synchronous and reluctance motors, the duration of the pole position identification when setting the delay time to evaluate safe encoderless actual value acquisition after pulse enable (p9586) must be taken into consideration.

Note

Taking into consideration the slip of induction motors

The speed of the motor shaft is relevant for the functional safety in or on a machine. However, the extended functions of the Safety Integrated Functions monitor the electrical speed of the motor against the limit values that have been set. If you use encoderless safety functions with an induction motor, you must take into account the motor slip when setting the speed monitoring.

⚠ WARNING

Unexpected load acceleration as a result of incorrect closed-loop motor control

The actual value acquisition without encoder does not identify all faults and errors in the motor control. As a consequence, encoderless safety functions cannot identify whether a pulling load undesirably accelerates due to a fault in the motor control.

• Never use safety functions with encoderless speed monitoring for drives with pulling loads.

⚠ WARNING

Unexpectedly high speeds as a result of incorrect motor data

If the parameterized motor pole pair number does not match the actual pole pair number, then the calculated, safety-related speed differs from the mechanical speed of the motor shaft. As a consequence, the motor shaft can accelerate above the configured monitoring limits of the safety function. This can result in death or severe injury.

• Directly enter the motor data.

The following motor types and operating modes are permitted for safe encoderless actual value acquisition:

- Induction motors in all control modes
- Synchronous reluctance motors in closed-loop speed control
- Group drives

Requirements of the application:

- Continuous operation at speeds > 5 % of the rated motor speed
- Rated converter current/rated motor current ≤ 5.
- Never operate the converter continuously at its current limit.

- Adapt the up and down ramps to the moment of inertia of the machine.
- Avoid reversing the motor < 2 s.
- Avoid sudden load changes.
- Limit the field weakening to a third of the rated magnetizing current.
- Limit the flux reduction to 60 % of the magnetizing current.

The safe encoderless actual value acquisition calculates the actual speed value independent of whether the following functions are active. For the following functions, safe encoderless actual value acquisition signals a fault:

- DC braking or compound braking
- Flying restart

Deselect all Safety Integrated Functions if you wish to use these functions. In the risk assessment, check whether it is permissible that you deactivate Safety Integrated Functions.

Closed-loop control settings:

- Encoderless closed-loop control down to f = 0 (pulse technique) is not possible (p1750 ≠ 5)
- The open-loop/closed-loop control mode "V/f control with independent voltage setpoint" (p1300 = 19) is not permitted.
- Perform the motor data identification at standstill and with a rotating measurement.
- Correct setting of the moment of inertia
  results in reliable stall torque monitoring and avoids multiple overshoots of the speed after a setpoint change.

Converter configuration:

- No pulse frequency reduction: p1810.08 = 0 signal and p1810.09 = 0 signal
- When switching over a drive data set, the number of pole pairs (p0314) and pulse frequency setpoint (p1800) must remain unchanged.
- Calculating the current controller and clocking of the power unit run in synchronism: Current controller clock cycle (p0115) · pulse frequency (p1800) = 1/4, 1/2, 1...
- Wobbulation is deactivated: p1810.02 = 0 signal
- No loss-optimized reduction of the pulse frequency when the power unit has an overload condition: p0290 ≠ 24 and ≠ 25

Function description

Setting p9506 = 1 activates safe encoderless actual value acquisition.

The following functions can be used with safe encoderless actual value acquisition:

- STO
- SS1/SS1E
- SLS
- SSM
- SDI

Parameters	Description
p9585	**Fault tolerance** The fault tolerance defines how often the converter tolerates the change of current and voltage angle per second as part of its internal plausibility check. Increasing the value of p9585 results in a potentially higher velocity deviation (r9787). Take into consideration this possible deviation when defining the velocity limit values (e.g. for SLS).
p9586	**Delay time** The delay time is the time between the pulses being enabled and the evaluation of the actual value acquisition without encoder. The value should be greater than or equal to the magnetization time of the motor (p0346).
p9587	**Filter time** The filter time sets the smoothing of the actual value for actual value acquisition without encoder.
p9588	**Minimum current** The minimum current is the minimum current limit value required by the safe actual value acquisition without encoder.
p9589	**Acceleration limit** The acceleration limit defines the maximum rate of change of the motor velocity. The encoderless closed-loop control system precisely and reliably estimates and controls motor position and velocity.

Parameters

The following list contains the parameters of function "Safe encoderless actual value acquisition/ mechanical system".

Number	Name	Unit
p9506	SI function specification	-
p9509.0...2	SI behavior during pulse cancellation	-
p9585	SI actual value acquisition encoderless fault tolerance	-
p9586	SI actual value acquisition encoderless delay time	ms
p9587	SI actual value acquisition encoderless filter time	ms
p9588	SI actual value acquisition encoderless minimum current	Arms
p9589	SI actual value acquisition encoderless acceleration limit	%
r9784[0...1]	SI diagnostics encoderless acceleration	mm/s²
r9784[0...1]	SI diagnostics encoderless acceleration	rev/s²
r9785[0...1]	SI diagnostics encoderless minimum current	mA
r9786[0...2]	SI diagnostics encoderless angle	°
r9787	SI diagnostics encoderless velocity deviation	mm/min
r9787	SI diagnostics encoderless velocity deviation	rpm

13.14.12.2 Starting and stopping the motor with speed monitoring active

Overview

With the appropriate setting, the speed monitoring of Safety Integrated Functions also issues a safety-related signal to the higher-level control system even when the motor is switched off.

Precondition

After the motor has been switched off, it can be ruled out that the motor moves.

Function description

When the motor is switched off, the encoderless actual value acquisition does not calculate the motor speed. In the factory setting, when the motor is switched off, the converter resets the appropriate bit with which the Safety Integrated Function signals the safe state of the motor:

- r9722.09 and r9722.10: Active SLS limit value bit 0 and bit 1
- r9722.12 or r9722.13: SDI positive active or SDI negative is active
- r9722.15: SSM (speed below limit value)

When parameter p9509 is appropriately set, the feedback signal of the Safety Integrated Function remains active when the motor is switched off:

- p9509.00 = 0: SSM (speed below limit value) remains active when the motor is switched off.
- p9509.01 = 0: SDI positive or SDI negative remains active when the motor is switched off.
- p9509.02 = 0: Active SLS limit value bit 0 and bit 1 remain active when the motor is switched off.

If the feedback signal of the Safety Integrated Function remains active with the motor switched off, then the procedure to restart the motor depends on how the motor was stopped:

Selecting function STO stopped the motor while a Safety Integrated Function with speed monitoring was still active.

1. To start the motor, deselect function STO and start the motor within 5 seconds with an ON/OFF1 = 0 → 1 signal change. An OFF1, OFF2 or OFF3 command stopped the motor while a Safety Integrated Function with speed monitoring was still active. The converter internally activates function STO.
2. To deactivate the internal STO, select function STO.
3. To start the motor, deselect function STO and start the motor within 5 seconds with an ON/OFF1 = 0 → 1 signal change.

13.14.12.3 Starting the motor with speed monitoring active

Overview

A certain procedure is required to start a motor with an active Safety Integrated Function with velocity monitoring.

Precondition

A Safety Integrated Function with speed monitoring is active when the motor is switched off.

Function description

You have 5 seconds to start the motor with an ON/OFF1 = 0 → 1 signal change after activating the Safety Integrated Function.

Proceed as follows to start the motor with an active Safety Integrated Function and after 5 seconds has elapsed:

1. Select the STO function.
2. Deselect function STO again.
3. Start the motor with a signal change ON/OFF1 = 0 → 1 within 5 seconds.

13.14.13 Control

13.14.13.1 Control via PROFIsafe

Overview

For "Control via PROFIsafe", the higher-level control selects and deselects the Safety Integrated Functions via a PROFIsafe telegram.

Requirement

One of the two communications modules CM-DP or CM-PN must be inserted.

Function description

Using PROFIsafe, Safety Integrated Functions can be selected and deselected, and safety faults can be safely acknowledged.

Properties of the PROFIsafe profile of the converter:

- CRC length 3: PROFIsafe profile V2.4 (IEC 61784-3 Ed. 3)
- CRC length 4: PROFIsafe profile V2.6 MU 1 (IEC 61784-3 Ed. 4)

The PROFIsafe configuration has the following effects:

Configuration	Effect
F-source address (p9613) F-destination address (p9610)	When using PROFIsafe address type 1, the uniqueness of the PROFIsafe address is only ensured by the F-destination address. When using PROFIsafe address type 2, the uniqueness of the PROFIsafe address is ensured by the combination of F-source address and F-destination address. The PROFIsafe address must be unique throughout the network and the CPU. The PROFIsafe address is unique if these conditions are satisfied: • The F-source address of the F-CPU is unique throughout the network. • The F destination address of the converter is unique throughout the CPU.
F-monitoring time (p9614)	A valid, current PROFIsafe telegram must have been received from the F-CPU within the monitoring time. As a consequence, the converter ensures the following: • The converter detects a telegram failure and telegram error. • The converter response initiates that the F-CPU goes into a safe state.
Response to PROFIsafe failure (p9612)	Converter stop response for a telegram failure and telegram error

Parameters

The following list contains the parameters of the "PROFIsafe configuration" function.

Number	Name	Unit
p9610	SI PROFIsafe destination address	-
p9611	SI PROFIsafe telegram selection	-
p9612	SI stop response for failure or control fault	-
p9613	SI PROFIsafe source address	-
p9614	SI PROFIsafe F_watchdog time	ms
p10000.0...2	SI F-DI enable	-
p10002	SI F-DI changeover discrepancy time	ms
r10075.0...28	SI PROFIsafe control word	-
r10076	SI PROFIsafe SLS-LIMIT	-
r10080.0...28	SI status signals channel A	-

13.14.13.2 Telegram 30

Overview

Via the PROFIsafe telegram, the higher-level fail-safe controller activates the Safety Integrated Functions of the converter and receives feedback on the status of the Safety Integrated Functions.

Function description

The converter receives data cyclically from the higher-level failsafe control and sends its send data cyclically back to the failsafe control.

Process data	**Telegram 30**			
	Failsafe control → Converter		**Converter → Failsafe control**	
	Signal	**Explanation**	**Signal**	**Explanation**
PZD01	S_STW1	Safety control word 1	S_ZSW1	Safety status word 1

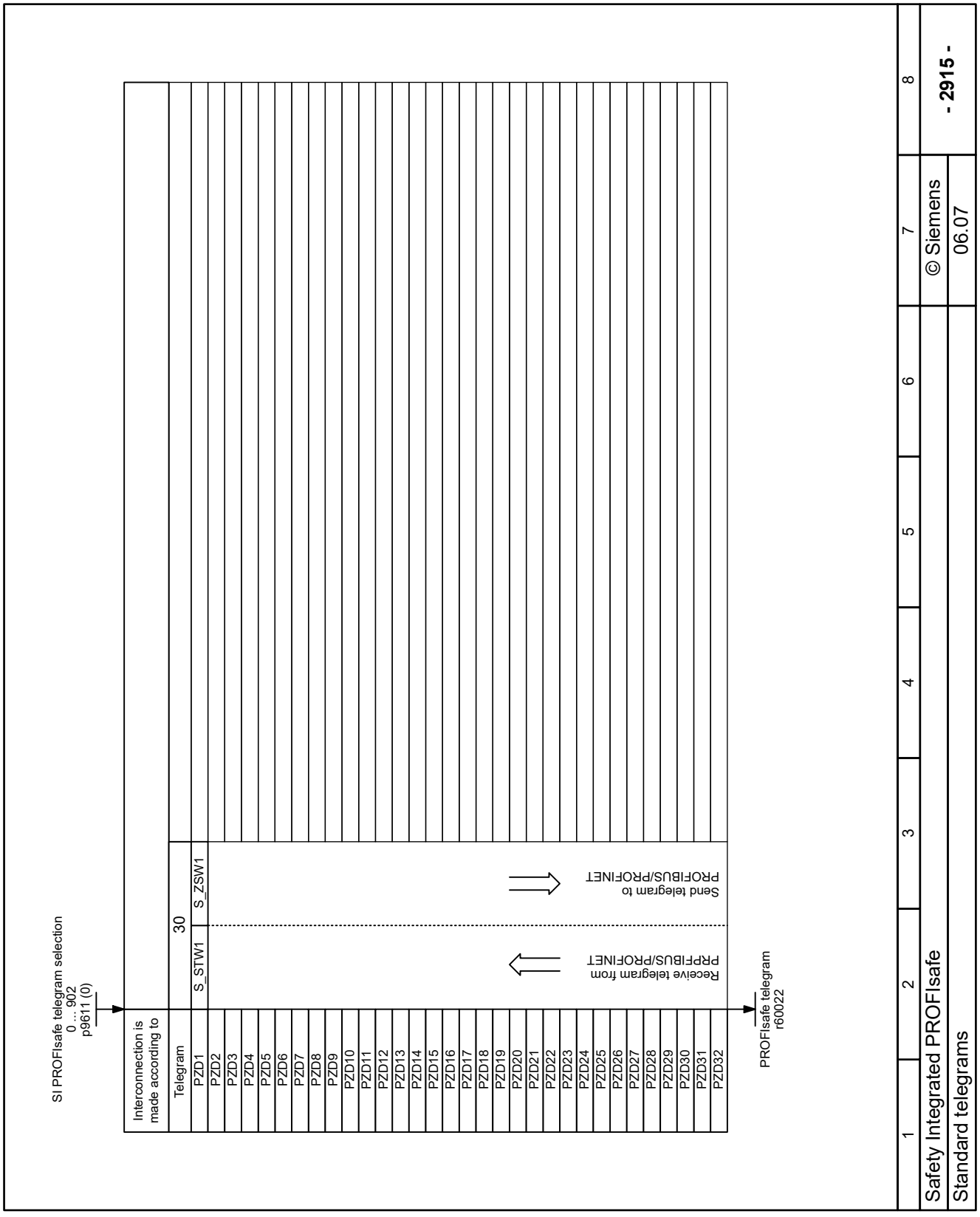


Figure 13-281 2915 – Standard telegrams

13.14.13.3 Telegram 902

Overview

Via the PROFIsafe telegram, the higher-level failsafe control activates the Safety Integrated Functions of the converter and receives feedback on the status of the Safety Integrated Functions.

Function description

The converter receives data cyclically from the higher-level failsafe control and sends its send data cyclically back to the failsafe control.

Process data	Telegram 902			
	Failsafe control → Converter		Converter → Failsafe control	
	Signal	Explanation	Signal	Explanation
PZD01	S_STW2	Safety control word 2	S_ZSW2	Safety status word 2
PZD02				
PZD03	S_SLS_LIMIT_A	Variable limit value for SLS	S_SLS_LIMIT_A_ACTIVE	Variable limit value for SLS
PZD04	---	Not assigned	Reserved	---
PZD05	---		Reserved	---
PZD06	---			

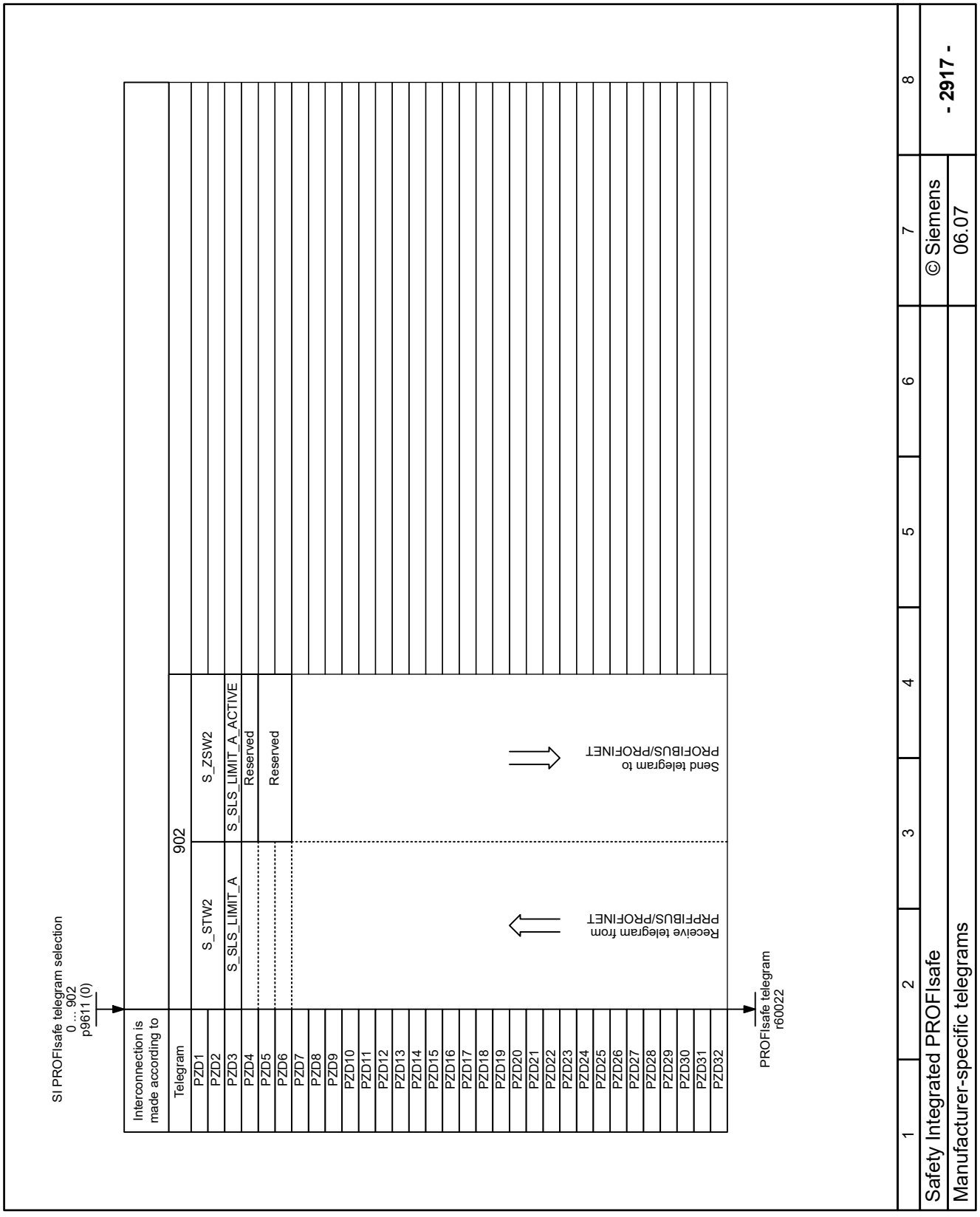


Figure 13-282 2917 - Manufacturer-specific telegrams

13.14.13.4 Safety control word 1 and safety status word 1

Overview

The higher-level control activates the Safety Integrated Functions of the converter using safety control word 1 (S_STW1).

The converter signals the status of the Safety Integrated Functions to the higher-level control using safety status word 1 (S_ZSW1).

Function description

Safety control word 1 (S_STW1)					
Failsafe control → Converter					
Bit	**Safety Integrated Function**	**Explanation**			
00	STO	1	Deselect STO		
		0	Select STO		
01	SS1	1	Deselect SS1		
		0	Select SS1		
02	SS2	1	Select SS2		
		0	Deselect SS2		
03	SOS	1	Select SOS		
		0	Deselect SOS		
04	SLS	1	Select SLS		
		0	Deselect SLS		
05, 06	Reserved	–	–		
07	Failsafe acknowledgment	0	–		
		1 → 0	Acknowledge "Internal event" for a 1 → 0 signal change		
08	SLA	1	Select SLA		
		0	Deselect SLA		
09	SLS limit value Bit 0	Select SLS limit value		Bit 1	Bit 0
10	SLS limit value bit 1		SLS1 SLS2 SLS3 SLS4	0 0 1 1	0 1 0 1
11	Reserved	–	–		
12	SDI positive	1	Deselect SDI with positive direction of rotation		
		0	Select SDI with negative direction of rotation		
13	SDI negative	1	Deselect SDI with negative direction of rotation		
		0	Select SDI with negative direction of rotation		
14	Reserved	–	–		
15	SSM	1	Deselect SSM		
		0	Select SSM		

Safety status word 1 (S_ZSW1)				
Converter → Failsafe control				
Bit	**Safety status**	**Explanation**		
00	STO active	1	STO is active	
		0	STO is not active	
01	SS1 active	1	SS1 is active	
		0	SS1 is not active	
02	SS2 active	1	SS2 is active	
		0	SS2 is not active	
03	SOS	1	SOS is active	
		0	SOS is not active	
04	SLS	1	SLS is active	
		0	SLS is not active	
05, 06	Reserved	–	–	
07	Internal event	1	The converter signals an "internal event"	
		0	Fault-free operation	
08	SLA active	1	SLA is active	
		0	SLA is not active	
09	Active SLS limit value bit 0		Bit 1	Bit 0
10	Active SLS limit value bit 1	SLS1	0	0
		SLS2	0	1
		SLS3	1	0
		SLS4	1	1
11	SOS selected	–	–	
12	SDI positive active	1	SDI positive direction of rotation is active	
		0	SDI positive direction of rotation is not active	
13	SDI negative active	1	SDI negative direction of rotation is active	
		0	SDI negative direction of rotation is not active	
14	Reserved	–	–	
15	Status SSM	1	Absolute value of the speed is less than or equal to the SSM limit value	
		0	Absolute value of the speed is greater than the SSM limit value	

Parameters

The following list contains parameters of function "Safety control word 1 and safety status word 1".

Number	Name	Unit
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-

13.14.13.5 Safety control word 2 and safety status word 2

Overview

The higher-level control activates the Safety Integrated Functions of the converter using safety control word 2 (S_STW2).

The converter signals the status of the Safety Integrated Functions to the higher-level control using safety status word 2 (S_ZSW2).

Function description

Safety control word 2 (S_STW2)						
Failsafe control → Converter						
Bit	**Safety Integrated Function**	**Explanation**				
00	STO	1	Deselect STO			
		0	Select STO			
01	SS1	1	Deselect SS1			
		0	Select SS1			
02	SS2	1	Deselect SS2			
		0	Select SS2			
03	SOS	1	Deselect SOS			
		0	Select SOS			
04	SLS	1	Deselect SLS			
		0	Select SLS			
05, 06	Reserved	–	–			
07	Failsafe acknowledgment	0	–			
		1 → 0	Acknowledge "Internal event" for a 1 → 0 signal change			
08	SLA	1	Deselect SLA			
		0	Select SLA			
09	SLS limit value bit 0	Select SLS limit value			Bit 1	Bit 0
10	SLS limit value bit 1			SLS1 SLS2 SLS3 SLS4	0 0 1 1	0 1 0 1
11	Reserved	–	–			
12	SDI positive active	1	Deselect SDI with positive direction of rotation			
		0	Select SDI with positive direction of rotation			
13	SDI negative active	1	Deselect SDI with negative direction of rotation			
		0	Select SDI with negative direction of rotation			
14	Reserved	–	–			
15	SSM	1	Deselect SSM			
		0	Select SSM			
16, 17	Reserved	–	–			

Safety control word 2 (S_STW2)			
Failsafe control → Converter			
Bit	**Safety Integrated Function**	**Explanation**	
18	SS1E	1	Deselect SS1E
		0	Select SS1E
19 ... 27	Reserved	–	–
28	SS2E	1	Deselect SS2E
		0	Select SS2E
29 ... 31	Reserved	–	–

Safety status word 2 (S_ZSW2)					
Converter → Failsafe control					
Bit	**Safety status**	**Explanation**			
00	STO active	1	STO is active		
		0	STO is not active		
01	SS1 active	1	SS1 is active		
		0	SS1 is not active		
02	SS2 active	1	SS2 is active		
		0	SS2 is not active		
03	SOS active	1	SOS is active		
		0	SOS is not active		
04	SLS active	1	SLS is active		
		0	SLS is not active		
05, 06	Reserved	–	–		
07	Internal event	1	The converter signals an "internal event"		
		0	Fault-free operation		
08	SLA active	1	SLA is active		
		0	SLA is not active		
09	Active SLS limit value bit 0			Bit 1	Bit 0
10	Active SLS limit value bit 1	SLS1 SLS2 SLS3 SLS4		0 0 1 1	0 1 0 1
11	Reserved	–	–		
12	SDI positive active	1	SDI positive direction of rotation is active		
		0	SDI positive direction of rotation is not active		
13	SDI negative active	1	SDI negative direction of rotation is active		
		0	SDI negative direction of rotation is not active		
14	Reserved	–	–		
15	Status SSM	1	The absolute value of the speed is less than the SSM limit		
		0	The absolute value of the speed is equal to or greater than the SSM limit		
16, 17	Reserved	–	–		

Safety status word 2 (S_ZSW2)			
Converter → Failsafe control			
Bit	**Safety status**	**Explanation**	
18	SS1E active	1	SS1E is active
		0	SS1 E is not active
19 ... 23	Reserved	–	–
24	F-DI 0	1	F-DI 0 has 0 signal
		0	F-DI 0 has 1 signal
25	F-DI 1	1	F-DI 1 has 0 signal
		0	F-DI 1 has 1 signal
26	F-DI 2	1	F-DI 2 has 0 signal
		0	F-DI 2 has 1 signal
27	Reserved	–	–
28	SS2E active	1	SS2E is active
		0	SS2E is not active
29	SOS selected	–	–
30, 31	Reserved	–	–

Parameters

The following list contains parameters of function "Safety control word 2 and safety status word 2".

Number	Name	Unit
r9720.0...28	SI control word	-
r9722.0...28	SI status signals	-
c10050[0...2]	SI status F-DI via PROFIsafe	-

13.14.13.6 Control via PROFIsafe and EMERGENCY STOP via terminal

Overview

For "Control via PROFIsafe and EMERGENCY STOP via terminal", the higher-level control selects and deselects the Safety Integrated Functions via a PROFIsafe telegram.

In addition, an F-DI of the converter is assigned a stop function for EMERGENCY STOP.

Requirement

One of the two communications modules CM-DP or CM-PN must be inserted.

Function description

Using PROFIsafe, Safety Integrated Functions can be selected and deselected, and safety faults can be safely acknowledged.

EMERGENCY STOP is permanently assigned to F-DI 0. The following functions can be selected:

- Safe Torque Off (STO)
- Safe Stop 1 (SS1)
- Safe Stop 1 with external stop (SS1E)

13.14.13.7 Control via terminal

Overview

The F-DI configuration includes the following steps:

- Assignment of Safety Integrated Functions to a failsafe digital input (F-DI)
- Defining the input modes of an F-DI

Description of function

The F-DI configuration allows the assignment of Safety Integrated Functions to the F-DI. After configuring the F-DI, the interconnected Safety Integrated Function can be selected and deselected.

In the F-DI configuration, it is also possible to set the input modes of an F-DI (p10040). The setting defines whether the F-DI should operate as NC contact/NC contact (default setting) or as NC contact/NO contact.

If the signal to select a Safety Integrated Function (c10026 ... c10035) is interconnected with the "Statically selected" value, then the Safety Integrated Function is continuously selected. After the converter supply voltage has been switched on, the Safety Integrated Function is permanently active.

13.14.13.8 Discrepancy time

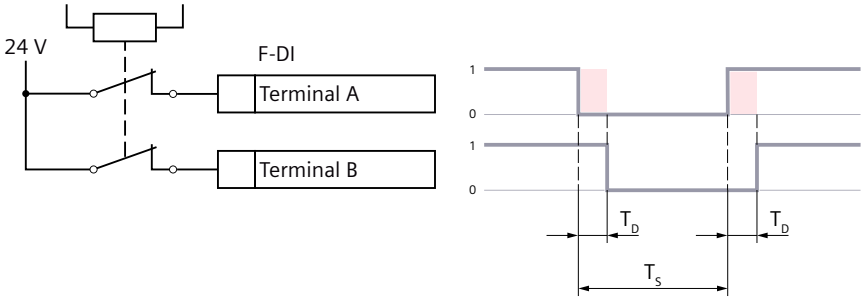
Overview

The converter tolerates brief, different logical signal states at a fail-safe digital input.

Function description

With electromechanical sensors, e.g. EMERGENCY STOP pushbutton or position switch, the two sensor contacts do not switch at exactly the same time.

During time T_D, the input signals of the F-DI have a different logical signal state.



T_D Temporary discrepancy

T_S Shortest switching interval to be expected

Figure 13-283 Signal states at the F-DI when switching a relay

There is an adjustable maximum discrepancy time p10002 so that the converter does not respond to a brief discrepancy with a safety message.

As a consequence, the converter tolerates a brief discrepancy. A permanent discrepancy signifies an error in the F-DI interconnection. In this case, after the discrepancy time has elapsed, the converter responds with a safety message.

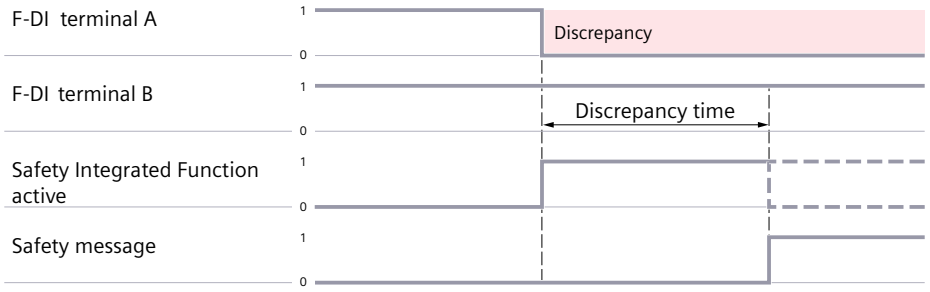


Figure 13-284 Safety message for continuous discrepancy at the F-DI terminal

A signal change at the F-DI terminal activates the Safety Integrated Function, which is assigned to the F-DI.

The safety message deactivates the Safety Integrated Function and the converter is stopped. The Safety Integrated Function remains active if the previously active Safety Integrated Function and the stop function are identical.

For p10002 the following applies:

- p10002 > T_D, to tolerate a brief discrepancy.
- p10002 < T_S, to be able to acquire even short signal changes at the F-DI.

The maximum discrepancy time p10002 does not extend the converter response time when a signal at the F-DI changes.

Parameters

The following list contains the parameters of the "Discrepancy time for F-DI" function.

Number	Name	Unit
p10002	SI F-DI changeover discrepancy time	ms

13.14.13.9 Input filter

Overview

The input filter suppresses unwanted brief signal changes at a failsafe digital input (F-DI).

Precondition

If the cable length at the digital input exceeds 30 m, then set the discrepancy time to a value greater than 20 ms.

Function description

If a failsafe digital input (F-DI) is interconnected with an electromechanical sensor, for example, then contact bounce leads to brief signal changes. In this case, an immediate response of the converter to signal changes is not desirable. Too many signal changes within a specific time result in a converter fault.

During the filter time (p10017) of the input filter, the converter ignores signal changes.

The input filter lengthens the response time of the Safety Integrated Function interconnected with the F-DI.

Parameters

The following list contains the parameters of the "Debounce time for the input filter" function.

Number	Name	Unit
p10017[0...2]	SI digital inputs input filter	ms
p10018	SI F-DI self test length dark pulses VS1/VS2	ms
c10035	SI SSM input terminal	-

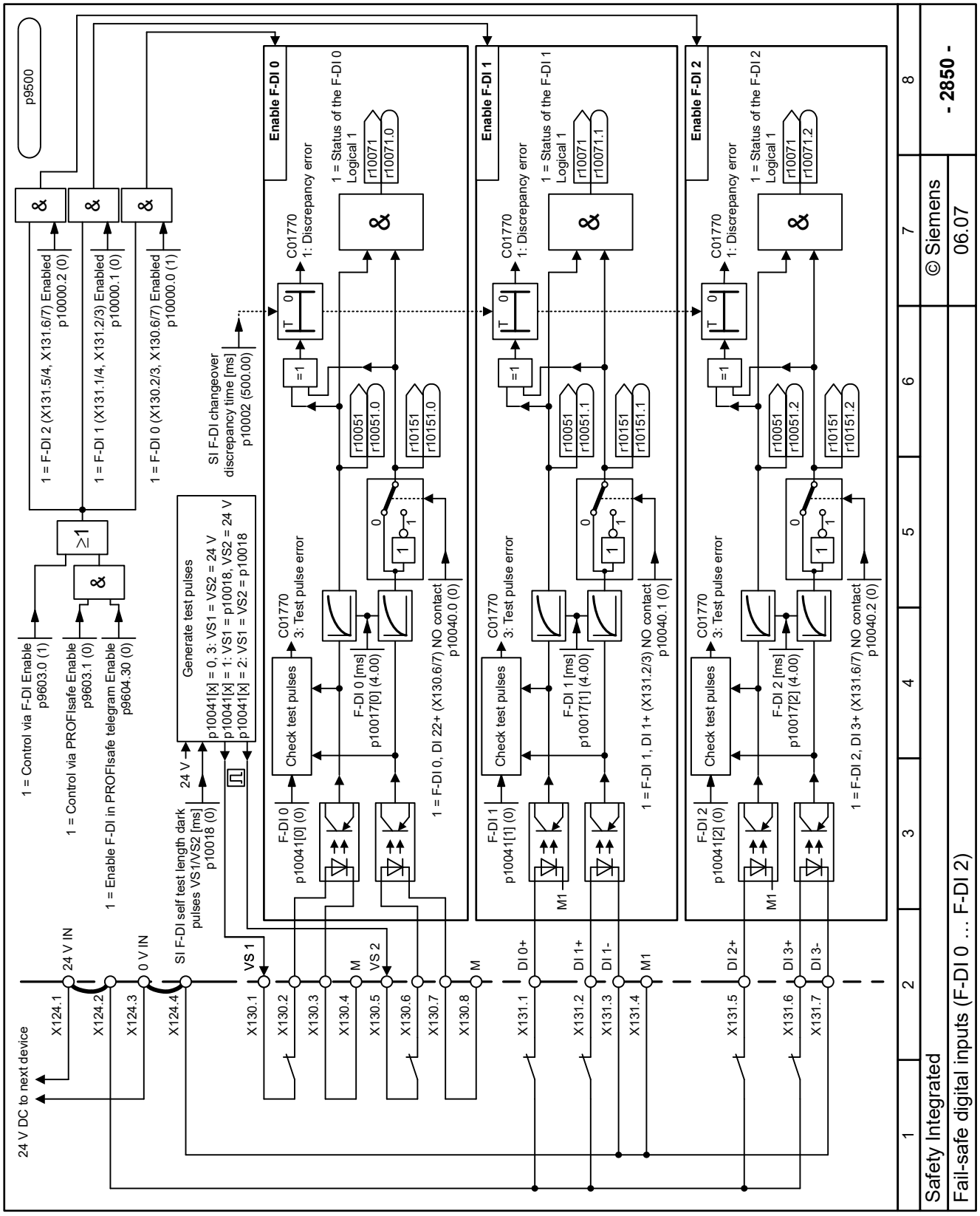


Figure 13-285 2850 - Fail-safe digital inputs (F-DI 0 ... F-DI 2)

Parameters

The following list contains the parameters of the "F-DI configuration" function.

Number	Name	Unit
p10000.0...2	SI F-DI enable	-
c10006	SI acknowledgment internal event F-DI	-
c10022	SI STO input terminal	-
c10023	SI SS1 input terminal	-
c10026	SI SLS input terminal	-
c10027	SI SLS limit bit 0 input terminal	-
c10028	SI SLS limit bit 1 input terminal	-
c10030	SI SDI positive input terminal	-
c10031	SI SDI negative input terminal	-
c10035	SI SSM input terminal	-
p10040.0...2	SI F-DI input mode	-

13.14.13.10 Self-test of the fail-safe digital input (F-DI)

Overview

The self-test detects whether a fail-safe digital input can be switched to the Low state. The converter responds with a fault if there is an unexpected feedback signal during the self-test.

Function description

The converter tests a fail-safe digital input continuously as soon as the fail-safe digital input is in the High state.

Different modes are available to test a fail-safe digital input (F-DI):

- Self-test with internal test signals: p10041 = 0
  The converter generates internal test signals for the input circuit of the F-DI. The test signals and the test cycle are predefined.
- Self-test using internally specified dark pulses: p10041 = 1
  The switchable power supply at the terminals generates dark pulses, to diagnose the control circuit, for example.
  The self-test detects a short-circuit to ground and to 24 V.

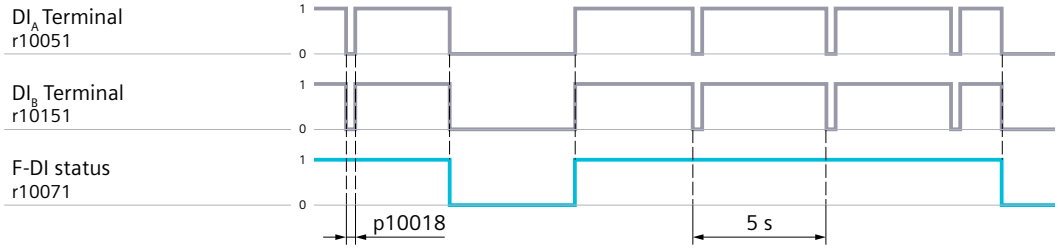


Figure 13-286 Dark pulses through switchable supply voltage VS 1

P10018 determines the length of the dark pulse. The cycle of the dark pulses has a fixed value of 5 seconds.
An undesirable converter response to the self-test is avoided by the input filter: p10017 > p10018 + 2 ms.
The higher the cable capacitance, the longer the dark pulses.

- Self-test using internally specified staggered dark pulses: p10041 = 2
  The converter provides both switchable power supplies at the terminals. These generate dark pulses, e.g. to diagnose the control circuit.
  The fail-safe digital input must be connected to different supply voltages:
  - VS 1 supplies terminal DI_A
  - VS 2 supplies terminal DI_B

  The self-test using specified dark pulses with VS 1 and VS 2 (p10041 = 2) detects a short-circuit to ground and 24 V as well as a cross circuit fault.

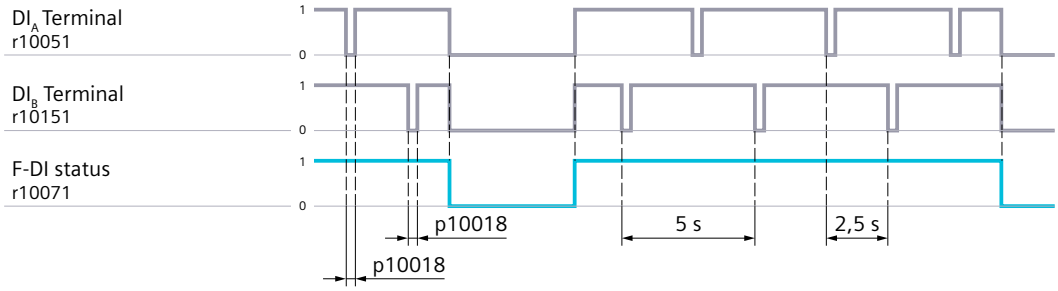


Figure 13-287 Dark pulses through switchable supply voltages VS 1 and VS 2.

P10018 determines the length of the dark pulse for VS 1 and VS 2. The cycle of the dark pulses has a fixed value of 5 seconds.
An undesirable converter response to the self-test is avoided by the input filter: p10017 > p10018 + 2 ms.
The higher the cable capacitance, the longer the dark pulses.

- Self-test with externally specified dark pulses: p10041 = 3
  An external control, e.g. F-CPU, generates dark pulses at the input terminals of a fail-safe digital input.
  If the self-test of the fail-safe input is activated, then the length of dark pulse must be longer than 0.5 ms.

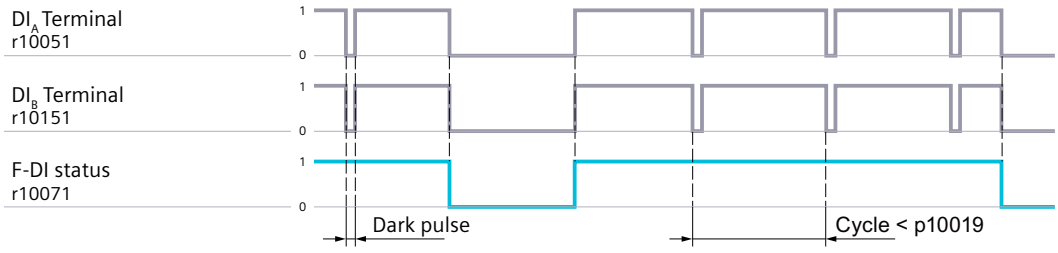


Figure 13-288 Dark pulses from external control system

The length of the dark pulse is predefined by the external control system. The maximum wait time for dark pulses (p10019) can be parameterized.
If the self-test of the fail-safe input is activated, then the length of dark pulse must be longer than 0.5 ms.
An undesirable converter response to the self-test is avoided by the input filter: p10017 > length of the dark pulse of the external control system + 2 ms.
The higher the cable capacitance, the longer the dark pulses.
The self-test monitors the cycle of the dark pulses. If the self-test does not detect a dark pulse during the wait time p10019, the converter responds with a fault.

Parameters

The following list contains the parameters of function "Self-test of the fail-safe digital input (F-DI)".

Number	Name	Unit
p10018	SI F-DI self test length dark pulses VS1/VS2	ms
p10019	SI F-DI self test external dark pulses wait time	s
p10041[0...2]	SI F-DI self test mode selection	-
r10071.0...2	SI F-DI status	-

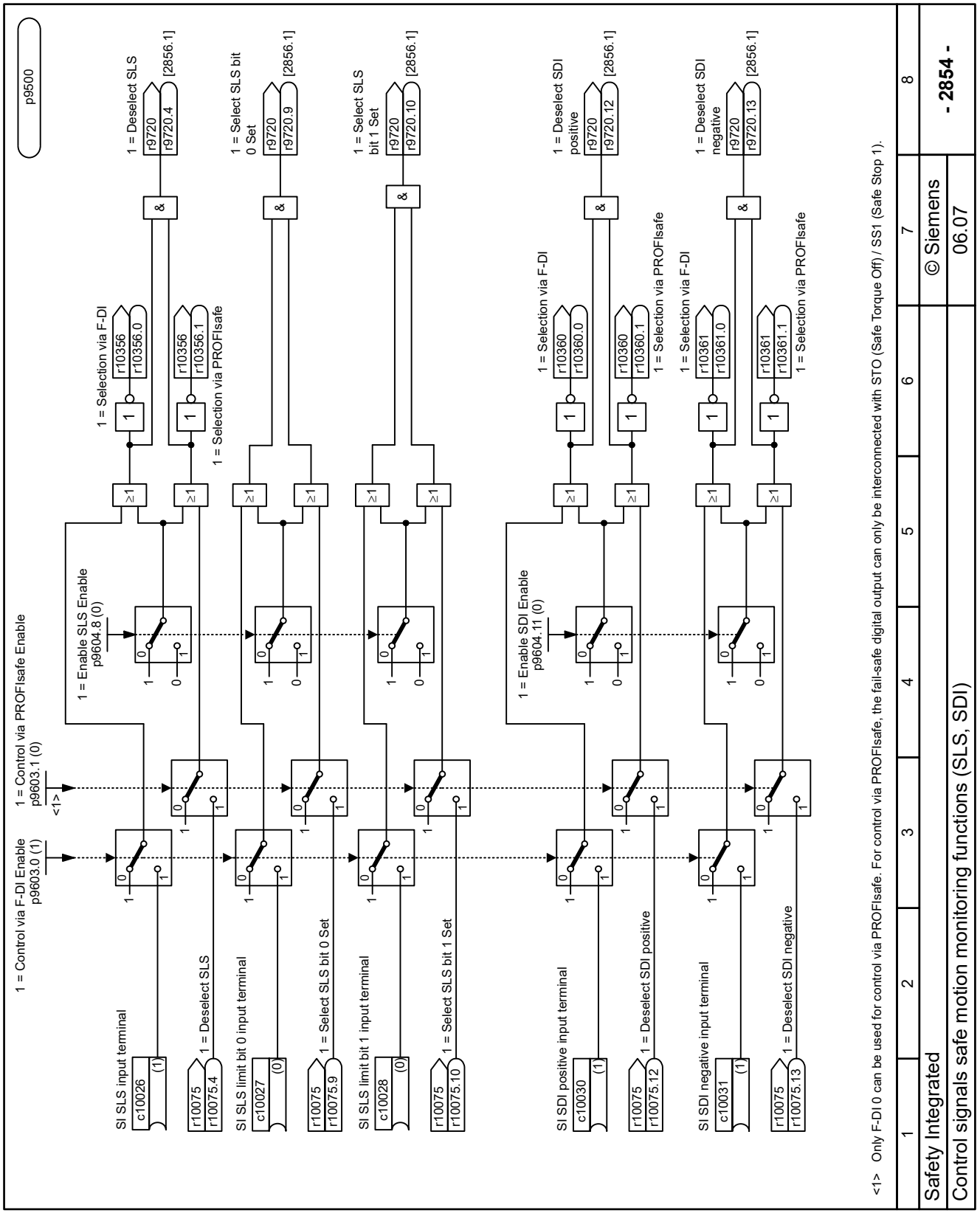


Figure 13-289 2854 – Control signals stop/motion monitoring function (SDI, SLS)

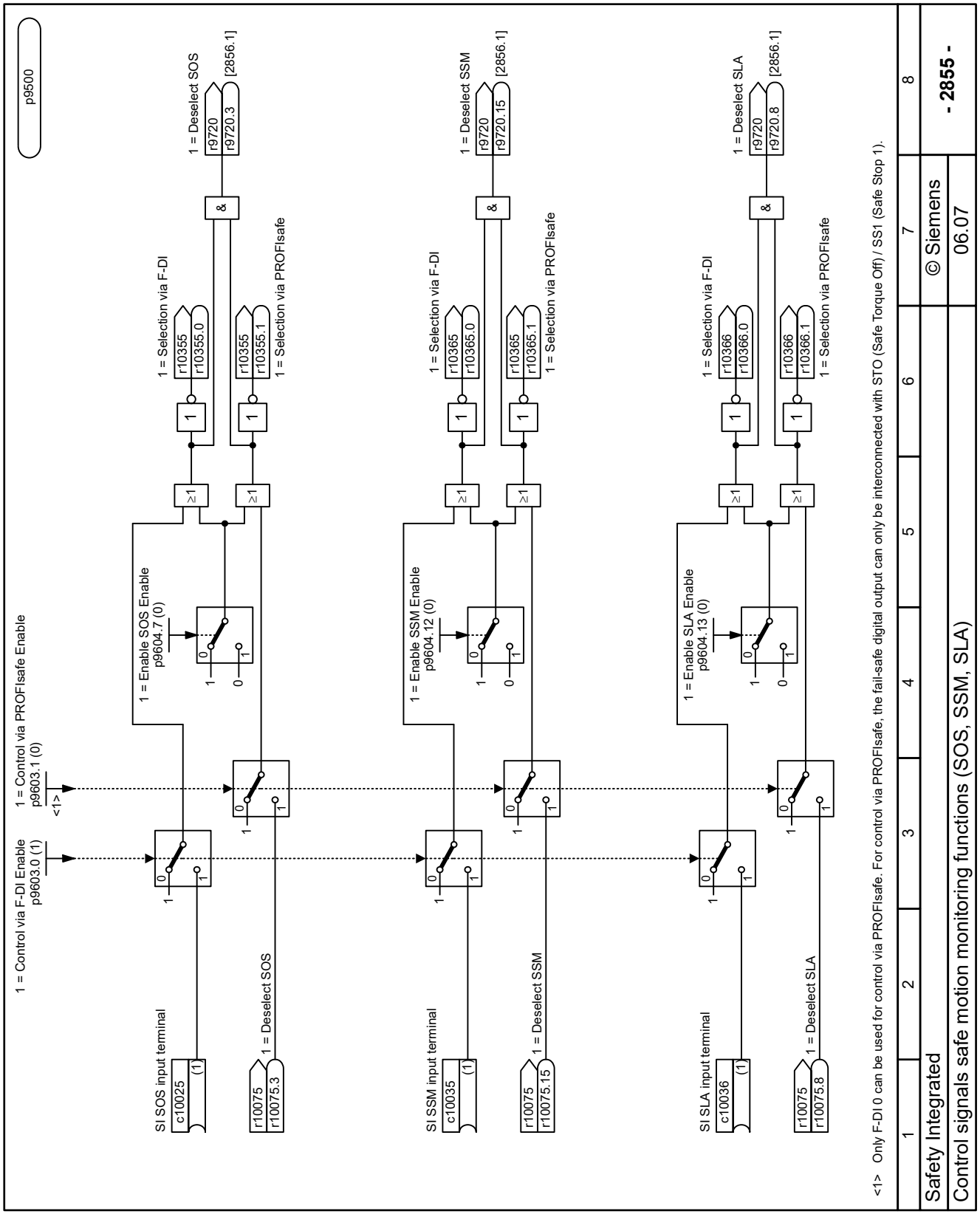


Figure 13-290 2855 – Control signals stop/motion monitoring functions (SSM, SOS, SLA)

13.14.13.11 F-DO configuration

Overview

The F-DO configuration interconnects up to 6 signals of the Safety Integrated Functions with the failsafe digital output (F-DO).

Requirement

To output the status of a Safety Integrated Function over the F-DO, the Safety Integrated Function must be enabled.

Description of function

The F-DO configuration interconnects multiple status signals with the failsafe output (F-DO). ANDing the following signals produces the status of the F-DO:

- Status of the Safety Integrated Functions
- Safe State
  The "Safe State" signal is the ORing of the statuses of multiple Safety Integrated Functions.

Parameters

The following list contains the parameters of the "Safe State and F-DO configuration" function.

Number	Name	Unit
p9603.0...1	SI control	-
r9722.0...28	SI status signals	-
r10038	SI Safe State status	-
p10039.0...11	SI Safe State signal selection	-
c10042[0...5]	SI F-DO 0 signals of the AND logic operation	-

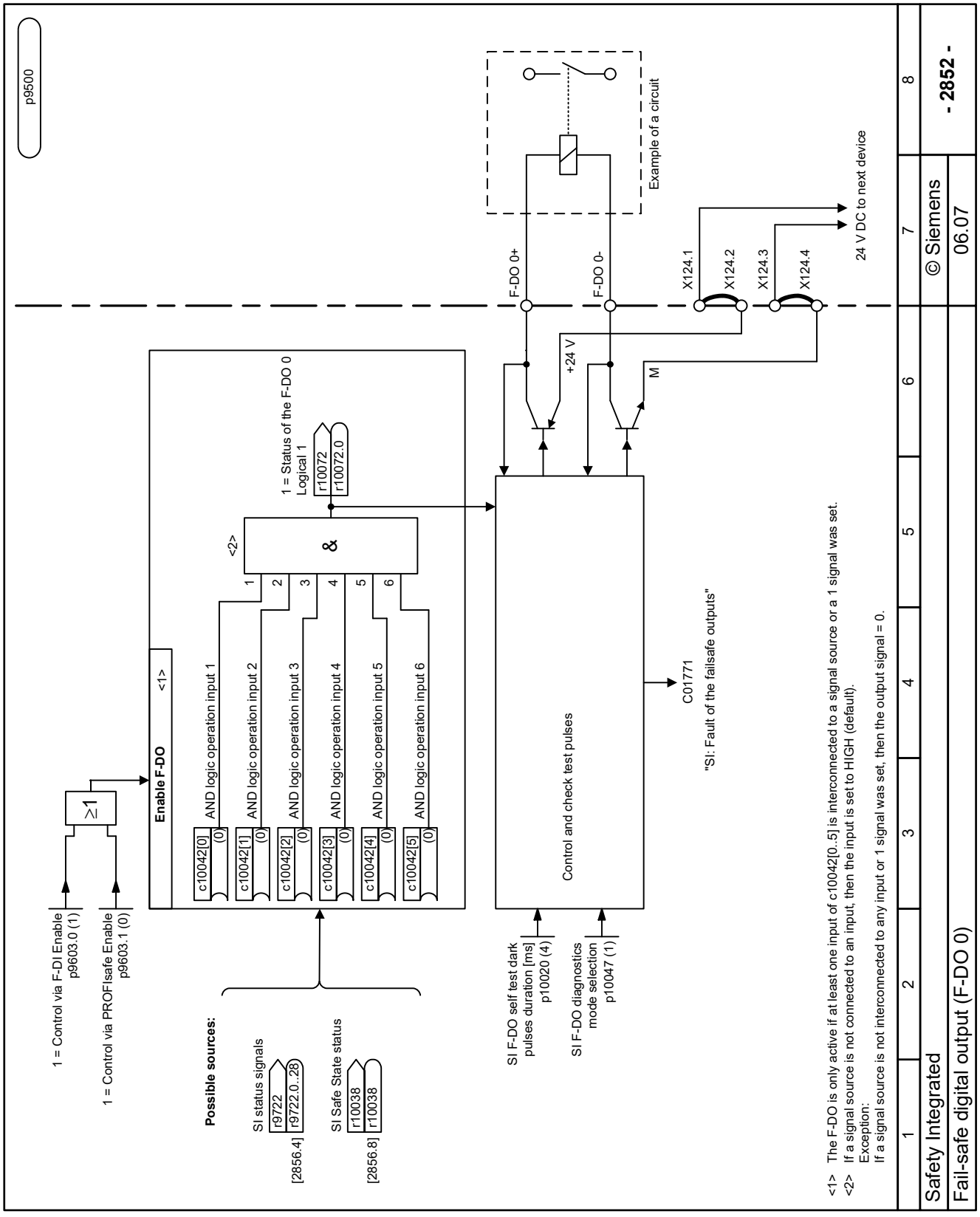


Figure 13-291 2852 – Fail-safe digital output (F-DO 0)

13.14.13.12 Self-test of the fail-safe digital output

Overview

The self-test detects whether the fail-safe digital output can be switched into the safe state.

- F-DO 0+ switches to the Low state
- F-DO 0- switches to the High state

The converter responds with a fault if there is an unexpected feedback signal during the self-test.

Description of function

Various modes are available for the self-test of a fail-safe digital output (F-DO):

- Diagnostics using internal feedback signals: p10047 = 0
  The self-test continuously monitors the activation and feedback, and detects errors in the output circuit.
- Self-test using internally specified dark pulses: p10047 = 1
  The self-test continuously monitors the activation and feedback, and detects errors in the output circuit. The converter also outputs dark pulses as soon as the fail-safe digital output is in the High state.
  The dark pulses at the output terminals reveal errors outside the converter.
  P10020 determines the length of the dark pulse. The test cycle of the dark pulses has a fixed value of 5 seconds.

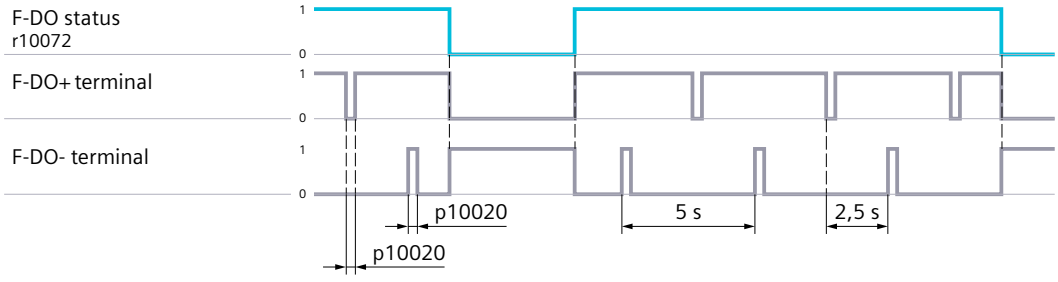


Figure 13-292 Dark pulses

Parameters

The following list contains the parameters of the "Self-test of the fail-safe digital output" function.

Number	Name	Unit
p10020	SI F-DO self test dark pulses duration	ms
p10047	SI F-DO diagnostics mode selection	-
r10072.0	SI F-DO status	-

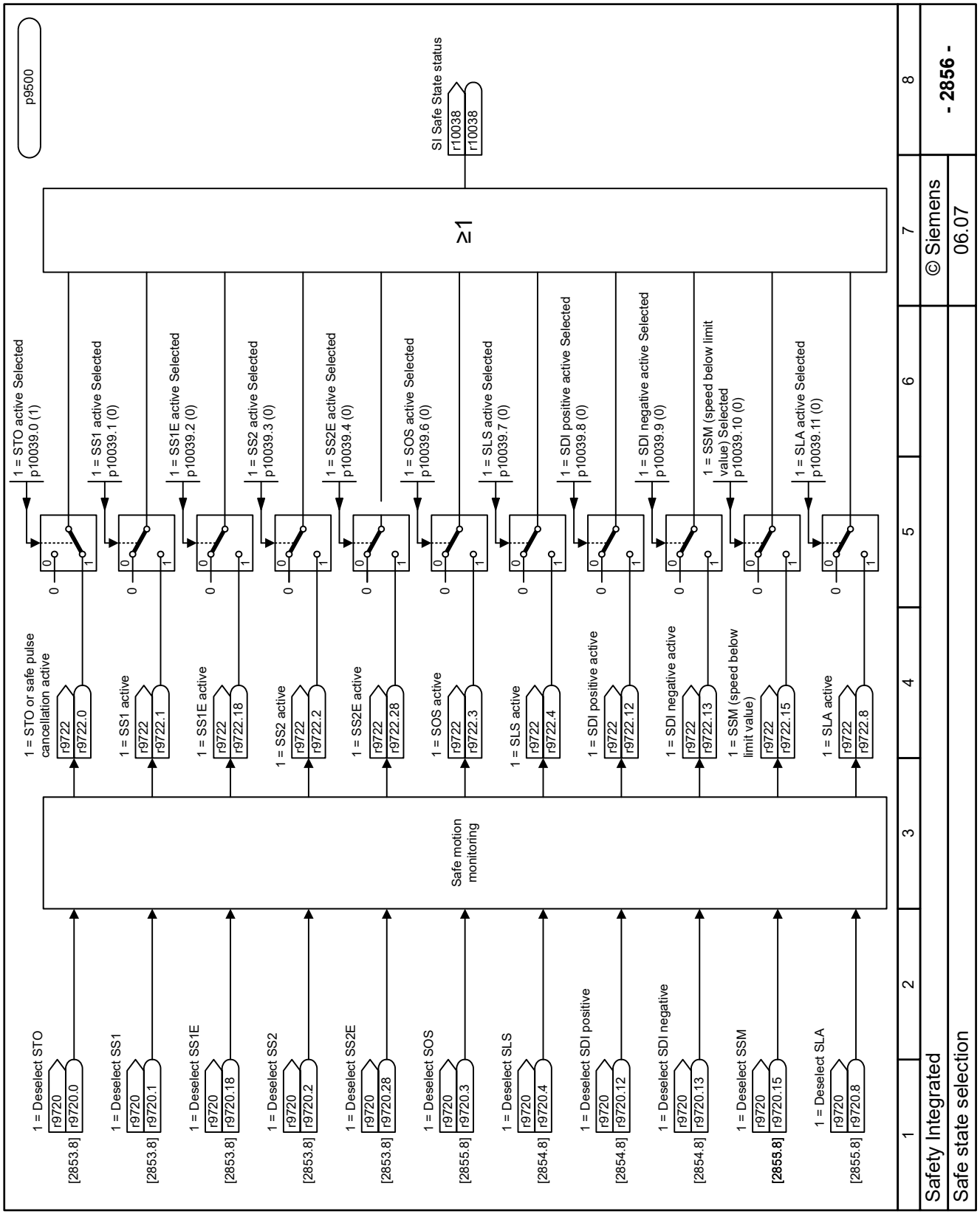


Figure 13-293 2856 – Safe state selection

13.14.14 Checksums of Safety Integrated Functions

Overview

The checksums correspond to a fingerprint or the parameterized Safety Integrated functionality of the converter.

Function description

Once commissioning has been completed, the converter calculates the checksums.

Functional checksum (r9780) and time stamp (r9781 and r9782) are used to track changes (safety logbook). The checksum is updated after completing the Safety Integrated commissioning.

Based on the checksum of functions (p9799 and r9798) and PROFIsafe (p9797 and r9796), it can be identified whether the parameterization of the Safety Integrated Functions or the PROFIsafe parameterization was changed.

An acceptance test is required after changing the checksums. The system outputs the appropriate messages to indicate that an acceptance test is required. The checksums are used for documentation purposes within the scope of an acceptance test.

Parameters

The following list contains the parameters for "Checksums of Safety Integrated Functions".

Number	Name	Unit
r9780[0...1]	SI checksum to check changes	-
r9781[0...1]	SI change control time stamp days	-
r9782[0...1]	SI change control time stamp milliseconds	ms
r9796	SI actual checksum PROFIsafe addresses	-
p9797	SI reference checksum PROFIsafe addresses	-
r9798	SI actual checksum over the drive configuration	-
p9799	SI reference checksum over the configuration of the drive	-

13.14.15 Firmware versions of the Safety Integrated Functions

Function description

The Safety Integrated Functions comprise the following firmware versions:

- SINAMICS Safety Integrated Firmware version of the Control Unit
- I/O processor firmware version of channel A
- I/O processor firmware version of channel B
- Encoder firmware version

- OM-SMT firmware version
- Safety BIOS firmware version

The firmware versions represent information for service, update and for the documentation in the acceptance report.

13.14.16 Acceptance - completion of commissioning

Overview

The machine manufacturer is responsible in ensuring that the plant or machine functions perfectly. As a consequence, after commissioning, the machine manufacturer must check those functions which represent an increased risk of injury or material damage, or have them checked by specialist personnel. This acceptance or validation is specified in the European Machinery Directive and comprises 2 parts:

- **Acceptance test:** Check the safety-relevant functions and machine parts after commissioning.
- **Documentation:** Generate an "Acceptance report" that describes the test results.

ISO 13849-1 provides additional information relating to validation, for example. The acceptance test requirements (configuration check) for the safety functions of electric drives are based on IEC 61800-5-2.

Description

Acceptance test of the machine or plant

The acceptance test checks whether the safety-relevant functions in the plant or machine function correctly. The documentation of the components used in the Safety Integrated Functions can also provide information about the tests required. Testing the safety-relevant functions includes, e.g. the following:

- Is all safety equipment, such as protective door monitoring devices, light barriers or EMERGENCY STOP buttons, connected and ready for operation?
- Does the higher-level control respond as expected to the safety-relevant feedback signals of the drive?
- Do the drive settings match the configured safety-relevant function in the machine?

Acceptance test of the converter

The acceptance test of the converter is a part of the acceptance test of the entire machine or plant.

The acceptance test of the converter verifies whether Safety Integrated Functions have been set to match the configured Safety Functions of the machine. The acceptance test documents the settings with which the real function fulfills the intended functionality.

Documentation

The documentation encompasses the following:

- Result of the acceptance tests
- Settings of the Safety Integrated Functions
- Firmware versions

The documentation must be signed.

Persons authorized to perform the acceptance test

Personnel from the machine manufacturer, who, on account of their technical qualifications and knowledge of the safety functions, are in a position to perform the acceptance test in the correct manner are authorized to perform the acceptance testing of the converter and the motor.

13.14.17 Responses to safety messages

13.14.17.1 Stop responses

Requirement

Safety Integrated Functions STO and SS1 are set so that they fit the specific application.

Function description

The converter triggers a fault reaction in response to certain events:

- Stop response Safe Channel Failure (SCF)
  In the Safety Integrated monitoring channels, the converter detects an error in the result and data comparison.
  If at least one safety function is selected, then the stop response SS1/SS1E is initiated after time p9555.
  Parameter p9561 defines whether the converter initiates an SS1 or an SS1E after stop response Safe Channel Failure (SCF).
- Stop response STO or SS1
  The converter detects a limit violation, for example involving the Safely-Limited Speed (SLS) function. The stop response is settable.
  If stop response SS1 is set, stop response STO automatically follows when the motor comes to a standstill.

It is not possible to select a stop response externally, for example via PROFIsafe.

All stop responses bring the motor to a standstill.

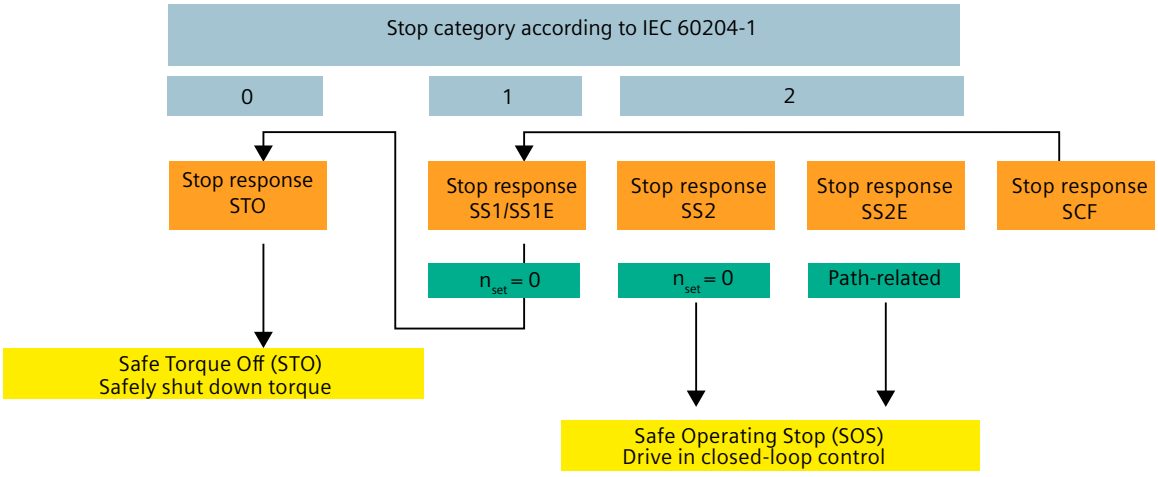


Figure 13-294 Stop responses

13.14.17.2 Fail-safe acknowledgment of safety messages

Overview

In the event of safety messages, e.g. due to limit value violations of the motor with active Safety Integrated Functions, the converter detects an internal event.

A safety message requires a fail-safe acknowledgement.

Precondition

You checked and eliminated the cause of the internal event.

Procedure

You must acknowledge safety messages with a fail-safe signal. You have the following options for fail-safe acknowledgement:

- Failsafe digital input (F-DI)
  Acknowledge the internal event with a positive edge at an F-DI that is interconnected with c10006 ("SI acknowledgment internal event F-DI"):
  F-DI = 0 → 1 → 0
  If PROFIsafe is activated, failsafe acknowledgement via F-DI is not possible.
- PROFIsafe
  Acknowledge the fault with bit 7 of safety control word 1 or 2: Bit 7 = 0 → 1 → 0
- Select and deselect STO or SS1/SS1E
  Select the Safety Integrated Function STO or SS1/SS1E and then deselect again:
  - Via F-DI = 1 → 0 → 1
    or
  - With bit 0 or 1 of the PROFIsafe safety control word 1 or 2: Bit 0 or 1 = 1 → 0 → 1

- Switching the supply voltage off and on
  Temporarily switch the power supply of the converter off and on again.
- Additional acknowledgement via the "standard" acknowledgement signal
  Safety Integrated uses its own message type (C) in the factory setting. When you reparameterize safety messages via p3117 as an alarm (A) or fault (F), you must additionally acknowledge the internal event with the "standard" acknowledgment signal.

13.15 Technology functions

13.15.1 Basic positioner

13.15.1.1 License for the basic positioner

Description

The "Basic positioner" function is subject to licensing.

13.15.1.2 Overview of the basic positioner

Overview

Position control means controlling the position of an axis. An "axis" is a machine or system component that comprises the converter with active position control and the driven mechanical system.

The basic positioner (EPOS) is a positioner integrated in the converter and calculates the traversing profile for the time-optimized traversing of the axis to the target position for the position controller. With the basic positioner (EPOS), the positioning tasks can be transferred to the converter and thus relieve the higher-level control system.

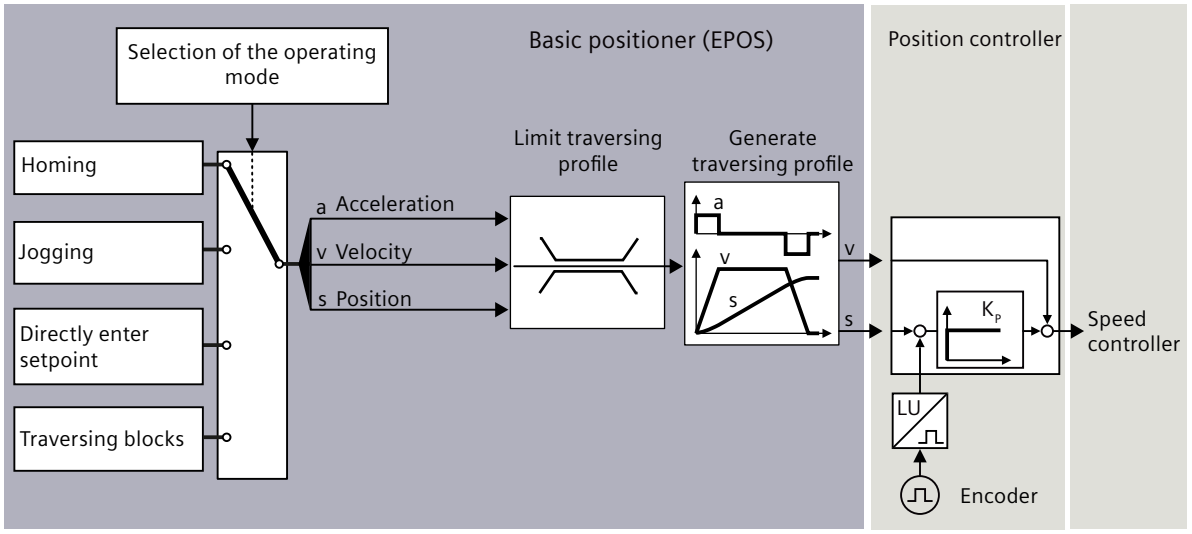


Figure 13-295 Basic positioner and position control

Description of function

The following functions can be carried out by using the basic positioner:

- **Limits**
  - Limiting the traversing range: specification of the possible traversing range through the configuration of positive and negative software limit switches, and positive and negative hardware limit switches
  - Limiting the traversing profiles: restriction of the dynamic travel response through limitation of the maximum velocity, acceleration, deceleration, and jerk
- **Monitoring**
  - Position/standstill monitoring: monitoring of the axis positioning motion and monitoring of the axis position after a traversing motion
  - Following error monitoring: monitoring of the maximum deviation between the actual value and the setpoint
- **Homing**
  Homing establishes the reference between the coordinate origin of the drive axis and the machine zero point. When homing, the absolute position of the measuring system used for EPOS is determined. Possible homing types are:
  - Active homing
  - Passive homing
  - Absolute encoder adjustment
- **Traversing blocks**
  Position, velocity, and acceleration are saved in different traversing blocks in the converter. The external control selects a traversing block.

- **Direct setpoint input (MDI)**
  The external control specifies the setpoints (position, velocity, and acceleration) for the axis.
- **Jogging**
  This function is used to traverse the axis in jog mode.

More information

For more information about configuring the basic positioner (EPOS) in Startdrive, see the information system of the TIA Portal.

13.15.1.3 Axis type

Overview

Axes in your actual application can be configured with different motion control applications:

- For speed control applications: flexible control of the speed and direction of rotation of rotary axes
- For positioning control applications: relative/absolute positioning of rotary or linear axes (depending on mechanics)

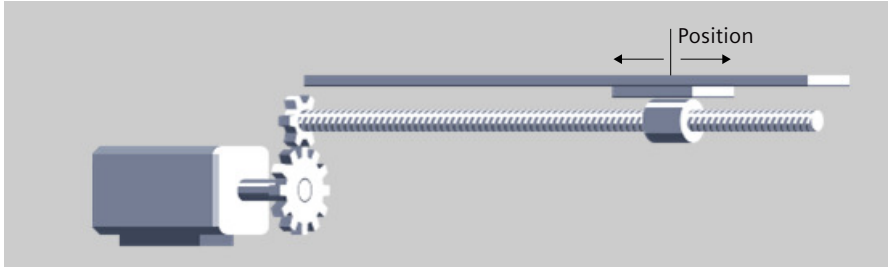
Description of function

Linear axis

A linear axis is an axis whose traversing range is limited in both motor directions of rotation by the mechanical system of the machine, for example:

- Stacker crane
- Elevating platform
- Tilting station
- Gate/door drive
- Conveyor belt
- Roller conveyor

For linear axes, the position of the axis is specified as a linear measure, for example, millimeters (mm).



Rotary axis

A rotary axis is an axis with an infinite traversing range, for example:

- Rotary table

For rotary axes, the position of the axis is specified as an angular measure, for example, degrees (°).



13.15.1.4 Units of measurement

Overview

In addition to physical units, the converter also supports the length unit (LU) for positioning operation.

Description of function

- **Physical units (default setting)**
  The converter provides the physical units for position, speed, acceleration/deceleration, and jerk. You can select the desired physical units according to the actual axis type via relevant parameters during commissioning.

Axis type	Available physical units	
	Position	**Velocity**
Linear axis	km, m, **mm**, µm, nm, in, ft, mi	km/h, km/min, m/h, m/min, m/s, mm/h, mm/min, **mm/s**, in/min, in/s, ft/min, ft/s, mi/h
Rotary axis	**degree (°)**	**degree (°)/s**

Note:

Units in bold are the default units.

The acceleration is set accordingly as the position/s^2 measurement unit.

The jerk is set accordingly as the position/s^3 measurement unit.

- **Length Unit**
  The converter calculates the position actual value of the axis using the neutral position unit LU (Length Unit). The length unit LU is independent of whether the converter controls the position of an elevating platform or the angle of rotary table.

Note

If you change the axis type from linear axis to rotary axis or vice versa, the units will be set to default units automatically.

The settings you made will not be converted when changing the units.

13.15.1.5 Load gear position tracking

Overview

Position tracking enables the load position to be reproduced when using gearboxes. It can also be used to extend the position range.

Requirement

- Using an absolute encoder

Description of function

Position tracking of the load gear is activated via parameter p2720.0 = 1 and is only relevant for a motor encoder. The load gear ratio is entered via parameters p2504 and p2505. Position tracking can be activated with rotary axes (modulo) and linear axes.

Position tracking for the load gear can only be activated once for each motor data set MDS.

The load actual position value in r2723 (must be requested via G1_STW.13) comprises the following information:

- Encoder pulses per revolution (p0408)
- Fine resolution per revolution (p0419)
- Virtual number of stored revolutions of a rotary absolute encoder (p2721)
- Load gear ratio (p2504/p2505)

Note

The sum of p0408, p0419 and p2721 is limited to 32 bits.

Features

- Configuration of p2720
- Virtual multiturn via p2721
- Tolerance window for monitoring the position at switching on p2722
- Input of the load gear via p2504 and p2505
- Display via r2723

Commissioning the function

You can commission the load gearbox via parameter p2720 as follows:

- p2720.0: Activation of position tracking
- p2720.2: Reset position
  The position values stored in a non-volatile fashion are reset for the following events:
  - When encoder replacement is detected.
  - When the configuration of the encoder data set (EDS) is modified.
  - When the absolute encoder is adjusted again.

Note

If position tracking of the load gear is activated with parameter p2720[0] = 1 (position gear load tracking) after the encoder is adjusted (p2507 = 3), the adjustment will be reset.

If the encoder is adjusted again when load position tracking is active, the load gear position will be reset (overflows).

The permissible position tracking range is mapped on the reproducible encoder range of EPOS.

It is possible to activate position tracking for several DDS.

Virtual multiturn (p2721)

The virtual multiturn resolution is used to set the number of resolvable load rotations for an absolute encoder with activated position tracking.

Note

The repeatability after power-off/power-on is specified by p0419. If you reduce the value of p0419 too much for a higher virtual multiturn resolution, the lower accuracy you get.

With activated position tracking (p2720.0 = 1), parameter p2721 is preset with p0421 and can be changed.

Note

If the gear ratio is not equal to 1, then p2721 always refers to the load side. The virtual resolution, which is required for the load, is then set here.

Example: Single-turn encoder

The value for p2721 is preset to 1. However, parameter p2721 can be altered subsequently, e.g. the user can program p2721 = 5. As a result, the encoder evaluation initiates five load rotations before the same absolute value is achieved again.

Example: Multiturn encoder

The value for p2721 is set to 4096 for an encoder with p0421 = 4096. If, as a result of extension of the multiturn information, the displayable area of r2723 (32 bits) is exceeded, the fine resolution (p0419) must be reduced accordingly.

Tolerance window (p2722)

After switching on, the difference between the stored position and the current position is determined and initiated depending on the following:

Difference within the tolerance window -> the position is reproduced based on the current actual encoder value.

Difference outside the tolerance window -> an appropriate fault (F07449) is output.

Note

When the fault F07449 occurs, click the reset button in Startdrive to reset the position tracking first and then acknowledge the fault.

If the telegrams 112 and 113 are used, you can also acknowledge the fault F07449 by setting POS_STW2, bit3 to 1 and 0 twice. After the acknowledgment, the position is set to the values of REF_COORDINATE_D and the absolute encoder is adjusted (p2507 = 3).

The tolerance window is preset to quarter of the encoder range and can be changed.

Note

The position can only be reproduced if, in the powered-down state, the encoder was moved through less than half of the range that it can represent. For the standard multiturn encoder, this is 2048 revolutions or half a revolution for single-turn encoders.

Note

The ratio stamped on the gear rating plate is often just a rounded-off value (e.g. 1:7.34). If, for a rotary axis, it is not permissible to have any long-term drift, then the actual ratio of the gearbox teeth must be requested from the gearbox manufacturer.

Example

Position range extension

With absolute encoders without position tracking, it must be ensured that the traversing range around 0 is less than half the encoder range, because beyond this range, no unique reference remains after switching on and off (see description on parameter p2507). This traversing range can be extended using the virtual multiturn (p2721).

The following diagram illustrates an absolute encoder that can represent eight encoder revolutions (p0421 = 8).

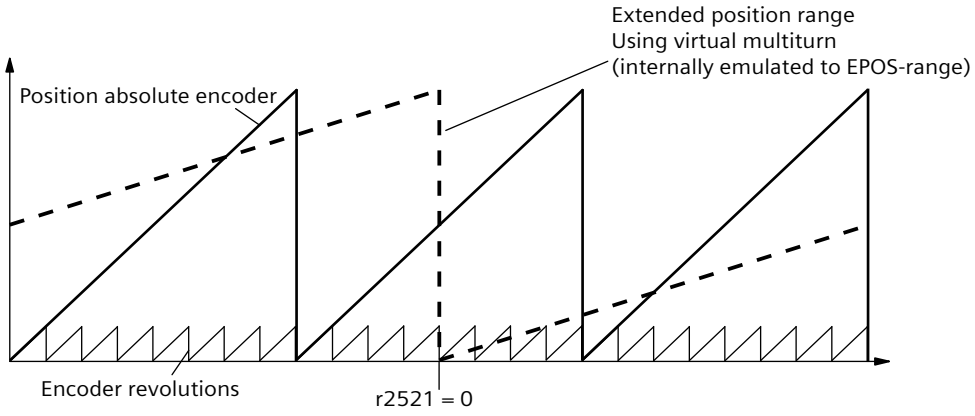


Figure 13-296 Position tracking (p2721 = 24), setting p2504 = p2505 =1 (gear ratio = 1)

In this example, this means:

- Without position tracking, the position for +/- 4 encoder revolutions around r2521 = 0 LU can be reproduced.
- With position tracking, the position for +/- 12 encoder revolutions (+/- 12 load revolutions with load gear) can be reproduced (p2721 = 24).

Parameters

The following list contains the parameters of function "Position tracking".

Number	Name	Unit
p0404[0...n].0...30	Encoder configuration effective	-
p0408[0...n]	Rotary encoder pulse number	-
p0421[0...n]	Absolute encoder rotary multiturn resolution	-
p2504[0...n]	LR motor/load motor revolutions	-
p2505[0...n]	LR motor/load load revolutions	-
p2507[0...n]	LR absolute encoder adjustment status	-
p2720[0...n].0...2	Load gear configuration	-
p2721[0...n]	Load gear rotary absolute encoder revolutions virtual	-
p2722[0...n]	Load gear position tracking tolerance window	-
r2723[0...n]	Load gear absolute value	-

13.15.1.6 Measuring gearbox position tracking

Overview

The position tracking for measuring gearboxes extends the position range of an absolute encoder.

Requirement

An absolute encoder acquires the position for the position controller.

Function description

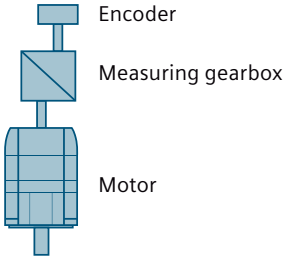


Figure 13-297 Measuring gearbox

Position tracking for measuring gearboxes addresses applications in which a mechanical gearbox is installed between the rotating motor and the absolute encoder for closed-loop position control.

The position tracking extends the position range of the encoder by virtual multiturn p0412.

The maximum resolution of position action values of 2^{32} bit also applies to the extended position range. If the extended position range exceeds the maximum resolution, then the fine resolution p0419 must be appropriately reduced.

Parameters p0432 and p0433 define the gear ratio of the measuring gearbox.

The gear ratio of the measuring gearbox compensates a possible offset between the zero positions of the encoder and the motor.

A 1 signal of parameter p0411.0 activates the position tracking of the measuring gearbox.

The converter saves the position actual value when the voltage fails. After the voltage returns, the converter compares the saved position actual value with the currently measured position actual value. The converter signals a fault if the difference between the two position actual values is greater than p0413.

Example

The measuring gearbox has a ratio p0433/p0432 = 1:3. This means that for 1 motor revolution the encoder makes 3 revolutions.

When position tracking is inactive, the load position after an encoder overflow can no longer be clearly reproduced.

When position tracking is activated via p0411.0 = 1, the converter takes into account the gearbox ratio with encoder position value r0483 and virtual multiturn p0412.

The absolute encoder has a multiturn resolution p0421 of 8 encoder revolutions.

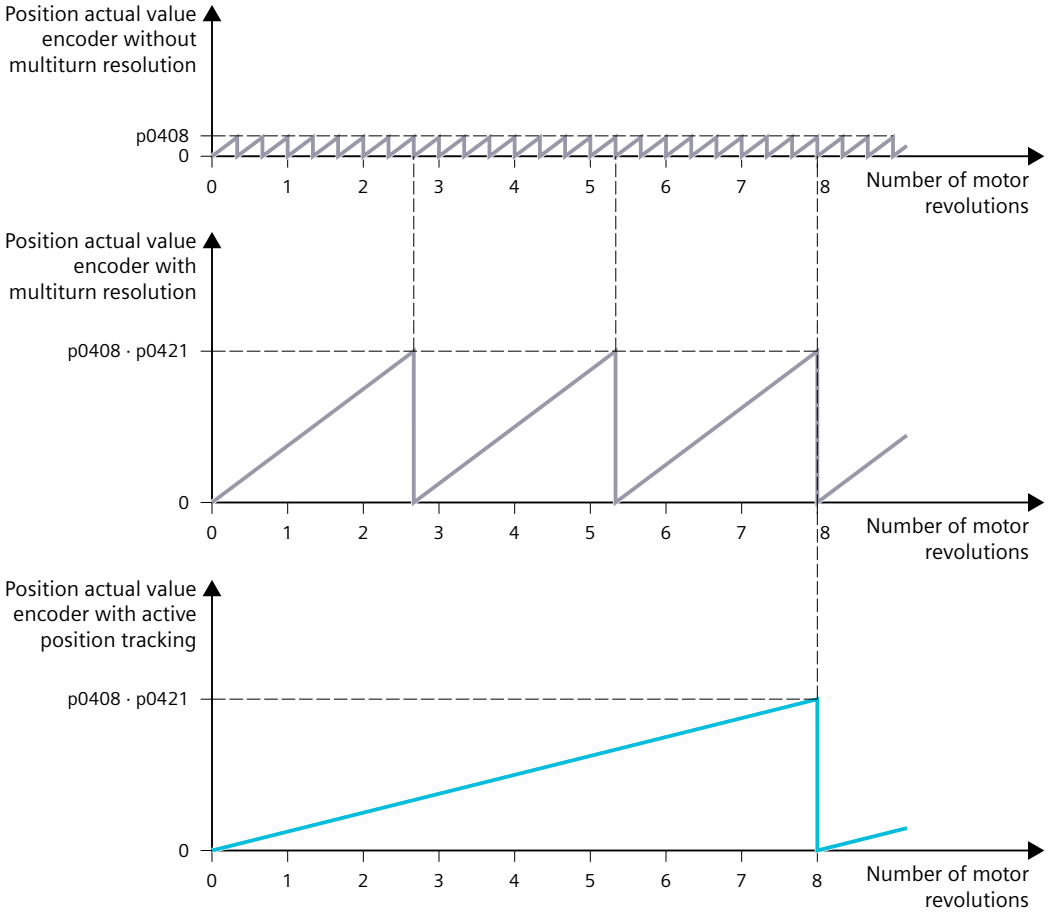


Figure 13-298 Example of load tracking for an encoder gearbox

Parameters

The following list contains the parameters of function "Position tracking" for a measuring gearbox.

Number	Name	Unit
p0402[0...n]	Gearbox type selection	-
p0411[0...n].0...3	Measuring gearbox configuration	-
p0412[0...n]	Measuring gearbox absolute encoder rotary revolutions virtual	-
p0413[0...n]	Measuring gearbox position tracking tolerance window	-
p0421[0...n]	Absolute encoder rotary multiturn resolution	-
p0432[0...n]	Gearbox factor encoder revolutions	-
p0433[0...n]	Gearbox factor motor/load revolutions	-
r0477[0...2]	Measuring gearbox position difference	-
r0485[0...2]	Measuring gearbox encoder raw value incremental	-
r0486[0...2]	Measuring gearbox encoder raw value absolute	-

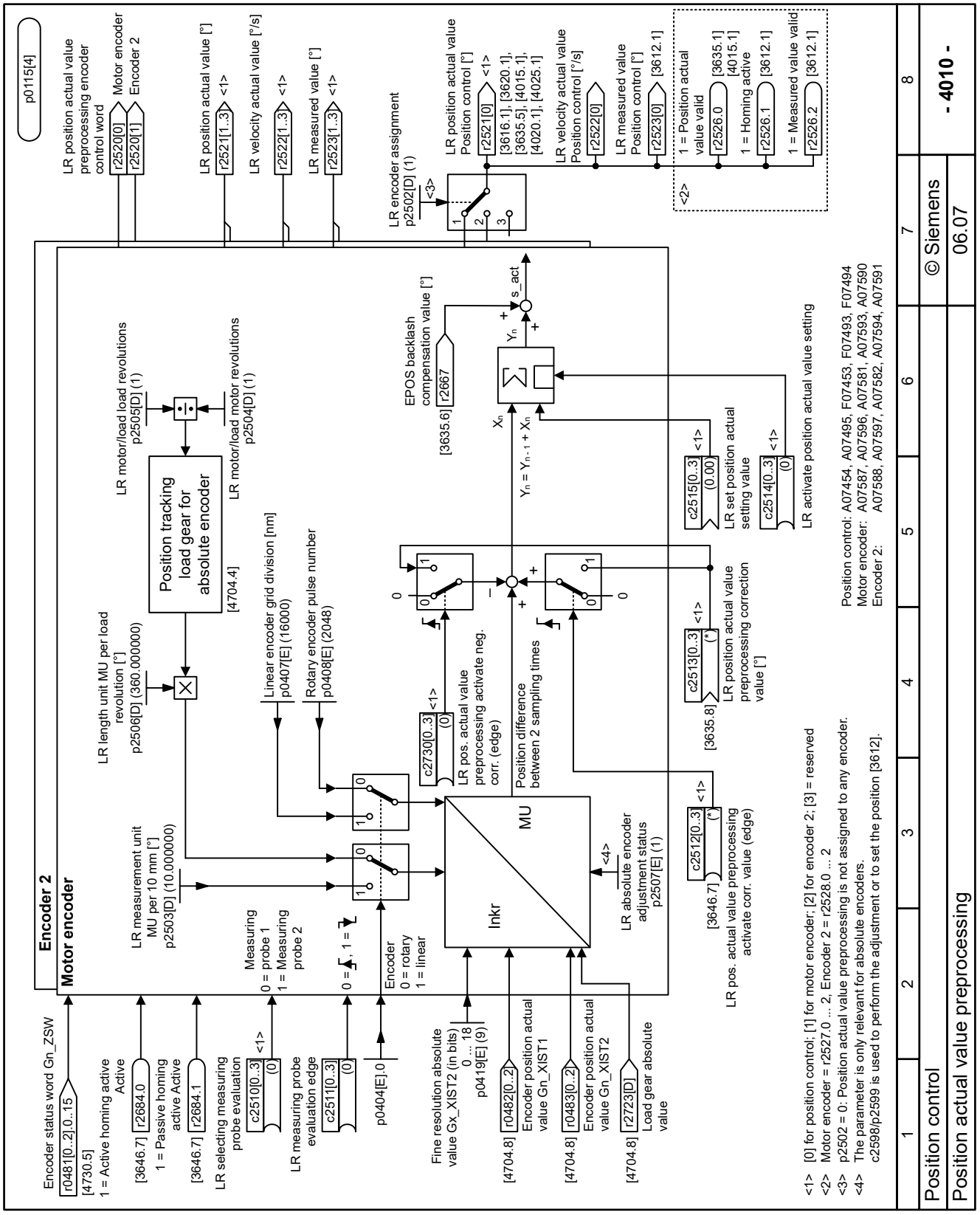


Figure 13-299 4010 – Position actual value preprocessing

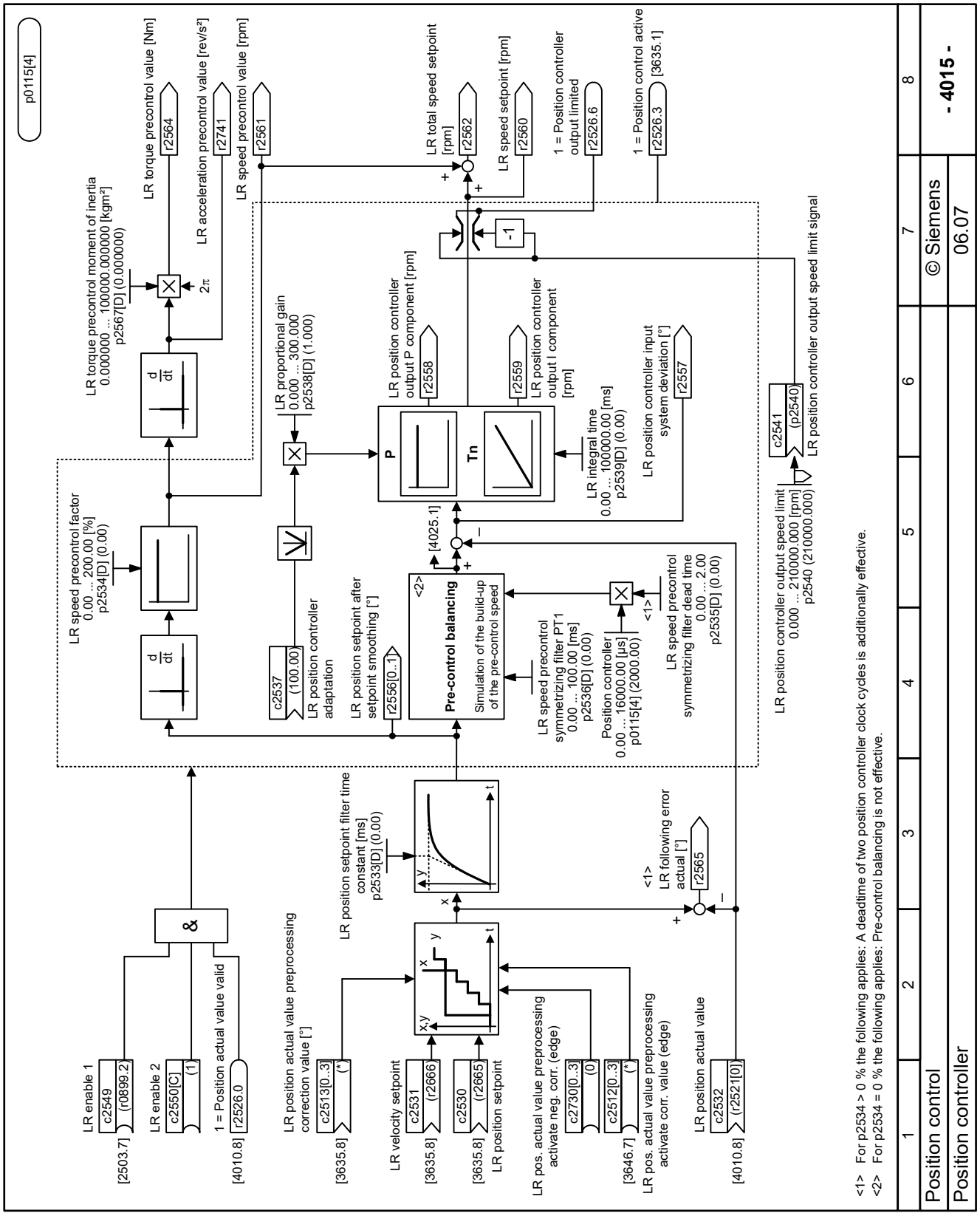


Figure 13-300 4015 – Position controller

13.15.1.7 Limiting the traversing range

Overview

The traversing range of a linear axis can be limited using either the software limit switch or the hardware limit switch.

Requirement

NOTICE
Damage to the machine when passing a hardware limit switch
The machine can be damaged when a hardware limit switch is passed. • Monitor axis motion, and manually stop the axis in time, e.g. by issuing an EMERGENCY STOP.

The traversing range limiting by using hardware limit switch is only active when the hardware limit switches are activated (c2568 = 1).

The traversing range limiting by using software limit switch is only active when the following preconditions are met:

- The software limit switches are activated (c2582 = 1).
- The home position is set (r2684.11 = 1).
- The modulo correction is not active (c2577 = 0).

Description of function

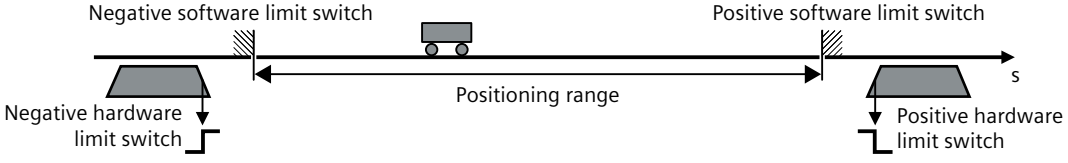


Figure 13-301 Software and hardware limit switches

If the position setpoint is beyond a software limit switch, the motor stops according to the travel profile before the software limit switch. During the braking process, the converter signals the warning A07479 or A07480.

Activated hardware limit switches are evaluated on the converter using c2569 (negative hardware limit switch) and c2570 (positive hardware limit switch) and they are low active. When triggering the hardware limit switch, the converter brakes the axis with the OFF3 ramp-down time, switches the motor off and outputs fault F07491 or F07492. After the fault is acknowledged, the motor is switched on again. In order to bring the axis back into the valid traversing range, you must move the axis away from the hardware limit switch, for example, by using the jogging function.

Parameters

The following list contains the parameters of function "Traversing range".

Number	Name	Unit
c2578	EPOS negative software limit switch	mm
c2578	EPOS negative software limit switch	°
c2579	EPOS positive software limit switch	mm
c2579	EPOS positive software limit switch	°
p2580	EPOS negative software limit switch	mm
p2580	EPOS negative software limit switch	°
p2581	EPOS positive software limit switch	mm
p2581	EPOS positive software limit switch	°
c2582	EPOS software limit switch activation	-

13.15.1.8 Limiting the traversing profiles

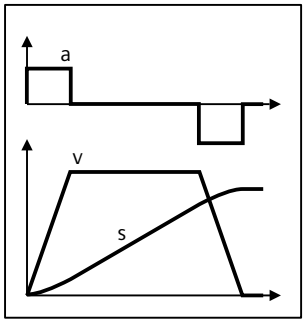
Overview

The traversing profile is the acceleration, velocity and position characteristics of an axis when being positioned. You can influence the traversing profile by limiting the velocity, the acceleration, or the jerk (= change of the acceleration over time).

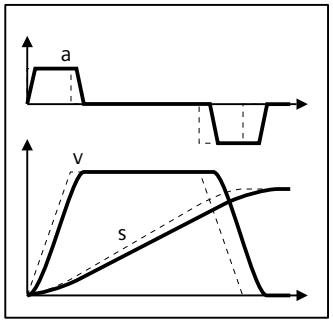
Description of function

If the axis must traverse more slowly or must accelerate at a lower rate or "softly", then you must set the relevant limits to lower values. The lower that one of the limits is, the longer the converter needs to position the axis.

- **Without jerk limitation**



- **With jerk limitation**



Jerk limitation is not active when messages are generated with stop responses OFF1/OFF2/ OFF3.

In the event of a fault with stop response OFF1, the motor brakes with the OFF1 ramp-down time p1121. The acceleration in the event of a fault can therefore be greater than the acceleration in positioning. In order to comply with the mechanical boundary conditions even in the event of a fault, we recommend to set the OFF1 ramp-down time p1121 to match the acceleration time.

Parameters

The following list contains the parameters of function "Traversing profile".

Number	Name	Unit
p2571	EPOS maximum velocity	mm/s
p2571	EPOS maximum velocity	°/s
p2572	EPOS maximum acceleration	mm/s²
p2572	EPOS maximum acceleration	°/s²
p2573	EPOS maximum deceleration	mm/s²
p2573	EPOS maximum deceleration	°/s²
p2574	EPOS jerk limiting	mm/s³
p2574	EPOS jerk limiting	°/s³
c2575	EPOS jerk limiting activation	-

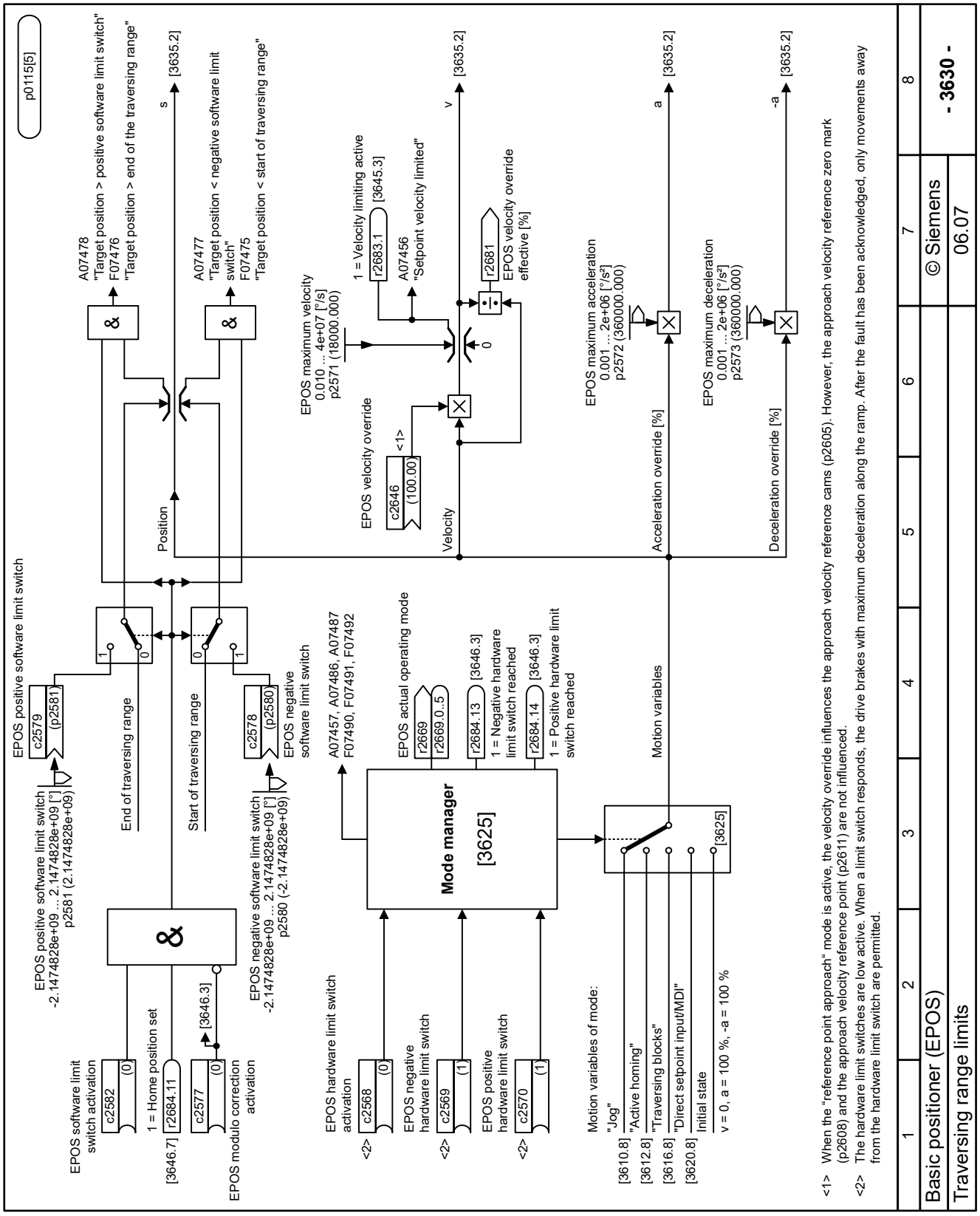


Figure 13-302 3630 – Traversing range limits

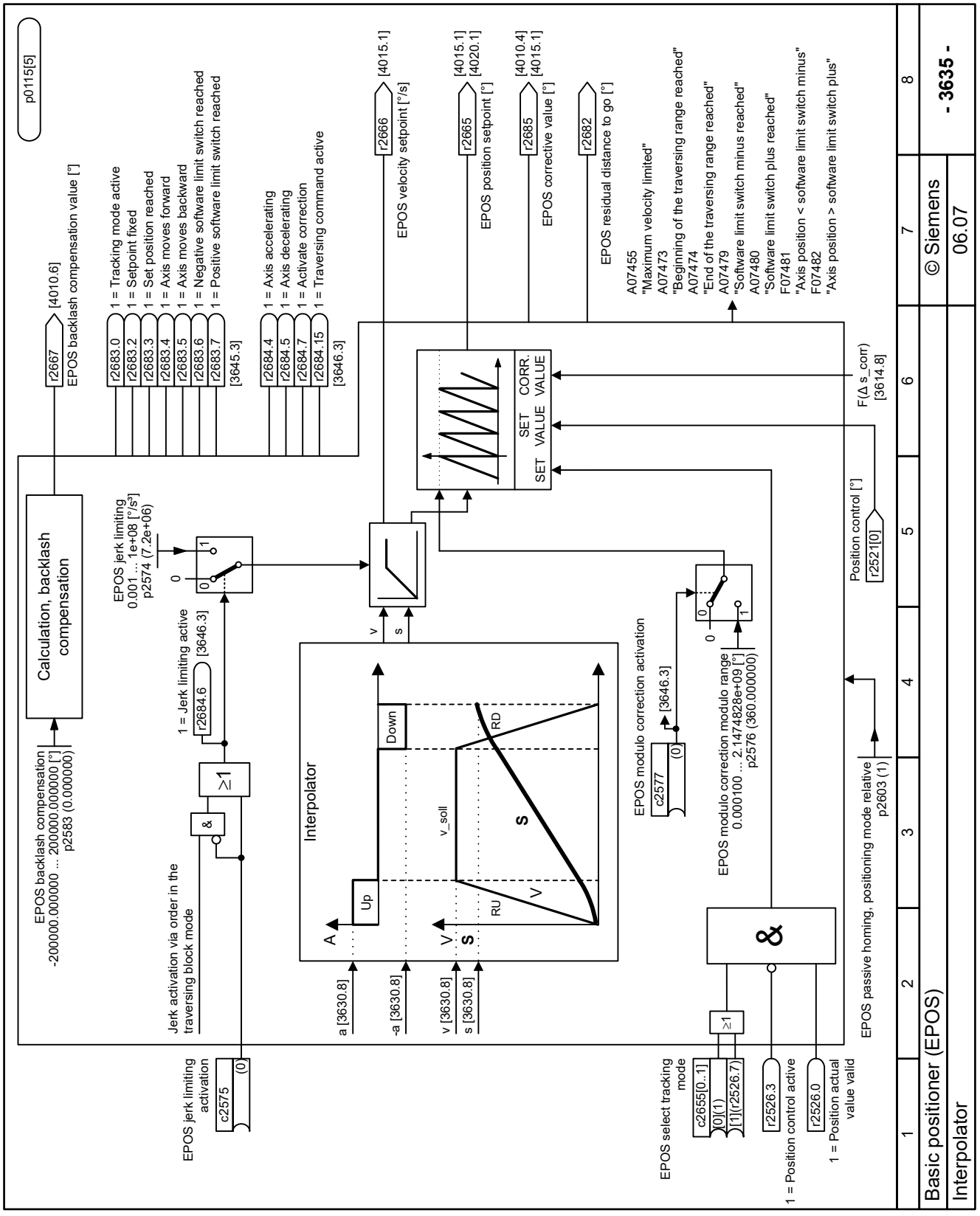


Figure 13-303 3635 – Interpolator

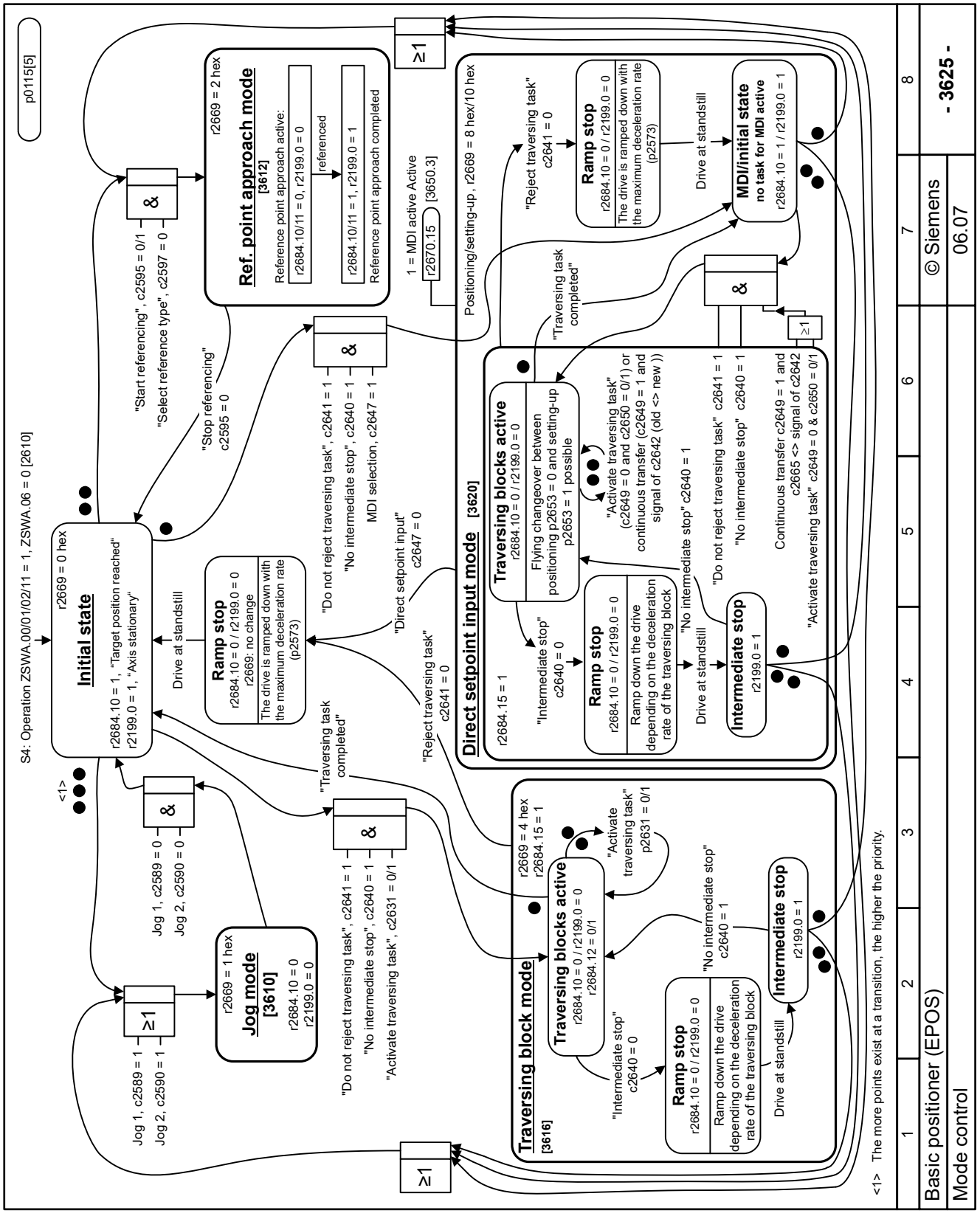


Figure 13-304 3625 – Mode control

13.15.1.9 Velocity limiting by Safety Integrated Functions

Description of function

Positioning responds to the active setpoint velocity limiting r9733 of the Safety Integrated Functions. The converter does not interrupt positioning, but adapts the maximum positioning velocity to that specified using r9733.

Parameters

The following list contains the parameters of function "Velocity limiting by Safety Integrated Functions".

Number	Name	Unit
c1051[0...n]	Speed limit RFG positive direction of rotation	rpm
c1052[0...n]	Speed limit RFG negative direction of rotation	rpm
r9733[0...2]	SI effective setpoint velocity limiting	rpm

13.15.1.10 Jog

Overview

It is possible to change over between jog incremental and jog velocity. The traversing distances p2587 and p2588 and velocities p2585 and p2586 are entered according to the jog signals c2589 and c2590. The traversing distances are only effective for a "1" signal at p2591 (jog incremental). For p2591 = "0", the axis moves with the specified velocity.

Description of function

Jog incremental

In the case of incremental jogging, input a relative traversing distance and a velocity setpoint into the converter. With the signals "Jogging 1" or "Jogging 2" the converter positions the axis by the respective travel path.

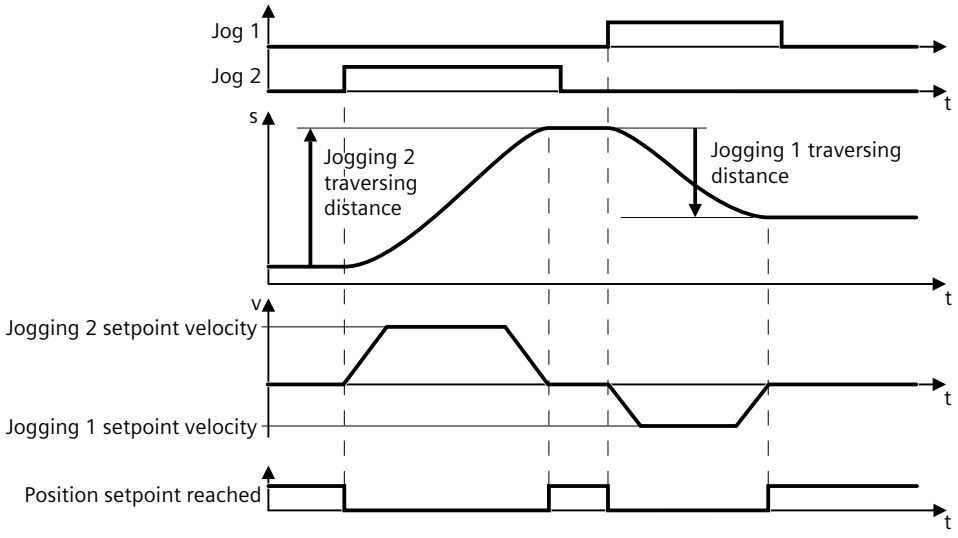


Figure 13-305 Jog incremental

Jog velocity

Only input a setpoint velocity for the converter for velocity jog. With the signal "Jogging 1" or "Jogging 2", the converter accelerates the axis to the relevant setpoint velocity. The converter stops the axis when the respective "Jog" signal returns to zero.

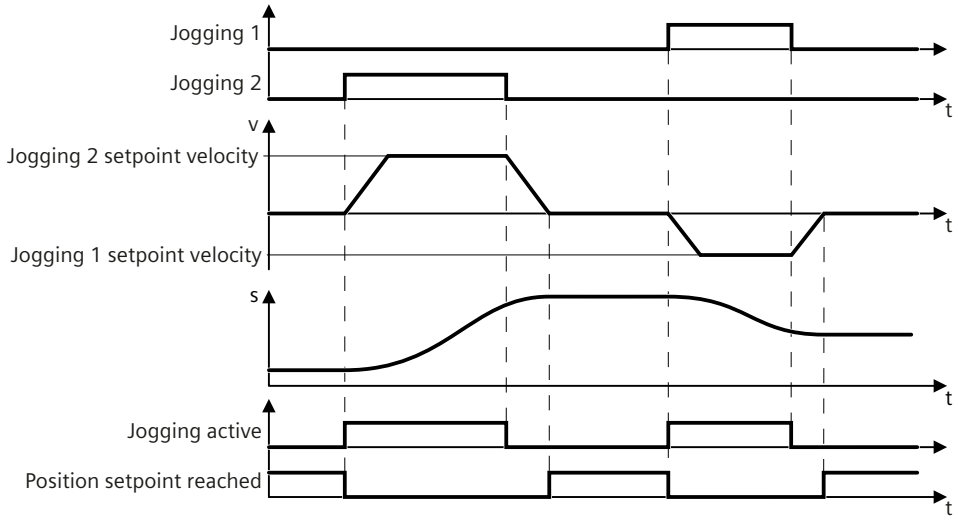


Figure 13-306 Jog velocity

Selecting a jogging channel

When telegrams 7, 9, 111, 112 and 113 are used, select a jogging channel with the control words STW1.8 and STW1.9:

Control word		**Description**
STW1.8	**STW1.9**	
0	0	No jogging channel activated
1	0	Activate Jog 1 signal source rising edge

Control word		Description
STW1.8	STW1.9	
0	1	Activate Jog 2 signal source rising edge
1	1	Keep old setpoint

Selecting a jogging mode

Note

When telegrams 7 and 9 are used, "Jog velocity" is activated.

When telegrams 111, 112 and 113 are used, select a jogging mode with the control word POS_STW2.5:

Control word	Signal	Description
POS_STW2.5	1	Activate "Jog incremental"
	0	Activate "Jog velocity"

Setting jogging setpoints

When telegrams 7 and 9 are used, set the following jogging setpoint with the appropriate parameters:

- Velocity (p2585, p2586)

When telegrams 111, 112 and 113 are used, set the following jogging setpoints with the appropriate parameters:

- Velocity (p2585, p2586)
- Traversing distance (p2587, p2588)

Parameters

The following list contains the parameters of the "Jog" function.

Number	Name	Unit
p2585	EPOS jog 1 setpoint velocity	mm/s
p2585	EPOS jog 1 setpoint velocity	°/s
p2586	EPOS jog 2 setpoint velocity	mm/s
p2586	EPOS jog 2 setpoint velocity	°/s
p2587	EPOS jog 1 traversing distance	mm
p2587	EPOS jog 1 traversing distance	°
p2588	EPOS jog 2 traversing distance	mm
p2588	EPOS jog 2 traversing distance	°
c2589	EPOS jog 1	-
c2590	EPOS jog 2	-
c2591	EPOS jogging incremental	-

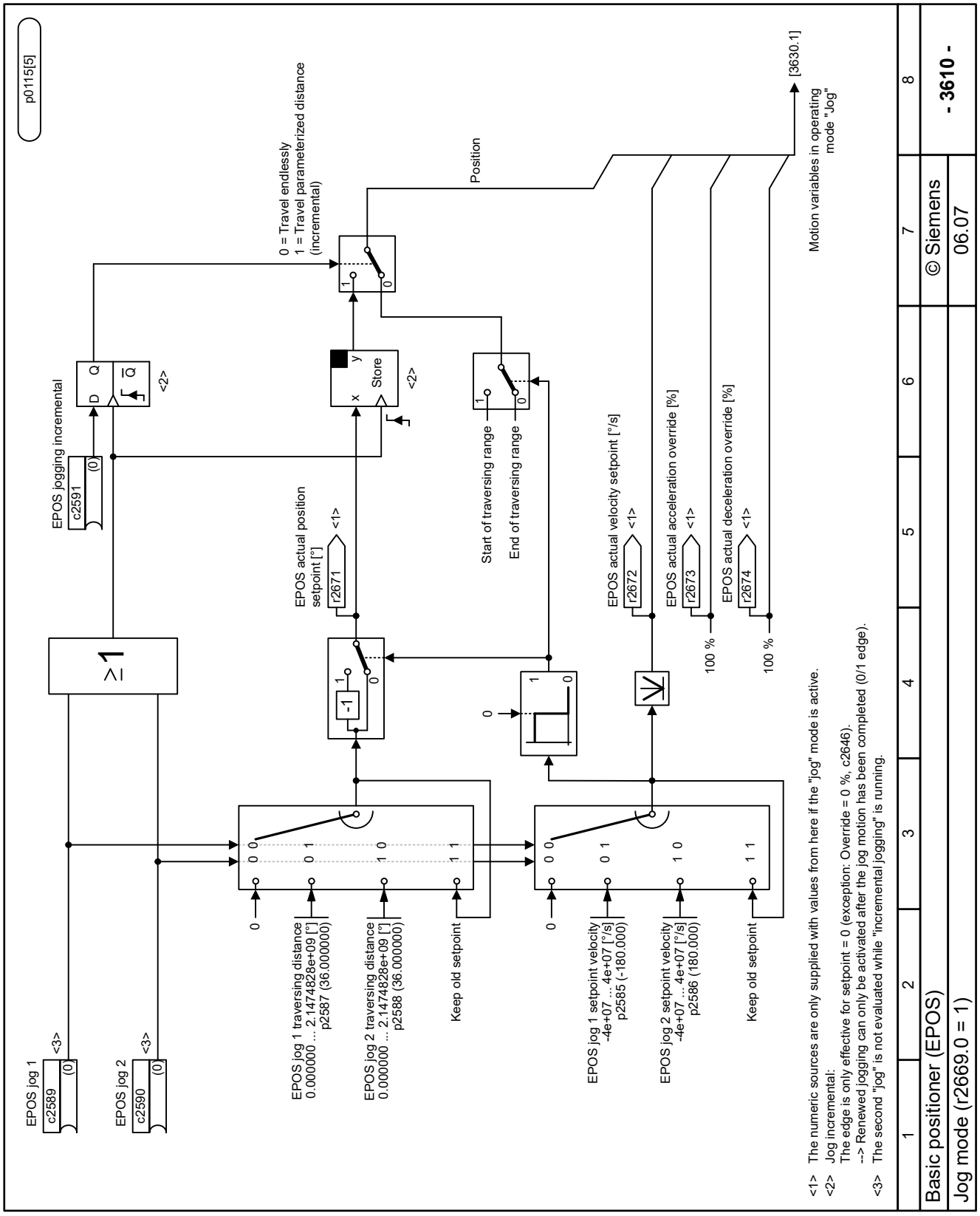


Figure 13-307 3610 – Jog mode (r2669.0 = 1)

13.15.1.11 Overview for homing

Overview

Homing establishes the reference between the coordinate origin of the drive axis and the machine zero point. When homing, the absolute position of the measuring system used for EPOS is determined.

Homing is a requirement for display of the correct position for the technology object and for absolute positioning.

Absolute encoders retain their position information, even after the supply has been switched off.

The converter offers various ways of homing the axis:

- Active homing - with all encoder types
- Passive homing - with all encoder types
- Absolute encoder adjustment - with absolute encoders

Description of function

Homing can occur by means of an independent homing motion (active homing), the detection of a homing mark during a motion initiated (passive homing) or a direct position assignment.

- **Active homing**
  The converter automatically traverses the axis to a defined home position.
- **Passive homing**
  The converter corrects its position actual value while traversing (homing during traversing).
- **Absolute encoder adjustment**
  The converter takes the reference point coordinate as the new axis position.

13.15.1.12 Terms for homing

Overview

After switching on the machine, the reference between the coordinate origin of the drive axis and the machine zero point must be established for positioning. This progress is called homing. The following terms are relevant to the homing.

Description

Homing mark

A homing mark is an input signal, on whose occurrence a known mechanical position can be assigned to the actual values.

A homing mark can be the zero mark of an encoder or an external zero mark via digital input.

Reference cam

If there are several zero marks in the traversing range, the reference cam is used to select a specific zero mark before or after the reference cam.

The reference cam is evaluated with the settings of the telegrams 111, 112 and 113 via the higher-level control system. Alternatively, there is also the possibility to evaluate the reference cam via a digital input of the converter. For this purpose, a digital input must be parameterized as the reference cam selection 2 (p11550 = 1).

Homing mark position

This is the position assigned to the homing mark.

With active homing, the homing mark position corresponds to the home position minus home position offset.

With passive homing, the homing mark position corresponds to the home position.

Reversing cam

A reversing cam causes the converter to change the search direction when referencing. After reaching a reversing cam, the converter continues to search for the reference cam in the opposite direction.

Home position

At the end of the active homing motion, the axis arrives at the home position.

Home position offset

The difference between the home position and the homing mark position is the home position offset.

Approach velocity

Up to three parameterizable approach velocities are available:

- to the reference cam
- to the zero mark
- to the home position

13.15.1.13 Active homing

Overview

Three homing modes are available for active homing:

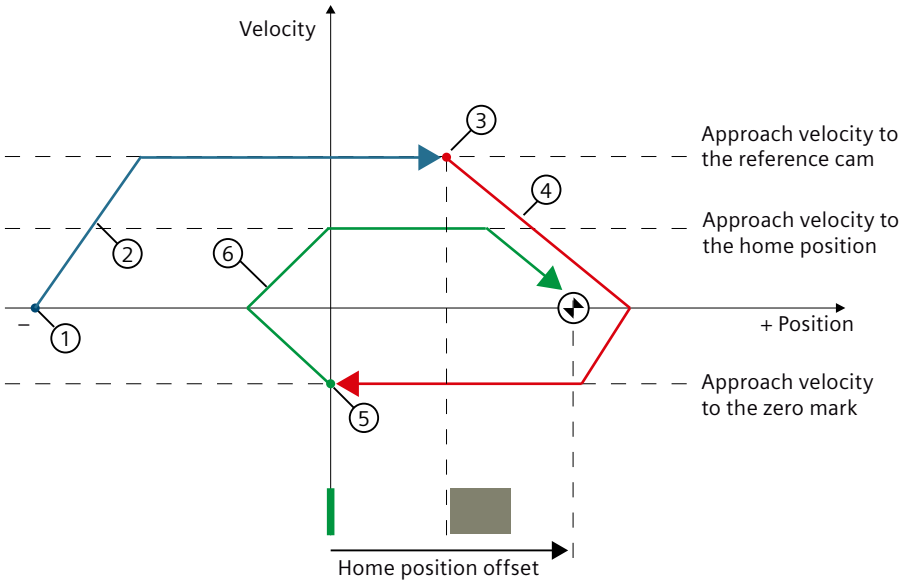
- Use encoder zero mark and reference cam
- Use encoder zero mark
- Use external zero mark via digital input

Description of function

Active homing by using encoder zero mark and reference cam

The following figure shows an example of the homing motion with the following settings:

- Active homing with reference cam and encoder zero mark
- Homing in the positive direction
- Positive home position offset



Home position

Encoder zero mark (Homing mark)

Reference cam

Motion sequence

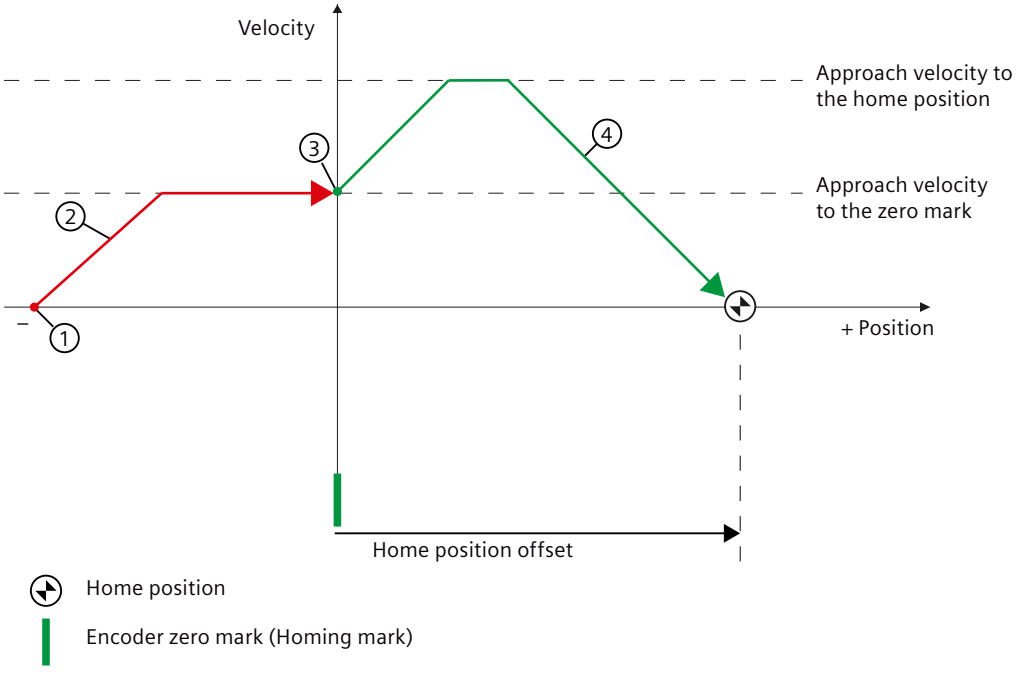
① Start of active homing
② Approach to the reference cam in approach direction with the corresponding approach velocity
③ Enable detection of the reference cam and homing mark detection
④ Approach to the homing mark with the corresponding approach velocity
⑤ Detection of the homing mark
⑥ Approach to the home position with the corresponding approach velocity

Figure 13-308 Example: active homing in positive direction by using encoder zero mark and reference cam

Active homing by using encoder zero mark

The following figure shows an example of the homing motion with the following settings:

- Active homing with encoder zero mark
- Homing in the positive direction
- Positive home position offset



Motion sequence

① Start of active homing
② Approach to the homing mark in the homing direction with the corresponding approach velocity to the zero mark
③ Detection of the homing mark
④ Approach to the home position with the corresponding approach velocity to the home position

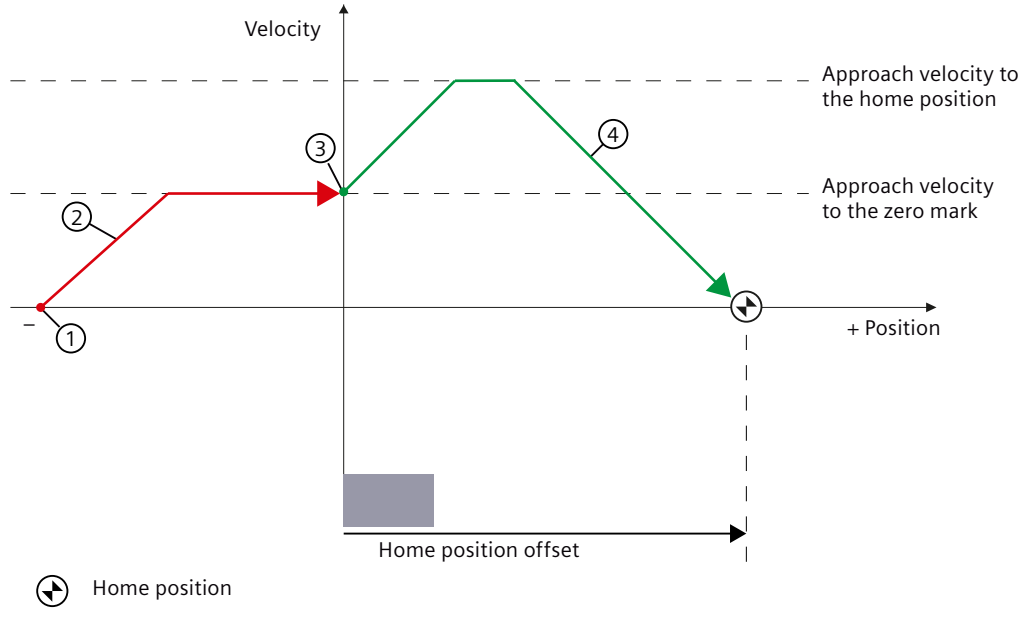
Figure 13-309 Example: active homing in positive direction by using encoder zero mark

Active homing by using external zero mark via digital input

The following figure shows an example of the homing motion with the following settings:

- Active homing with digital input
- Approach in the positive direction

- Homing mark on the negative side of the digital input
- Positive home position offset



Motion sequence

① Start of active homing
② Approach to the homing mark in the homing direction with the corresponding approach velocity to the zero mark
③ Detection of the homing mark via digital input
④ Approach to the home position with the corresponding approach velocity to the home position

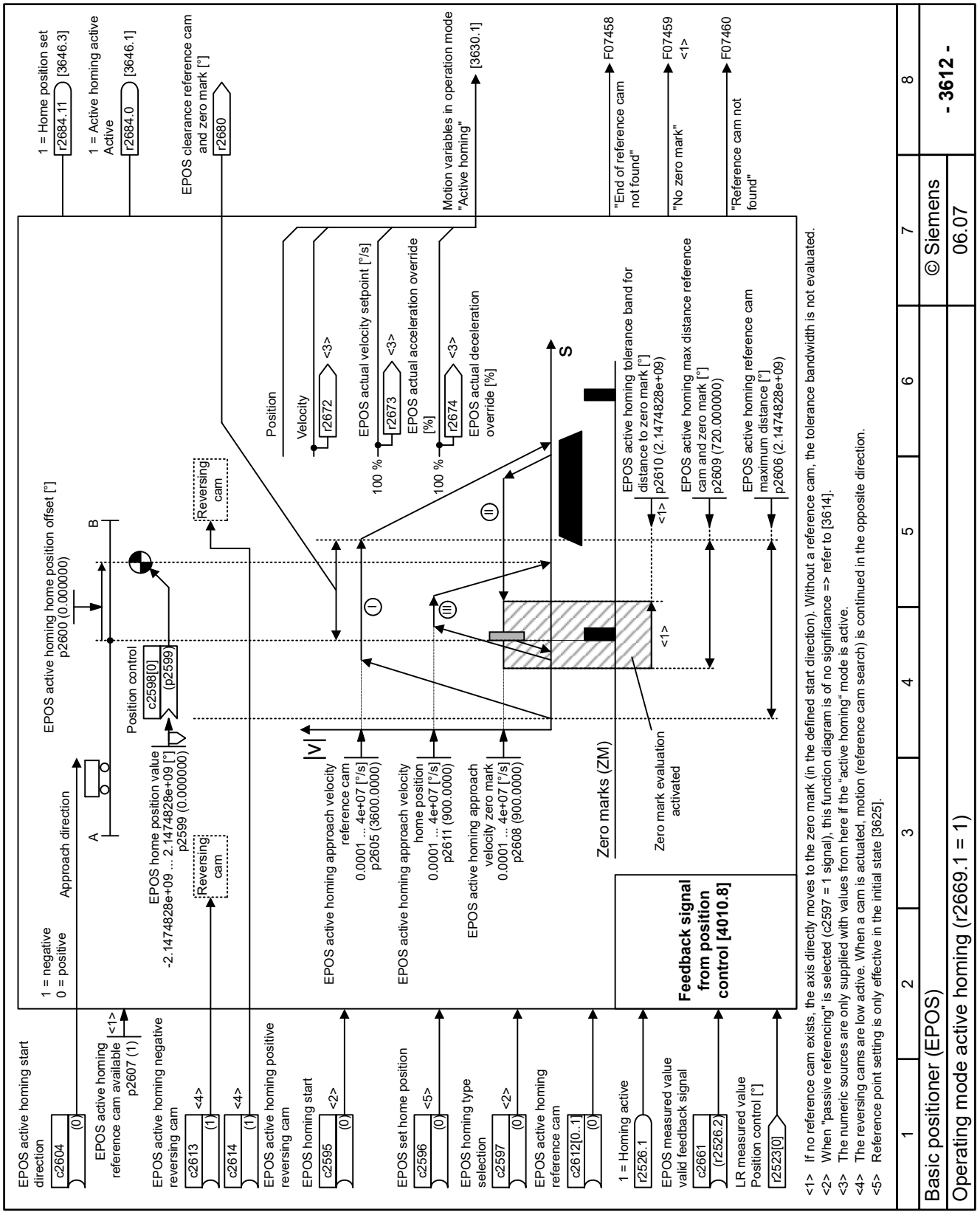
Figure 13-310 Example: active homing in positive direction by using external zero mark via digital input

Parameters

The following list contains the parameters of function "Active homing".

Number	Name	Unit
c2595	EPOS homing start	-
c2596	EPOS set home position	-
c2597	EPOS homing type selection	-
c2598[0...3]	EPOS home position signal	mm
c2598[0...3]	EPOS home position signal	°
p2599	EPOS home position value	mm
p2599	EPOS home position value	°
p2600	EPOS active homing home position offset	mm
p2600	EPOS active homing home position offset	°
c2604	EPOS active homing start direction	-
p2605	EPOS active homing approach velocity reference cam	mm/s

p2605	EPOS active homing approach velocity reference cam	°/s
p2606	EPOS active homing reference cam maximum distance	mm
p2606	EPOS active homing reference cam maximum distance	°
p2607	EPOS active homing reference cam available	-
p2608	EPOS active homing approach velocity zero mark	mm/s
p2608	EPOS active homing approach velocity zero mark	°/s
p2609	EPOS active homing max distance reference cam and zero mark	mm
p2609	EPOS active homing max distance reference cam and zero mark	°
p2610	EPOS active homing tolerance band for distance to zero mark	mm
p2610	EPOS active homing tolerance band for distance to zero mark	°
p2611	EPOS active homing approach velocity home position	mm/s
p2611	EPOS active homing approach velocity home position	°/s
c2612[0...1]	EPOS active homing reference cam	-
c2613	EPOS active homing negative reversing cam	-
c2614	EPOS active homing positive reversing cam	-



<1> If no reference cam exists, the axis directly moves to the zero mark (in the defined start direction). Without a reference cam, the tolerance bandwidth is not evaluated.
<2> When "passive referencing" is selected (c2597 = 1 signal), this function diagram is of no significance => refer to [3614].
<3> The numeric sources are only supplied with values from here if the "active homing" mode is active.
<4> The reversing cams are low active. When a cam is actuated, motion (reference cam search) is continued in the opposite direction.
<5> Reference point setting is only effective in the initial state [3625].

Figure 13-311 3612 – Active homing mode (r2669.1 = 1)

13.15.1.14 Passive homing

Overview

Passive homing is used to dynamically modify the current position value to zero when the axis is working in any positioning state. The function can be used in every mode (jog, traversing block, direct setpoint specification for positioning / setup) and is superimposed over the active operating mode.

Description of function

The "Passive homing" function is superimposed on an active operating mode, it is therefore not an active mode. In contrast to the home position approach, the function can be carried out superimposed by the machine process.

As standard, for passive homing, measuring probe evaluation is used; when enabled, the measuring probe is selected and the measuring probe edge evaluation is active. (In the default settings, measuring probe 1 is always the measuring probe and the measuring probe evaluation is always the 0/1 edge.)

If the axis has reached the home position, the actual position value and position setpoint are set to the values specified via c2598 which is interconnected to p2599 as default. The axis is then homed and the status r2684.11 (Home position set) is set.

Parameters

The following list contains the parameters of function "Passive homing".

Number	Name	Unit
p2601	EPOS passive homing inner window	mm
p2601	EPOS passive homing inner window	°
p2602	EPOS passive homing outer window	mm
p2602	EPOS passive homing outer window	°

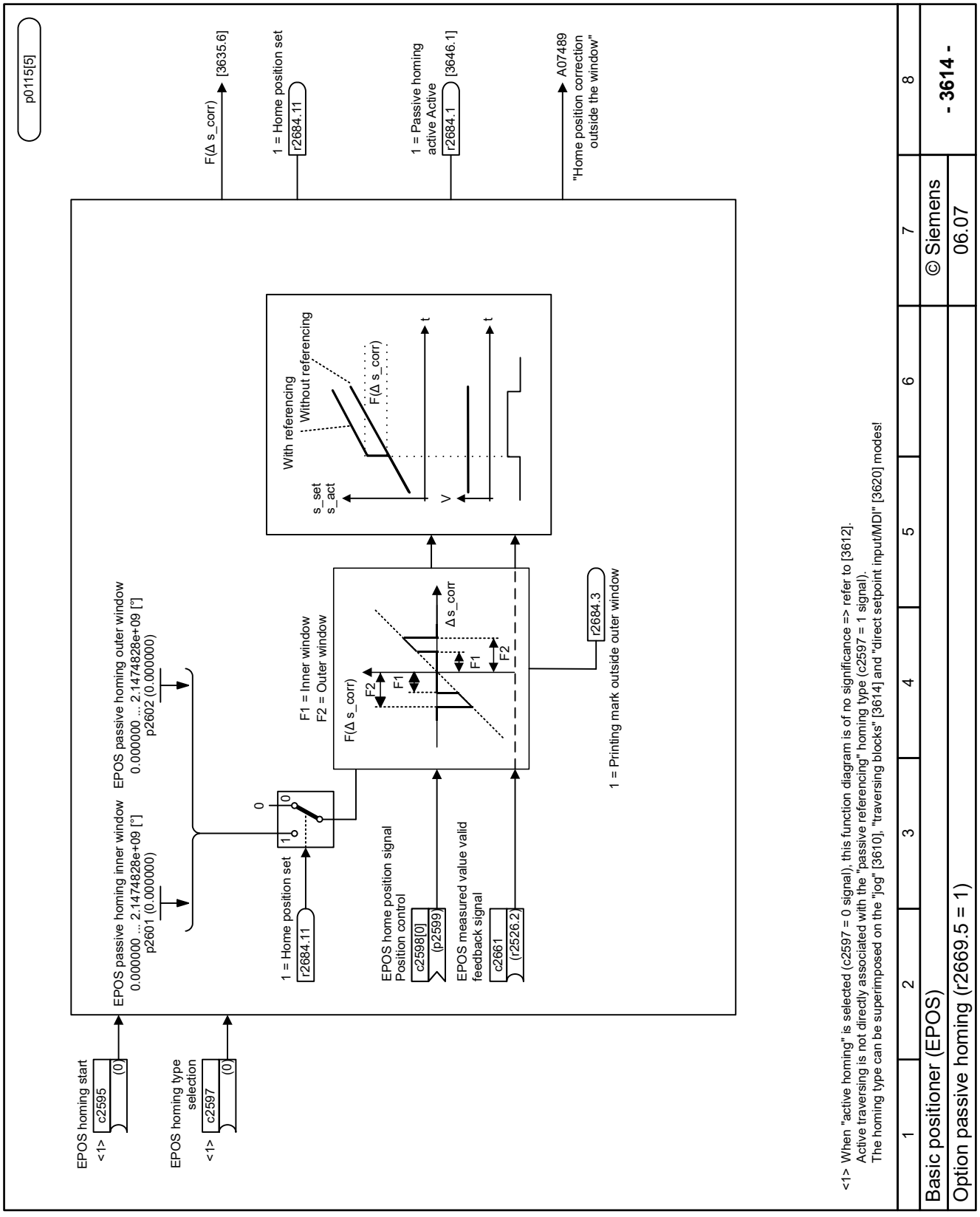


Figure 13-312 3614 – Passive homing mode (r2669.5 = 1)

13.15.1.15 Measuring probe evaluation and homing mark search

Overview

The converter supports the "homing mark search" and the "measuring probe evaluation" in position control.

Description of function

The "homing mark search" and the "measuring probe evaluation" functions mode can be defined via c2510 (measuring probe evaluation selection) and c2511 (measuring probe evaluation edge). In the default settings, measuring probe 1 is always the measuring probe and the measuring probe evaluation is always the 0/1 edge.

The probe signals are recorded via the encoder status and control word. To speed up signal processing, direct measuring probe evaluation can be activated by selecting the input terminals for probes 1 or 2.

The system outputs a message if the same probe input is already being used (see also p0488, p0489).

The appropriate function is started using a 0/1 edge via the encoder control word. Status bit r2526.1 (homing active) signals that the function is active (feedback from the encoder status word). Status bit r2526.2 (measured value valid) shows the presence of the required measurement r2523.

Once the function is completed (position determined for homing mark or measuring probe), r2526.1 (homing active) and r2526.2 (measured value valid) remain active and the measurement is provided by r2523 until the corresponding encoder control word is reset (0 signal).

If the function (homing mark search or measuring probe evaluation) has not been completed yet, while the encoder control word is reset, then the function is interrupted and the status bit r2526.1 (homing active) is reset via the encoder status word.

If the homing mark search and the measuring probe evaluation functions are simultaneously set, this causes the active function to be interrupted or no function is enabled. Alarm A07495 "homing function interrupted" occurs and remains until the signals at the inputs are reset. The alarm is also generated if a fault is signaled using the encoder status word during an activated function (homing mark search or measuring probe evaluation).

If the "position control" function is activated, these parameters (c2510 to c2511) are preassigned with "0". If the "basic positioner" function is activated, the "homing mark search" (for the homing position searching) and "measuring probe evaluation" (for the passive homing function) functions are initiated by the "basic positioner" function and feedback (r2526, r2523) returned to this.

13.15.1.16 Absolute encoder adjustment

Overview

The function is only available when using a motor with the absolute encoder. When commissioning the absolute encoder for the first time, a mechanical axis position is aligned with the encoder absolute position and then the system is synchronized.

After the drive has been switched off, the encoder position information is retained. This means that the axis does not have to be readjusted when the drive powers up.

Description of function

Absolute encoder adjustment (via telegram 112 or 113)

Requirement

The absolute encoders must be adjusted the first time that they are commissioned.

For the absolute encoder adjustment, the machine axis must be moved to the desired position first. This can be done as follows:

- In jog mode or manually.
  A position marking, a fixed stop, or the measuring distance between the axis and the fixed home position can be used as a reference. Once the desired position of the axis is reached, the absolute encoder adjustment can be performed. You must save the settings in the device permanently.
- With the active homing.
  You must select the option during configuration of the active homing.

When using the telegram 112 or 113, the absolute encoder adjustment can be initiated via the position control word 2, bit 3 (POS_STW2.3).

Note

After being commissioned for the first time, carefully ensure that the drive train and its configuration cannot be mechanically changed or modified. When mechanical changes are made, the synchronization between the encoder actual value and the machine zero is lost. In this particular case, it is crucial that the axis is readjusted.

Absolute encoder adjustment (via Startdrive)

Requirement

The function is only available when the converter is online in Startdrive.

- Setting the absolute encoder adjustment status
  You can perform the absolute encoder adjustment (p2507 = 2) and the status "Home position set" (r2684.11) is updated. When the adjustment is correct, "Absolute encoder adjusted" is displayed.
- Resetting the absolute encoder adjustment status
  You can also reset the status "Absolute encoder adjusted" and the status display for the absolute encoder adjustment is then updated. The adjustment is deactivated. After the reset, "Absolute encoder not adjusted" is displayed.

13.15.1.17 Setting the home position

Condition

The function is only available when the converter is online in Startdrive.

Description of function

Setting the home position

You can set the home position (p2507 = 2) and the status "Home position set" (r2684.11) is updated. When the adjustment is correct, "Absolute encoder adjusted" is displayed.

Resetting the home position

You can also reset the home position (p2507 = 1) and the status display for the absolute encoder adjustment is then updated. The adjustment is deactivated. After the reset, "Absolute encoder not adjusted" is displayed.

13.15.1.18 Closed-loop position control with virtual encoder

Overview

The positioning accuracy of the closed-loop position control of the converter when operated without an encoder is lower than when an encoder is used. The positioning accuracy that can be achieved depends on the motor and the torque load of the motor.

Precondition

The following requirements apply when using the virtual motor encoder:

- The virtual motor encoder is configured in the hardware configuration in Startdrive.
- Function "Advanced positioning" is licensed and activated.
- Closed-loop drive control with speed controller is selected.
  Open-loop speed control, e.g. V/f control is not permissible.

The drive has been commissioned including a motor identification.

We recommend the following to minimize position errors.

- Evaluating a motor temperature sensor
- Recording the friction characteristic

The following functions are not possible with a virtual encoder:

- "Travel to fixed stop"
- Active homing with encoder zero mark

Function description

In the motor model, the converter simulates a virtual encoder that responds just the same as a real incremental encoder and supplies position actual value r0482 for the position controller.

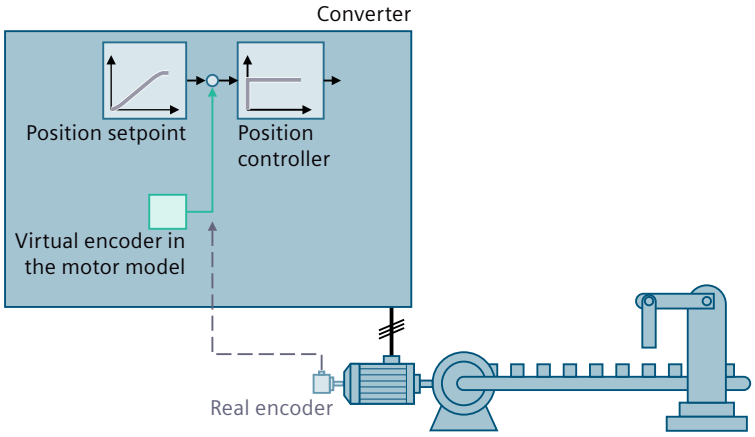


Figure 13-313 Position controller with a virtual encoder instead of a real encoder

The position error with virtual motor encoder depends on the following factors:

- Motor type:
  - Permanent magnet synchronous motor, synchronous-reluctance motor:
    When the closed-loop speed control is operated in the open-loop mode, at speeds n < p1755, with increasing load torque, the load angle increases. Recommended ratio between the load torque M_{Load} and stall torque M_{Stall} of the motor:
    $M_{Load} / M_{Stall} \leq 1/2$
    Under this condition, depending on the motor, an expected electrical angle is obtained. The electrical angle causes the position error = electrical angle/pole pair number.

Permanent-magnet synchronous motor			Synchronous reluctance motor		
Electrical angle	**Number of pole pairs**	**Positioning error**	**Electrical angle**	**Number of pole pairs**	**Positioning error**
30°	1	30°	15°	1	15°
	2	15°		2	10°
	3	10°		3	5°

    The position error decreases if M_{Load} / M_{Stall} decreases.
    Function "Encoderless closed-loop speed control of a synchronous motor from standstill" (optimized pulse technique) increases the positioning accuracy. When the function is active, the converter avoids open-loop controlled operation of the closed-loop speed control. As a consequence, the position error is independent of the load torque for an electrical angle of ≃ 5°.
  - Induction motor:
    The position error results from a speed error. The speed error is obtained from the error in the slip calculation. The slip is independent of the speed. For a constant load torque, the slip calculation error remains approximately constant. The position error increases with time and with the load torque.
    Field weakening and flux reduction increase the slip and therefore the mechanical position error.
    Estimate: Speed error ≃ Error in the slip calculation · slip speed · load torque/rated motor torque
    Example:

Assumptions	Result for the example
Rated motor slip = 2 % The rated slip corresponds to 30 r/min Error in the slip calculation = 10 %	At rated torque, the speed error is = 3 r/min. In 1 minute at rated torque, the position error increases to 3 revolutions or 1 080°.

Methods to reduce position errors when using virtual motor encoders:

- Flying homing, e.g. using a homing cam in front of the target position
- Start of an additional positioning task using a proximity switch in front of the target position
- A load gearbox with a ratio drive side/output side > 1

The converter only calculates the position actual value of the virtual motor encoder when the motor is switched on. If the motor is switched off then the motor model does not detect when the motor shaft rotates. As a consequence, when the motor that has been switched off moves, the home position for positioning in the system or machine changes. This is the

reason that in the factory setting, after the motor is switched off, the converter deletes its home position and signals to the higher-level control system that new homing is required.

Parameter p4644 defines the behavior of the home position for a motor that is switched off for an application with basic positioner or with a higher-level control system with technology object:

- Bit p4644.0 = 1 defines that the axis must be homed again after the motor is switched off: After the motor is switched off, the converter temporarily sets encoder status bit "Parking encoder active" (r0481.14). By setting encoder status bit "Parking encoder active" (r0481.14 = 1) the converter signals that the system must be re-homed.
- If a motor holding brake keeps the switched-off motor in position, then a new homing operation is not required. In this case, bit p4644.1 = 1 prevents the converter from setting encoder status bit "Parking encoder active" (r0481.14 = 1) after the motor has been switched off. As a consequence, the encoder signal remains valid for the higher-level control system or the basic positioner.
- If the position of the motor that has been switched off is fixed, and is not changed as a result of external influences, then bit p4644.2=1 prevents encoder status bit "Parking encoder active" (r0481.14 = 1) from being set. As a consequence, the encoder signal remains valid for the higher-level control system or the basic positioner and homing is not required.

Parameters

The following list contains the parameters of function "Closed-loop position control with virtual encoder".

Number	Name	Unit
r0313[0...n]	Motor pole pair number, actual (or calculated)	-
p0314[0...n]	Motor pole pair number	-
p0400[0...n]	Encoder type selection	-
p0400[0...n]	Encoder type selection	-
r0481[0...2].0...15	Encoder status word Gn_ZSW	-
r0482[0...2]	Encoder position actual value Gn_XIST1	-
p1300[0...n]	Open-loop/closed-loop control mode	-
p1755[0...n]	Motor model changeover speed encoderless operation	rpm
p1756[0...n]	Motor model changeover speed hysteresis encoderless operation	%
p4644.0...2	Virtual motor encoder configuration	-

13.15.1.19 Positioning and standstill monitoring

Overview

Positioning and standstill monitoring is used to monitor the axis positioning motion and the axis position after a traversing motion.

Description of function

As soon as the setpoint for the position within a positioning operation no longer changes, then the converter sets the "Setpoint stationary" signal to 1. With this signal, the converter starts to monitor the position actual value:

- As soon as the axis has reached the positioning window, the converter signals that the target has been reached, and maintains the axis in closed-loop control.
- If the axis does not come to a standstill within the standstill monitoring time, the converter reports fault F07450.
- If the axis does not enter the positioning window within the positioning monitoring time, the converter reports fault F07451.

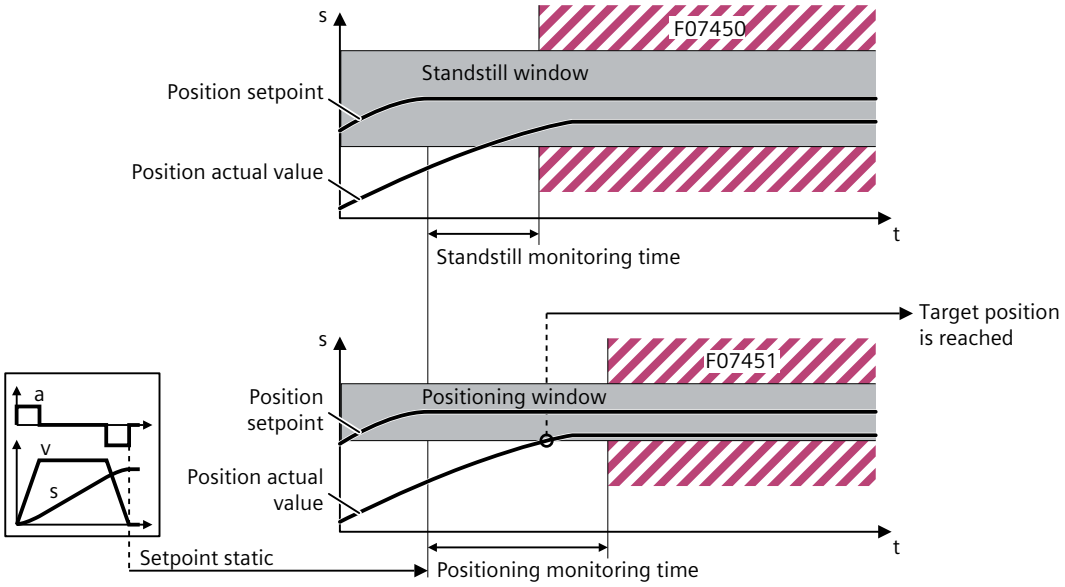


Figure 13-314 Standstill monitoring and positioning monitoring

Parameters

The following list contains the parameters of function "Positioning and standstill monitoring".

Number	Name	Unit
p2542	LR standstill window	mm
p2542	LR standstill window	°
p2543	LR standstill monitoring time	ms
p2544	LR positioning window	mm
p2544	LR positioning window	°
p2545	LR positioning monitoring time	ms

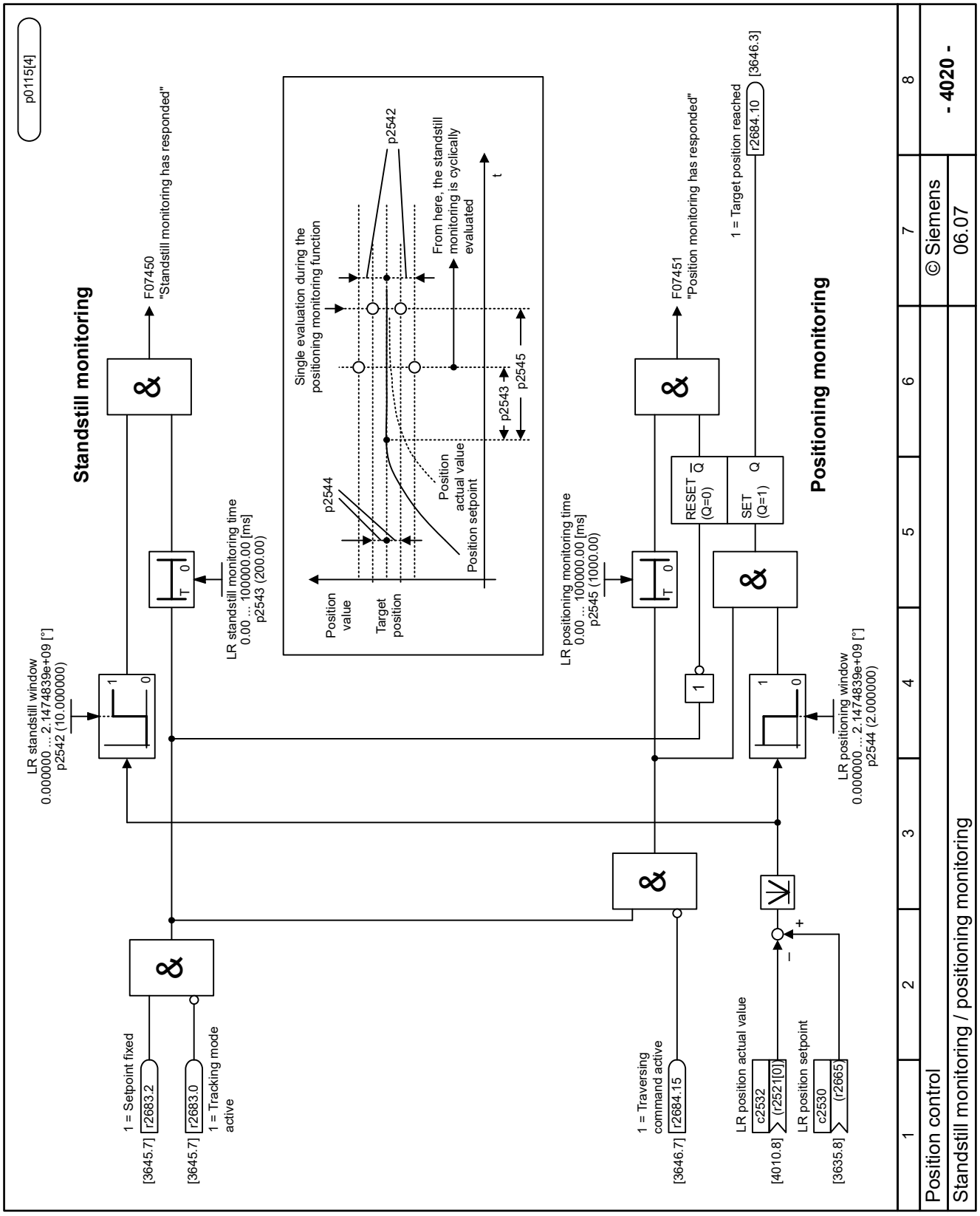


Figure 13-315 4020 – Standstill monitoring / positioning monitoring

13.15.1.20 Following error monitoring

Overview

Following error monitoring is used to monitor the maximum deviation between the actual value and the position setpoint.

Description of function

The following error is the deviation between the position setpoint and the position actual value while the converter is positioning the axis. The converter reports fault F07452 if the following error is too high. If you set the tolerance to 0, monitoring is deactivated.

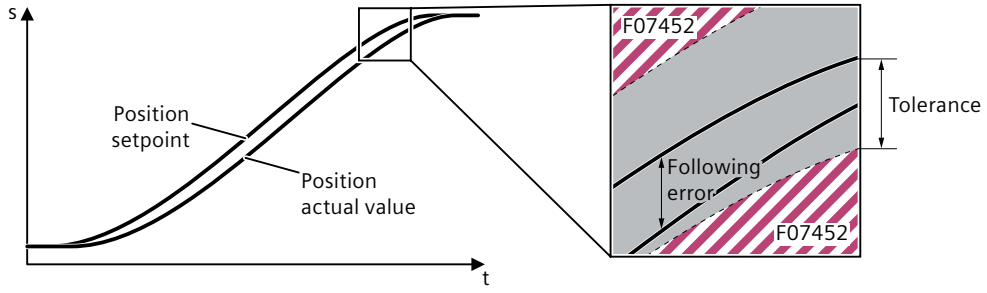


Figure 13-316 Following error monitoring

Parameters

The following list contains the parameters of function "Following error monitoring".

Number	Name	Unit
p2546[0...n]	LR dynamic following error monitoring tolerance	mm
p2546[0...n]	LR dynamic following error monitoring tolerance	°
r2563	LR following error dynamic model	mm
r2563	LR following error dynamic model	°

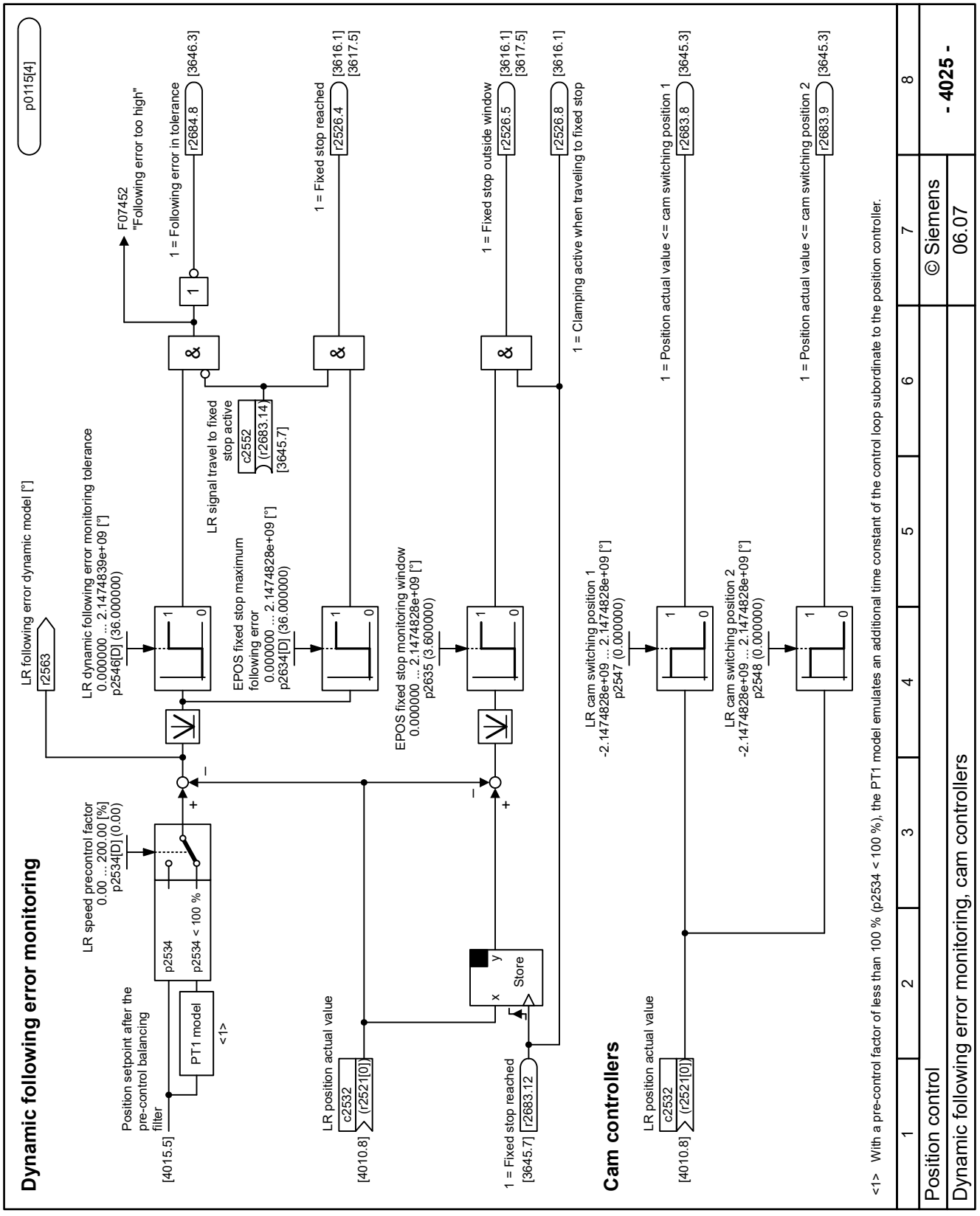


Figure 13-317 4025 – Dynamic following error monitoring, cam controllers

13.15.1.21 Traversing blocks

Overview

A traversing block describes a positioning instruction for the drive.

Function description

A traversing block contains the following data:

- Traversing block number p2616[0 ... n]
  The drive executes the traversing blocks in the sequence of the traversing block numbers. The drive ignores a traversing block number with the value "-1". A traversing block with traversing block number -1 is reserved for subsequent additional traversing blocks, for example.
- Task p2621[0 ... n]

Name	Active parameters	Explanation	Possible continuation condition to the next traversing block
1. POSITIONING	p2616 p2617 p2618 p2619 p2620 p2623	Task POSITIONING traverses the axis until the target position is reached. If the axis has already reached the target position when the POSITIONING task is issued, then the response depends on the continuation condition: • CONTINUE_FLYING or CONTINUE_EXTERNAL The drive activates the following traversing block in the same interpolation cycle. • CONTINUE_WITH_STOP The drive activates the next traversing block in the next interpolation cycle. • CONTINUE_EXTERNAL_ALARM The drive immediately generates a message.	All continuation conditions are possible.
2: FIXED STOP	p2616 p2617 p2618 p2619 p2620 p2623 p2622	The FIXED STOP task triggers a traversing movement with reduced torque to fixed stop.	END CONTINUE_WITH_STOP CONTINUE_EXTERNAL CONTINUE_EXTERNAL_WAIT

Name	Active parameters	Explanation	Possible continuation condition to the next traversing block
3: ENDLESS_POS 4: ENDLESS_NEG	p2618 p2619 p2623	Tasks ENDLESS_POS and ENDLESS_NEG accelerate the axis to the specified velocity and traverse the axis until one of the following events occurs: • A software limit switch has been reached. • A hardware limit switch has been reached. • The traversing range limit has been reached. • Control signal STW1.5 = 1 (intermediate stop). • Control signal STW1.4 = 1 (reject traversing block). • For an appropriate continuation condition, the higher-level control initiates an external block change.	All continuation conditions are possible.
5: WAITING	p2622 p2623	Task WAITING specifies the wait time p2622 until execution of the following task. For the continuation condition CONTINUE_EXTERNAL_ALARM, the drive signals that after the wait time, the higher-level control had still not selected "external block change".	END CONTINUE_WITH_STOP CONTINUE_EXTERNAL CONTINUE_EXTERNAL_WAIT CONTINUE_EXTERNAL_ALARM
6: GOTO	p2622	Task GOTO jumps to process traversing block number p2622. The converter signals that the traversing block number p2622 that was jumped to does not exist and marks the traversing block as being inconsistent. In an interpolation cycle, the drive processes any 2 of the SET_O, RESET_O and GOTO tasks and starts a subsequent task POSITIONING and WAITING.	A continuation condition is not permissible.

Name	Active parameters	Explanation	Possible continuation condition to the next traversing block
7: SET_O 8: RESET_O	p2616 p2622	Tasks SET_O and RESET_O set the EPOS status word 1, binary signals r2683.10 and r2683.11. p2622 = 1 sets r2683.10 = 1. p2622 = 2 sets r2683.11 = 1. p2622 = 3 sets r2683.10 = 1 and r2683.11 = 1. In an interpolation cycle, the drive processes any 2 of the SET_O, RESET_O and GOTO tasks and starts a subsequent task POSITIONING or WAITING.	END CONTINUE_FLYING CONTINUE_WITH_STOP CONTINUE_EXTERNAL_WAIT
9: JERK	p2622 p2574	Task JERK with p2622 = 1 activates jerk limiting or with p2622 = 0 de-activates jerk limiting. c2575 "Activate jerk limiting" must be set to zero.	All continuation conditions are possible

- Target position or traversing distance p2617[0 ... n]
- Velocity p2618[0 ... n]
- Acceleration override p2619[0 ... n]
- Deceleration override p2620[0 ... n]

- Task mode p2623[0 ... n]
  The task mode controls the traversing block via the following structure:
  p2623 = 0000 cccc bbbb aaaa
  - aaaa: Identifier
    0000: Show traversing block
    0001: Hide traversing block
  - bbbb: Continuation condition
    0000, END: 0/1 edge at STW1.6
    0001, CONTINUE_WITH_STOP:
    The axis stops in the positioning window of the target position before the drive continues executing the traversing block.
    0010, CONTINUE_FLYING:
    The drive switches to the next traversing block when the axis reaches the brake application point of the actual block.
    If a direction reversal is required, the drive only switches to the next traversing block after the motor comes to a stop in the positioning window.
    0011, CONTINUE_EXTERNAL:
    The drive response is the same as for CONTINUE_FLYING; however, at the brake application point, the higher-level control can initiate an immediate traversing block change using a 0/1 edge.
    If the higher-level control does not initiate an external change of the traversing block, then the drive changes the traversing block at the brake application point.
    0100, CONTINUE_EXTERNAL_WAIT:
    Control signal "External block change" initiates a flying change into the following traversing block. A flying change into the following traversing block is possible during the entire traversing phase.
    Without control signal "External block change", the axis remains at the target position and waits for control signal "External block change".
    0101, CONTINUE_EXTERNAL_ALARM:
    The response is the same as for CONTINUE_EXTERNAL_WAIT; however, after reaching the target position, the drive signals that control signal "External block change" was not issued.
  - cccc: Positioning mode
    Task POSITIONING (p2621 = 1) defines how the axis approaches the target position specified in the traversing block.
    0000, ABSOLUTE: The axis traverses to the absolute target position p2617.
    0001, RELATIVE: The axis is traversed around position p2617 in relative terms.
    0010, ABS_POS: Only for rotary axes with modulo correction. The axis traverses in the positive direction to the target position p2617.
    0011, ABS_NEG: Only for rotary axes with modulo correction. The axis traverses in the negative direction to the target position p2617.
- Task parameter p2622[0 ... n] with command-dependent meaning

PROFIdrive control words POS_STW1 or SATZANW activate a traversing block:

Control word	Signal	Description
POS_STW1.15	1	MDI selection
	0	Selecting the traversing block
SATZANW.15	1	MDI selection
	0	Selecting the traversing block

PROFIdrive control word STW1 activates an intermediate stop or rejects a traversing block.

Control word	Signal	Description
STW1.4	1	Do not reject traversing block
	0	Reject traversing block The axis stops with maximum deceleration.
STW1.5	1	No intermediate stop
	0	Intermediate stop

Parameters

The following list contains the parameters of function "Traversing blocks".

Number	Name	Unit
p2615	EPOS maximum number of traversing blocks	-
p2616[0...n]	EPOS traversing block block number	-
p2617[0...n]	EPOS traversing block position	mm
p2617[0...n]	EPOS traversing block position	°
p2618[0...n]	EPOS traversing block velocity	mm/s
p2618[0...n]	EPOS traversing block velocity	°/s
p2619[0...n]	EPOS traversing block acceleration override	%
p2620[0...n]	EPOS traversing deceleration override	%
p2621[0...n]	EPOS traversing block task	-
p2622[0...n]	EPOS traversing block task parameter	-
p2623[0...n]	EPOS traversing block task mode	-
c2625	EPOS traversing block selection bit 0	-
c2626	EPOS traversing block selection bit 1	-
c2627	EPOS traversing block selection bit 2	-
c2628	EPOS traversing block selection bit 3	-
c2629	EPOS traversing block selection bit 4	-
c2630	EPOS traversing block selection bit 5	-
c2631	EPOS activate traversing task (0 -> 1)	-
p2632	EPOS external block change evaluation	-
c2633	EPOS external block change (0 -> 1)	-
c2640	EPOS intermediate stop (0 signal)	-
c2641	EPOS reject traversing task (0 signal)	-

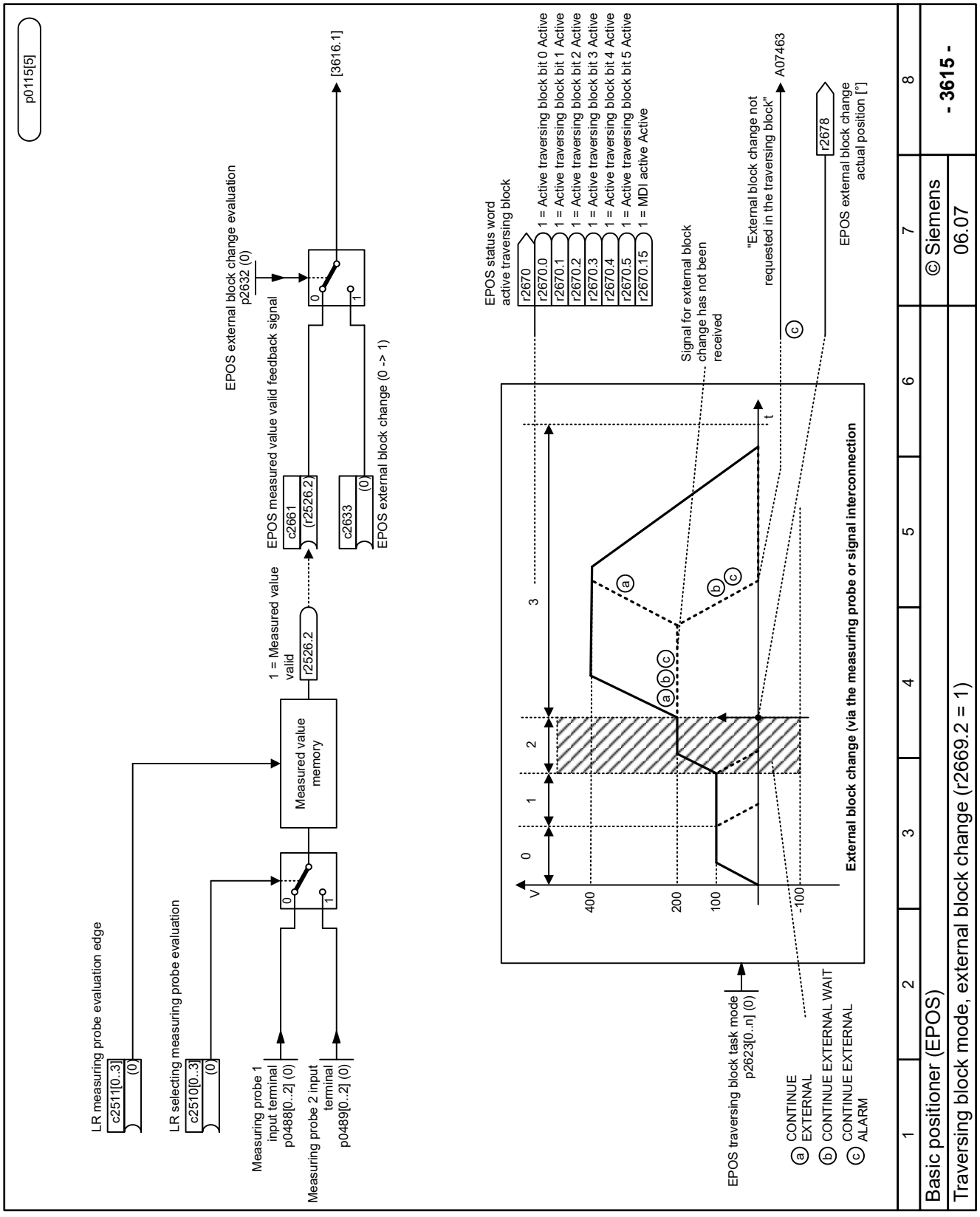


Figure 13-318 3615 – Traversing block mode, external block change (r2669.2 = 1)

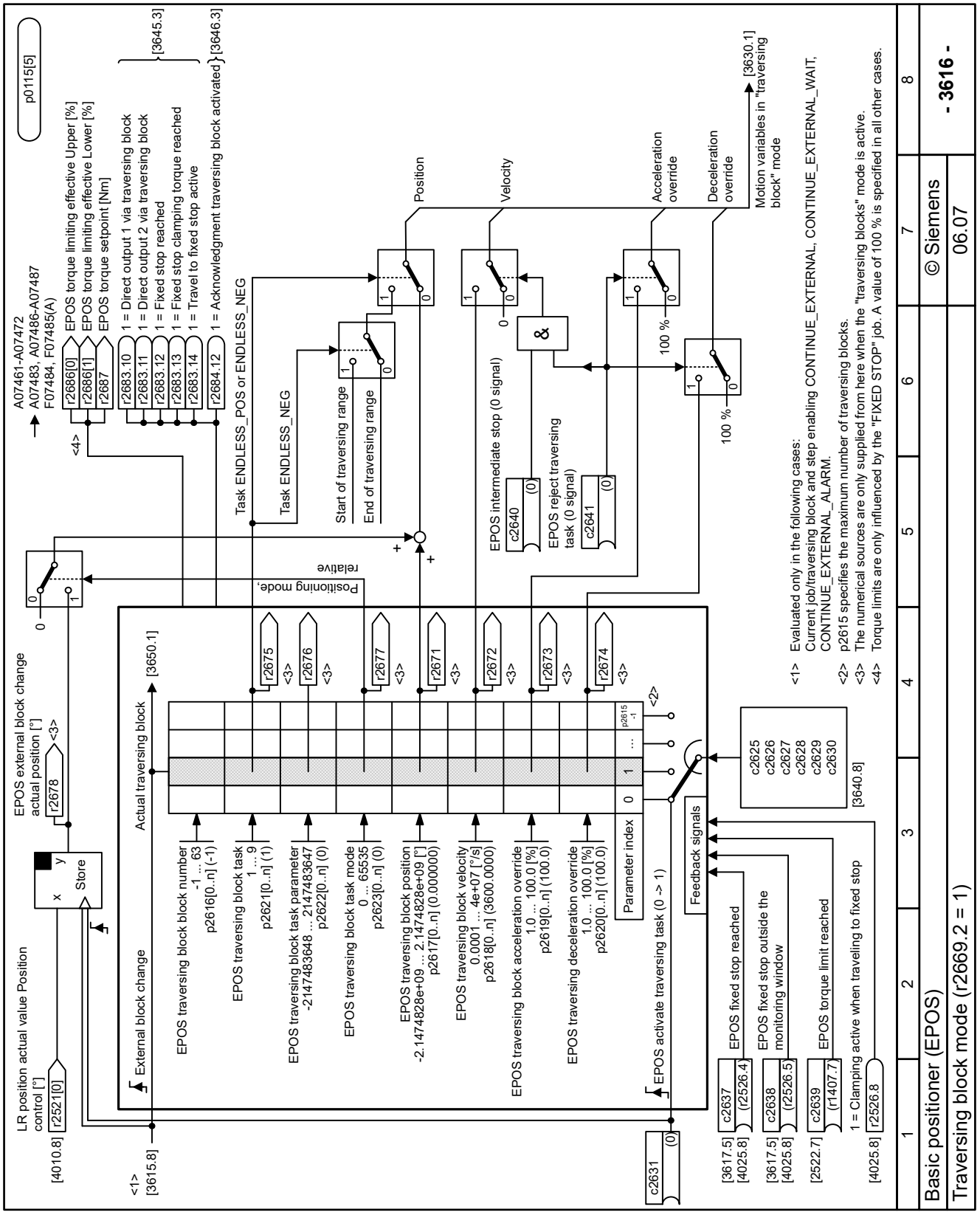
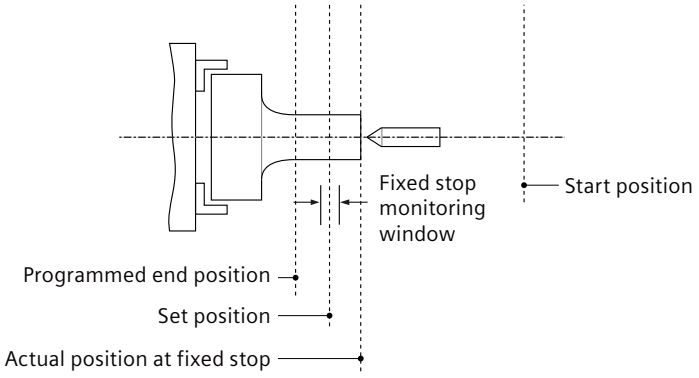


Figure 13-319 3616 – Traversing block mode (r2669.2 = 1)

13.15.1.22 Travel to fixed stop

Overview

The function can be used to move the motor to a fixed stop at a specified torque without a fault being signaled. The specified torque is built up and remains applied after the motor reaches the fixed stop.



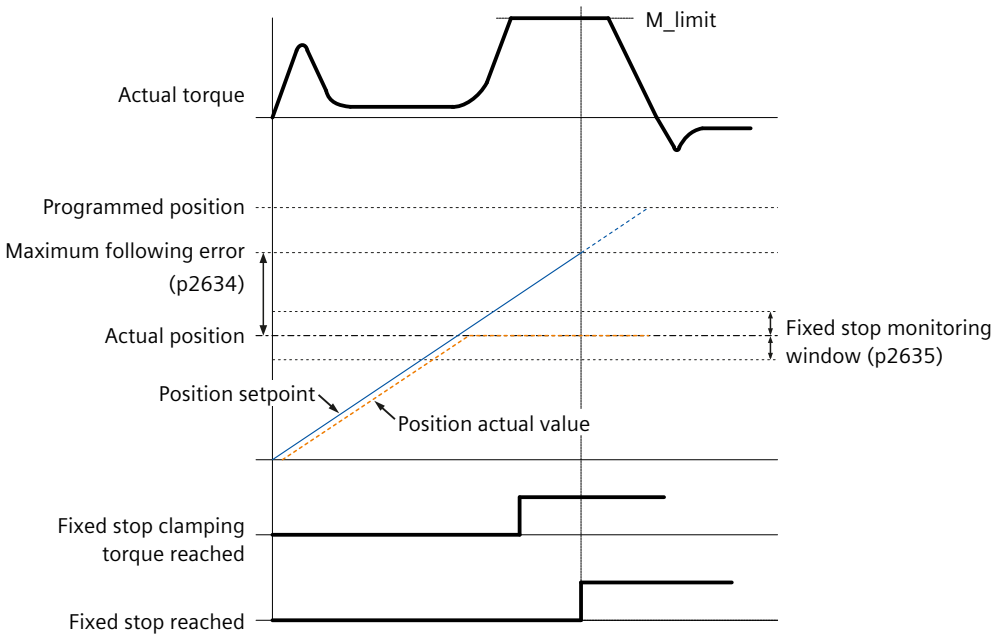
Description of function

In positioning mode, travel to fixed stop is started when a traversing block is processed with the FIXED STOP task. You can set the required clamping torque of the FIXED STOP function by the task parameter p2622.

An adjustable monitoring window for travel to fixed stop prevents the drive from traveling beyond the window if the fixed stop should break away.

From the start position onwards, the target position is approached with the parameterized speed. The fixed stop (the workpiece) must be between the start position and the braking point of the axis; that is, the target position is placed inside the workpiece. The preset torque limit is effective from the start, i.e. travel to fixed stop also occurs with a reduced torque. The preset acceleration and delay overrides and the current speed override are also effective.

Dynamic following error monitoring (p2546) in the position controller is not effective when traveling to the fixed stop. As long as the drive travels to the fixed stop or is in fixed stop, the "Travel to fixed stop active" status bit r2683.14 is set.



Fixed stop is reached

As soon as the axis comes into contact with the mechanical fixed stop, the closed-loop control in the drive raises the torque so that the axis can move on. The torque increases up to the value specified in the task and then remains constant. If the actual position following error exceeds the value set in parameter p2634 (Fixed stop: maximum following error), fixed stop is reached.

Once the "Fixed stop reached" status has been detected, the traversing task "Travel to fixed stop" is ended. The program advances to the next block depending on the task parameterization.

If the axis leaves the position that has been detected as the fixed stop by more than the selected monitoring window for the fixed stop (p2635), the speed setpoint is set to 0, and fault F07484 "Fixed stop outside of the monitoring window" is triggered with the reaction OFF3 (quick stop). The monitoring window can be set using the parameter p2635 ("Fixed stop monitoring window"). It applies to both positive and negative traversing directions and must be selected such that it will only be triggered if the axis breaks away from the fixed stop.

Fixed stop is not reached

If the brake application point is reached without the "Fixed stop reached" status being detected, then the fault F07485 "Fixed stop is not reached" is output with fault reaction OFF1, the torque limit is canceled and the drive cancels the traversing block.

Parameters

The following list contains the parameters of function "Travel to fixed stop".

Number	Name	Unit
p2634[0...n]	EPOS fixed stop maximum following error	mm
p2634[0...n]	EPOS fixed stop maximum following error	°

p2635	EPOS fixed stop monitoring window	mm
p2635	EPOS fixed stop monitoring window	°
c2637	EPOS fixed stop reached	-
c2638	EPOS fixed stop outside the monitoring window	-
c2639	EPOS torque limit reached	-

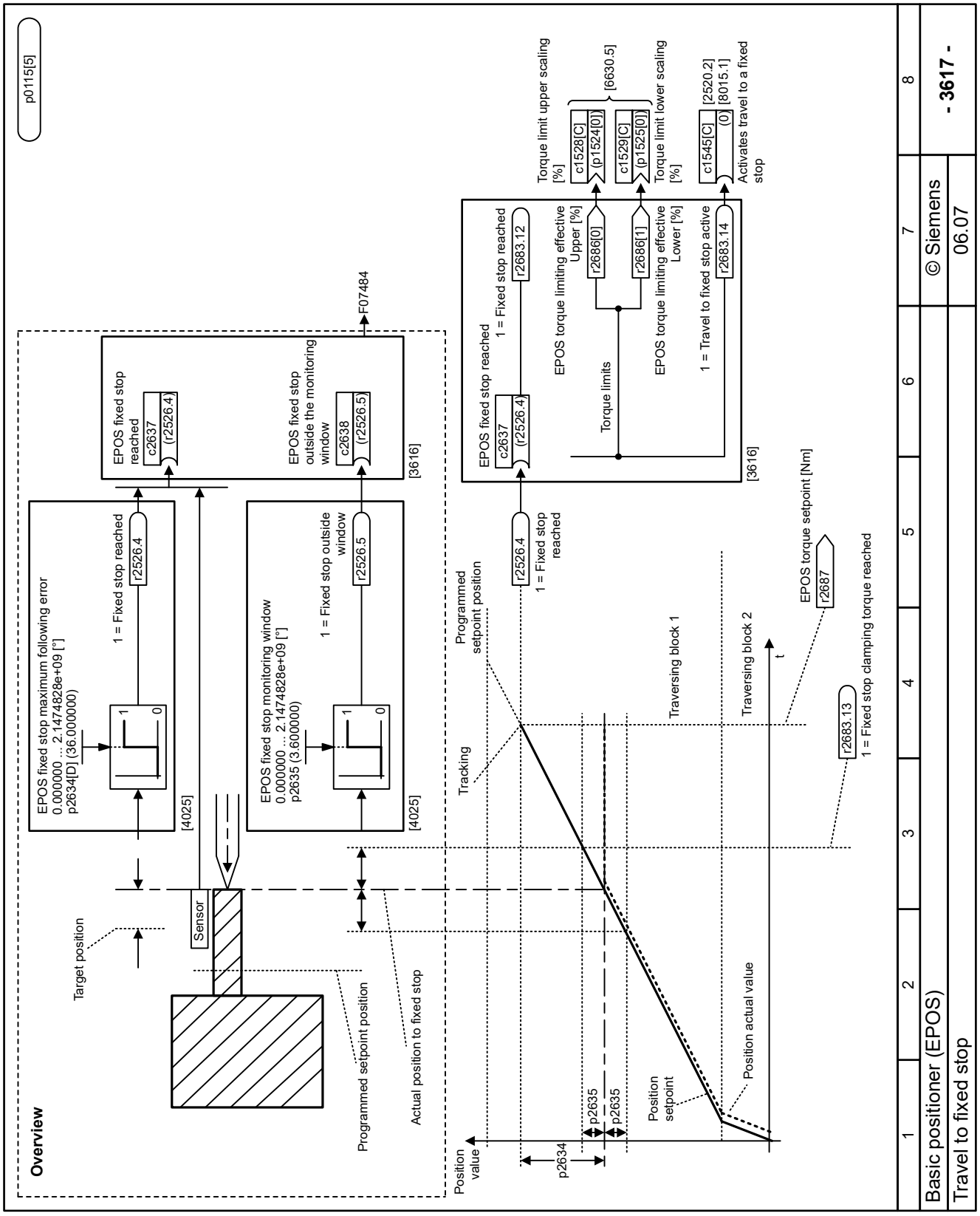


Figure 13-320 3617 – Travel to fixed stop

13.15.1.23 Direct setpoint input (MDI)

Overview

The "direct setpoint input (MDI, Manual Data Input)" function allows for positioning (absolute, relative) and setting-up (endless position-controlled) by means of direct setpoint inputs (e.g. via the PLC using process data). A higher-level control provides the converter with the position setpoint and traversing profile.

Description of function

During traversing, the motion parameters can also be influenced (on-the-fly setpoint acceptance) and an on-the-fly change can be undertaken between the "setting-up" and "positioning" modes. The "direct setpoint specification" mode (MDI) can also be used if the axis is not homed in the "setting-up" or "relative positioning" modes.

"Setting-up" mode

The higher-level control selects the mode "Set-up":

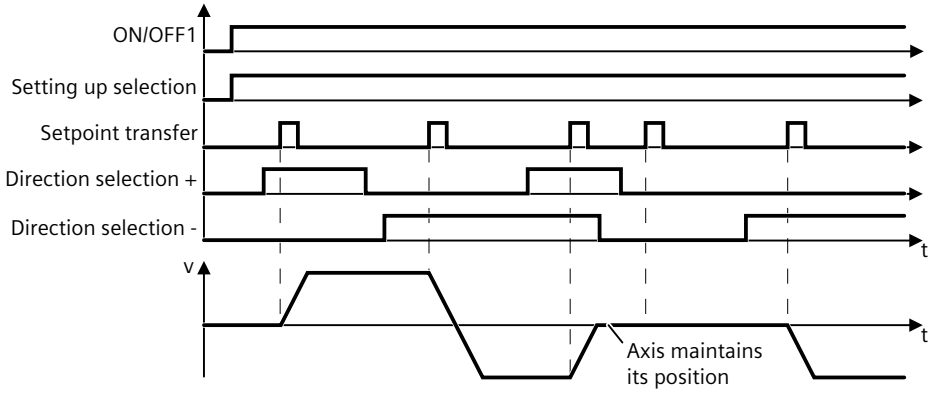


Figure 13-321 Set up axis with direct setpoint input (MDI)

"Positioning" mode

The higher-level control specifies the value of the setpoint either as a relative or an absolute position setpoint:

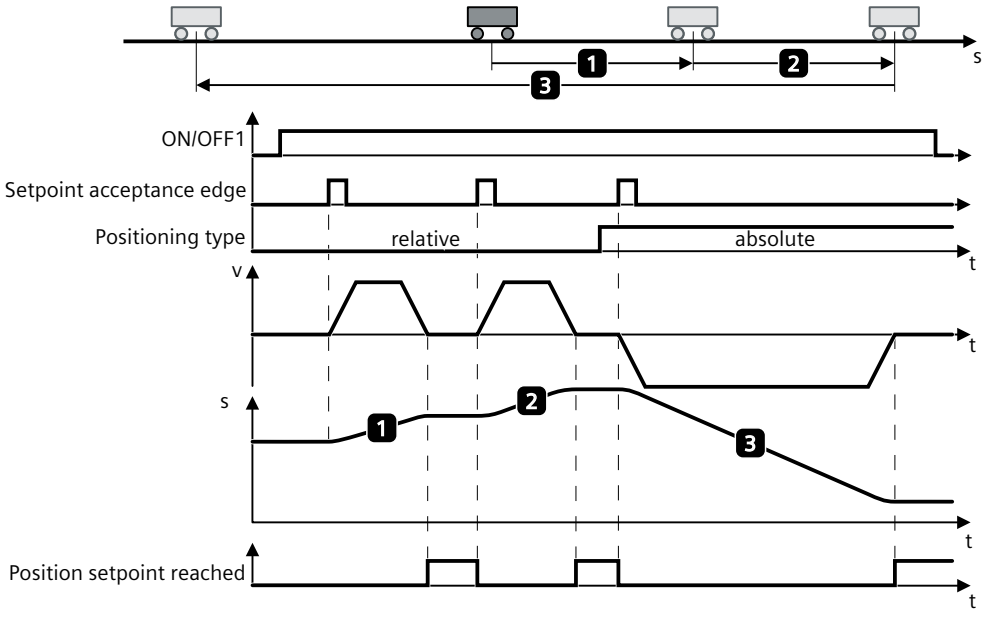


Figure 13-322 Position axis with direct setpoint input (MDI)

Activating the direct setpoint input function

When telegrams 111, 112, and 113 are used, the direct setpoint input function can be configured with the PROFINET control word POS_STW1.15:

Control word	Signal	Description
POS_STW1.15	1	MDI selection.
	0	Traversing block selection.

When telegrams 7 and 9 are used, the direct setpoint input function can be configured with the PROFINET control word SATZANW.15:

Control word	Signal	Description
SATZANW.15	1	MDI selection.
	0	Traversing block selection.

Selecting a working mode

In "Positioning" mode, the parameters (position, velocity, acceleration and deceleration) can be used to carry out absolute or relative positioning.

In "Setting-up" mode, using parameters (velocity, acceleration and deceleration) endless closed-loop position control behavior can be carried out.

When telegrams 111, 112, and 113 are used, select a working mode with the PROFINET control word POS_STW1.14:

Control word	Signal	Description
POS_STW1.14	1	Select "setting-up" mode.
	0	Select "positioning" mode.[1)]

[1)] Telegrams 7 and 9 can only work in "positioning" mode.

Selecting a positioning type in "positioning" mode

When telegrams 111, 112, and 113 are used, select a positioning type with the PROFINET control word POS_STW1.8:

Control word	Signal	Description
POS_STW1.8	1	Select absolute positioning.
	0	Select relative positioning.

When telegram 9 is used, select a positioning type with the PROFINET control word MDI_MOD.0:

Control word	Signal	Description
MDI_MOD.0	1	Select absolute positioning.
	0	Select relative positioning.

Selecting an absolute positioning direction in "positioning" mode

When telegrams 111, 112, and 113 are used, select an absolute positioning direction with the PROFINET control words POS_STW1.9 and POS_STW1.10:

Control word		Description
POS_STW1.9	POS_STW1.10	
0	0	Absolute positioning through the shortest distance.
0	1	Absolute positioning/MDI direction selection, positive.
1	0	Absolute positioning/MDI direction selection, negative.
1	1	Absolute positioning through the shortest distance.

When telegram 9 is used, select an absolute positioning direction with the PROFINET control words MDI_MOD.1 and MDI_MOD.2:

Control word		Description
MDI_MOD.1	MDI_MOD.2	
0	0	Absolute positioning through the shortest distance.
0	1	Absolute positioning/MDI direction selection, positive.
1	0	Absolute positioning/MDI direction selection, negative.
1	1	Absolute positioning through the shortest distance.

Selecting a direction in "setting-up" mode

When telegrams 111, 112, and 113 are used, select a direction with the PROFINET control words POS_STW1.9 and POS_STW1.10

Control word		Description
POS_STW1.9	POS_STW1.10	
0	1	MDI direction selection, positive.
1	0	MDI direction selection, negative.

Selecting an MDI transfer type

When telegrams 111, 112, and 113 are used, select an MDI transfer type with the PROFINET control word POS_STW1.12:

Control word	Signal	Description
POS_STW1.12	1	Continuous transfer.
	0	Activate MDI block change with of a traversing task (STW1.6).

Setting MDI setpoints

When telegrams 9, 111, 112, and 113 are used, set MDI setpoints with the following PROFINET control words:

- Position setpoint
  - MDI_TARPOS in telegrams 9, 111: 1 hex = 1 LU
  - MDI_TARPOS_F in telegram 112: LU or MU as floating-point number with the set physical unit
  - MDI_TARPOS_D in telegram 113: LU or MU as 64-bit floating-point number with the set physical unit
- Velocity setpoint
  - MDI_VELOCITY in telegrams 9, 111: 1 hex = 1000 LU/min referred to p2572
  - MDI_VELOCITY_F in telegrams 112, 113: floating-point number with the set physical unit
- Acceleration override
  - MDI_ACC in telegrams 9, 111: 4000 hex = 100% referred to p2573
  - MDI_ACC_F in telegrams 112, 113: floating-point number as physical unit from c11560
- Deceleration override
  - MDI_DEC in telegrams 9, 111: 4000 hex = 100%
  - MDI_DEC_F in telegrams 112, 113: floating-point number as physical unit from c11561

Intermediate stop and reject an MDI task

When telegrams 7, 9, 111, 112, and 113 are used, perform an intermediate stop with the PROFINET control word STW1.5:

Control word	Signal	Description
STW1.5	1	No intermediate stop.
	0	Intermediate stop with parameterized deceleration MDI_DEC (telegrams 9, 111, 112, and 113).

When telegrams 7, 9, 111, 112, and 113 are used, reject an MDI task with the PROFINET control word STW1.4:

Control word	Signal	Description
STW1.4	1	Do not reject a traversing task.
	0	Reject a traversing task (ramp-down with the maximum deceleration).

Parameters

The following list contains the parameters of function "Direct setpoint specification".

Number	Name	Unit
c2642	EPOS direct setpoint input/MDI position setpoint	mm
c2642	EPOS direct setpoint input/MDI position setpoint	°
c2643	EPOS direct setpoint input/MDI velocity setpoint	mm/s
c2643	EPOS direct setpoint input/MDI velocity setpoint	°/s
c2644	EPOS direct setpoint input/MDI acceleration override	%
c2645	EPOS direct setpoint input/MDI deceleration override	%
c2646	EPOS velocity override	%
c2647	EPOS direct setpoint input/MDI selection	-
c2648	EPOS direct setpoint input/MDI positioning type	-
c2649	EPOS direct setpoint input/MDI transfer type selection	-
c2650	EPOS direct setpoint input/MDI setpoint acceptance edge	-
c2651	EPOS direct setpoint input/MDI direction selection, positive	-
c2652	EPOS direct setpoint input/MDI direction selection negative	-
c2653	EPOS direct setpoint input/MDI setting-up selection	-
c2654	EPOS direct setpoint input/MDI mode adaptation	-

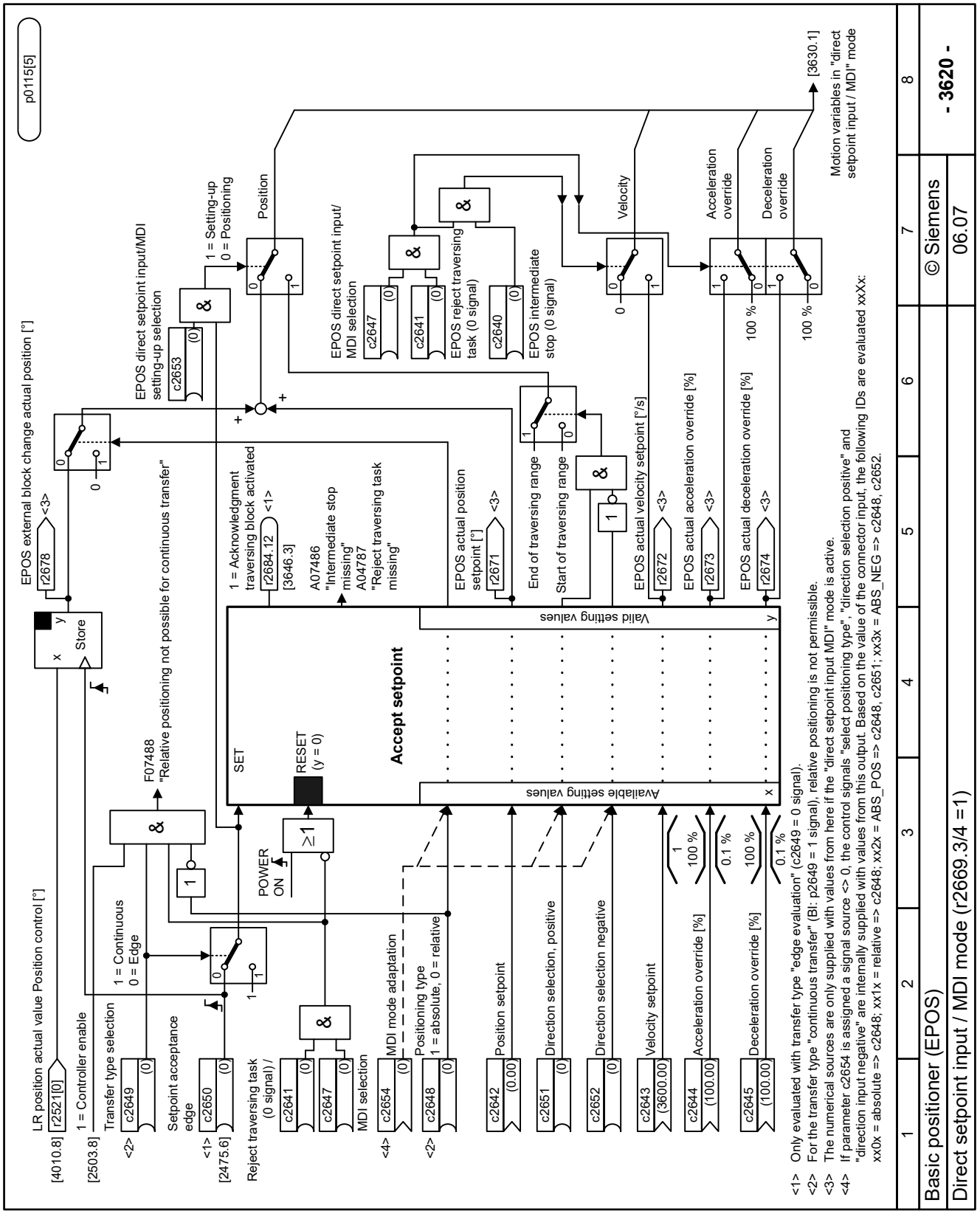
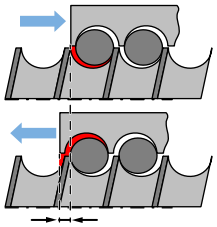


Figure 13-323 3620 – Direct setpoint input/MDI mode (r2669.3/4 =1)

13.15.1.24 Setting the backlash

Overview



Backlash: p2583

Backlash (also called play, dead travel on reversing) is the distance or the angle that a motor must travel through when the direction of rotation reverses until the axis actually moves in the other direction.

Description of function

Backlash measurement

Proceed as follows to measure the backlash:

1. Move the axis to position A in the machine. Mark this position in the machine and note down the actual position value in the converter.
2. Move the axis a little bit more in the same direction.
3. Move the axis in the opposite direction until the actual position value in the converter shows the same value as at position A. Due to the backlash when reversing, the axis is now at position B.
4. Measure the position difference Δ = A - B in the machine.

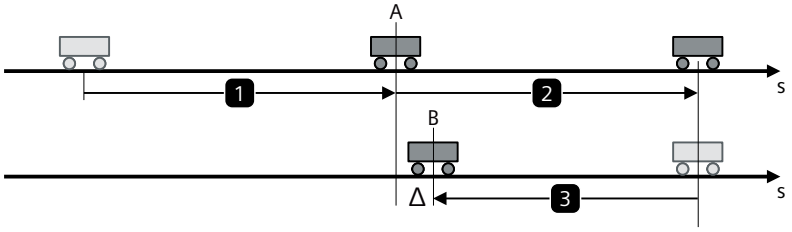


Figure 13-324 Measuring backlash

Backlash compensation

When mechanical force is transferred between a machine part and its drive, generally backlash occurs. If the mechanical system was to be adjusted/designed so that there was absolutely no backlash, this would result in high wear. Thus, backlash can occur between the machine component and the encoder.

When the axis with the motor encoder is operated in a process that the traversing direction is reversed, the mechanical backlash can increase or decrease the traversing distance and thus result in an error of the traversing distance.

Note

Precondition for backlash compensation

The backlash compensation is active with the precondition that the axis has been homed.

In order to compensate the backlash, the determined backlash must be specified in p2583 with the correct polarity. At each direction of rotation reversal, the actual axis value is corrected dependent on the actual traversing direction and displayed in r2667. This value is taken into account in the actual position value using position offset.

If a stationary axis is homed by setting the home position or an adjusted axis is powered-up with an absolute encoder, then the parameter c2604 (home position approach, starting direction) is relevant for switching-in the compensation value.

Parameters

The following list contains the parameters of function "Backlash".

Number	Name	Unit
p2583	EPOS backlash compensation	mm
p2583	EPOS backlash compensation	°
r2685	EPOS corrective value	mm
r2685	EPOS corrective value	°

13.15.2 Technology controller

13.15.2.1 PID technology controller

Overview

The technology controller controls process variables, e.g. pressure, temperature, level or flow.

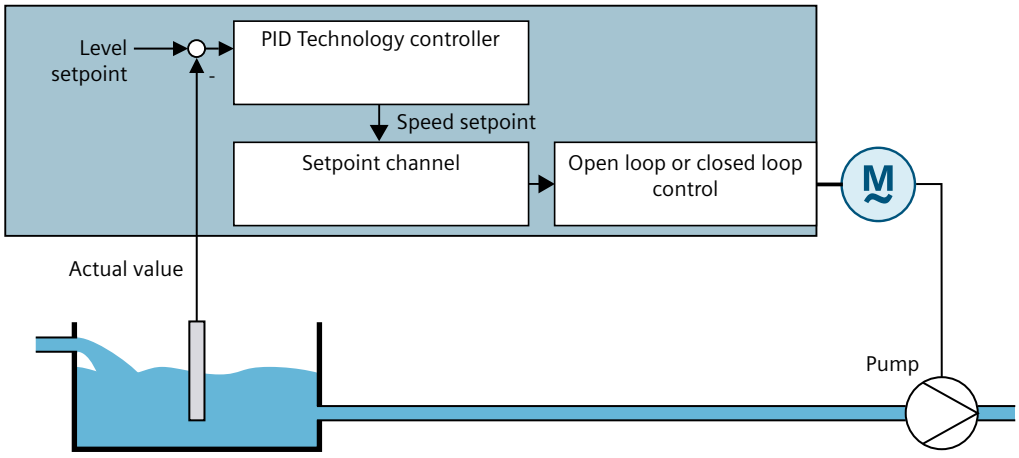
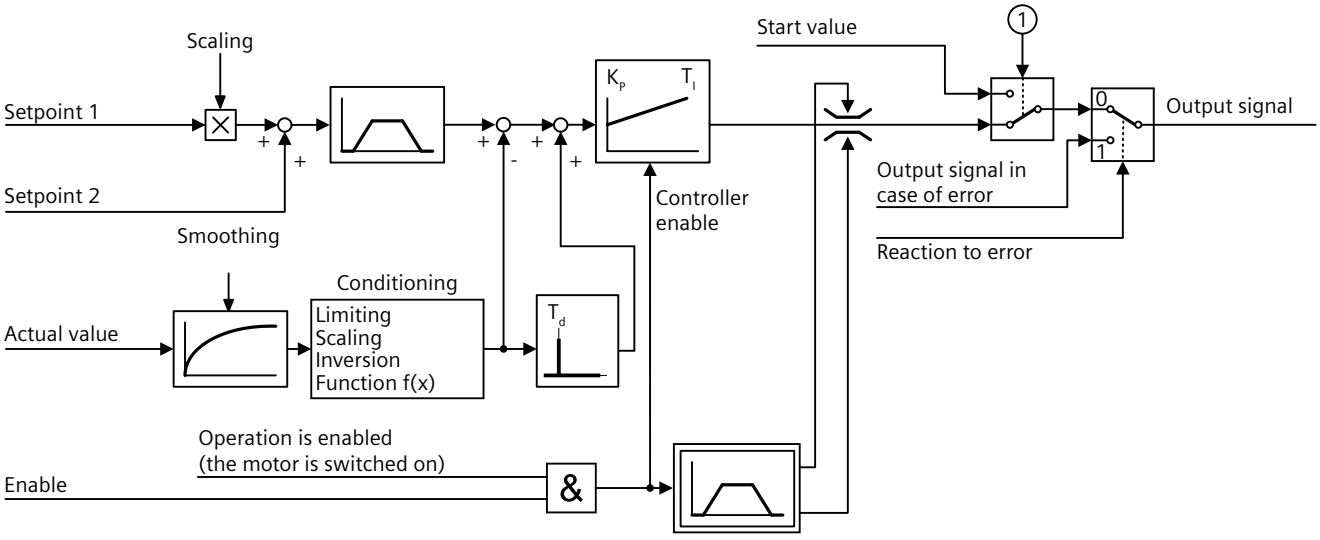


Figure 13-325 Example: Technology controller as a level controller

Function description

The technology controller is implemented as a PID controller (controller with proportional, integral, and derivative action).



① The converter uses the start value when all the following conditions are simultaneously satisfied:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

Figure 13-326 Simplified representation of the technology controller

The setpoint of the technology controller is interconnected with c2253.

The following options are available for the setpoint source:

- Motorized potentiometer
- Fixed setpoints
- Numerical signal sources, e.g. an analog input

The actual value of the technology controller is interconnected with c2264.

Every numerical signal source is permissible as actual value source.

c2200 enables the technology controller.

p2251 defines the interconnection of the output signal:

- p2251 = 0: The technology controller output signal is interconnected with the main speed setpoint.
  The interconnection cannot be changed.
- p2251 = 1: The technology controller output signal is interconnected with the supplementary speed setpoint.
  The interconnection cannot be changed.
- p2251 = 2: The technology controller output signal can be freely interconnected.

In the factory setting, the output of the technology controller is limited to ± maximum speed. This limitation must be changed according to the respective application.
Example: The output of the technology controller supplies the speed setpoint for a pump. The pump should only run in the positive direction.

Parameters

The following list contains the parameters of the "PID - technology controller" function.

Number	Name	Unit
r0046.0...31	Missing enable signals	-
r0052.0...15	Status word 1	-
r0056.0...15	Status word, closed-loop control	-
r1084	Positive speed limit effective	rpm
r1087	Negative speed limit effective	rpm
c2200[0...n]	Technology controller enable	-
p2201[0...n]	Technology controller fixed value 1	%
p2202[0...n]	Technology controller fixed value 2	%
p2203[0...n]	Technology controller fixed value 3	%
p2204[0...n]	Technology controller fixed value 4	%
p2205[0...n]	Technology controller fixed value 5	%
p2206[0...n]	Technology controller fixed value 6	%
p2207[0...n]	Technology controller fixed value 7	%
p2208[0...n]	Technology controller fixed value 8	%
p2209[0...n]	Technology controller fixed value 9	%
p2210[0...n]	Technology controller fixed value 10	%
p2211[0...n]	Technology controller fixed value 11	%
p2212[0...n]	Technology controller fixed value 12	%
p2213[0...n]	Technology controller fixed value 13	%
p2214[0...n]	Technology controller fixed value 14	%
p2215[0...n]	Technology controller fixed value 15	%
p2216[0...n]	Technology controller fixed value selection method	-
c2220[0...n]	Technology controller fixed value selection bit 0	-
c2221[0...n]	Technology controller fixed value selection bit 1	-
c2222[0...n]	Technology controller fixed value selection bit 2	-
c2223[0...n]	Technology controller fixed value selection bit 3	-
r2224	Technology controller fixed value effective	%
r2225.0	Technology controller fixed value selection status word	-
r2229	Technology controller number actual	-
p2230[0...n].0...4	Technology controller motorized potentiometer configuration	-
r2231	Technology controller motorized potentiometer setpoint memory	%
c2235[0...n]	Technology controller motorized potentiometer raise setpoint	-
c2236[0...n]	Technology controller motorized potentiometer lower setpoint	-
p2237[0...n]	Technology controller motorized potentiometer maximum value	%
p2238[0...n]	Technology controller motorized potentiometer minimum value	%
p2240[0...n]	Technology controller motorized potentiometer starting value	%
r2245	Technology controller mot. potentiometer setpoint before RFG	%
p2247[0...n]	Technology controller motorized potentiometer ramp-up time	s
p2248[0...n]	Technology controller motorized potentiometer ramp-down time	s
r2250	Technology controller motorized potentiometer setpoint after RFG	%

p2251	Technology controller mode	-
p2252.0...8	Technology controller configuration	-
c2253[0...n]	Technology controller setpoint 1	%
c2254[0...n]	Technology controller setpoint 2	%
p2255	Technology controller setpoint 1 scaling	%
p2256	Technology controller setpoint 2 scaling	%
p2257	Technology controller ramp-up time	s
p2258	Technology controller ramp-down time	s
r2259	Technology controller total setpoint	%
r2260	Technology controller setpoint after ramp-function generator	%
p2261	Technology controller setpoint filter time constant	s
r2262	Technology controller setpoint after filter	%
p2263	Technology controller type	-
c2264[0...n]	Technology controller actual value	%
p2265	Technology controller actual value filter time constant	s
r2266	Technology controller actual value after filter	%
p2267	Technology controller upper limit actual value	%
p2268	Technology controller lower limit actual value	%
p2269	Technology controller gain actual value	%
p2270	Technology controller actual value function	-
p2271	Technology controller actual value inversion (sensor type)	-
r2272	Technology controller actual value scaled	%
r2273	Technology controller system deviation	%
p2274	Technology controller differentiation time constant	s
p2280	Technology controller proportional gain	-
p2285	Technology controller integral time	s
c2286[0...n]	Hold technology controller integrator	-
c2289[0...n]	Technology controller precontrol signal	%
c2290[0...n]	Technology controller limiting enable	-
p2291	Technology controller maximum limiting	%
p2292	Technology controller minimum limiting	%
p2293	Technology controller ramp-up/ramp-down time	s
r2294	Technology controller output signal	%
p2295	Technology controller output scaling	%
c2296[0...n]	Technology controller output scaling	%
c2297[0...n]	Technology controller maximum limiting	%
c2298[0...n]	Technology controller minimum limiting	%
c2299[0...n]	Technology controller limit offset	%
p2302	Technology controller output signal starting value	%
p2306	Technology controller system deviation inversion	-
c2310	Technology controller Kp adaptation input value	%
p2311	Technology controller Kp adaptation lower value	-
p2312	Technology controller Kp adaptation upper value	-
p2313	Technology controller Kp adaptation lower starting point	%
p2314	Technology controller Kp adaptation upper starting point	%
c2315	Technology controller Kp adaptation scaling	%
r2316	Technology controller, Kp adaptation output	-
c2317	Technology controller Tn adaptation input value	%
p2318	Technology controller Tn adaptation upper value	s

p2319	Technology controller Tn adaptation lower value	s
p2320	Technology controller Tn adaptation lower starting point	%
p2321	Technology controller Tn adaptation upper starting point	%
r2322	Technology controller Tn adaptation output	s
p2339	Hold techn. controller I component for n_skip threshold value	%
r2344	Technology controller last speed setpoint (smoothed)	%
p2345	Technology controller fault response	-
r2349.0...15	Technology controller status word	-

13.15.2.2 Autotuning of the PID controller

Overview

"PID Autotuning" is a converter function to automatically optimize the PID technology controller.

Requirement

Requirements:

- The motor closed-loop control has been optimized.
- The PID technology controller must be set the same as when used in subsequent operation:
  - The actual value is interconnected.
  - Scalings, filter and ramp-function generator have been set.
  - The PID technology controller is enabled (c2200 = 1 signal).
- The speed controller uses the output of the PID technology controller as main speed setpoint (p2251 = 0)

Function description

When "PID autotuning" is active, then the converter interrupts the connection between the PID technology controller and the speed controller. Instead of the PID technology controller output, function "PID Autotuning" specifies the speed setpoint.

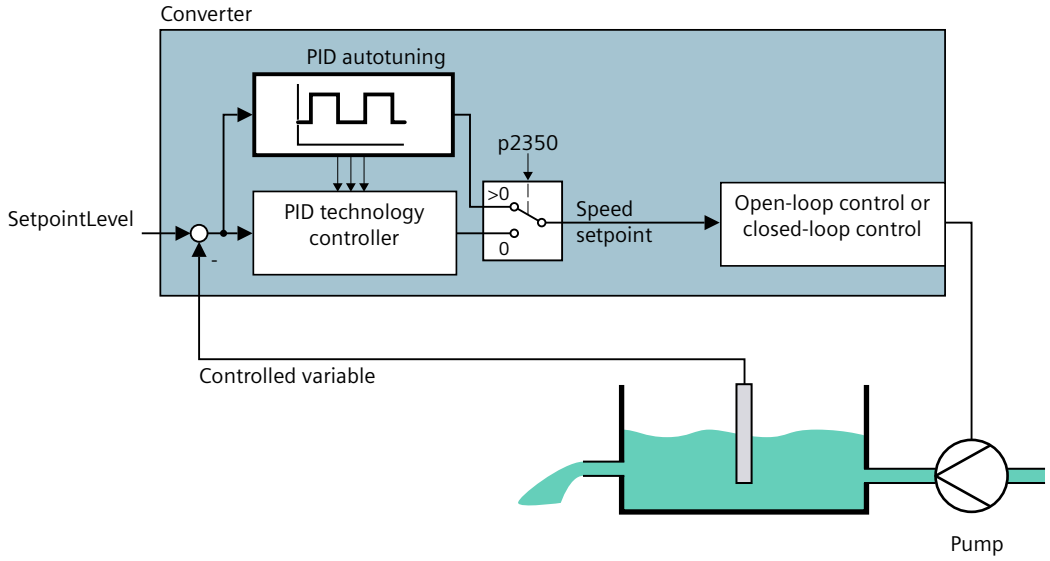


Figure 13-327 Autotuning using closed-loop level control as example

After the on command, function "PID Autotuning" excites one oscillation of the controlled variable. The speed setpoint is obtained from the offset p2355[1] and the amplitude p2355[0] of the higher-level square-wave excitation signal. As soon as the controlled variable reaches offset p2355[1] then function "PID Autotuning" switches over the polarity of the speed setpoint.

The converter issues alarm A07444 when function "PID Autotuning" is active.

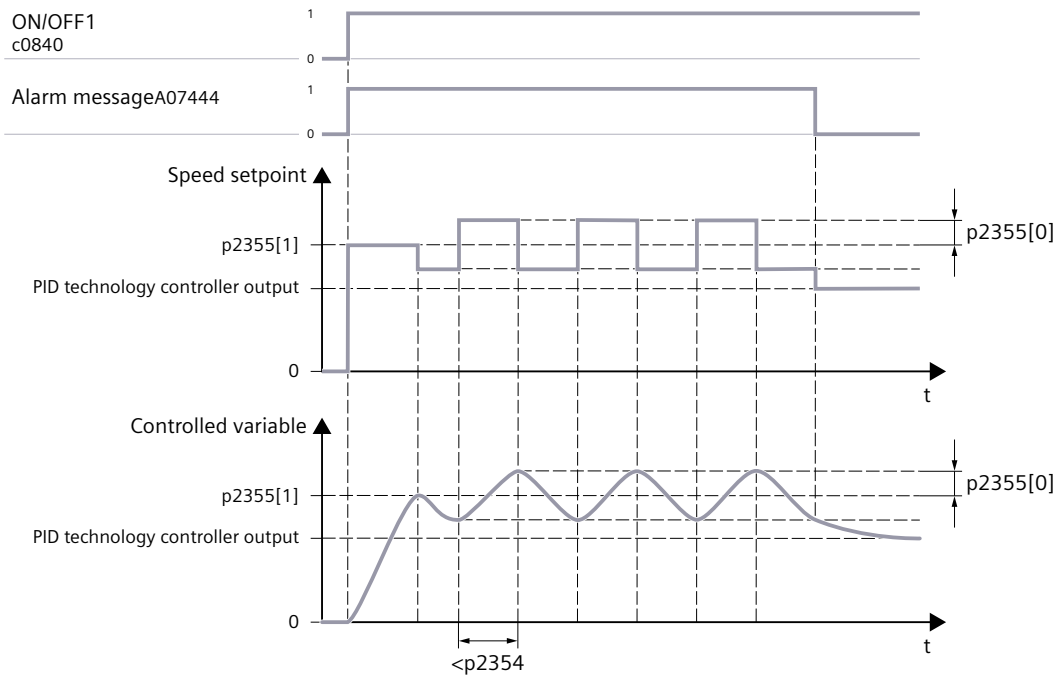


Figure 13-328 Example for speed setpoint and controlled variable for autotuning

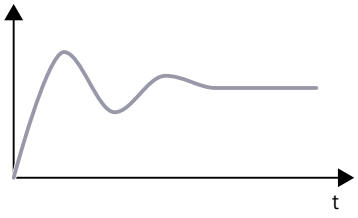
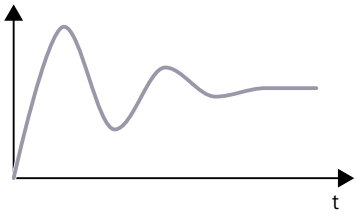
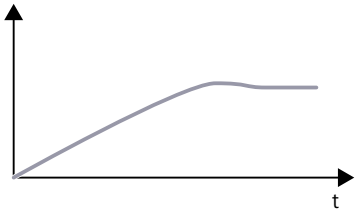
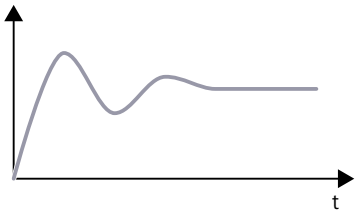
Function "PID Autotuning" requires 3 ... 4 periods of excited oscillation to tune the PID controller. After the PID controller has been successfully tuned, the converter deletes alarm A07444 and the PID technology controller transitions into regular operation.

Constraints for successful PID controller tuning:

- The offset and amplitude of the speed setpoint must excite a measurable controlled variable response.
- If the amplitude of the speed setpoint is too high, then this can activate the Vdc_max control. An active Vdc_max control during a PID autotuning results in incorrect results.
- Within the monitoring time p2354, the actual value of the controlled variable must have reached the speed setpoint.

The converter calculates parameters p2280, p2285 and p2274 of the PID controller from the vibration frequency that was determined.

Parameter p2350 defines the PID controller tuning:

PID controller tuning p2350	Response of the PID technology controller
0 The converter sets p2350 = 0 after "PID Autotuning" has been completed.	No PID controller tuning
1 Recommended PID controller tuning according to Ziegler/Nichols for standard applications	The controlled variable follows the setpoint after a sudden setpoint change (step function) relatively quickly, however with a possible overshoot. 
2 PID controller tuning for applications that demand a higher dynamic response than for p2350 = 1	Short rise time with possible overshoot of the controlled variable 
3 PID controller tuning for applications where low overshoot of the controlled variable is desirable	Overshoot of the controlled variable is, to a large extent, avoided. 
4 PID controller tuning as for p2350 = 1; however, without D component of the PID controller	Controller settings similar to p2350 = 1 

Parameters

The following list contains the parameters of function "Autotuning of the PID controller".

Number	Name	Unit

p2350	Enable PID autotuning	-
p2354	PID autotuning monitoring time	s
p2355[0...1]	PID autotuning excitation	%

13.15.2.3 Manually setting the controller parameters of the PID technology controller

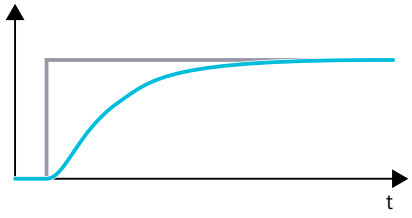
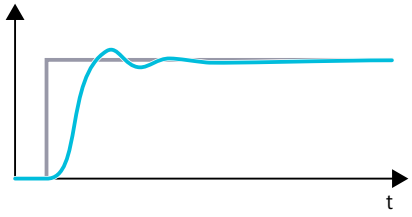
Requirement

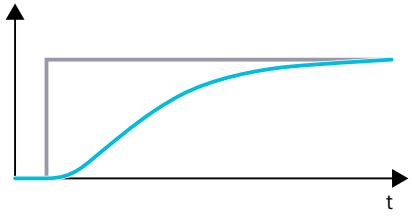
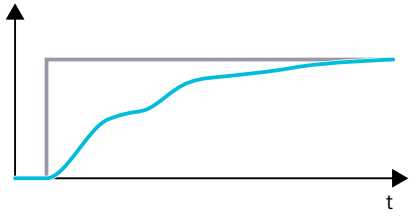
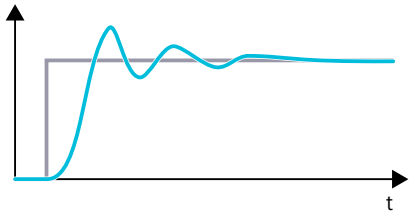
The closed-loop drive control is set.

Procedure

Proceed as follows to manually set controller parameters K_P, T_I and T_d:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

Optimum control response	
	Optimum controller response for applications that do not permit any overshoot. The actual value approaches the setpoint without any significant overshoot.
	Optimum controller behavior for fast correction and quick compensation of disturbance components. The actual value approaches the setpoint and slightly overshoots, maximum 10% of the setpoint step.

Controller response with optimization potential	
	The actual value only slowly approaches the setpoint. • Increase the proportional component K_P (p2280) and reduce the integration time T_I (p2285).
	The actual value only slowly approaches the setpoint with slight oscillation. • Increase the proportional component K_P (p2280) and reduce the derivative-action time T_d (p2274).
	The actual value quickly approaches the setpoint, but overshoots too much. • Decrease the proportional component K_P (p2280) and increase the integration time T_I (p2285).

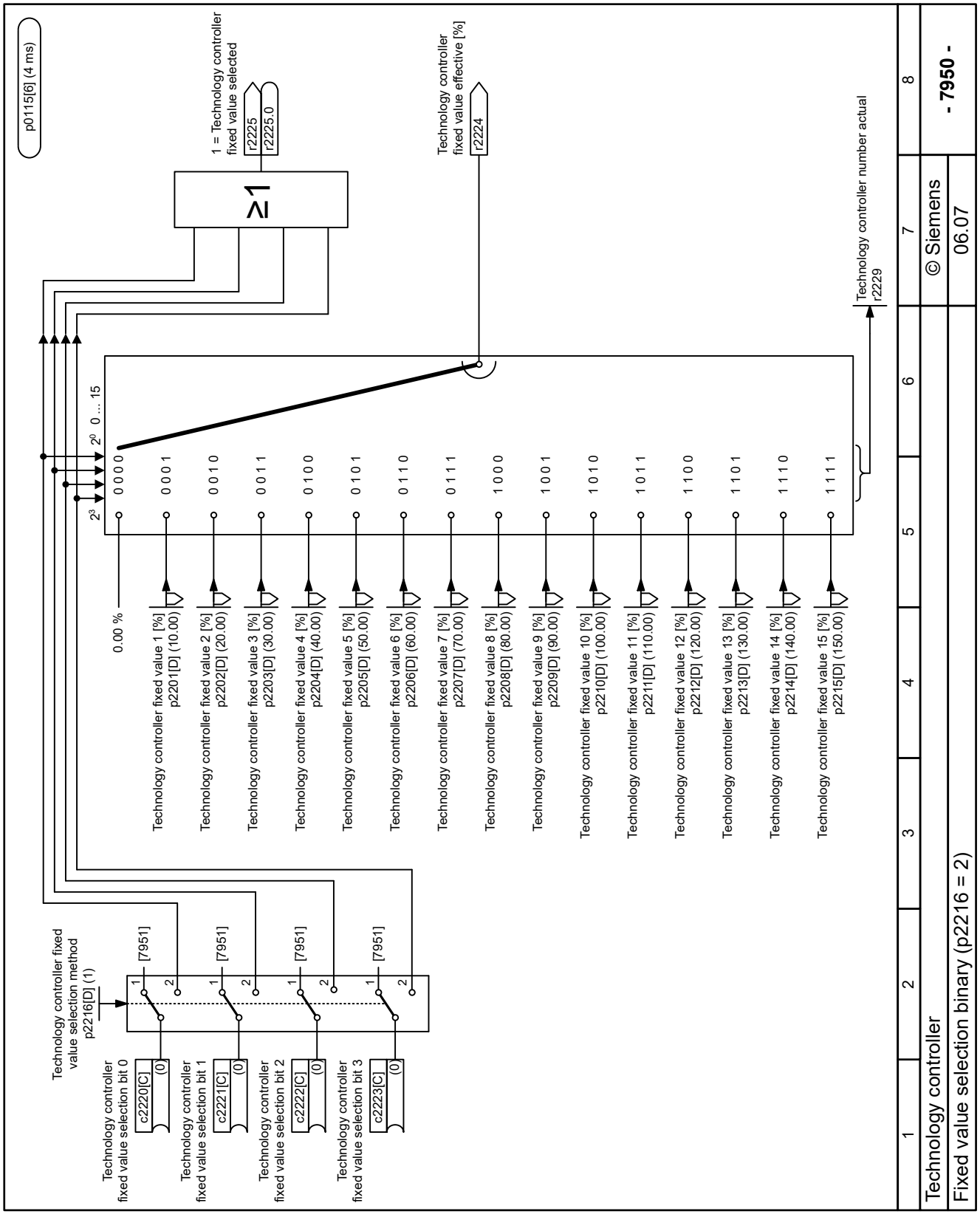


Figure 13-329 7950 - Fixed values, binary selection

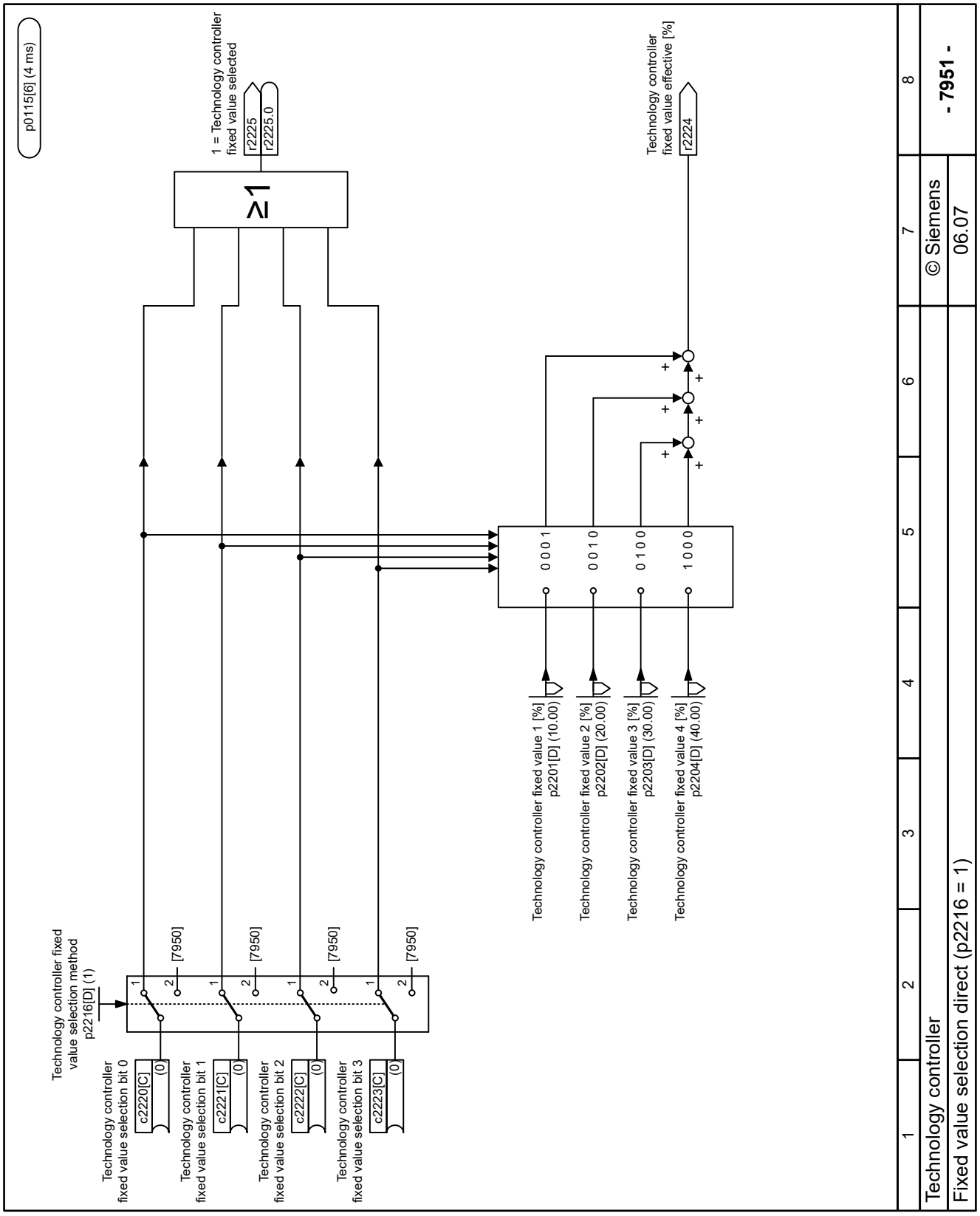


Figure 13-330 7951 - Fixed values, direct selection

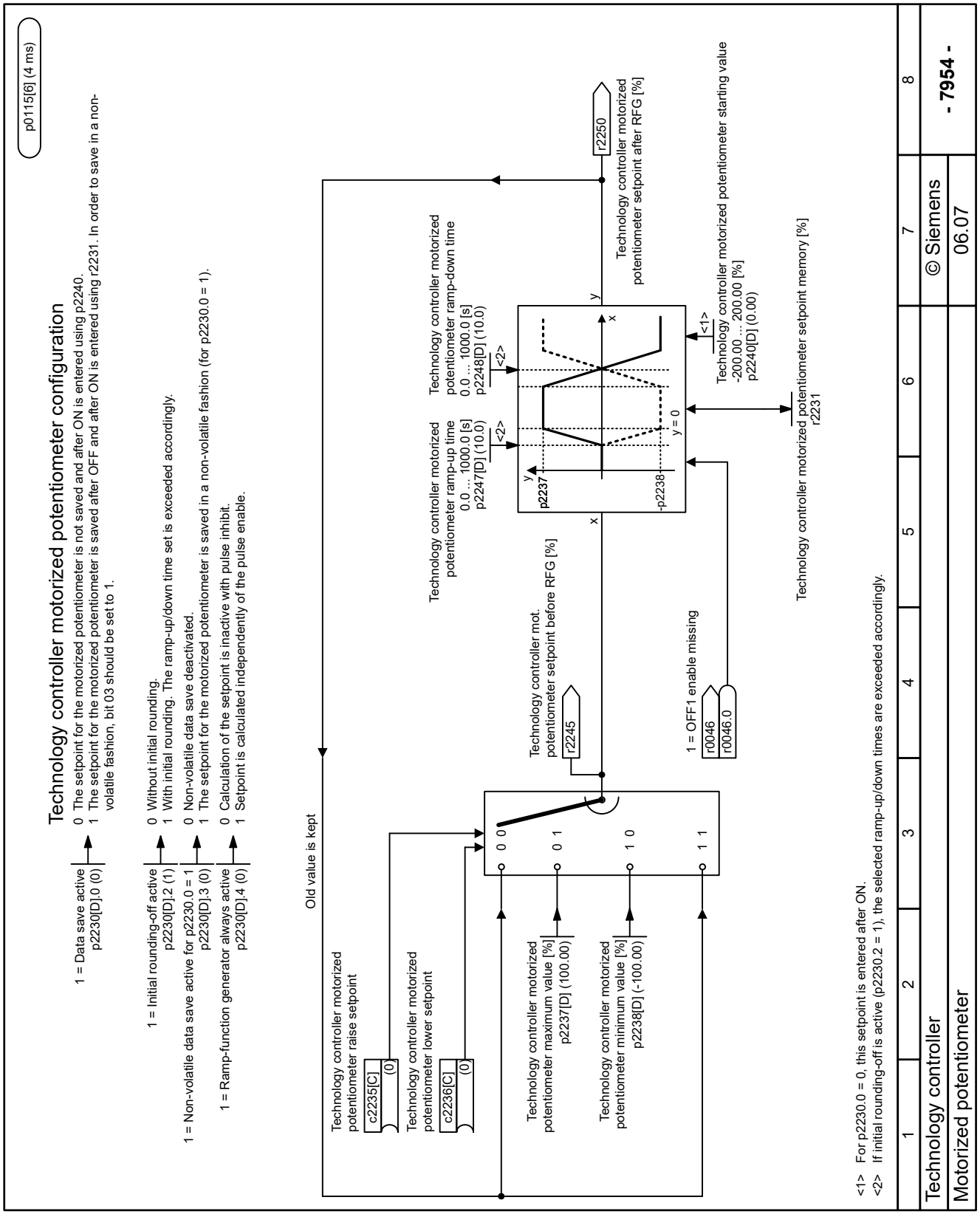


Figure 13-331 7954 - Motorized potentiometer

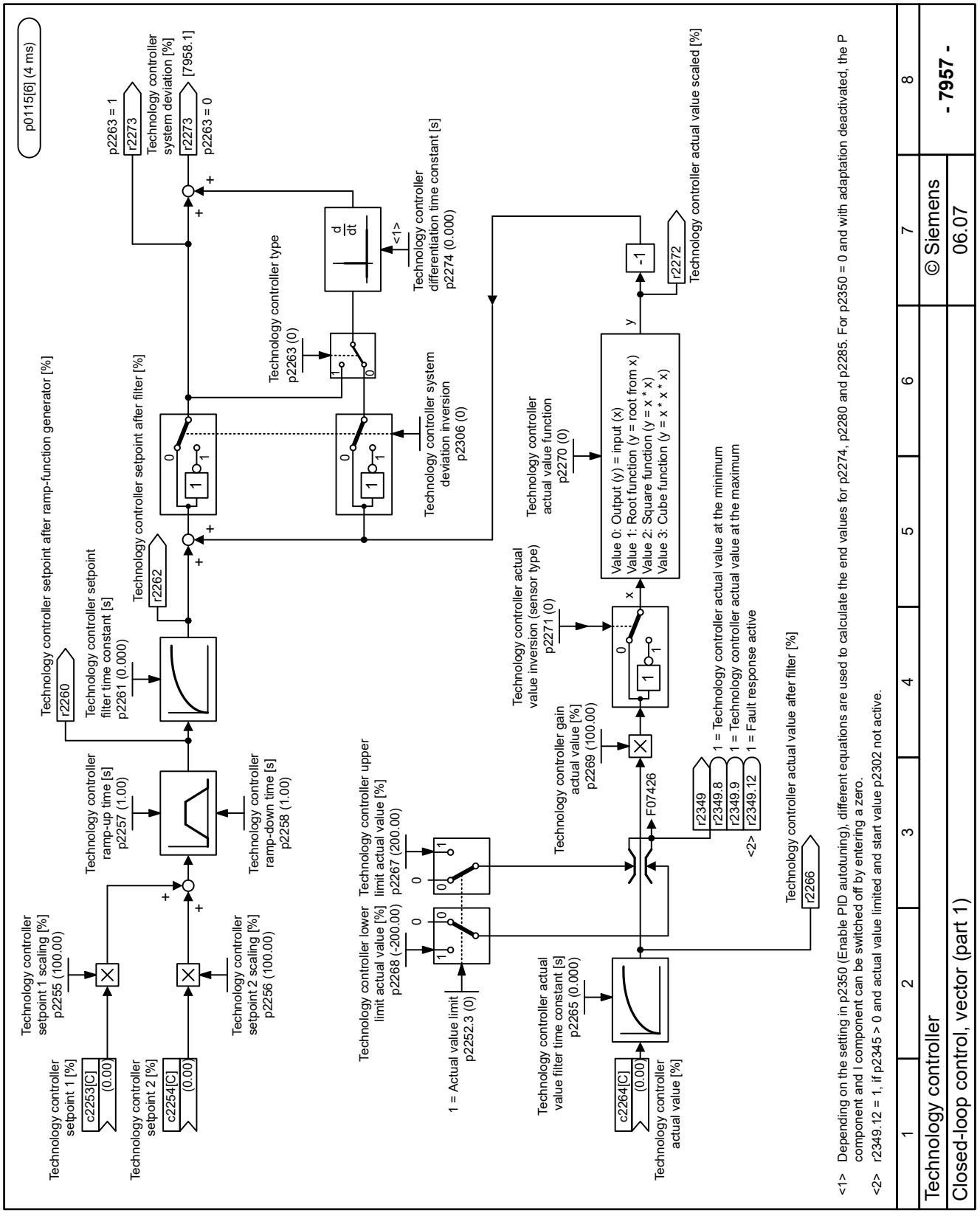


Figure 13-332 7957 – Closed-loop control, vector (Part 1)

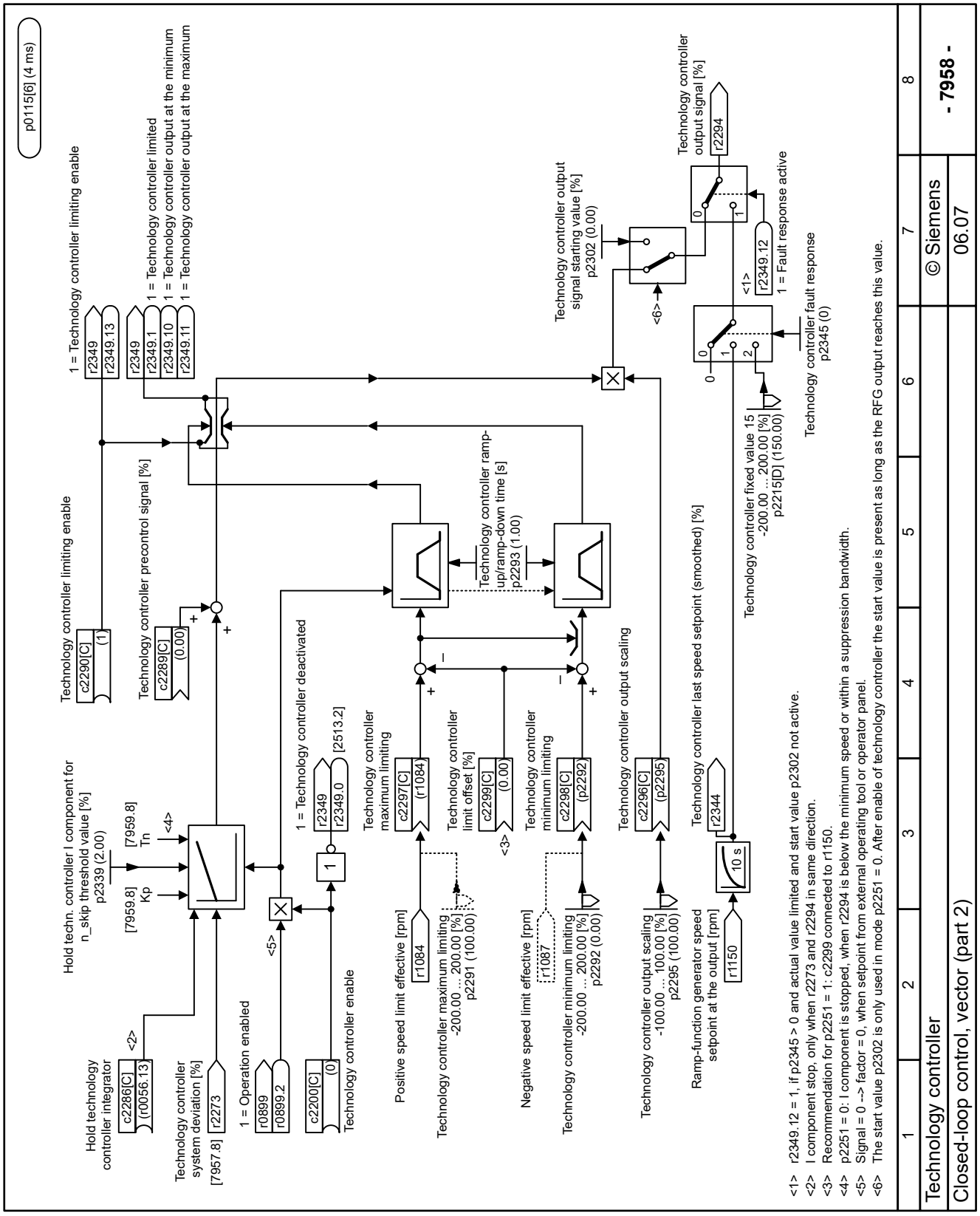


Figure 13-333 7958 – Closed-loop control, vector (Part 2)

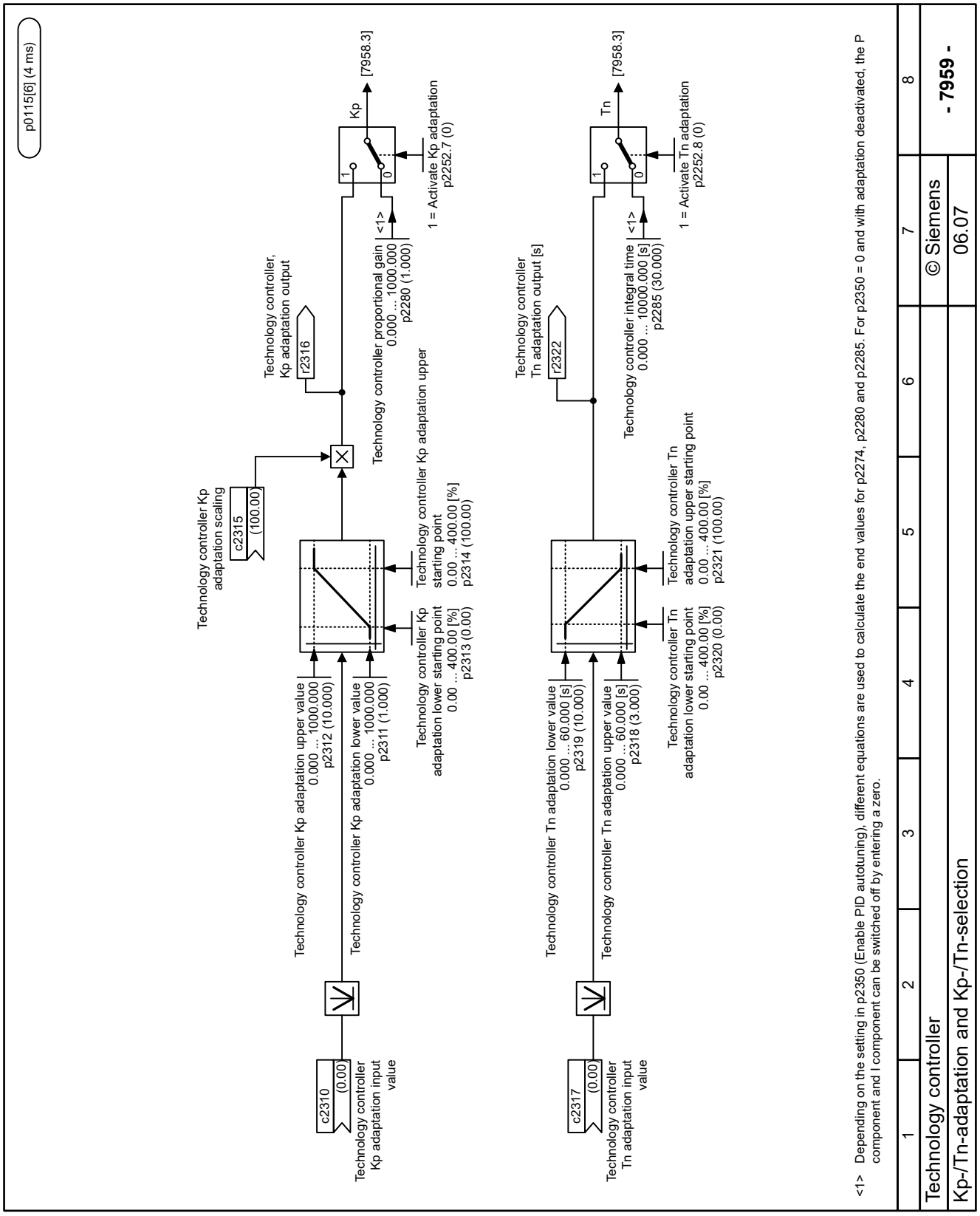


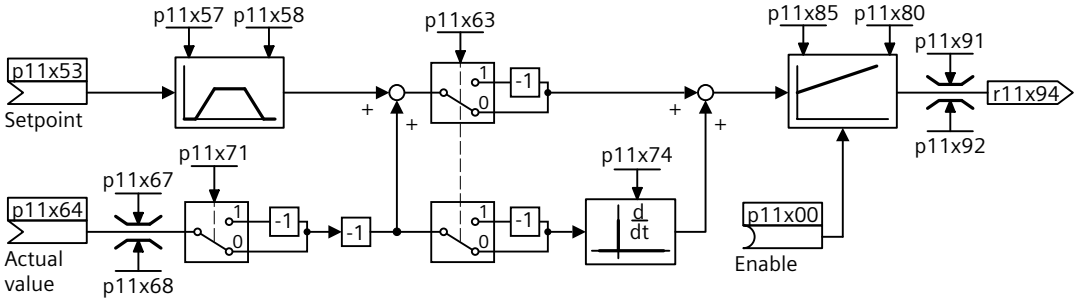
Figure 13-334 7959 – Kp/Tn adaptation and Kp/Tn selection

13.15.3 Free technology controllers

Overview

The additional 3 free technology controllers allow several process variables to be controlled using one converter.

Function description



x = 0 Free technology controller 1

x = 1 Free technology controller 2

x = 2 Free technology controller 3

Figure 13-335 Free technology controllers 1 ... 3

Each of the 3 free technology controllers x (x = 1, 2 or 3) has the following properties:

- Binary signal sink p11x00 = 1 signal enables the technology controller.
- The technology controller receives the setpoint and actual value via a signal interconnection of numerical signal sink p11x53 or p11x64.
- The ramp-function generator with ramp-up time p11x57 and ramp-down time p11x58 smooths the setpoint.
- Parameters p11x67 and p11x68 limit the actual value to a maximum value and a minimum value.
- Parameter p11x71 = 1 signal inverts the actual value.
- Parameter p11x63 inverts the setpoint and also the actual value.
- In the PID controller, proportional component p11x86, integral component p11x80 and differential component p11x74 can be set.
- Parameters p11x91 and p11x92 limit the technology controller output to a maximum value and a minimum value.

Example

An HVAC system with heating and cooling valves to process the air requires several controllers that are independent of one another:

- The main technology controller controls the speed of the fan drive.
- The free technology controllers alternately control the cooling and heating.

Parameters

The following list contains the parameters of the "PID - technology controller" function.

Number	Name	Unit
c11000	Free tec_ctrl 1 enable	-
p11026	Free tec_ctrl 1 unit selection	-
p11027	Free tec_ctrl 1 unit reference quantity	-
p11028	Free tec_ctrl 1 sampling time	-
r11049.0...11	Free tec_ctrl 1 status word	-
c11053	Free tec_ctrl 1 setpoint signal	-
p11057	Free tec_ctrl 1 setpoint ramp-up time	s
p11058	Free tec_ctrl 1 setpoint ramp-down time	s
r11060	Free tec_ctrl 1 setpoint after ramp-function generator	%
p11063	Free tec_ctrl 1 system deviation inversion	-
c11064	Free tec_ctrl 1 actual value signal	-
p11065	Free tec_ctrl 1 actual value smoothing time constant	s
p11067	Free tec_ctrl 1 actual value upper limit	%
p11068	Free tec_ctrl 1 actual value lower limit	%
p11071	Free tec_ctrl 1 actual value inversion	-
r11072	Free tec_ctrl 1 actual value after limiter	%
r11073	Free tec_ctrl 1 system deviation	%
p11074	Free tec_ctrl 1 differentiation time constant	s
p11080	Free tec_ctrl 1 proportional gain	-
p11085	Free tec_ctrl 1 integral time	s
p11091	Free tec_ctrl 1 limit maximum	%
p11092	Free tec_ctrl 1 limit minimum	%
p11093	Free tec_ctrl 1 limit ramp-up/ramp-down time	s
r11094	Free tec_ctrl 1 output signal	%
c11097	Free tec_ctrl 1 limit maximum signal	-
c11098	Free tec_ctrl 1 limit minimum signal	-
c11099	Free tec_ctrl 1 limit offset signal	-
c11100	Free tec_ctrl 2 enable	-
p11126	Free tec_ctrl 2 unit selection	-
p11127	Free tec_ctrl 2 unit reference quantity	-
p11128	Free tec_ctrl 2 sampling time	-
r11149.0...11	Free tec_ctrl 2 status word	-
c11153	Free tec_ctrl 2 setpoint signal	-
p11157	Free tec_ctrl 2 setpoint ramp-up time	s
p11158	Free tec_ctrl 2 setpoint ramp-down time	s
r11160	Free tec_ctrl 2 setpoint after ramp-function generator	%
p11163	Free tec_ctrl 2 system deviation inversion	-
c11164	Free tec_ctrl 2 actual value signal	-
p11165	Free tec_ctrl 2 actual value smoothing time constant	s
p11167	Free tec_ctrl 2 actual value upper limit	%
p11168	Free tec_ctrl 2 actual value lower limit	%
p11171	Free tec_ctrl 2 actual value inversion	-
r11172	Free tec_ctrl 2 actual value after limiter	%
r11173	Free tec_ctrl 2 system deviation	%

p11174	Free tec_ctrl 2 differentiation time constant	s
p11180	Free tec_ctrl 2 proportional gain	-
p11185	Free tec_ctrl 2 integral time	s
p11191	Free tec_ctrl 2 limit maximum	%
p11192	Free tec_ctrl 2 limit minimum	%
p11193	Free tec_ctrl 2 limit ramp-up/ramp-down time	s
r11194	Free tec_ctrl 2 output signal	%
c11197	Free tec_ctrl 2 limit maximum signal	-
c11198	Free tec_ctrl 2 limit minimum signal	-
c11199	Free tec_ctrl 2 limit offset signal	-
c11200	Free tec_ctrl 3 enable	-
p11226	Free tec_ctrl 3 unit selection	-
p11227	Free tec_ctrl 3 unit reference quantity	-
p11228	Free tec_ctrl 3 sampling time	-
r11249.0...11	Free tec_ctrl 3 status word	-
c11253	Free tec_ctrl 3 setpoint signal	-
p11257	Free tec_ctrl 3 setpoint ramp-up time	s
p11258	Free tec_ctrl 3 setpoint ramp-down time	s
r11260	Free tec_ctrl 3 setpoint after ramp-function generator	%
p11263	Free tec_ctrl 3 system deviation inversion	-
c11264	Free tec_ctrl 3 actual value signal	-
p11265	Free tec_ctrl 3 actual value smoothing time constant	s
p11267	Free tec_ctrl 3 actual value upper limit	%
p11268	Free tec_ctrl 3 actual value lower limit	%
p11271	Free tec_ctrl 3 actual value inversion	-
r11272	Free tec_ctrl 3 actual value after limiter	%
r11273	Free tec_ctrl 3 system deviation	%
p11274	Free tec_ctrl 3 differentiation time constant	s
p11280	Free tec_ctrl 3 proportional gain	-
p11285	Free tec_ctrl 3 integral time	s
p11291	Free tec_ctrl 3 limit maximum	%
p11292	Free tec_ctrl 3 limit minimum	%
p11293	Free tec_ctrl 3 limit ramp-up/ramp-down time	s
r11294	Free tec_ctrl 3 output signal	%
c11297	Free tec_ctrl 3 limit maximum signal	-
c11298	Free tec_ctrl 3 limit minimum signal	-
c11299	Free tec_ctrl 3 limit offset signal	-

13.15.4 Cascade control

Overview

The cascade control combines external, uncontrolled motors with a main motor operated by the converter. As the uncontrolled motors operate at full load and the converter with the main motor covers the partial load, the cascade control increases the efficiency of the system or machine.

Requirement

The cascade control requires that a technology controller is active.

Function description

Depending on the system deviation of the technology controller, the converter cascade control switches up to 3 additional motors directly to the line supply via contactors.

The following diagram shows an example of a system with 3 pump drives. Via the technology controller with main motor MD, the converter controls the flow in the system, for example. Using contactors K1 and K2, the cascade control starts or stops uncontrolled motors M1 and M2.

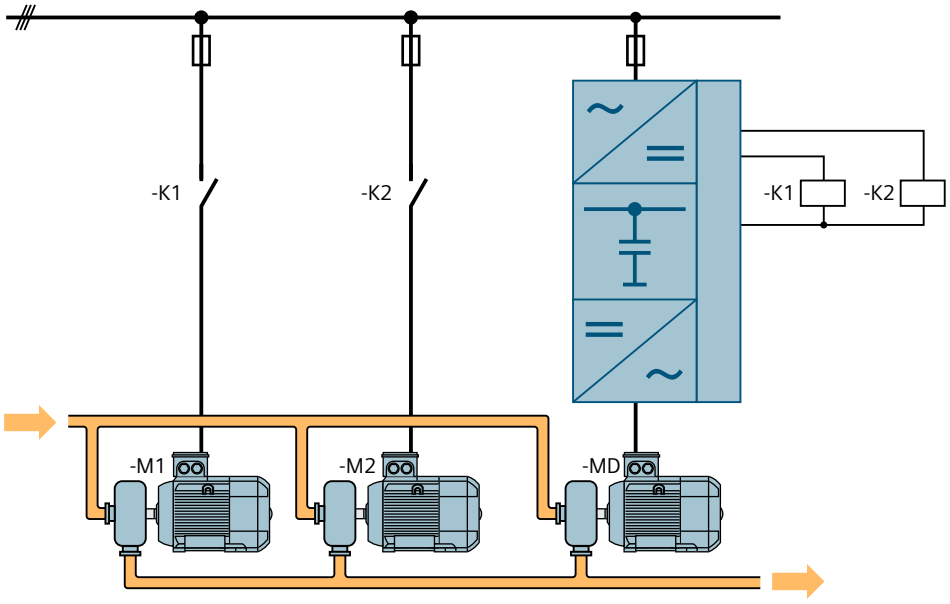


Figure 13-336 Example: Cascade control with 2 uncontrolled pumps

If the total power of external motors Mn is not sufficient to control the process variable, then the cascade control starts an additional or a larger external motor Mn

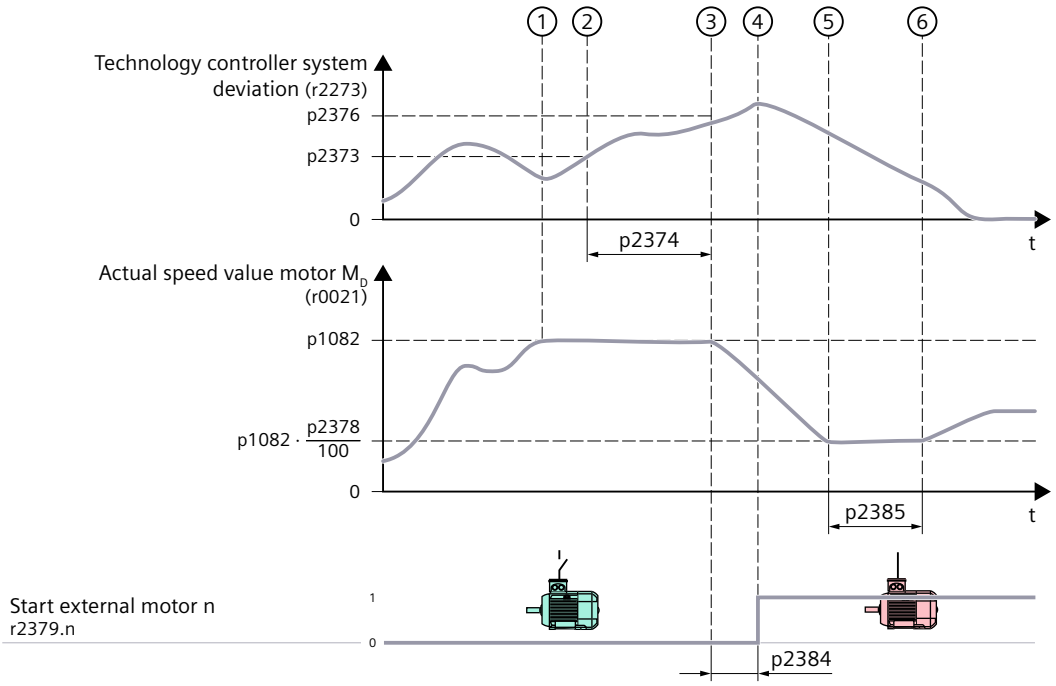


Figure 13-337 Starting an external motor

Procedure for starting an uncontrolled motor:

1. The main motor reaches maximum speed p1082.
2. Switch-in delay p2374 starts if the technology controller system deviation reaches the switch-in threshold p2373.
3. If switch-in delay p2374 has elapsed or if the overcontrol threshold p2376 is exceeded, then "Motor switch-on delay" p2384 starts and the converter brakes the main motor down to switch-in/switch-out speed p2378.
   The converter temporarily deactivates the technology controller.
4. The converter starts an external motor if "Motor switch-on delay" p2384 has elapsed.
5. If the switch-in/switch-out speed p2378 is reached, "Holding time switch-in speed" p2385 starts.
6. After "Holding time switch-in speed" elapses p2385, the converter enables the technology controller. Via the technology controller, with the main motor, the converter reduces the system deviation to ≈ 0.

If the total power of external motors Mn is too high to control the process variable, then the cascade control stops an external motor Mn or starts an external motor Mn with a lower power.

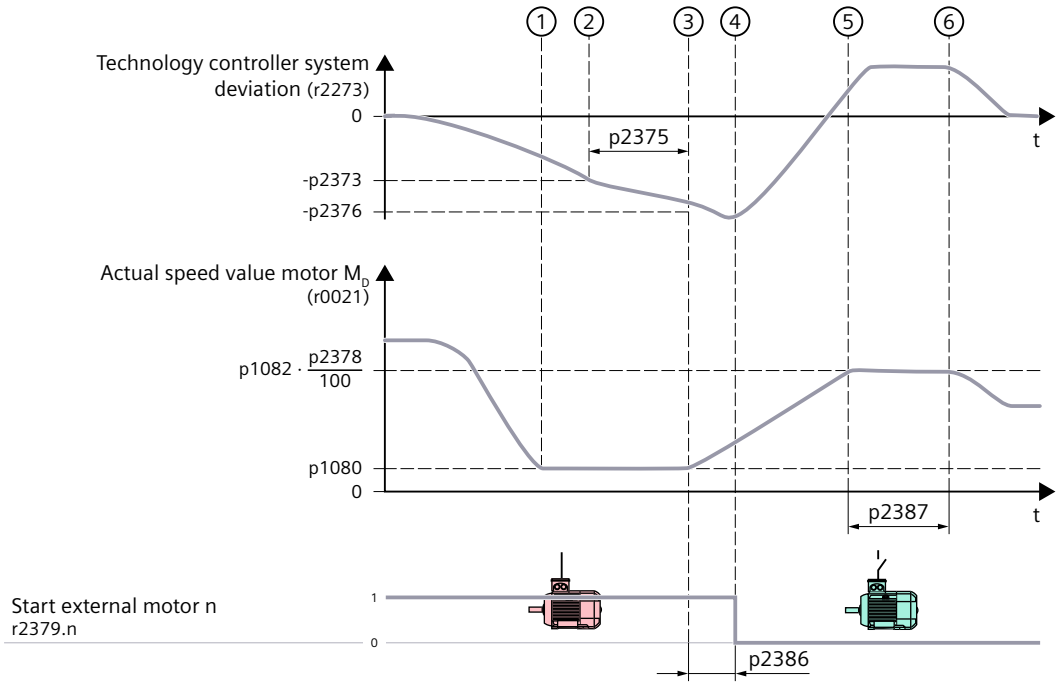


Figure 13-338 Stopping an external motor

Procedure for stopping an external motor:

1. The main motor reaches minimum speed p1080.
2. Switch-out delay p2375 starts if the technology controller system deviation reaches the switch-in threshold -p2373.
3. If the switch-out delay p2375 has elapsed, or if the overcontrol threshold -p2376 has been fallen below, "Motor switch-off delay" p2386 starts and the converter accelerates the main motor up to the switch-in/switch-out speed p2378.
   The converter temporarily deactivates the technology controller.
4. The converter stops an external motor if "Motor switch-off delay" p2386 has elapsed.
5. If the switch-in/switch-out speed p2378 is reached, "Holding time switch-out speed" p2387 starts.
6. After "Holding time switch-out speed" p2387 elapses, the converter enables the technology controller. Via the technology controller, with the main motor, the converter reduces the system deviation to ≈ 0.

Configuration p2371 defines the number, the power and the switching sequence of external motors M1 ... M3. External motors with the same power rating as the main motor MD or with the following steps are practical for the cascade control:

- Same power
- Double power
- Triple power

Table 13-124 Switching sequence of external motors

p2371	→ → → sequence when starting external motors → → → ← ← ← sequence when stopping external motors ← ← ←						Power P of the external motors Mn in comparison to the main motor MD		
	Total power P of the external motors that have started						P(Mn) = P(MD)	P(Mn) = 2 · P(MD)	P(Mn) = 3 · P(MD)
	P(MD)	2 · P(MD)	3 · P(MD)	4 · P(MD)	5 · P(MD)	6 · P(MD)			
1	M1						M1	---	---
2	M1	M1+M2					M1, M2	---	---
3	M1	M2	M1+M2				M1	M2	---
4	M1	M1+M2	M1+M2 +M3				M1, M2, M3	---	---
5	M1	M3	M1+M3	M1+M2 +M3			M1, M2	M3	---
6	M1	M2	M1+M2	M2+M3	M1+M2 +M3		M1	M2, M3	---
7	M1	M1+M2	M3	M1+M3	M1+M2 +M3		M1, M2	---	M3
8	M1	M2	M3	M1+M3	M2+M3	M1+M2 +M3	M1	M2	M3

To switch the contactor of an external motor, for example, the contactor must be wired to a digital output of the converter and the binary signal sink of the digital output must be interconnected with the corresponding bit of binary signal source r2379:

- r2379.00 = 1 signal: Start external motor M1
- r2379.01 = 1 signal: Start external motor M2
- r2379.02 = 1 signal: Start external motor M3

Parameters

The following list contains the parameters of function "Cascade control".

Number	Name	Unit
p2370[0...n]	Cascade control activation	-
p2371	Cascade control configuration	-
p2372	Cascade control mode motor selection	-
p2373	Cascade control switch-in threshold	%
p2374	Cascade control switch-in delay	s
p2375	Cascade control switch-out delay	s
p2376	Cascade control overmodulation threshold	%
p2377	Cascade control interlocking time	s
p2378	Cascade control switch-in/switch-out speed	%
r2379.0...10	Cascade control status word	-
p2380[0...2]	Cascade control operating hours	h
p2381	Cascade control max time for continuous operation	h
p2382	Cascade control absolute operating time limit	h
p2383	Cascade control switch-out sequence	-

p2384	Cascade control motor switch-on delay	s
p2385	Cascade control holding time switch-in speed	s
p2386	Cascade control motor switch-off delay	s
p2387	Cascade control holding time shutdown speed	s
p2388	Cascade control switch-in speed hysteresis	rpm

13.15.5 Infrastructure functions

13.15.5.1 Emergency operation mode

Overview

In the emergency operation mode (EOM), the converter attempts to maintain a system in operation, which has been installed for an emergency, even under irregular ambient conditions.

Requirement

A configured control of the Safety Integrated Functions (p9603 ≠ 0) prevents the emergency operation mode from being activated.

Warranty claims after the emergency operation mode has been active:

- When the emergency operation mode is active, and faults occur in the converter, all warranty claims associated with the converter become null and void.
- The test mode for the emergency operation mode has no impact on warranty claims.

Function description

When the emergency operation mode is active, the converter uses a certain speed setpoint specifically selected for this purpose. The converter ignores commands to stop the motor and no longer responds to every fault that occurs.

The converter logs how frequently the emergency operation mode was activated and the faults that occurred while in the emergency operation mode. The log is accessible only for the service and repair organization.

The emergency operation mode has a test function. The duration of test operation is limited to the maximum energy consumption of the last 24 hours / rated power of the converter.

The number of activations and the faults that occurred during test operation are not logged.

The "emergency operation mode" function has the following properties:

- Activating and deactivating the emergency operation mode:
  - c3880 = 1 signal activates the emergency operation mode.
    You must use a negated digital input with binary signal sink c3880 if the emergency operation mode should also be active for a short-circuit to ground (ground fault) or if the control cable is interrupted.
  - c3880 = 0 signal deactivates the emergency operation mode.
  - The converter signals that the emergency operation mode is active with an alarm and with r3889.0 = 1 signal.
- When the emergency operation mode is active, it is not possible to switch off the motor:
  - The OFF1, OFF2 and OFF3 commands for switching off the motor have no effect.
  - The converter blocks all functions that switch off the motor to save energy, e.g. PROFIenergy or hibernation mode.
- Speed setpoint when the emergency operation mode is active:
  p3881 specifies the speed setpoint.
  If an analog input is selected as setpoint source, for a wire breakage, the converter switches over to the setpoint defined using p3882.
- Activating and deactivating the test mode of the emergency operation mode:
  - p3888 = 1 signal activates the test mode.
  - p3888 = 0 signal deactivates the test mode.
  - r3879 indicates the accumulated energy consumption in the test mode:
    0% = still no energy consumed
    100% = maximum energy consumption reached

- Response to faults when the emergency operation mode is active
  r3887 counts the number of EOM activations and faults in EOM.
  In the "emergency operation mode", the converter does not switch off the motor when faults develop, but instead responds differently depending on the specific fault type:
  - The converter ignores faults, which do not directly result in the destruction of the converter or the motor.
  - Faults with the reaction "OFF2" switch the motor off immediately.
- Interaction with other functions
  - Automatic restart
    When the emergency operation mode is active, the converter ignores the settings in p1206 (faults without automatic restart). Instead, the converter operates with the "Restart after fault with additional start attempts" setting (p1210 = 6).
    If the start attempts in p1211 are unsuccessful or the monitoring time p1213 during one of the start attempts has elapsed, then the converter signals a fault. The converter then performs a restart and initiates the start attempts once more.
  - Bypass
    If the bypass mode is active when the emergency operation mode is activated, the converter changes to converter operation. This ensures that the converter uses the EOM setpoint source.
    If the converter signals a fault, then the converter can switch over to bypass operation and directly connect to the motor to the line supply (DOL operation).

Example

To improve air circulation in the stairwells, the ventilation system creates an underpressure condition in the building. With this control, a fire would mean that flue gases would enter the stairwell. This means that the stairs can no longer be used as evacuation route.

The ventilation system generates an overpressure condition when the emergency operation mode function is active. The emergency operation mode prevents flue gas from propagating in the stairwell. As a consequence, the stairwell can still be used as evacuation route.

Parameters

The following list contains the parameters of function "Essential service mode".

Number	Name	Unit
r3879	EOM test mode utilization	%
c3880	EOM activation signal	-
p3881	EOM setpoint selection	-
p3882	EOM setpoint selection alternative	-
c3883	EOM direction of rotation signal	-
c3884	EOM setpoint technology controller	%
c3886	EOM setpoint OM-AIO analog input	rpm
r3887[0...1]	EOM activations/fault quantity	-
p3888	EOM test mode activation	-
r3889.0...12	EOM status word	-

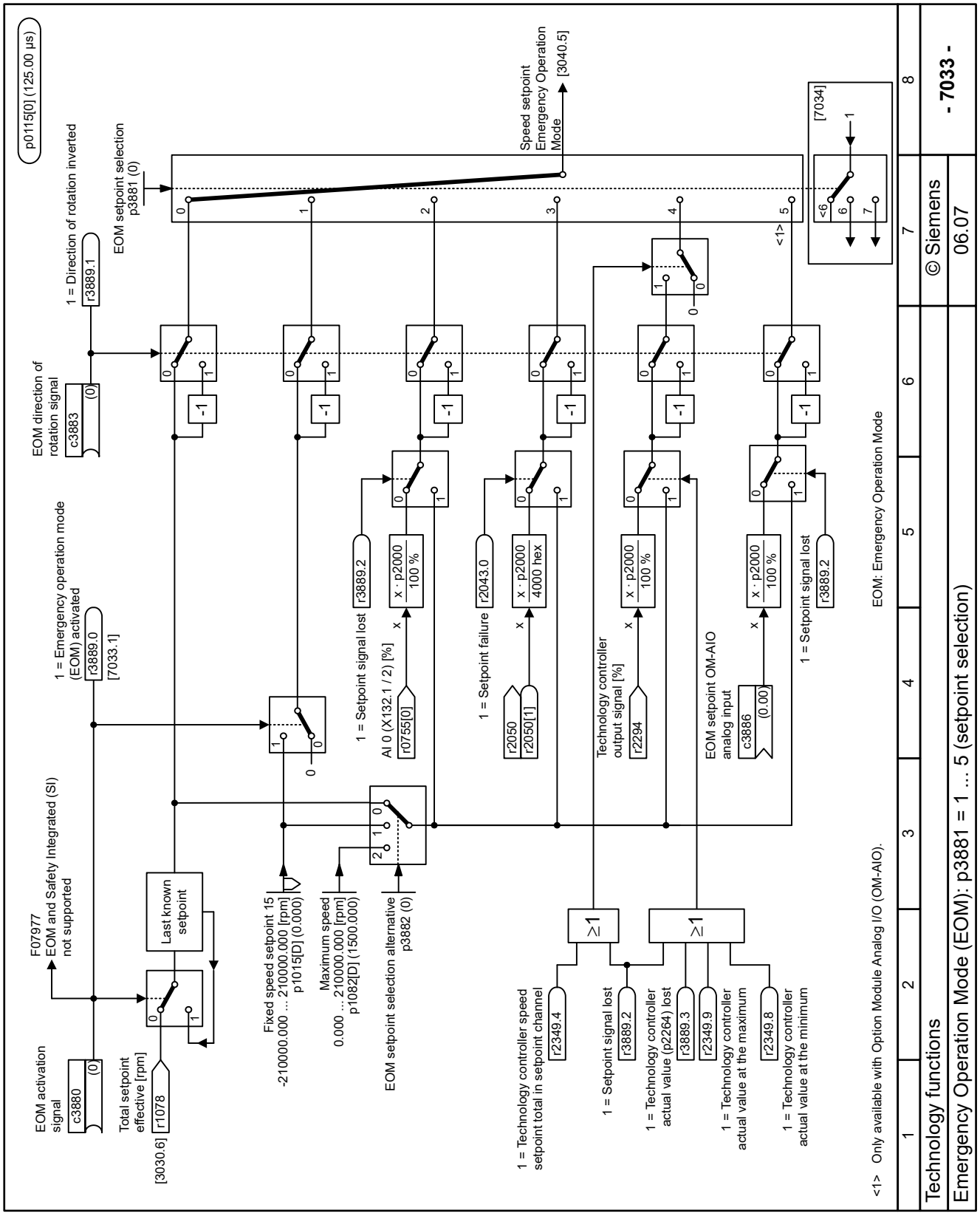


Figure 13-339 7033 - Emergency operation mode (EOM): p3881 = 1 ... 5 (setpoint selection)

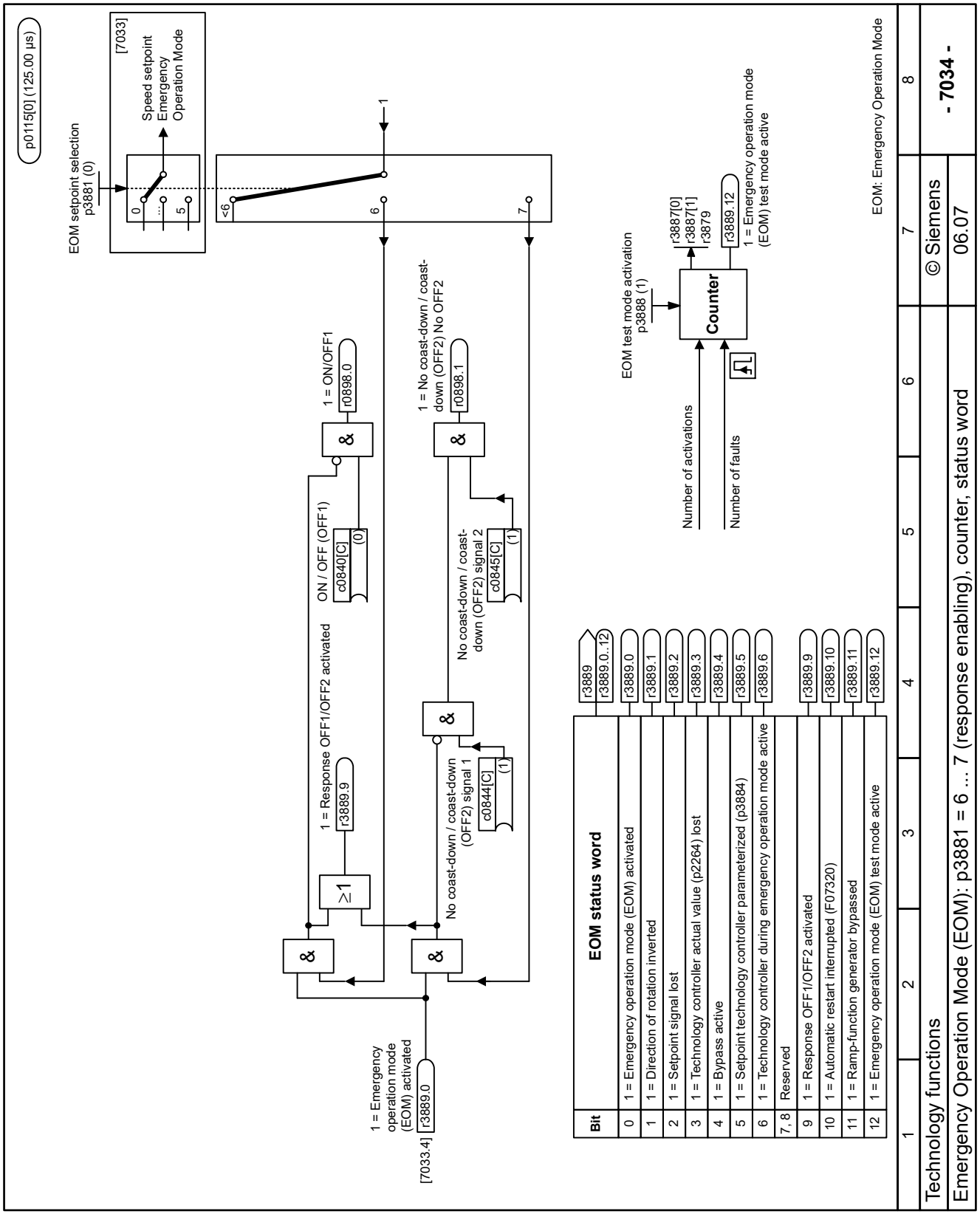


Figure 13-340 7034 - Emergency operation mode (EOM): p3881 = 6 ... 7 (response enable), counter, status word

13.15.5.2 Hibernation mode

Overview

When the hibernation mode is active, the converter switches off the motor once the system conditions allow it.

The hibernation mode reduces energy consumption, wear and noise emitted by the machine or system.

Function description

The converter enables function "Hibernation mode" with "Hibernation mode operating type" p2398 > 0.

Further, the "Hibernation mode operating type" defines which events activate the hibernation mode:

- Operating mode p2398 = 1:
  The motor speed falls below "Hibernation mode starting speed" or signal c2400 changes from 0 → 1.
- Operating mode p2398 = 2:
  Signal c2400 changes from 0 → 1.
  When activating the hibernation mode, the motor speed is of no significance.

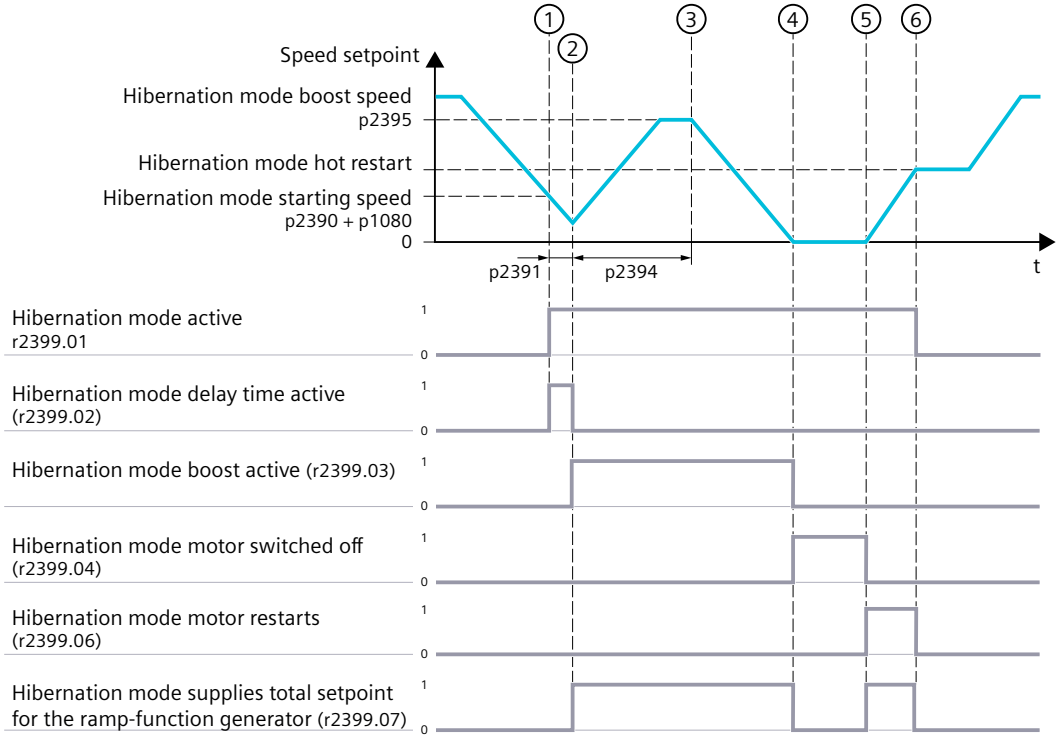


Figure 13-341 Activating the hibernation mode below the "Hibernation mode starting speed", operating mode p2398 = 1

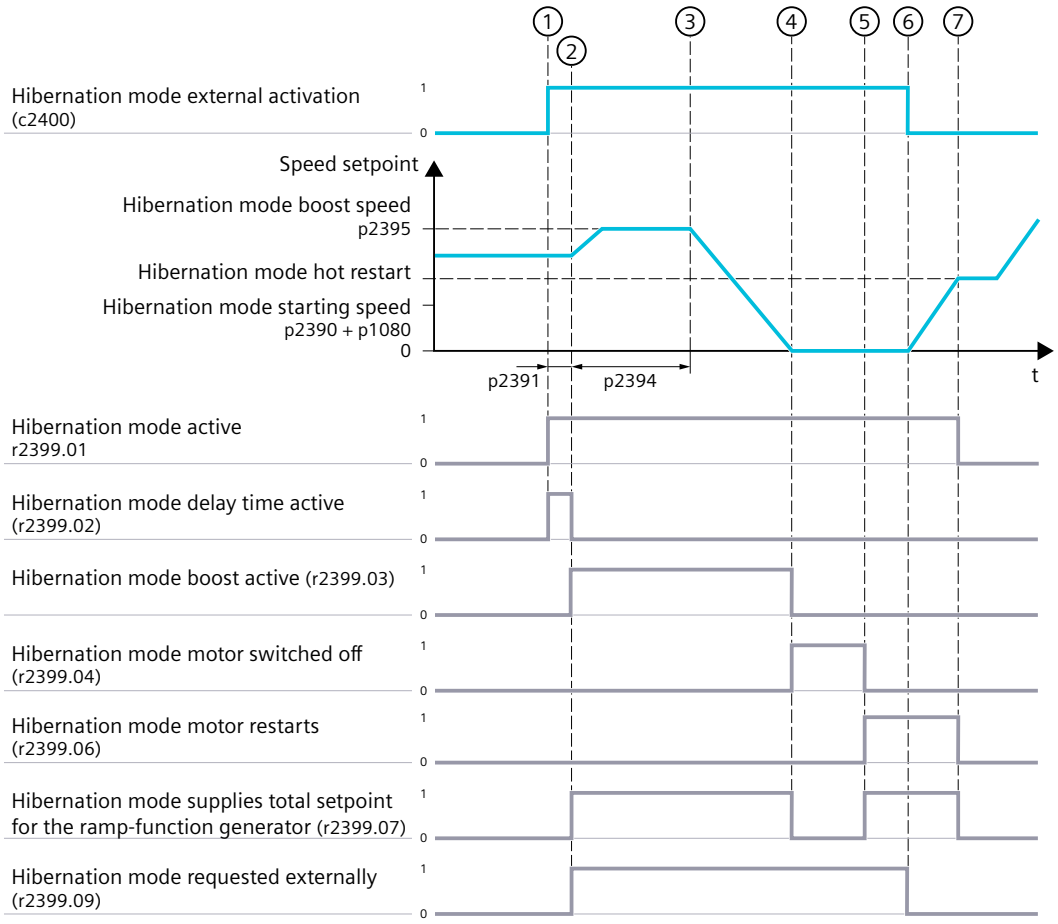


Figure 13-342 Activating the hibernation mode using binary signal sink c2400, operating mode p2398 = 1 or 2

Explanation of the time diagrams:

	Activating below the "Hibernation mode starting speed"	**Activating via binary signal sink c2400**
①	The converter activates the hibernation mode if the motor speed falls below the "Hibernation mode starting speed". [1)]	For a signal change c2400 = 0 → 1 signal, the converter activates the hibernation mode.
②	The converter activates "Boost" after the "Hibernation mode delay time". [2)] The converter switches over the speed setpoint to "Hibernation mode boost speed".	
③	The motor stops after the "Hibernation mode boost time period" (p2394).	
④	The converter switches off the motor when zero speed is reached.	

	Activating below the "Hibernation mode starting speed"	**Activating via binary signal sink c2400**
⑤	For one of the following conditions, the converter signals that the motor can be started: • For p2398 = 2 and c2400 = 1 signal. • For p2398 = 1 and one of the following conditions: – For an external setpoint specification and a positive setpoint > p1080 + p2390 – If the technology controller specifies the setpoint value and a positive technology controller system deviation > p2392 – After "Hibernation mode maximum switch-off time" p2396 elapses	
	The motor accelerates to setpoint = (p1080 + p2390) · 1.05. The converter then switches the setpoint to the technology controller output.	The converter waits for c2400 = 0 signal.
⑥	The converter deactivates the hibernation mode if the motor speed reaches "Hibernation mode starting speed".	For a signal change c2400 = 1 → 0 signal, the motor accelerates to setpoint = (p1080 + p2390) · 1.05. The converter then switches the setpoint over to the external setpoint or the technology controller output.
⑦	---	The converter deactivates the hibernation mode if the motor reaches "Hibernation mode starting speed".

1) If, after switching on the supply voltage and starting the motor, the speed remains below the "Hibernation mode starting speed", then after a wait time, the converter activates the hibernation mode.
The wait time is the longest of the following times:
- "Ramp-function generator ramp-up time" p1120
- "Hibernation mode delay time" p2391
- 20 s

2) The "boost" function prevents the motor from being frequently switched-on and switched-off. Depending on the application, this is realized by temporarily increasing the pressure to be controlled so that the motor remains switched-off for a longer period of time, for example.

Example

Closed-loop pressure and temperature controls involving pumps and fans are typical applications for the hibernation mode.

Deactivating the hibernation mode in a time-controlled fashion is typically used for liquids in order to avoid deposits forming in a tank.

Parameters

The following list contains the parameters of function "Hibernation mode".

Number	Name	Unit
p1080[0...n]	Minimum speed	rpm
p1120[0...n]	Ramp-function generator ramp-up time	s
p2390[0...n]	Speed start of hibernation mode	rpm
p2391[0...n]	Hibernation mode delay time	s
p2392	Hibernation mode restart value with technology controller	%

p2393[0...n]	Hibernation mode restart speed relative w/o techn controller	rpm
p2394[0...n]	Hibernation mode boost time period	s
p2395[0...n]	Hibernation mode boost speed	rpm
p2396[0...n]	Hibernation mode maximum shutdown time	s
r2397[0...1]	Hibernation mode output speed actual	rpm
p2398	Hibernation mode operating type	-
r2399.0...9	Hibernation mode status words	-
c2400[0...n]	Hibernation mode activation external	-

13.15.6 Drive Control Chart (DCC)

Description

Drive Control Chart (DCC) is an optional extension of the TIA Portal. Drive Control Chart allows closed-loop control, arithmetic and logic blocks to be graphically configured. The configured technology functions are transferred to the converter via Startdrive. As a consequence, the Drive Control Chart extends the converter firmware to include the configured technology functions.

More information

You can find more information on the Internet:

Drive Control Chart (https://youtu.be/-aTpVN_lrmg?si=_KlUC7ffbnaFERIS)

13.15.7 Technology Extensions (TEC)

Description

Technology Extensions (TEC) are configurable functions or technologies that extend firmware functions. Technology Extensions are used to implement application-specific tasks in various domains, e.g. for test stands, storage and retrieval machines and transport systems.

More information

You can find more information on the Internet:

Technology Extensions (https://support.industry.siemens.com/cs/ww/en/view/109771648)

13.16 Vibration suppression (VIBSUP)

Overview

The low-frequency vibration suppression function uses a configurable setpoint filter to minimize vibrations in the natural frequency range of the moved mechanical system. Function "Vibration Suppression" is also known as "VIBSUP".

Requirement

The following requirements are always applicable for "Basic Vibration Suppression":

- Function "Basic Vibration Suppression" is activated.
- The "Basic positioner (EPOS)" function is activated.

The following requirements are always applicable for "Extended Vibration Suppression":

- Function "Extended Vibration Suppression" is licensed and activated.
- The functions required for the particular application mode, such as "Basic positioner" and "Position control", have been parameterized and activated.
- The telegrams for the functions were created, e.g.
  - Speed: Telegram 2

Function description

To absorb oscillations, the configurable setpoint filter changes the command variable of an axis so that there is as little oscillation as possible excited in the damped natural frequency range of the moving mechanical system. While this does slightly delay the motion sequence, with correct parameterization, the additional travel time is significantly less than the wait time for the oscillation levels in the mechanical system to be within the tolerance range.
From the following frequency, low frequency natural frequency oscillations can be suppressed:

- "Basic Vibration Suppression" from 10 Hz
- "Extended Vibration Suppression": from 0.1 Hz

When the online frequency change is activated, the filter frequency is automatically adapted if the natural frequency of the mechanical system changes (e.g. as a result of various load states).

The following application modes are possible:

- Application mode "Basic positioner and position control"
  This application mode is used when the drive-internal positioning is used (function "Basic positioner" and "Position control").
- Application mode "Closed-loop speed control"
  This application mode is recommended when using a speed setpoint specified from a higher-level control or from the drive.

13.16.1 Application mode

Overview

Selecting the application mode defines at which position the setpoint filter acts and which signals are filtered.

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- Depending on the specific requirement, function "Basic Vibration Suppression" or "Extended Vibration Suppression" is activated.

13.16.1.1 Application mode "Basic positioner and position control"

The setpoint filter acts between functions "Basic positioner, EPOS" and "Position control, LR". The following signals are filtered between the output of EPOS and the input of LR:

- Position setpoint
- Velocity setpoint

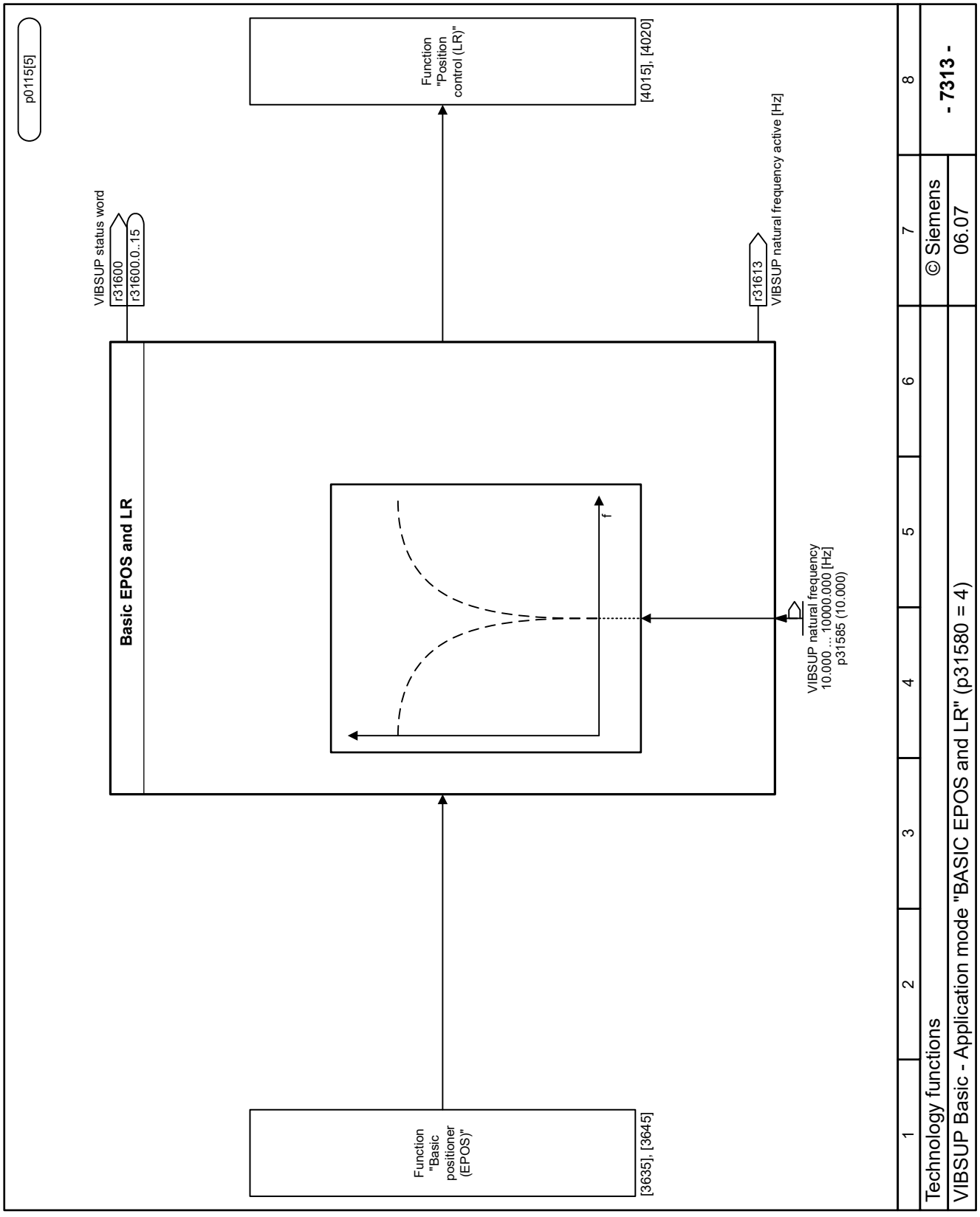


Figure 13-343 7313 – VIBSUP Basic / Extended: Application mode "BASIC EPOS and LR" (p31580 = 4)

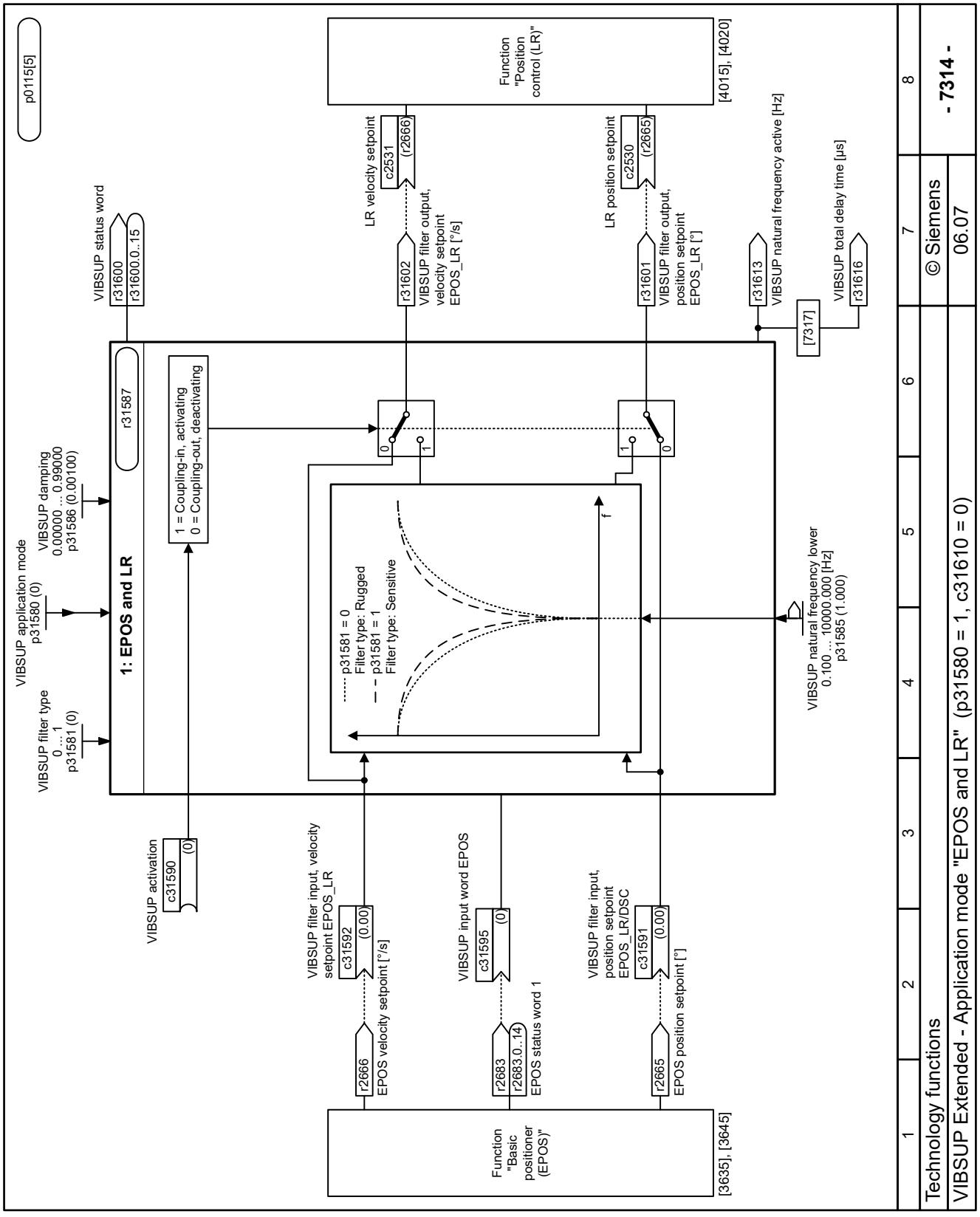


Figure 13-344 7314 – VIBSUP Extended: Application mode "EPOS and LR" (p31580 = 1, c31610 ≡ 0)

13.16.1.2 Application mode "Closed-loop speed control"

The setpoint filter acts within the control loop between the position controller of the higher-level control system and the position controller of the drive, i.e. between the PROFIdrive receive telegram and the speed controller. The following signals are filtered between the PROFIdrive telegram and speed controller:

- Speed setpoint NSOLL_B

In the "Closed-loop speed control" application mode, the existing telegram must be switched over to "Free telegram" with active clock cycle synchronization and the following interconnections established:

- c31593 = NSOLL_B (for telegram 2, corresponds to PZD2+3 and therefore r2060[1])
- c1070 = r31603
- c1430 = 0

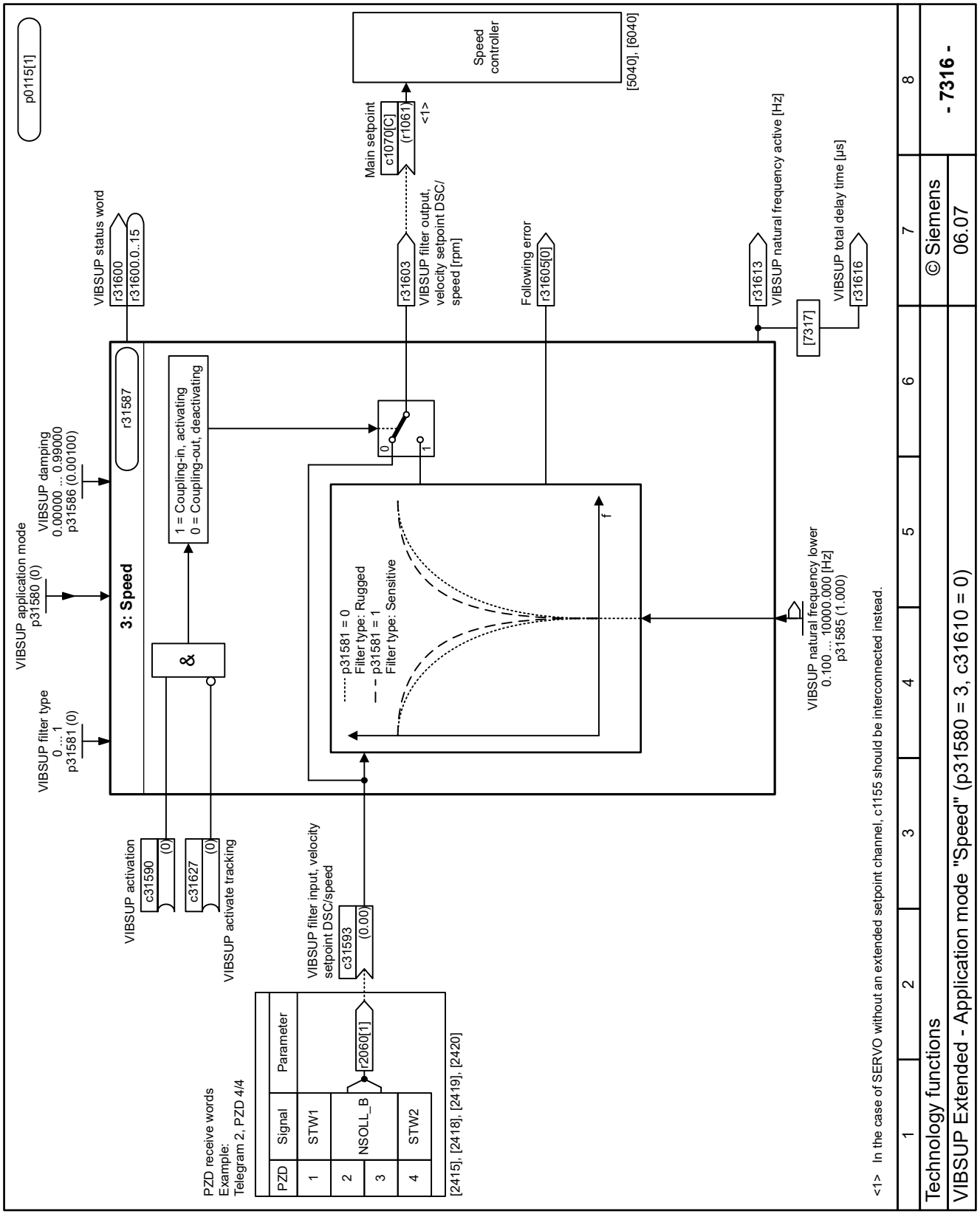


Figure 13-345 7316 – VIBSUP Extended: Application mode "Speed" (p31580 = 3, c31610 ≡ 0)

13.16.1.3 Notes for application mode "Closed-loop speed control"

In application mode "Closed-loop speed control", the VIBSUP filter acts within the control loop between the position controller of the higher-level control system and the position/speed controller of the drive.

The following constraints apply:

- The filter is calculated in the fixed runtime group "Receive AFTER IF1 PROFIdrive PZD". For reasons relating to performance, this runtime group should not be used anywhere else (e.g. in DCC applications).
- Measuring functions (position controller control frequency response) are influenced as the VIBSUP filter characteristics are also measured.
- The delay of the VIBSUP filter is added to the actual following error in the following error monitoring of the higher-level control system. The percentage component of the following error, generated by VIBSUP during motion, is displayed in r31605[0].
  - To correctly calculate the following error an additional delay time <TO>.FollowingError.AdditionalSetpointDelayTime can be parameterized, which delays the position setpoint by the time required to calculate the following error.
    The following setting is recommended for <TO>.FollowingError.AdditionalSetpointDelayTime:
    VIBSUP with p31581 = 0 (rugged filter type): 0.5 / fd_min
    VIBSUP with p31581 = 1 (filter type, sensitive): 0.25 / fd_min

More information

Note

Detailed information about PROFIdrive telegrams is provided in Chapter "PROFINET and PROFIBUS communications (Page 345)" of this manual or in the List Manual.

Note

Information about the following error monitoring and the settings required in the higher-level control are described in the following reference, for example:

- "SIMATIC S7-1500 STEP 7 (https://support.industry.siemens.com/cs/us/en/view/109990072): S7-1500/S7-1500T axis functions V10.0 from STEP 7 V21 and higher" Function Manual, Chapter "Position monitoring"

13.16.2 Natural frequency and damping

Overview

Setting natural frequency f_d (p31585) and damping D (p31586) of the mechanical natural oscillation defines, to a significant extent, the response of the setpoint filter. When the natural frequency and damping are either incorrectly or inaccurately set, then the setpoint filter does not cause any oscillation to be excited; however, in this case, the oscillation is either insufficiently dampened or not at all.

A constant natural frequency can be set for "Basic Vibration Suppression". Alternatively, a variable natural frequency can be parameterized for "Extended Vibration Suppression"

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- The corresponding application mode is selected.

Function description

"Basic Vibration Suppression"

A fixed natural frequency above 10 Hz can be set in p31585.

"Extended Vibration Suppression"

A fixed natural frequency above 0.1 Hz can be set in p31585.

As an alternative, a lower natural frequency can be set in p31585 and an upper natural frequency can be set in p31584. For natural frequencies, which strongly depend on the system state, then the natural frequencies are determined in both extreme states. Using the online frequency change, it is possible to interpolate the natural frequency between the extreme states, see "Online frequency change and dead time symmetrization (Page 992)".

More information

Information about determining the natural frequency is provided in Chapter "Determining the natural frequency (Page 986)".

13.16.3 Filter type

Overview

The "Rugged" and "Sensitive" filter types available differ regarding the sensitivity with respect to frequency shifts and the delay of the motion sequence.

Only the sensitive filter is used for "Basic Vibration Suppression". A rugged or sensitive filter can be selected for "Extended Vibration Suppression".

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- "Extended Vibration Suppression" must be activated in order to change the filter type.

Function description

Rugged (p31581 = 0)

The rugged VIBSUP filter has a lower sensitivity to frequency offsets compared with the sensitive filter type, but results in a higher delay of the motion sequence. The complete motion sequence is extended by one period T_d, where $T_d = 1/f_d$.

Sensitive (p31581 = 1)

The sensitive VIBSUP filter has a higher sensitivity to frequency offsets compared with the rugged filter type, but results in a lower delay of the motion sequence. The complete motion sequence is extended by half a period $T_d/2$, where $T_d = 1/f_d$.

13.16.4 Filter activation

Overview

To activate setpoint filtering, the filter must either be manually activated or activated from a higher-level control system. Without activation, it remains in the initialization state "Filter ready" (r31600.2 = 1). This is automatically the case after powering up, as the filter parameters are pre-assigned valid values. In this state, the actual setpoints are passed through without any filtering.

The actual state of the setpoint filter at an axis is displayed in VIBSUP status word (r31600).

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- Filter frequency and damping are correctly set.

Function description

Activating/deactivating the VIBSUP filter

The VIBX filter can be activated/deactivated when the axis is enabled or not enabled:

- When the axis is enabled, coupling in is bumpless.
- Activating when the axis is moving temporarily reduces the velocity.
- When the axis is enabled, coupling-out is bumpless.
- Deactivating when the axis is moving temporarily increases the velocity. Take this response into consideration when parameterizing the drive (velocity limiting).

Activating

VIBSUP is activated for p31590 = 1 signal. The state transitions from "Filter ready" to "Filter active".

The filter coupling-in process is indicated with r31600.3 = 1. Successful activation is confirmed with r31600.4 = 1 and r31600.2 = r31600.3 = 0.

In the "Filter active" state, the setpoints are filtered according to what has been parameterized.

Deactivating

VIBSUP is deactivated for p31590 = 0 signal or for "Activate tracking" (p31627 = 1 signal). The state transitions from "Filter active" to "Filter ready".

The filter coupling-out process is displayed with r31600.5 = 1. Successful deactivation is confirmed with r31600.2 = 1 and r31600.4 = r31600.5 = 0.

Activate/deactivate for axes that have not been enabled

Note

Coupling-in/coupling out is skipped for constant setpoints in the filter or if the axis is not enabled.

A direct transition is made between states "Filter ready" and "Filter active".

Behavior for OFF responses

The setpoint filter is inactive for axis faults, which result in the position controller being deactivated. The filter changes into the "Filter ready" state (r31600.2 = 1). The filter is coupled-in when the position controller is activated, see "Activating VIBSUP filter".

As an OFF1, OFF2 or OFF3 response has an effect on the speed controller setpoint channel and the position controller is deactivated, VIBSUP has no reaction on the OFF responses.

13.16.5 Expanding telegrams for activation/monitoring by a control system

Overview

For PROFIdrive telegrams for positioning (e.g. 111), no control and status information is included for the VIBSUP filter. When function "Vibration Suppression" is activated and monitored from a higher-level control system via PROFIdrive, then the telegrams can be expanded to include the corresponding information (e.g. c31590, r31600).

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- "Extended Vibration Suppression" is activated.

Function description

When vibration suppression is to be activated and monitored from a higher-level control system via PROFIdrive, then the telegrams can be expanded to include the corresponding information (e.g. c31590, r31600) using the free telegram configuration (r0922 = 999).

- In application mode "Basic positioner and position control", signal "Setpoint fixed" can be interconnected in a telegram (e.g. PZD POS_ZSW2.2 in telegram 111) as follows: c2053[2].2 = r31600.8

More information

The structure of the telegrams and the telegram configuration is provided in Chapter "PROFINET and PROFIBUS communications (Page 345)" of this manual or in the List Manual.

13.16.6 Determining the natural frequency

Overview

Natural frequency f_d is set in p31585. When using the variable natural frequency (only for "Extended Vibration Suppression"), the lower natural frequency is set in p31585 and in addition, the upper natural frequency is set in p31584.

The frequency can be determined in 3 different ways:

- Empirically
- With the measurement function in the frequency domain
- Using traversing motion in the time domain

Requirement

- For the measuring function via Startdrive: The "Startdrive Advanced" license is available.
- When using a variable natural frequency or frequencies below 10 Hz: "Extended Vibration Suppression" is activated.

Function description

If the value for frequency f_d of the mechanical natural oscillation is not known, it can be either empirically determined or determined using the trace function of the commissioning software. In exceptional cases, an additional measuring device may be required (e.g. an oscillation sensor).

As the damping is low for almost all practical applications (for instance, a storage and retrieval machine), the following applies:

Natural frequency of damped system f_d ~resonant frequency f_r

For this reason, the frequency to be parameterized can either be determined in the time domain (f_d) or in the frequency domain (f_r).

Note

The damping refers to the natural mechanical oscillation to be damped.

Typical damping values lie in the range 0.1...3 % (D = 0.001...0.03). If damping cannot be determined, then a value of D = 0.001 is recommended.

Frequency f_d must be determined by making the appropriate measurements.

A following error (difference between the filter input and filter output) is obtained as a result of the filter. This is added to the following error that already exists in the closed-loop position control. This secondary condition should especially be taken into account for interpolating axes.

13.16.6.1 Empirical determination

Overview

This method is suitable if the natural frequency to be absorbed is approximately known.

Requirement

- The general requirements for function "Vibration Suppression" are fulfilled.
- The natural frequency to be absorbed is approximately known.

Function description

For the empirical determination, the estimated frequency can be set in p31585 or the estimated frequency band with adaptation factor can be set in p31584, p31585 and c31610. The VIBSUP filter is activated via c31590, and while traversing, the filter effect is visually evaluated for various load states.

The settings in p31584, p31585 and c31610 are then adapted and a visual check is again performed. The best results are then adopted.

The lowest value should be used if several values for the frequency were determined.

13.16.6.2 Determination in the frequency domain with measurement function

Overview

With this method, the natural frequency to be absorbed is determined using the internal SINAMICS measuring function "Speed controller loop (excitation after the current setpoint filter)" The speed controller control loop manifests the mechanical transfer response of the drive train. Based on the measurement, the transfer function vmotor / Fmotor is determined and shown in a Bode diagram. The measuring function excites the motor with a frequency spectrum (white noise).
As a consequence, a higher noise level can occur during the measuring time. In spite of the noise, when the measuring function is correctly parameterized, this measuring technique does not subject the mechanical system to any stress.

Requirement

- The "Startdrive Advanced" license is available.
- Speed controller settings
  It may be necessary to adapt the proportional gain Kp (p1460) and the integral time Tn (p1462). Typically, Kp should be reduced and Tn increased.

Function description

Initially, measurement function "Speed controller loop (excitation after the current setpoint filter)" must be parameterized and performed. After the measuring function has been completed, the transfer function is graphically displayed in the Bode diagram. The Bode diagram shows the absolute value (top) and the phase (bottom) in a logarithmic scale. The natural frequency f_d to be damped can be identified by the notch in the absolute value diagram (zero position). A positive phase rotation also occurs at this position.

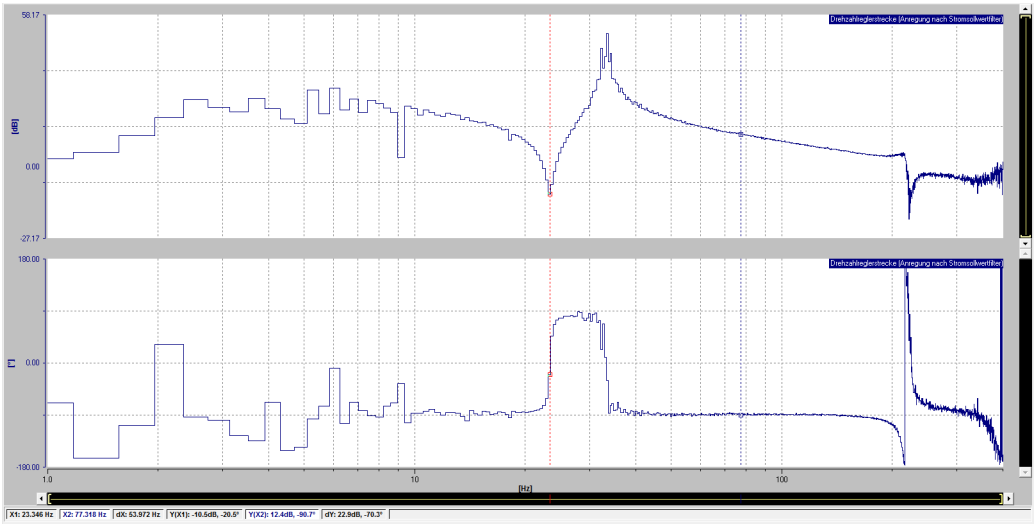


Figure 13-346 Evaluate the result of the measuring function

Note

This measuring technique is only used to determine the natural frequency. It cannot be used to check the effect of the filter.

Example

Possible settings for the measurement function:

Amplitude

From experience, practical values lie in the range 1...5 %. The value is scaled to p2003.

Offset

The offset is intended to ensure that the axis is traversed slowly.
The value should be selected so that the axis visibly moves in order to overcome the stiction.
From experience, values in the range 0.5 ... 1 % of the maximum axis velocity are sufficient.

Acceleration time

This value should be generously dimensioned corresponding to the offset that has been set (e.g. 200 ... 500 ms).

Measuring period

The highest possible number of measuring periods is advantageous (e.g. number = 4). The available travel distance of the axis must be observed for the offset velocity that has been set and the displayed measurement time.

Bandwidth

The value must be selected so that the expected natural frequency can be displayed with a good resolution (e.g. bandwidth < 400 Hz).

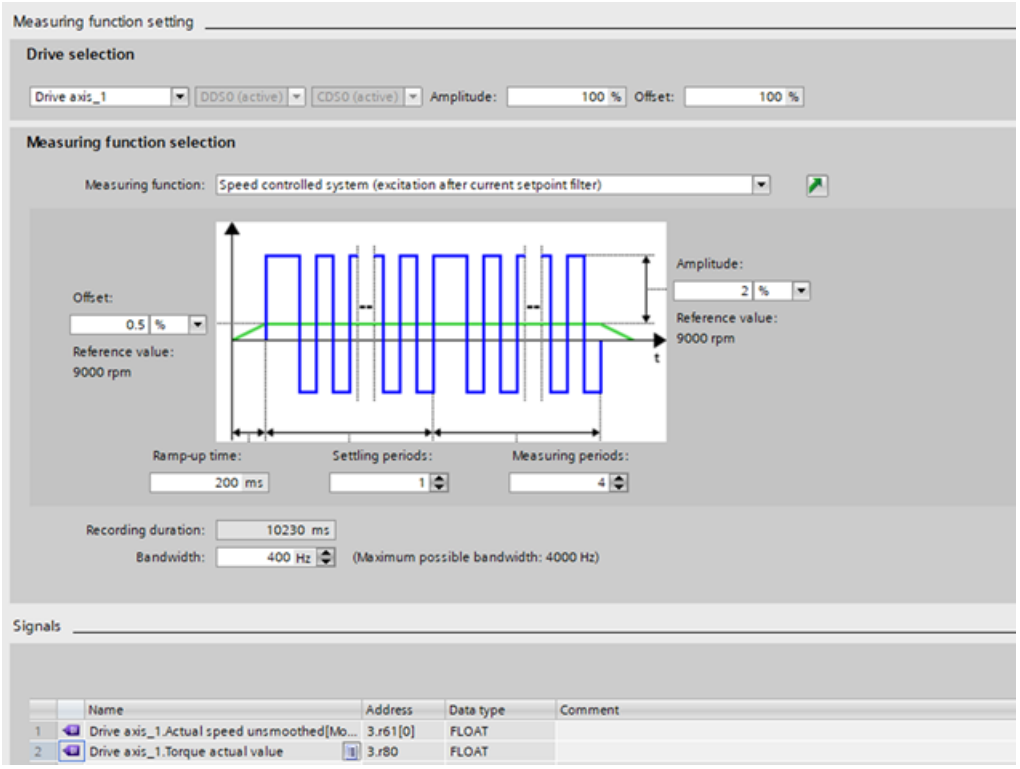


Figure 13-347 Setting the measuring function

13.16.6.3 Determining in the time domain using traversing motion

Overview

With this method, the natural frequency to be absorbed is determined using a dynamic positioning operation, where the actual values with respect to time are recorded in a trace.

Requirement

- The "Startdrive Advanced" license is available.

Function description

The setpoint excites the mechanical system of the axis to oscillate and acts on the motor. In spite of the fact that the speed controller has been correctly set, motor oscillation can be identified if a direct measuring system is not being used.

The frequency is determined from the inverse of the time period of the oscillation at the motor.

Example

Example for application mode "Basic positioner and position control"

The following parameters are recommended as measured variables. These parameters are shown in color in the following diagrams.

r2665: EPOS position setpoint (red)
r2521[1]: LR position actual value, encoder 1 (green)
r2521[2]: LR position actual value, encoder 2 (blue, if available)

The following diagram shows a positioning operation to determine the frequency.

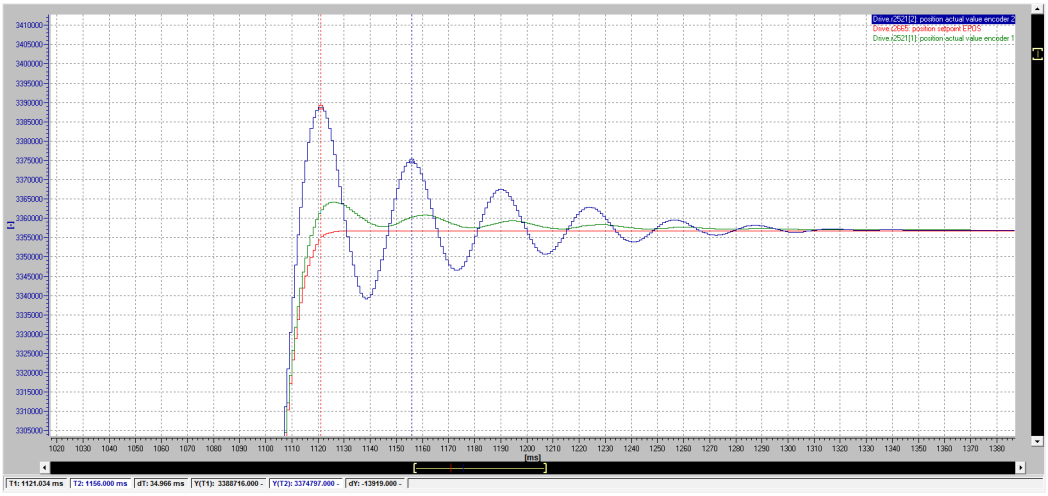


Figure 13-348 Displaying the positioning operation and determining the frequency

In the diagram above, the time period is marked using a colored measuring cursor. The result is shown below with dT = 34.966 ms (≈ 35.0 ms).

The frequency of the natural oscillation to be damped is calculated as follows:

f_d = 1 / time period = 1 / 0.0350 s = 28.6 Hz

The following diagram shows the effect of the "Vibration Suppression" function. The natural frequency is set to f_d = 28.6 Hz. The diagram shows travel with vibration suppression activated and deactivated.

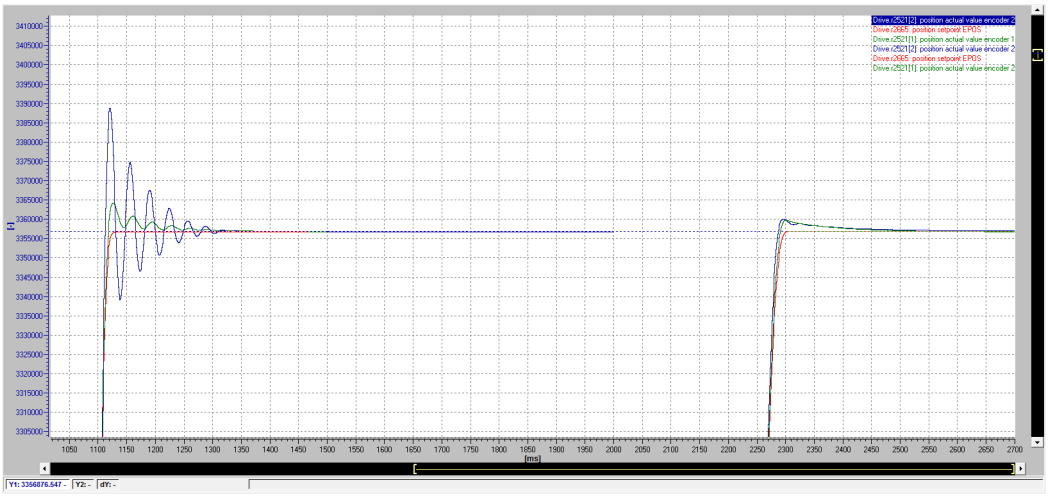


Figure 13-349 Traversing with VIBSUP deactivated (left) and VIBSUP activated (right)

Alternatively, you can use the velocity or the torque as measurement variables.

Recommended parameter for velocity:
r2666: EPOS velocity setpoint
r0061[0]: Unsmoothed speed actual value, encoder 1
r0061[1]: Speed actual value, unsmoothed, encoder 2 (if one is being used)

Recommended parameter for current:
r0080 or r0080[0]: Torque actual value

13.16.7 Online frequency change and dead time symmetrization

Using the online frequency change, you can adapt frequency f_d of the damped natural oscillation during the runtime, with filtering active and an enabled axis that is moving.

The function offers the advantage that during motion the filter frequency can be adapted to the properties of the mechanical system as a function of the position

Preconditions

The online frequency change requires the following preconditions:

- The deadtime symmetrization must be activated (p31612 = 1 signal), or the frequency change is only accepted when the setpoint is fixed and no longer changes (r31600.8 = 1).
  The dead time symmetrization prevents undesirable axis velocity changes, which occur as a result of a varying delay time (dead time) of the filter due to a changing effective filter frequency f_d.
  You can find the dependency of the filter delay time on the filter type and the effective filter frequency, in "Notes for application mode "Closed-loop speed control" (Page 982)".
  When the deadtime symmetrization is activated, a constant, frequency-dependent filter delay time is generated, which is obtained from the lower of the two frequencies p51585[0] and p51585[1].
- Filter type "Sensitive" (p31581 = 1) is recommended.
  Using the "Sensitive" filter type, for the online frequency change, the natural frequency can be precisely adapted to the different physical attributes of the system.

Note

When using the "Sensitive" filter type a lower deceleration of the motion sequence is obtained, see "Filter type (Page 983)".

Application example

Storage and retrieval machines for high bay warehouses generally comprise a mast. The mast is equipped with a load handling device, which can be deployed at the top of the mast. This load handling device is used to place goods into a rack or remove them from a rack. The natural oscillation frequency of a storage and retrieval machine essentially depends on the position of the load handling device and its associated load (i.e. either moving with or without a load).

Procedure

1. Enter the lower and upper frequency f_d of the damped natural oscillation of the mechanical system in p31585[0, 1].
2. Interconnect connector input p31610 with the signal source for the frequency to be interpolated.
   0 % at the signal source corresponds to the lower frequency p31585[0] and 100% to the upper frequency p31585[1]. The system linearly interpolates between the two values.
3. Activate the deadtime symmetrization (p31612 = 1 signal).
   A signal change is only accepted when the setpoint is fixed (r31600.8 = 1).

Note

As a result of the settling process of the filter, the frequency cannot change at any speed, as otherwise the filter would not be effective. The rate with which the frequency can change is limited. This is internally calculated, and can be adapted by the user as a percentage (p31611).

The currently effective frequency is output at connector output r31613.

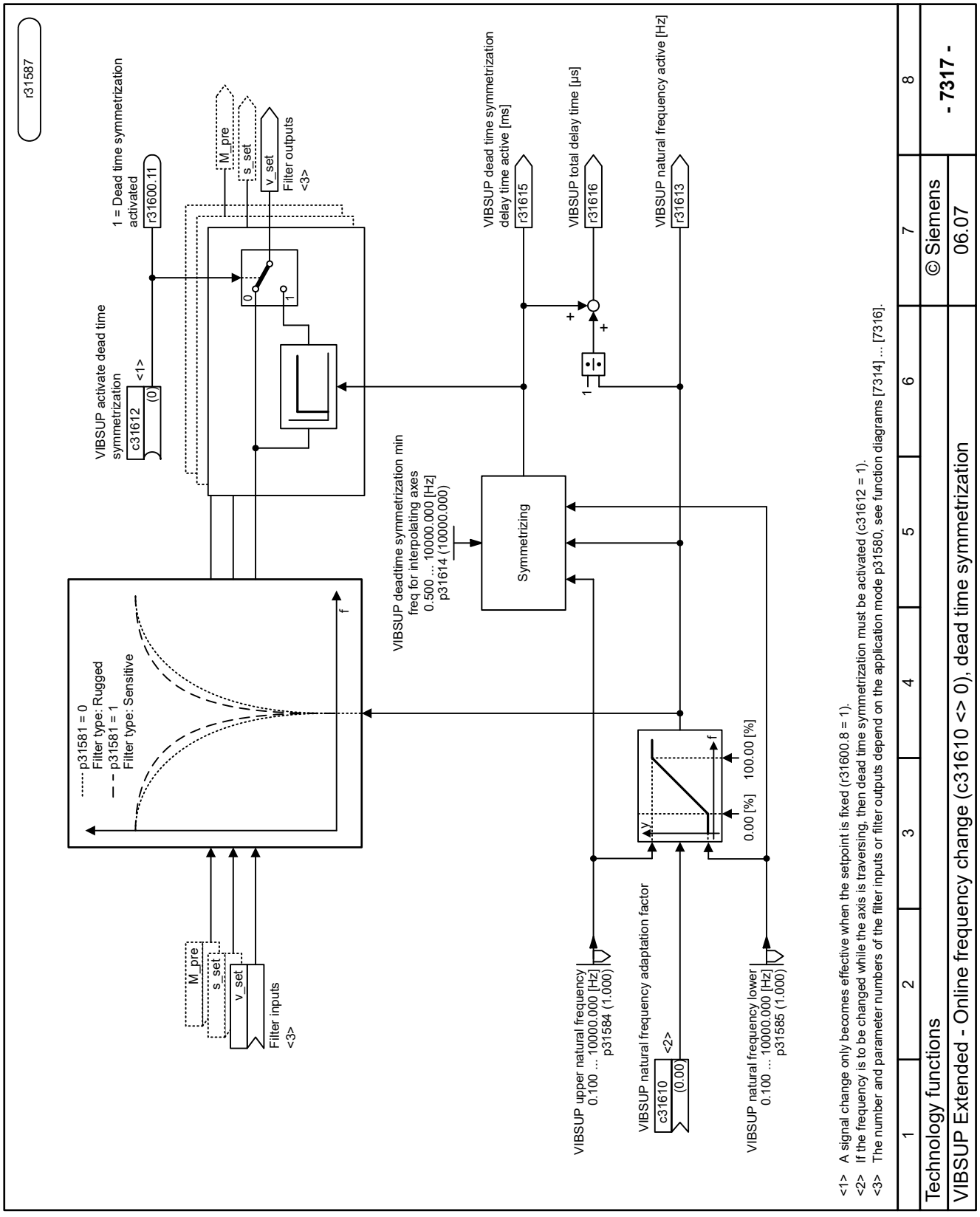


Figure 13-350 7317 – VIBSUP Extended: Online frequency change (c31610 ≠ 0), deadtime symmetrization

13.17 Functions that require a license

13.17.1 Using a function that requires a license

Overview

Firmware functions of the converter can be extended by functions that require a license.

Description

To use a function requiring a license, the appropriate license must be assigned to the converter.

The following options are available for assigning the license to the converter:

- License on a SINAMICS memory card
  The license is assigned to the serial number of the memory card.
  The memory card contains the license file and is inserted in the converter as long as you use functions that require a license.
  The memory card can be ordered with preinstalled license as Z option.
- License in the converter
  The license is assigned to the serial number of the converter.
  Using the "Web License Manager", you create a license file that you then store in the converter using a commissioning tool.

Every license that is purchased has an associated license certificate (eCoL).

The certificate of license (eCoL) contains information about the license. We recommend that you archive the license certificate (eCoL). Depending on the license assignment, we recommend the following:

- The license is assigned to a SINAMICS memory card:
  - When ordering a SINAMICS memory card together with the license, the certificate of license (eCoL) is stored on the SINAMICS memory card in the factory. To archive, transfer the license certificate (eCoL) from the memory card to your operating unit or another storage medium.
  - If you subsequently purchased a license and you then stored the license certificate (eCoL) on the SINAMICS memory card, transfer the license certificate (eCoL) from the memory card to your operating unit or another storage medium.
- The license is assigned to the converter:
  - The certificate of license (eCoL) cannot be stored in the converter.
  - Archive the certificate of license (eCoL) on your operating unit, on the memory card of the converter or on another storage medium.

Table 13-125 Differences between certificates of license (eCoL) and a license

Name	Description
Certificate of license (eCoL)	• PDF file for each purchased license • Contains the delivery note number and license number • Required to create a license in the "Web License Manager" • Not contained in the license file • Stored on any external memory, on an operating unit of the converter or on the memory card of the converter
License	• ZIP file • Contains the serial number of the memory card or the converter in the file name • Cannot be transferred to other memory cards or converters. • Required in order to use a function in the converter that requires a license • Contains a signature The converter uses the signature to verify the authenticity of the license.

More information

More information on licensing is provided on the Internet:

Siemens Support (https://support.industry.siemens.com/cs/ww/en/view/110002326)

13.17.2 Creating and downloading a license using the "Web License Manager"

Overview

After you have purchased a license, create a license file in the "Web License Manager" with the certificate of license (eCoL).

Requirement

For a SINAMICS memory card with preinstalled license, the following procedure is not required.

Authentication with a Siemens ID is required to access the "Web License Manager".

The following information is required to create a license file in the "Web License Manager":

- Certificate of license (eCoL)
- Product designation
- Serial number of the SINAMICS memory card or the converter
  The serial numbers are on the converter or on the memory card or also in the license overview of the commissioning tool being used.

Procedure

Proceed as follows to create a license file:

1. Click "Direct access" in the "Web License Manager".
2. Enter the license number and delivery note number of your certificate of license (eCoL).
3. Enter the serial number of the memory card or the converter.
4. Select your project.
   In the "Already assigned licenses" column, you can see which licenses have already been assigned to a memory card or a converter.
   In the "Additional licenses to be assigned" column, activate the licenses you want and specify how many additional licenses you require.
5. Activate the required licenses.
6. Click "Assign".
   The "Web License Manager" assigns the license to the memory card or to the converter and provides the license file so that it can be downloaded.
7. Load the license file "LK_HW_aabb.zip" to the file system of your operating unit.
   aabb = serial number of the SINAMICS memory card or the converter

Result

The "Web License Manager" has created a license file and you have downloaded the license file "LK_HW_aabb.zip" from the "Web License Manager" to the file system of your operating unit.

More information

The "Web License Manager" can be found on the Internet:

Web License Manager (http://www.siemens.com/automation/license)

13.17.3 Loading a license file into the operating unit at a later point in time

Overview

After you have created a license file in the "Web License Manager" load the license file to your operating unit.

Requirement

The license file has already been created in the "Web License Manager".

Authentication with Siemens ID is required to access the "Web License Manager".

Procedure

Proceed as follows to save the license file to your operating unit:

1. In the "Web License Manager", click on entry "Display license key" in the "User menu".
2. Enter the serial number of the memory card or the converter you are using in field "Hardware serial number".
3. Enter the corresponding license number from the certificate of license (eCoL) in field "License No.".
4. Click the "Display license key" button.
   The "Web License Manager" provides the license file so that it can be downloaded.
5. Load the license file "LK_HW_aabb.zip" to the file system of your operating unit.
   aabb = serial number of the SINAMICS memory card or the converter

Result

You have downloaded license file "LK_HW_aabb.zip" from the "Web License Manager" to the file system of your operating unit.

More information

The "Web License Manager" can be found on the Internet:

Web License Manager (http://www.siemens.com/automation/license)

13.17.4 Assigning a license file to the converter and activating it

Overview

If you created a license file using the "Web License Manager" and you loaded it to your operating unit, then assign the license file to the converter and activate the license.

The procedure using the Startdrive commissioning tool is described as example below.

Requirement

For a SINAMICS memory card with preinstalled license, the following procedure is not required.

You have created license file "LK_HW_aabb.zip" using the "Web License Manager" and saved it to the file system of your operating unit.

aabb = serial number of the SINAMICS memory card or the converter

A commissioning tool is required to assign a license created in the "Web License Manager" to a converter.

The data in the converter and in the Startdrive project must be consistent if you are using the Startdrive commissioning tool.

If you assign the license to a SINAMICS memory card, the memory card must be inserted in the converter.

Procedure

Proceed as follows to assign a license to the converter and activate it:

1. Call the license overview page in the commissioning tool.
2. Select button "Activate license key file".
3. Select the license file in the file system of your operating unit.
4. Close the load dialog.
   After a check has been successfully completed, dialog "Licensing" opens.
5. Press the "Activate" button.

Result

The appropriate license is activated in the converter.

A license can be also activated without using a commissioning tool if you copy the following data to a SINAMICS memory card:

- License file "LK_HW_aabb.zip" for the SINAMICS card is in directory "KEYS/SINAMICS".
- The certificate of license (eCoL) is in directory "KEYS/SINAMICS/eCoL".

13.17.5 Restoring licensing after the memory card is removed

Overview

If you remove a memory card with a license from the converter, then converter operation is locked after restarting the converter.

Requirement

The license file is saved on a SINAMICS memory card.

Procedure

Proceed as follows to restore the license of the converter:

1. Insert the memory card into the converter.
2. Switch off the converter supply voltage.
3. Wait until all the LEDS on the front of the converter have gone dark.
4. Switch on the converter supply voltage.
5. Check whether the license is activated on the license overview page of the commissioning tool.

13.17.6 Backing up the certificate of license (eCoL) on the operating unit

Overview

You back up the certificate of license (eCoL), which is stored on the memory card, to your operating unit.

Requirement

A certificate of license (eCoL) is stored on the memory card in directory "KEYS/SINAMICS/eCOL".

Procedure

Proceed as follows to backup the certificate of license (eCoL) on your operating unit.

1. Click on the "Save eCoL archive" button.
2. Select the directory on your operating unit in which you wish to back up the license certificate (eCoL).
3. Confirm the selection.

13.17.7 Trial License mode

Overview

With a "Trial License", license-based firmware functions can be activated for a limited time without a valid license.

Requirement

The Trial License is activated with a commissioning tool.

The Trial License is only permissible during commissioning and servicing.

Function description

License-only firmware functions without a valid license can be activated with a Trial License.

The Trial License does not require a memory card with a license file nor a license file stored in the converter.

The Trial License is valid for 3 Trial License periods, each for a maximum of 300 operating hours.

The operating hours of a Trial License period start being counted when the supply voltage of the converter is switched on and firmware functions subject to licensing are activated without a valid license.

The operating hours of a Trial License period stop being counted when one of the following conditions is satisfied:

- All firmware functions requiring a license but that do not have a valid license are deactivated.
- A valid license for using the firmware functions requiring a license is activated.
- The converter power supply has been switched off.

No additional Trial License can be activated once the last Trial License period has elapsed.

The converter can only continue to operate if all firmware functions requiring a license but without a valid license are either deactivated or licensed.

Example

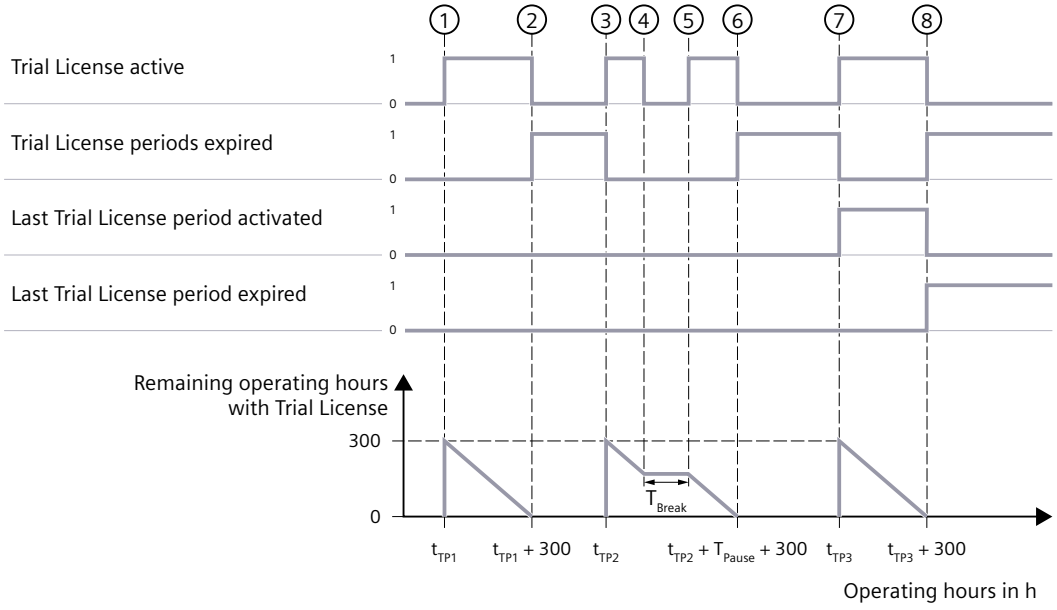


Figure 13-351 Trial License periods

Table 13-126 Explanation of the example

①	The 1st Trial License period is activated
②	The 1st Trial License period has expired
③	The 2nd Trial License period is activated
④	The operating hours counter stops, for example as all firmware functions requiring a license have been temporarily deactivated
⑤	The operating hours counter restarts, e.g. as a firmware function requiring a license has been reactivated.
⑥	The 2nd Trial License period has expired
⑦	The last Trial License period is activated
⑧	The last Trial License period has expired

System messages

14

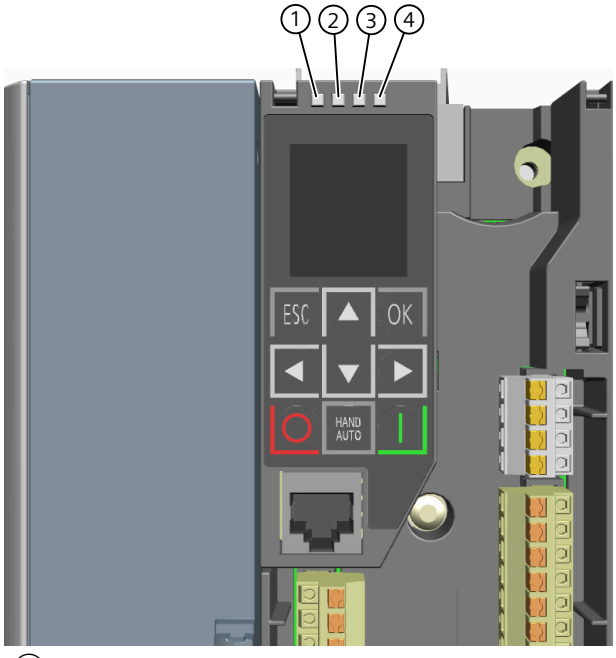
14.1 LEDs

14.1.1 LEDs on the converter

Overview

The LEDs at the front provide information about the operating state of the converter.

Description



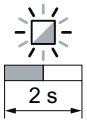
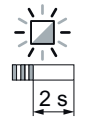
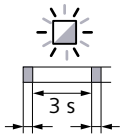
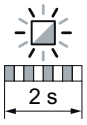
① RDY
② BF
③ LNK1
④ LNK2

Figure 14-1 LED on the front panel

14.1.2 Explanation of icons

Response of the LEDs

The following tables explain the LED icons.

Icon	Description
	LED is bright
	LED is OFF
	LED flashes slowly
	LED flashes in alternating order 3 times quickly - 2 s pause - ...
	LED flashes briefly every 3 s
	LED flashes quickly
	LED flashes with variable frequency

14.1.3 LED LNK

Behavior of the LEDs when powering up and during operation of the converter

LNK	Description	Remedy
 Green	The Ethernet-based fieldbus link (X150) is successfully established.	
	The Ethernet-based fieldbus link (X150) has not been established.	• Establish the missing or interrupted Ethernet-based fieldbus link • Switch on connected and linked products

14.1.4 LED RDY and LED BF

Response of the LEDs

RDY	BF	Description	Remedy
 Green	Not relevant	Converter is ready for operation and is fault free.	
Not relevant	 Green	Cyclic communications running.	
 Green	 Green	Possible causes • Temporary state after the supply voltage is switched on. firmware being loaded and initialized. • Firmware is being updated. • All user-defined settings are reset to the factory setting.	
 Green	☐	Firmware update completed The converter is waiting.	Switch the converter supply voltage off and on.
 Green	☐	All user-defined settings are reset to the factory setting.	Switch the converter supply voltage off and on.
 Green	Not relevant	PROFIenergy energy saving mode is active.	
 Orange	☐	Commission or restore factory settings using the commissioning tool	
 Orange	 Orange	Possible causes • Temporary state after the supply voltage is switched on • Restart	
 Orange	☐	The converter is identified, e.g. using the commissioning tool.	

RDY	BF	Description	Remedy
 Red	☐	Possible causes • Converter signals a fault. • Firmware error • No license	Appropriate remedies: • Check message display, rectify cause of fault • Activate required license
☐	 Red	No fieldbus connection: • No data exchange or configuration error • Data exchange lost • Data is being exchanged, but there are no set-points (controller in the stop state)	Possible remedies: • Check message display and rectify cause of fault. • Check operating mode of controller (PLC)
☐	 Red	Firmware update signals an error.	Possible remedies: • Switch the converter supply voltage off and on, and repeat the firmware update. • Firmware update via memory card: Replace memory card and repeat firmware update. • Contact Support/Hotline.
☐		Reset of all user-defined settings to the factory setting unsuccessful.	Possible remedies: • Check the memory card with the empty file called RESET.TXT • Switch off and switch on the converter supply voltage and reset all user-defined settings to the factory setting. • Contact Support/Hotline.
☐	 Red	Possible causes • BIOS error – General error – Loading error • File error: – Memory card is not available or is faulty. – File corrupt • CRC error	Possible remedies: • Switch the converter supply voltage off and on. • Check memory card if available • Reload firmware • Contact Hotline/Support.

14.1.5 LED RDY of the option modules

Behavior of the LEDs

Table 14-1 Signal states of the RDY LED

RDY	Description	Remedy
☐	The electronic power supply is missing or outside the permissible tolerance.	Check power supply
 Green	The option module is ready for operation. Cyclic DRIVE-CLiQ communication is taking place.	
 Orange	DRIVE-CLiQ communication is being established.	
 Red	The option module signals a fault. The LED is activated irrespective of the corresponding messages being reconfigured.	
 Green - red	Firmware update in progress	
 Green - red	Firmware update completed Waiting for the supply voltage to be switched off and on	Switch the converter supply voltage off and on.
 Green - orange OR  Red - orange	Option module detection is activated. The color of the flashing LED depends on the LED state on activation with the commissioning tool.	

14.1.6 LED COM of option module OM-IIoT

Behavior of the LEDs

Table 14-2 Signal states of the LED COM

COM	Description	Remedy	
	The power supply is missing or outside the permissible tolerance.	Check power supply	
 Green	The option module is ready for operation.		
 Orange	Temporary state after switching on the power supply or when the firmware is being updated		
 Red - orange	A file is being transferred to the option module.	Wait for:	 Green
 Green - red	Firmware is being updated.	Wait for:	 Green - red
 Green - red	The firmware update is completed.	Switch off the converter power supply and switch on again	

14.2 Identification & Maintenance (I&M) data

Technical data

The converter supports the following identification and maintenance (I&M) data.

Table 14-3 I&M data

I&M data	Format	Explanation	Example for the content
I&M0	unsigned8[54] PROFINET	Converter-specific data, read only	See below
I&M1	Visible String [32]	Plant/system identifier	"ak12-ne.bo2=fu1"
	Visible String [22]	Location code	"sc2+or45"
I&M2	Visible String [16]	Date	"2013-01-21 16:15"

I&M data	Format	Explanation	Example for the content
I&M3	Visible String [54]	Any comment or remark	-
I&M4	Octet String[54]	Check signature to track changes for Safety Integrated. This value can be changed by the user.	Values of r9780[0], r9781[0] and r9782[0]

When requested, the converter transfers its I&M data to a higher-level control or to a PC/PG with installed STEP 7 or TIA Portal.

Table 14-4 I&M0

Designation	Format	Example for the content
MANUFACTURER_ID	unsigned16	2A hex (=Siemens)
ORDER_ID	Visible String [20]	"6SL4113-0CA12-2AF0"
SERIAL_NUMBER	Visible String [16]	"T-R32015957"
HARDWARE_REVISION	unsigned16	0001 hex
SOFTWARE_REVISION	char, unsigned8[3]	"V" 06.10.00
REVISION_COUNTER	unsigned16	0000 hex
PROFILE_ID	unsigned16	3A00 hex
PROFILE_SPECIFIC_TYPE	unsigned16	0000 hex
IM_VERSION	unsigned8[2]	01.01
IM_SUPPORTED	unsigned16	001E hex

14.3 Date and time

Overview

The converter continuously determines the date and time, e.g. to save the precise time that a fault or alarm occurs.

Function description

The converter has a hardware real-time clock. The hardware real-time clock continuously determines date and time.

The following options are available to determine the date and time.

- Date and time are manually set
  After the date and time have been set once at an operating unit, the converter calculates the date and time based on its hardware real-time clock.
- The higher-level control is synchronized with the NTP server
  The converter synchronizes the date and time with the higher-level control system via the fieldbus.

- Synchronize with another NTP server
  The converter synchronizes the date and time with a central NTP server via the fieldbus.
- Default settings can be set when switching over to daylight saving or standard time.
  These default settings enable automatic switching between daylight saving and standard time on the converter.

The hardware real-time clock buffers power supply interruptions for up to 20 days.

Parameters

The following list contains the parameters of function "Date and time".

Number	Name	Unit
r8400[0...2]	Date	-
r8401[0...2]	Time	-

14.4 Faults and alarms

Definitions

A message comprises a letter followed by the relevant number.

The letters have the following meaning:

- A means "Alarm"
- F means "Fault"
- N means "No message" or "Internal message"
- C means "Safety message"
  In the factory setting (p3117 = 0), safety messages correspond to message type "C" and the safety message buffer is active. With p3117 = 1, safety messages correspond to the message types "A" or "F". Therefore search for Safety Integrated messages in this list only by their number without the message type (e.g. 01711).

The optional brackets indicate whether the type specified for this message can be changed and which message types can be adjusted via parameters (p2118, p2119).

Information about response and acknowledgment is specified independently for a message with changeable message type (e.g. response for F, acknowledgment for F).

Detailed examples:

Axxxxx	Alarm xxxxx
Fxxxxx	Fault xxxxx
Nxxxxx	No message
Cxxxxx	Safety message (dedicated message buffer)

14.5 Alarms

Overview

An alarm indicates that the reliable operation of the motor by the converter is at risk.

The extended diagnostics have an alarm buffer and an alarm history, in which the converter stores the most recent alarms.

Description of function

Alarms have the following properties:

- Incoming alarms have no direct effect on the converter.
- When the cause is eliminated, the alarm is no longer displayed.
- Alarms do not have to be acknowledged.
- Alarms are displayed as follows:
  - Display via bit 7 in status word 1 (r0052)
  - Display on the operating unit
  - Display in the commissioning tool

Alarm code or alarm value describes the cause of the alarm.

14.6 Alarm buffer

Overview

The converter saves alarms in the alarm buffer. As a consequence, alarms that have been resolved are kept for diagnostic purposes.

Function description

The alarm buffer contains a maximum of 8 active alarms.

	Alarm code	Alarm value		Alarm time received			Alarm time resolved		Component alarm	Diagnostic attribute alarm
		I32	float	Days	ms		Days	ms		
Alarm 1	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	old	r2146[0]	r2125[0]	r3121[0]	r3123[0]
Alarm 2	[1]	[1]	[1]	[1]	[1]		[1]	[1]	[1]	[1]
	[2]	[2]	[2]	[2]	[2]		[2]	[2]	[2]	[2]
	[3]	[3]	[3]	[3]	[3]		[3]	[3]	[3]	[3]
...	[4]	[4]	[4]	[4]	[4]		[4]	[4]	[4]	[4]
	[5]	[5]	[5]	[5]	[5]		[5]	[5]	[5]	[5]
	[6]	[6]	[6]	[6]	[6]		[6]	[6]	[6]	[6]
Alarm 8	[7]	[7]	[7]	[7]	[7]	new	[7]	[7]	[7]	[7]

Figure 14-2 Active alarms in the alarm buffer

An alarm includes an alarm code, an alarm value, and 2 alarm times.

The alarm code and the alarm value describe the alarm cause. The alarm value contains additional information about the alarm.

Active alarms are sorted according to "Alarm time received". When 8 alarms are active and an additional alarm is received, the converter overwrites the values at position [7].

As long as the alarm is not resolved, the value in "Alarm time resolved" = 0.

Once the cause of the alarm has been resolved, the converter writes the time to "Alarm time resolved" and shifts the alarm into the alarm history.

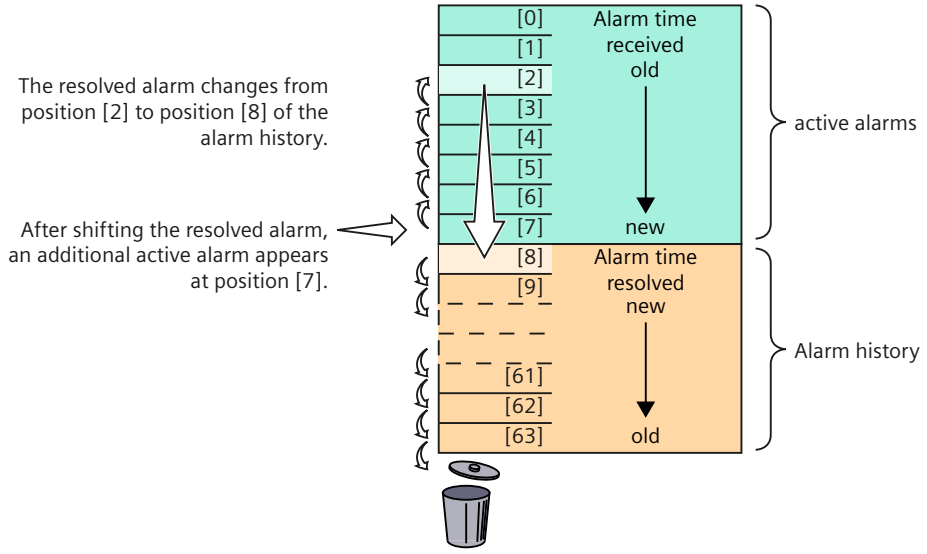


Figure 14-3 Alarm buffer with active alarms and alarm history

The alarm history contains up to 56 alarms that have been resolved.

In the alarm history, alarms are sorted according to the "Alarm time resolved". The alarm that was last resolved is at position [8].

The converter shifts a resolved alarm in the alarm history as follows:

1. To create a free position [8], the converter shifts all alarms in the alarm history to the position with the next higher index.
   The converter deletes the alarm that was previously saved at position [63].
2. The converter shifts the resolved alarm to position [8] of the alarm history.

By shifting the resolved alarm, a free position is created for the active alarms. To close the free position, the converter shifts the active alarms to the position with the next lower index.

If an alarm is active, which was still not visible in the alarm buffer, then this alarm appears at position [7].

Parameters

The following list contains the parameters of function "Alarm buffer".

Number	Name	Unit
r2111	Alarm counter	-
p2118[0...19]	Change message type message number	-

p2119[0...19]	Change message type type	-
r2121	Counter alarm buffer changes	-
r2122[0...63]	Alarm code	-
r2123[0...63]	Alarm time received in milliseconds	ms
r2124[0...63]	Alarm value	-
r2125[0...63]	Alarm time removed in milliseconds	ms
r2132	Actual alarm code	-
r2134[0...63]	Alarm value for float values	-
r2139.0...15	Status word faults/alarms 1	-
r2145[0...63]	Alarm time received in days	-
r2146[0...63]	Alarm time cleared in days	-
r3113.0...15	NAMUR message bit bar	-
r3121[0...63]	Component alarm	-
r3123[0...63].0...20	Diagnostic attribute alarm	-

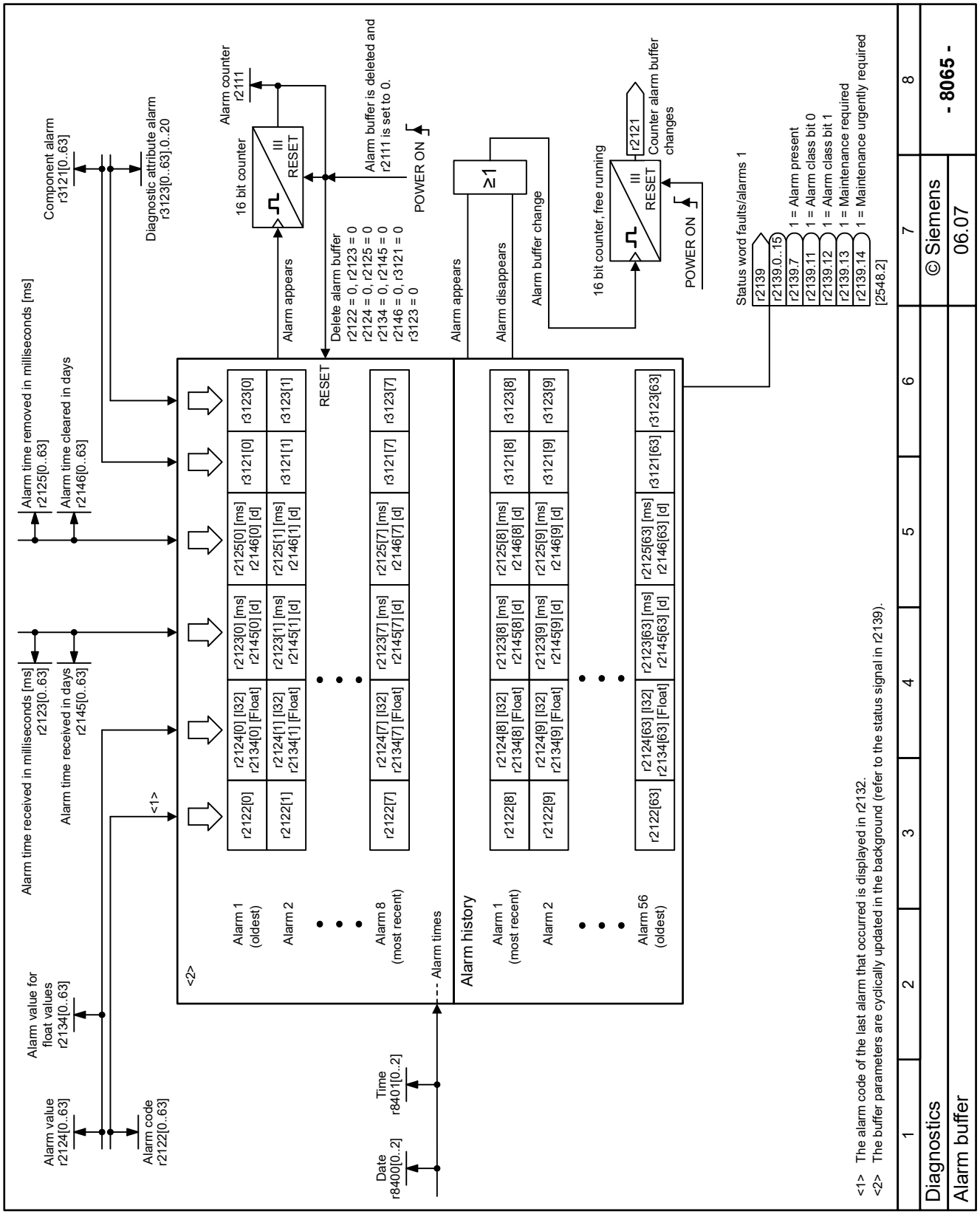


Figure 14-4 8065 - Alarm buffer

14.7 Faults

Overview

A fault indicates that the reliable operation of the motor by the converter is at risk.

The extended diagnostics have a fault buffer and a fault history, in which the converter stores the most recent faults.

Description of function

Faults have the following properties:

- A fault may cause the motor to switch off.
- A fault must be acknowledged.
- Faults are displayed as follows:
  - Display in bit 3 of status word 1 (r0052)
  - Display on the operating unit
  - Display on the converter via the LED RDY
  - Display in the commissioning tool

14.8 Acknowledging a fault

Overview

Faults can be acknowledged in several ways.

Requirement

A fault can be acknowledged if the cause of the fault has been resolved.

Function description

To acknowledge a fault, the converter offers the following options:

- Acknowledgment signal from a binary signal sink:
  r2103 (signal 1)
  r2104 (signal 2)
- PROFIdrive control signal STW1.07, r2090.7, which is interconnected with the acknowledgment signal.
- Digital input, which is interconnected with the acknowledgment signal.
- Operating unit, e.g. a PC with Startdrive
- Switching the converter power supply off and on

Faults involving the internal converter monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again.

The acknowledgment requires that the acknowledgment signal changes from a 0 signal to a 1 signal.

14.9 Fault buffer

Overview

The converter saves faults in the fault buffer. As a consequence, faults that have been resolved are kept for diagnostic purposes.

Function description

The fault buffer comprises the current incident and the fault history.

The current incident contains a maximum of 8 active faults, which have still not been acknowledged.

	Fault code	Fault value		Fault time received			Fault time resolved	
		I32	float	Days	ms		Days	ms
Fault 1	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	old	r2136[0]	r2109[0]
Fault 2	[1]	[1]	[1]	[1]	[1]	↓	[1]	[1]
	[2]	[2]	[2]	[2]	[2]		[2]	[2]
	[3]	[3]	[3]	[3]	[3]		[3]	[3]
...	[4]	[4]	[4]	[4]	[4]		[4]	[4]
	[5]	[5]	[5]	[5]	[5]		[5]	[5]
	[6]	[6]	[6]	[6]	[6]		[6]	[6]
Fault 8	[7]	[7]	[7]	[7]	[7]	new	[7]	[7]

Figure 14-5 Current incident

The fault code and fault value describe the cause of the fault. The fault value contains additional information about the fault.

The faults are sorted by "Fault time received". If the current incident is completely full and an additional fault is received, the converter overwrites the values at position [7].

As long as the fault is not resolved, the value in "Fault time resolved" = 0.

With the acknowledge signal, the converter transfers the current incident into the fault history.

		Fault code	Fault value		Fault time received		Fault time resolved		Component fault	Diagnostic attribute fault
			I32	float	Days	ms	Days	ms		
Current incident	Fault 1	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]	r3120[0]	r3122[0]
	Fault 2	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]
	...	...	...	...	...	...	...	...	...	...
	Fault 8	[7]	[7]	[7]	[7]	[7]	[7]	[7]	[7]	[7]
1st acknowledged incident	Fault 1	r0945[8]	r0949[8]	r2133[8]	r2130[8]	r0948[8]	r2136[8]	r2109[8]	r3120[8]	r3122[8]
	Fault 2	[9]	[9]	[9]	[9]	[9]	[9]	[9]	[9]	[9]
	...	...	...	...	...	...	...	...	...	...
	Fault 8	[15]	[15]	[15]	[15]	[15]	[15]	[15]	[15]	[15]
...										
7. Acknowledged incident [oldest]	Fault 1	r0945[56]	r0949[56]	r2133[56]	r2130[56]	r0948[56]	r2136[56]	r2109[56]	r3120[56]	r3122[56]
	Fault 2	[57]	[57]	[57]	[57]	[57]	[57]	[57]	[57]	[57]
	...	...	...	...	...	...	...	...	...	...
	Fault 8	[63]	[63]	[63]	[63]	[63]	[63]	[63]	[63]	[63]

Figure 14-6 Current incident and acknowledged incidents in the fault history

The fault history contains up to 7 acknowledged incidents each with 8 faults.

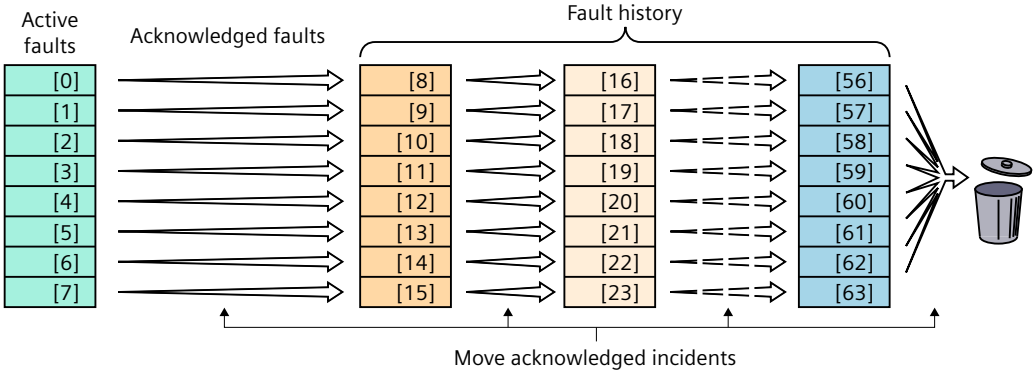


Figure 14-7 Transferring acknowledged faults into the fault history

The converter populates the fault history as follows:

1. The converter shifts the faults previously saved in the fault history by 8 positions. The converter deletes the faults that were saved to positions [56 ... 63] before acknowledgement.
2. The converter copies the current incident in positions [8 ... 15] of the fault history. After a resolved fault has been acknowledged, it is no longer visible in the current incident. A fault that has not been resolved contains value "Fault time resolved = 0" and also remains as active fault in the current incident.

After a resolved fault has been acknowledged, a free location is created in the current incident. If an additional fault is still active, which was not visible in the current incident, then the converter adds this active fault to the free position in the current incident.

The fault history is kept when the converter supply voltage is switched off or when a Startdrive project is downloaded.

The current incident before the supply voltage is switched off appears after supply voltage is switched on again as the 1st acknowledged incident in the fault history.

Parameters

The following list contains the parameters of function "Fault buffer".

Number	Name	Unit
r0944	Counter for fault buffer changes	-
r0945[0...63]	Fault code	-
r0948[0...63]	Fault time received in milliseconds	ms
r0949[0...63]	Fault value	-
p0952	Fault cases counter	-
p2100[0...19]	Change fault response fault number	-
p2101[0...19]	Change fault response response	-
r2109[0...63]	Fault time removed in milliseconds	ms
p2118[0...19]	Change message type message number	-
p2119[0...19]	Change message type type	-
r2130[0...63]	Fault time received in days	-
r2131	Actual fault code	-
r2133[0...63]	Fault value for float values	-
r2136[0...63]	Fault time removed in days	-
r2139.0...15	Status word faults/alarms 1	-
r3113.0...15	NAMUR message bit bar	-
r3120[0...63]	Component fault	-
r3122[0...63].0...20	Diagnostic attribute fault	-

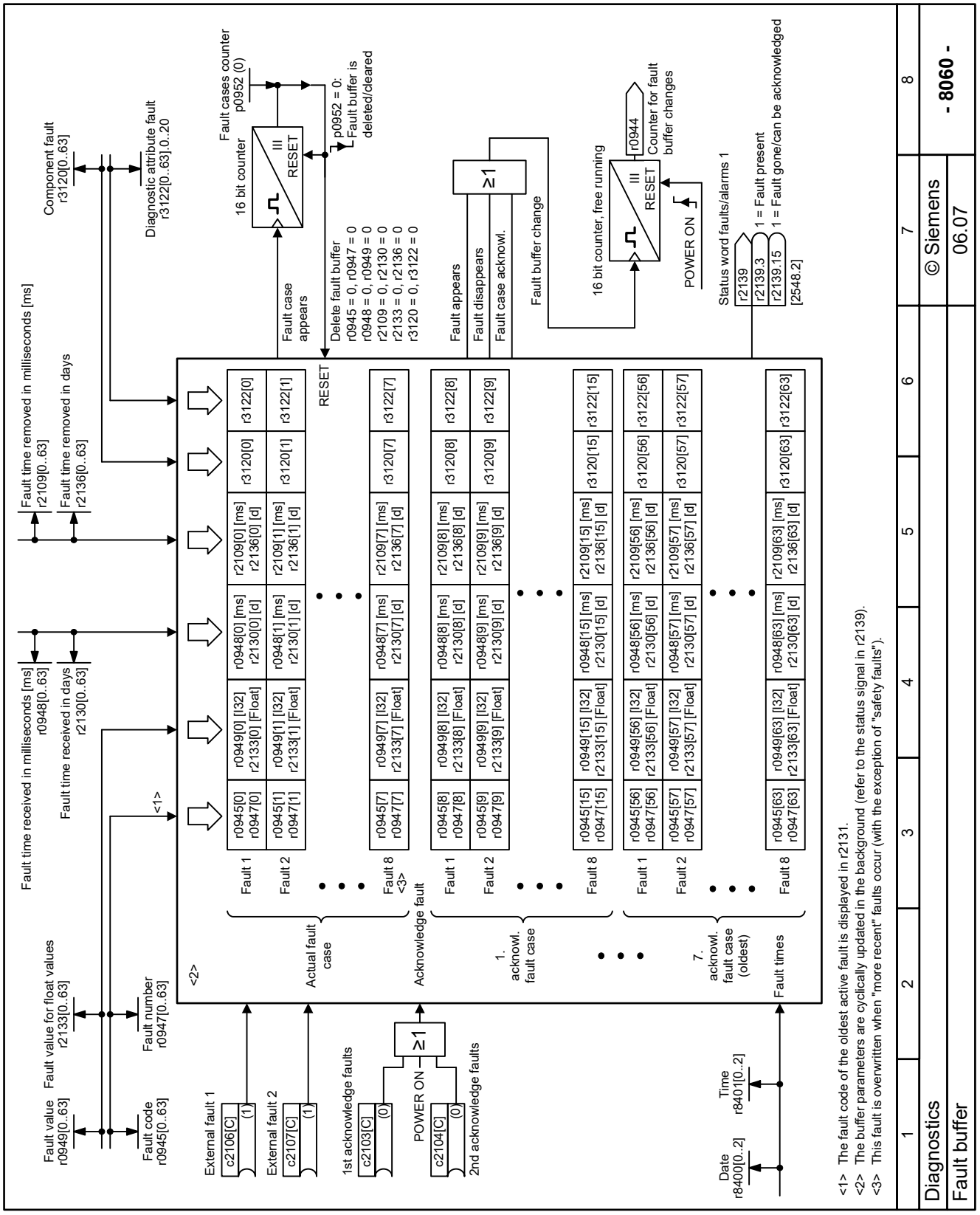


Figure 14-8 8060 - Fault buffer

14.10 Safety message buffer

Overview

The converter saves safety messages in the safety message buffer. As a consequence, safety messages that have been resolved are kept for diagnostic purposes.

Precondition

In the factory setting (p3117 = 0), safety messages correspond to message type "C" and the safety message buffer is active.

With p3117 = 1, safety messages are assigned message types Alarm (A) or Fault (F) and are stored in the alarm buffer or the fault buffer.

The values of the safety message buffer are only valid under the following preconditions:

- "Safety message active", r2139.5 = 1 signal
- The "Message buffer counter changes", r60044, is incremented.

Function description

The safety message buffer comprises the current safety message incident and the safety message history.

The current safety message contains a maximum of 8 active safety messages.

	Message code	Message value		Message time received			Message time acknowledged	
		I32	float	Days	ms		Days	ms
Message 1	r60045[0]	r60049[0]	r9753[0]	r9754[0]	r60048[0]	old	r9756[0]	r9755[0]
Message 2	[1]	[1]	[1]	[1]	[1]		[1]	[1]
	[2]	[2]	[2]	[2]	[2]		[2]	[2]
	[3]	[3]	[3]	[3]	[3]		[3]	[3]
...	[4]	[4]	[4]	[4]	[4]		[4]	[4]
	[5]	[5]	[5]	[5]	[5]		[5]	[5]
	[6]	[6]	[6]	[6]	[6]		[6]	[6]
Message 8	[7]	[7]	[7]	[7]	[7]	new	[7]	[7]

Figure 14-9 Current safety message case

The message code and the message value describe the message cause. The message value contains additional information about the safety message.

The safety messages are sorted by "Message time received". If the current safety message incident is completely full and an additional safety message is received, the converter overwrites the values at position [7].

As long as the safety message is not resolved, the value in "Message time resolved" = 0.

With the acknowledge signal, the converter transfers the current safety message incident into the safety message history.

		Message code	Message value I32	Message value float	Message time received Days	Message time received ms	Message time acknowledged Days	Message time acknowledged ms	Component	Diagnostic attributes
Current message case	Message 1	r60045[0]	r60049[0]	r9753[0]	r9754[0]	r60048[0]	r9756[0]	r9755[0]	r9745[0]	r9750[0]
	Message 2	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]
	...	...	...	...	...	...	...	...	...	...
	Message 8	[7]	[7]	[7]	[7]	[7]	[7]	[7]	[7]	[7]
1st acknowledged message case	Message 1	r60045[8]	r60049[8]	r9753[8]	r9754[8]	r60048[8]	r9756[8]	r9755[8]	r9745[8]	r9750[8]
	Message 2	[9]	[9]	[9]	[9]	[9]	[9]	[9]	[9]	[9]
	...	...	...	...	...	...	...	...	...	...
	Message 8	[15]	[15]	[15]	[15]	[15]	[15]	[15]	[15]	[15]
...										
7th acknowledged message case [oldest]	Message 1	r60045[56]	r60049[56]	r9753[56]	r9754[56]	r60048[56]	r9756[56]	r9755[56]	r9745[56]	r9750[56]
	Message 2	[57]	[57]	[57]	[57]	[57]	[57]	[57]	[57]	[57]
	...	...	...	...	...	...	...	...	...	...
	Message 8	[63]	[63]	[63]	[63]	[63]	[63]	[63]	[63]	[63]

Figure 14-10 Structure of the safety message buffer

The safety message history contains up to 7 message incidents each with 8 safety messages.

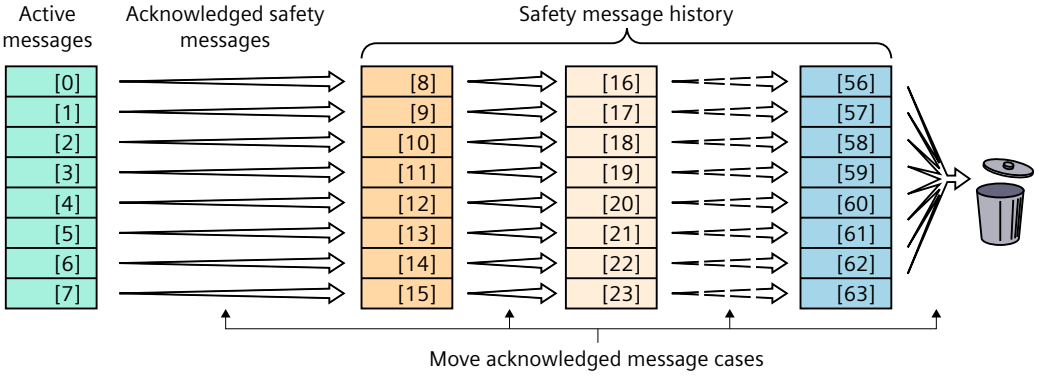


Figure 14-11 Movement of the acknowledged safety messages to the safety message history

The converter populates the safety message history as follows:

1. The converter shifts the values previously saved in the safety message history by 8 positions. The converter deletes the safety messages that were saved to positions [56 ... 63] before acknowledgement.
2. The converter copies the current safety message incident in positions [8 ... 15] of the safety message history.
   After a resolved safety message has been acknowledged, it is no longer visible in the current safety message incident.
   A fault that has not been resolved contains value "Fault time resolved = 0" and also remains as active safety message in the current safety message incident.

After a resolved safety message has been acknowledged, a free location is created in the current safety message incident. If an additional safety message is still active, which was not visible in the current safety message incident, then the converter adds this active safety message to the free position in the current safety message incident.

The safety message buffer is kept when the converter supply voltage is switched off or when a Startdrive project is downloaded.

The current safety message incident active before switching off the supply voltage appears, after the supply voltage is switched on again, as the 1st acknowledged safety message incident in the safety message history.

Parameters

The following list contains the parameters of function "Safety message buffer".

Number	Name	Unit
r2139.0...15	Status word faults/alarms 1	-
r3113.0...15	NAMUR message bit bar	-
p3117	Change safety message type	-
r9745[0...63]	SI components	-
r9750[0...63].0...20	SI diagnostic attributes	-
r9753[0...63]	SI message value for float values	-
r9754[0...63]	SI message time received in days	-
r9755[0...63]	SI message time removed in milliseconds	ms
r9756[0...63]	SI message time removed in days	-
r60044	SI message buffer counter changes	-
r60045[0...63]	SI message code	-
r60047[0...63]	SI message number	-
r60048[0...63]	SI message time received in milliseconds	ms
r60049[0...63]	SI message value	-
p60052	SI message cases counter	-

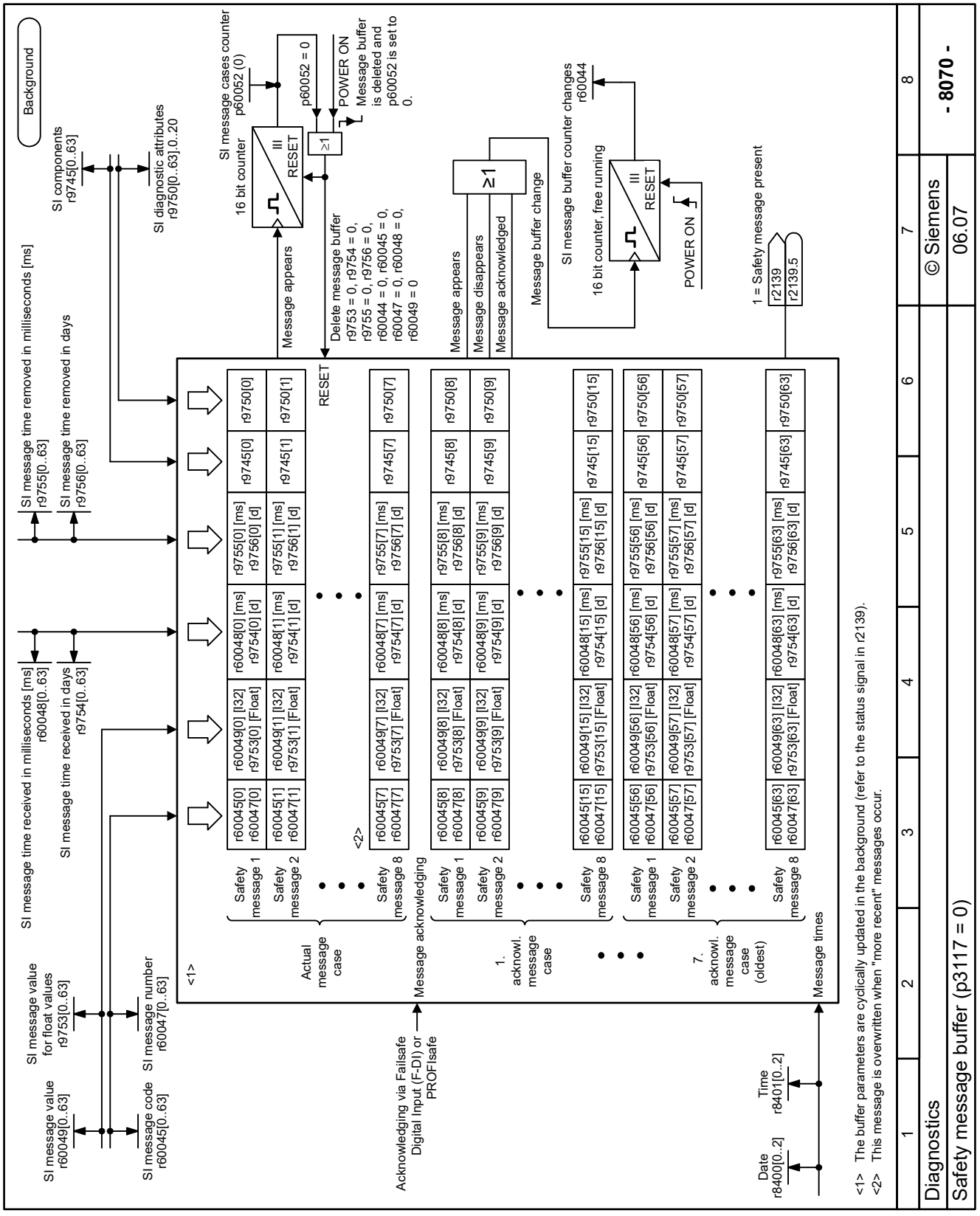


Figure 14-12 8070 - Safety message buffer

14.11 Deleting a safety message buffer

Procedure

Set p60052 = 0 to delete the safety message buffer.

The message history is deleted entirely. Active safety messages in the current message case are retained.

More information

The converter deletes the safety message buffer if the following events occur:

- Restore factory settings
- Download with modified drive topology

Corrective maintenance

15

15.1 Backing up and restoring drive data

15.1.1 Automatically backing up drive data using a memory card and restoring this data

Overview

An inserted memory card backs up all drive data and in the case of service, after a converter has been replaced, guarantees that the system or machine is immediately ready for operation again.

Function description

The drive backs up changed drive data both in its internal memory as well as on the inserted memory card.

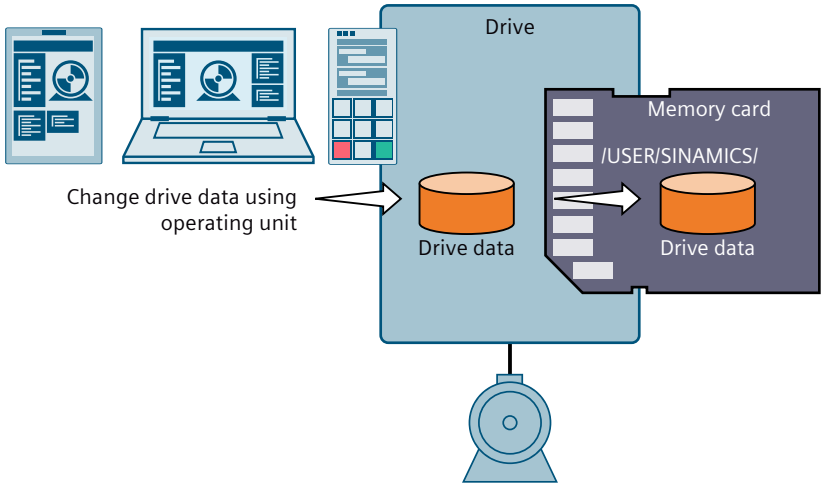


Figure 15-1 Drive data backed up on the memory card

The drive data comprise the following components:

- Changed parameters
- UMAC settings

The drive data are on the memory card in directory /USER/SINAMICS/.

After inserting an empty memory card for the first time, the drive creates directory /USER/SINAMICS/.

After the supply voltage has been switched on, the drive loads the drive data from the memory card into its internal memory.

Automatically loading the drive data from the memory card allows a converter to be replaced without using an operating unit.

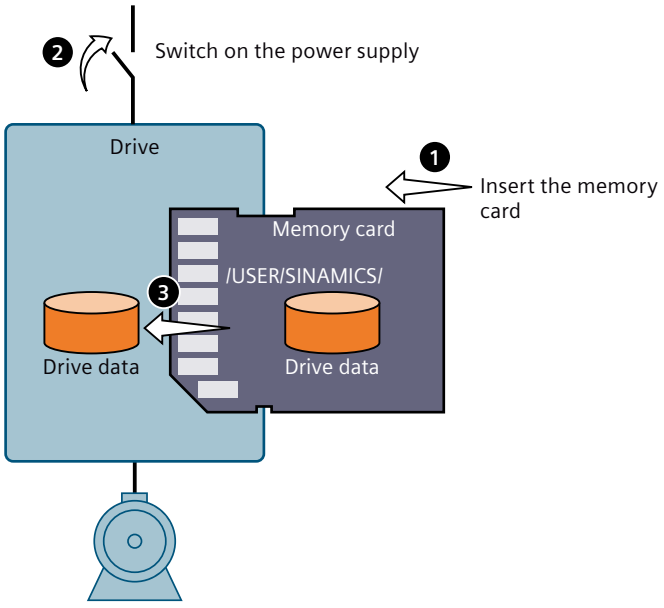


Figure 15-2 Automatically loading drive data from a memory card after a converter has been replaced

15.1.2 Backing up drive data to the backup file

Overview

A backup file backs up the drive data and allows the drive data to be restored if service is required or for series commissioning. A backup file can be created in various ways.

Requirement

One of the following preconditions applies depending on the backup option:

- If you back up the backup file on the operating unit via web server or Startdrive:
  You are connected online with the drive with a commissioning tool.
- If you back up the backup file on a memory card with a SINAMICS SDI:
  A memory card is inserted in the converter.
- If you create the backup file in the TIA portal and back it up on the operating unit:
  You have configured the drive in the TIA Portal.

Procedure

The following options are available to save the drive data to a backup file:

- Back up the backup file on the operating unit via web server or Startdrive:
  Using function "Backup/restore" → "Save drive data to backup file", back up the drive data in a backup file on your operating unit, e.g. on a PC.

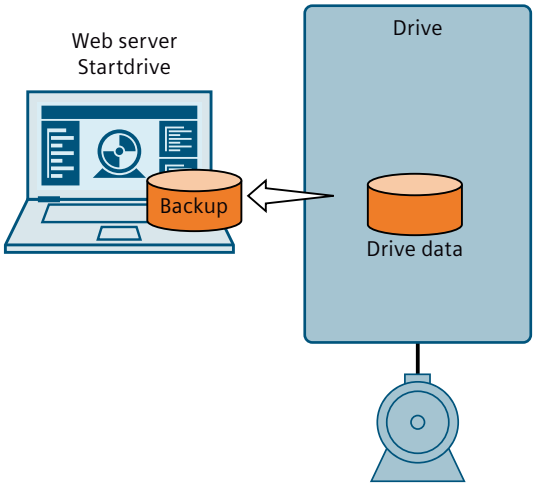


Figure 15-3 Back up the backup file on the operating unit

- Back up the backup file on a memory card with a SINAMICS SDI operating unit:
  Using function "Back up data", back up the drive data in a backup file on the memory card. The drive backs up the backup file in the "/BACKUP/" directory.

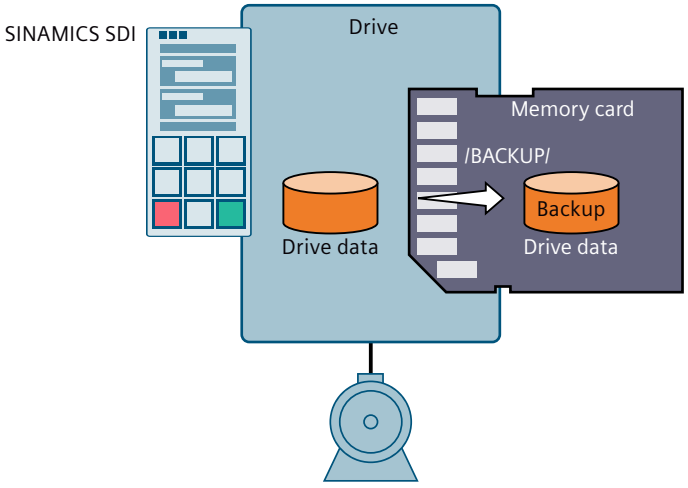


Figure 15-4 Back up the backup file on a memory card with a SINAMICS SDI

- Create a backup file from the TIA Portal and back it up on an operating unit:
  In the TIA Portal, drag and drop the configured drive to entry "Card Reader/USB Memory" in the project tree. There, drag and drop the drive to a subdirectory in folder "Removable Data Media" or a subdirectory in folder "Reader_x".

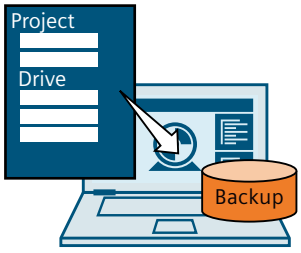


Figure 15-5 Back up the backup file in the TIA Portal on the operating unit

Result

The backup file contains the following drive data:

- Changed parameters
- UMAC settings

15.1.3 Restoring drive data from a backup file

Overview

A backup file backs up the drive data and allows the drive data to be restored if service is required. The drive data can be restored using a commissioning tool or via a memory card.

Requirement

One of the following preconditions applies, depending on the restore option:

- Drive data restoration using a web server or Startdrive:
  You have stored the backup file on the operating unit.
- If you restore the backup file using a SINAMICS SDI from the memory card:
  You have a memory card with the backup file in the /BACKUP/ directory.
- Automatic restoration of the drive data with a backup file on a memory card:
  You have a memory card with the backup file in the /BACKUPFILE_NEXT_START/ directory.

Procedure

The following options are available to restore the drive data from a backup file:

- Restore drive data using a web server or Startdrive:
  Use the "Backup/restore" → "Restore drive data from backup file" function to transfer the backup file from an operating unit to the drive. The drive accepts the content of the backup file into the drive data on its internal memory.

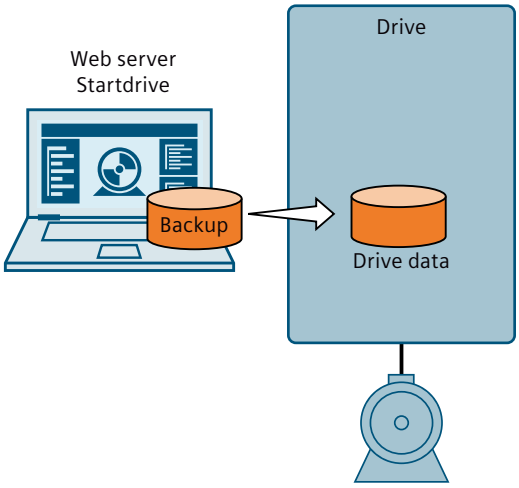


Figure 15-6 Restoring drive data from a backup file

- Restore the backup file using a SINAMICS SDI operating unit from the memory card:
  Use the "Restore from file" function to load the drive data from the backup file in the /BACKUP/ directory on the memory card to the drive.

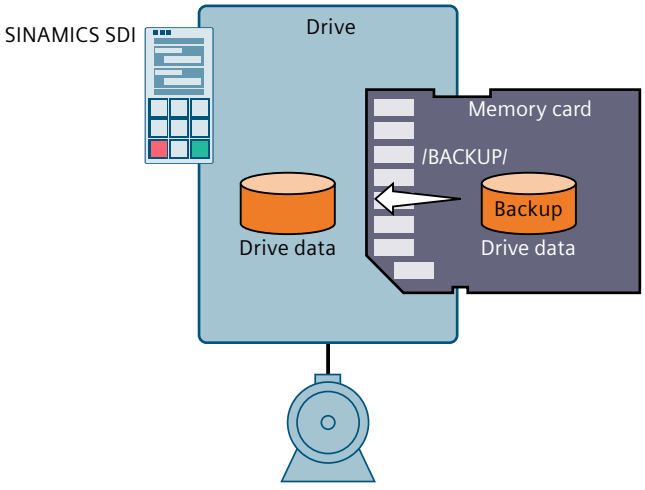


Figure 15-7 Restoring drive data from a backup file on the memory card using SINAMICS SDI

- Automatically restore drive data with a backup file on a memory card:
  After the supply voltage has been switched on, the drive retrieves the drive data from the backup file in the /BACKUPFILE_NEXT_START/ directory and transfers it to its internal memory.

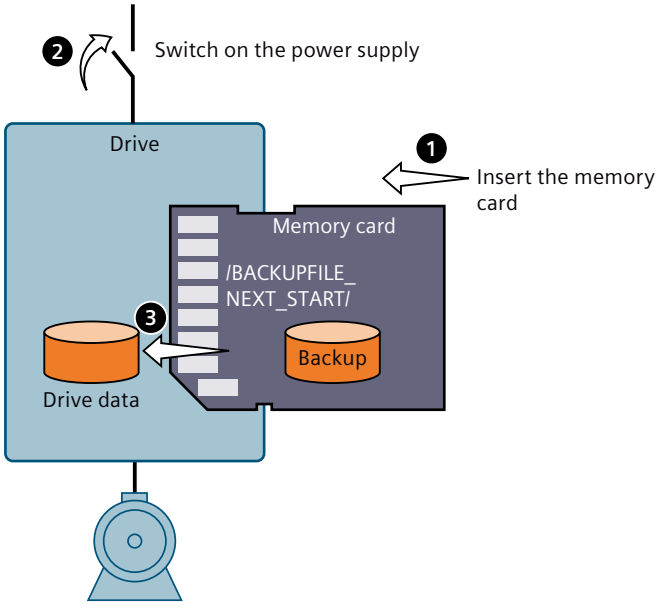


Figure 15-8 Automatically restoring drive data using a backup file on a memory card

After accepting the drive data:

– The drive deletes the backup file and directory /BACKUPFILE_NEXT_START/
– The drive backs up the drive data from the memory card in directory /USER/SINAMICS/

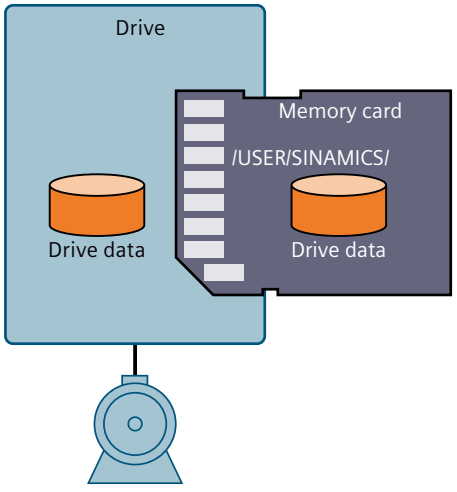


Figure 15-9 Memory card after restoring the drive data

Result

The LEDs signal the drive status:

RDY	BF	Explanation
	not relevant	The drive has accepted the following drive data from the backup file into its internal memory: • Changed parameters • UMAC settings
	☐	The drive signals a fault. Check the cause of the fault.

15.1.4 Creating a memory card with backup file to automatically restore the drive data

Overview

A memory card with backup file allows drive data to be automatically restored after the card is inserted into the drive. The memory card can be created with and without Startdrive.

Requirement

Depending on the procedure, one of the following requirements applies:

- Create a memory card with backup file offline using Startdrive:
  A memory card (SD card) is inserted in the card reader of your PC.
- Create a memory card with backup file without Startdrive:
  You have either configured the drive using Startdrive or you already have the backup file of your drive.

Procedure

The following options are available to create a memory card with a backup file:

- Create a memory card with backup file offline using Startdrive:
  In the TIA project, drag and drop the configured drive to "Card Reader/USB Memory" in the project tree. There, drag and drop the drive to a subdirectory in the "Reader_x" folder and follow the instructions.
  Startdrive creates directory /BACKUPFILE_NEXT_START/ and saves the backup file there.

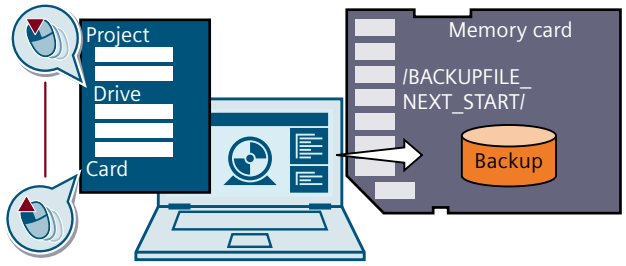


Figure 15-10 Create a memory card with backup file using Startdrive

- Create a memory card with backup file without Startdrive:
  The backup file can be received by email, stored in a cloud or locally.
  Create directory /BACKUPFILE_NEXT_START/ on the memory card and copy the backup file to this directory.

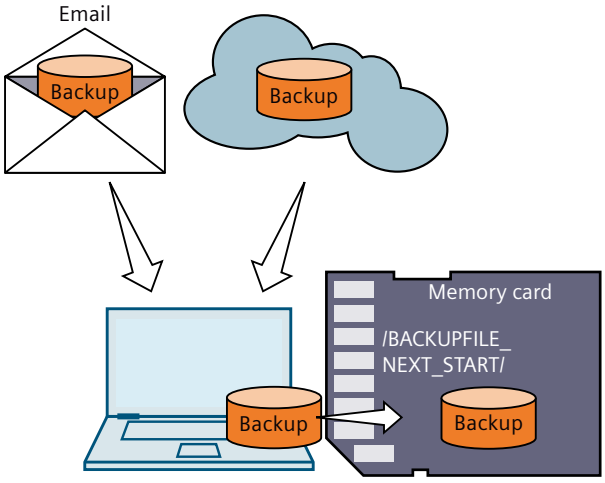


Figure 15-11 Save the backup file to the memory card without using Startdrive

Result

The memory cards contains the backup file with the following drive data:

- Changed parameters
- UMAC settings

15.1.5 Backup file with drive data encryption

Overview

Restoring drive data from a backup file with encrypted data is only possible if you know the backup password.

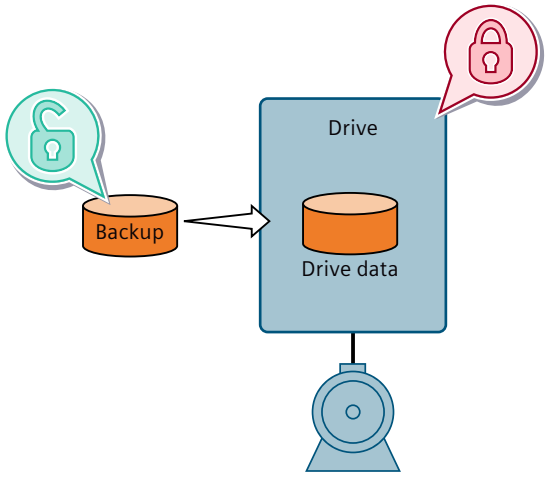
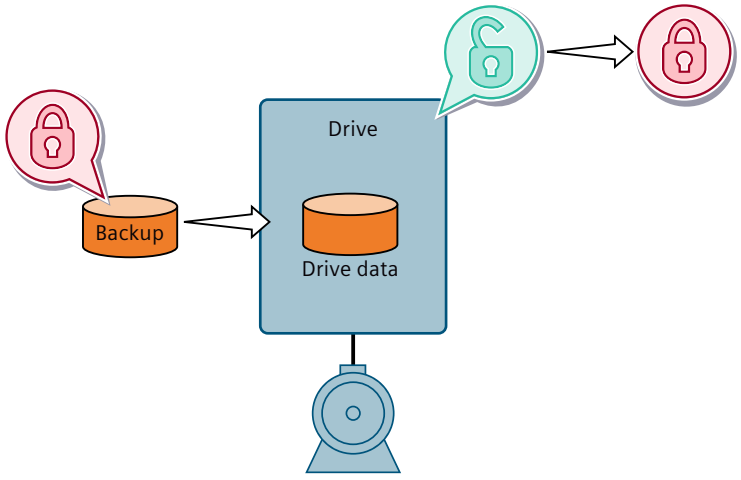
Requirement

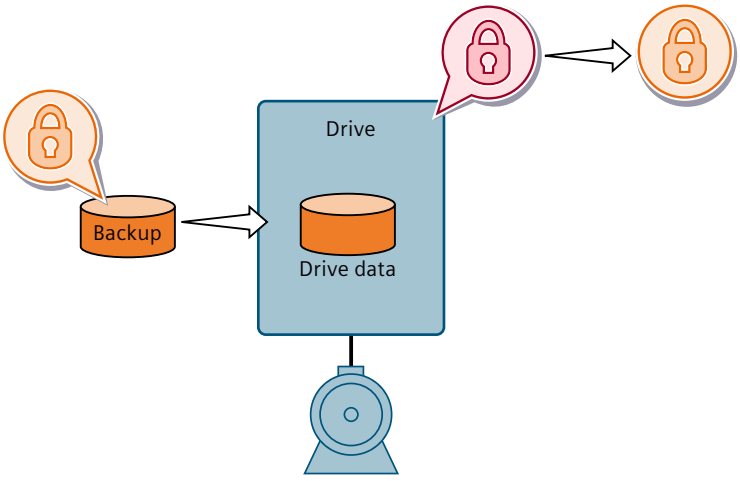
Required runtime authorizations with active user management (UMAC):

- "Create backup or load drive data to Startdrive"
- If the backup file contains Safety Integrated Functions settings:
  "Edit Safety Integrated application"

Description of function

Procedures vary depending on which of the following drive data encryption scenarios applies:

Encryption	Password to be entered to restore the drive data	Result
The backup file is unencrypted. The drive data is encrypted. 	None	The drive data is restored from the backup file data. The drive password is retained after the drive data has been restored.
The backup file is encrypted. The drive data is unencrypted. 	Backup password	The drive data is restored from the backup file data. The drive data is encrypted. The drive handles the backup file password.

Encryption	Password to be entered to restore the drive data	Result
The backup file and the drive data are encrypted. The backup password and the drive password are different, or the backup file was created with a different drive. 	Backup password	The drive data is restored from the backup file data. The drive data remains encrypted. The drive handles the backup file password.

15.2 Replacing a converter

Overview

When replacing a converter, you may only replace it with another converter under certain conditions.

Requirement

The following requirements apply to a replacement:

- The new converter has the same or more recent firmware version than that of the converter being replaced.
- The two converters must also satisfy one of the following conditions:
  - The new and replaced converters have the same power rating.
  - The new converter has a different power rating to the converter it replaced but the same frame size.
    In this case, the rated power of the converter and motor power must not differ too much. The following values are permissible for the quotients (rated motor power)/(rated converter power): 0.25 ... 1.5



⚠ WARNING

Fire or electric shock after tripping of overcurrent protection devices

If an overcurrent protection device is tripped, the converter may be defective. A defective converter can cause a fire or electric shock.

- Have the converter and the overcurrent protection device checked by a specialist.



⚠ WARNING

Electric shock as a result of a residual charge in power components

After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the residual charge is at a non-hazardous level.

- Check the voltage at the converter connections, before removing the connecting cables.

⚠ WARNING

Unexpected machine movement caused by incorrect converter type

If a replacement is made with a converter of a different type, this can result in incomplete or unsuitable converter settings. This can result in unexpected machine movements, e.g. speed oscillation, overspeed or incorrect direction of rotation. Unexpected machine movements can result in death, injury or property damage.

- In all cases not permitted according to the above requirements, you must recommission the drive after replacing the converter.

⚠ WARNING

Unexpected machine movement caused by unsuitable converter settings

Missing or unsuitable converter settings can lead to unexpected operating states or machine movements, e.g. a non-functioning EMERGENCY STOP or an incorrect direction of rotation. This can result in damage to machine components or system sections or in death or bodily injury.

- Restore the drive data of the replaced converter from a backup file or using a memory card.
- Recommission the drive if there is no drive data backup.

NOTICE

Damage caused by interchanging the motor cables

The direction in which the motor rotates switches if the two phases of the motor cable are interchanged. An incorrect direction of rotation can lead to damage in the machine or system.

- Connect the 3 phases of the motor cables in the correct sequence.

Procedure

Proceed as follows to replace a converter:

1. Disconnect the line voltage to the converter.
2. Remove the connecting cables of the converter.
3. Remove the defective converter.
4. Install the new converter.
5. Connect all of the cables to the converter.
6. Switch on the line voltage of the converter.
7. Set the new converter to suit the application:
   - You have backed up the settings of the converter that was replaced to an external storage medium, e.g. a memory card:
     If the new converter has the same power rating or frame size as the converter replaced, transfer the settings to the new converter.
   - If there is no backup of the data for the converter replaced or if the new converter has a different frame size, then recommission the converter.

15.3 Restore factory settings

Requirement

Rights required for active user management (UMAC):

- "Edit device configuration or drive applications"
- "Edit Safety Integrated application"

Description

The reset to factory settings with a commissioning tool (web server, Startdrive) only deletes the user-specific parameterization of the converter, for example motor data.

The following settings are retained with the reset:

- Activation and settings of User Management & Access Control
- The communication settings "IP configuration" and/or "Device name" of the following interfaces:
  - Service interface X127
  - PROFINET interface X150
  - Digitalization interface to the Edge device X128
- Installed firmware on the converter
- Date and time
- Language setting

15.4 Restore Safety Integrated to factory settings

Overview

A separate function exists for Safety Integrated settings, which exclusively restores Safety Integrated settings to factory settings.

Requirement

You have the rights required for active user management (UMAC):

- "Edit device configuration or drive applications"
- "Edit Safety Integrated application"

Procedure

Proceed as follows to reset the converter Safety Integrated settings to the factory settings:

1. Call the "Backup and restore" menu.
2. Click on the "Reset Safety Integrated" button.
3. Acknowledge the confirmation prompt.
4. Wait: the converter resets its Safety Integrated settings.
5. Wait: the converter restarts.
6. The converter is in the "Ready" state and the "RDY" and "BF" LEDs are green.

Result

The Safety Integrated settings for the converter have been reset.

15.5 Full reset of all device settings

Overview

The following user-defined settings are stored in the converter:

- Parameterization of the converter
- Activation and settings of User Management & Access Control
- Communication settings "IP configuration" and "Device name" of the following interfaces:
  - Service interface (X127)
  - PROFINET interface (X150)
- Self-generated certificates

- User-defined parameter lists in the web server
- License file to activate functions requiring a license, which is assigned to the serial number of the converter.
  A license file, which is assigned to the serial number of the SINAMICS memory card, is not included in the settings saved in the converter. As a consequence, the license file on the SINAMICS memory card is not affected when the device settings are completely reset.

In the following cases it may be necessary to reset all user-defined converter settings to the factory setting:

- The available credentials do not allow the necessary configuration of the converter (no password for example).
- Before recommissioning of the converter, for example if the application use of the converter changes.
- Before the converter is sold or disposed of, in order to erase all user-defined settings.

Requirement

The following preconditions apply when completely resetting all device settings:

- You can access the converter manually.
- All electrical connections from the converter to the motor are disconnected.
- You have an empty writable SD card with max. 32 GB; e.g. 6SL5970-0AA00-0AA0.

Procedure

Proceed as follows to perform a full reset of all device settings of the converter:

1. Create an empty file called RESET.TXT in the root directory of the memory card.
   When you write text "KEEP_COMM" in upper case letters as shown to file RESET.TXT, then the settings for the communications interfaces are kept after the reset.
2. Switch off the converter supply voltage.
3. Wait until all LEDs on the converter are dark.
4. Insert the memory card into the converter.
5. Switch on the converter supply voltage.
6. The converter deletes the user-defined settings.

7. The user-defined settings are deleted.

RDY	BF	Description
		Factory settings are being restored
		Factory settings have been restored
		Restoring factory settings unsuccessful

8. Remove the memory card.
9. Switch off the converter supply voltage.

Result

The result depends on the content of file RESET.TXT:

File RESET.TXT is empty	File RESET.TXT contains text "KEEP_COMM"
All user-defined converter settings are deleted. After all device settings have been completely reset, access to the web server is possible via the service interface (X127) and via the PROFINET interface (X150). For access via the service interface (X127), use the secure transmission protocol HTTPS. If option module OM-IIoT is inserted, then the settings of digitalization interface X128 to the Edge device are deleted.	The setting of the communications interfaces, e.g. the setting of service interface (X127) or the fieldbus interface, is unchanged. All other user-defined converter settings are deleted.

The converter firmware is unchanged.

To continue using a license file deleted from the converter for activating functions that require a license, assign the license file to a converter again and then activate the license file.

15.6 Firmware update

15.6.1 Options for updating the converter firmware

Description

The converter firmware can also be updated via the web server, using Startdrive or using a memory card.

If the BIOS of the converter must be updated when the firmware is updated, then when updating the firmware, the converter signals a fault via the web server or via Startdrive.

A firmware update including a BIOS update is only possible with a memory card.

15.6.2 Converter firmware update using a memory card

Precondition

Drive data that have been changed with respect to the factory setting are saved to a backup file.

We recommend that you use an empty Siemens memory card for the firmware update.

NOTICE
Damage to equipment during firmware update due to voltage failure
A voltage failure during a firmware update can lead to defects or malfunctions of the converter. • Do not switch off the converter power supply during a firmware update. • If the power supply was interrupted during a firmware update, restart the firmware update.

Procedure

Proceed as follows to update the firmware using a memory card:

1. Download the required firmware to your PC from the Internet.
   Alternatively, the firmware can be ordered on a memory card.
2. Extract the files to a directory of your choice on your PC.
3. Copy the unzipped files to the root nodes of an empty memory card.

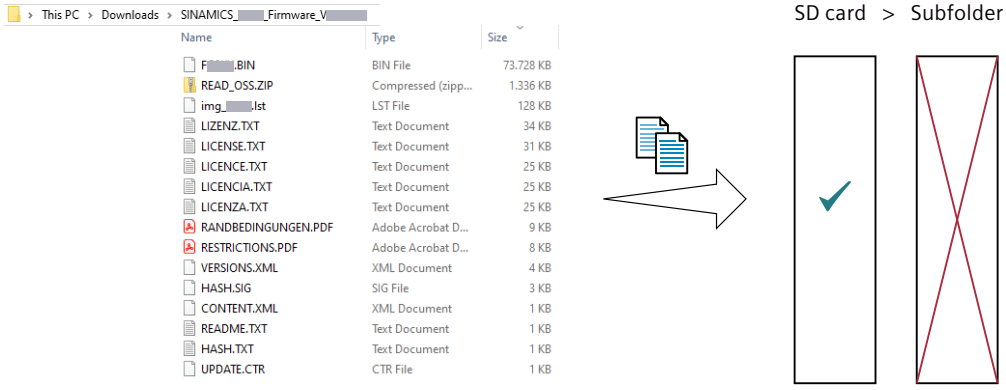


Figure 15-12 Copy the files for the firmware update to the root nodes of the memory card

4. Switch off the converter supply voltage.
5. Insert the memory card with the downloaded firmware into the converter.
6. Switch on the converter supply voltage.

7. The new firmware is installed. The procedure takes a few minutes.

RDY	BF	Explanation of LED displays
		The firmware is being updated. Do not switch off the converter supply voltage.
	-	Firmware update completed

8. Switch off the converter supply voltage.
9. Remove the memory card.
10. Switch on the converter supply voltage.
    If required, the firmware of the Clean Power infeed and connected DRIVE-CLiQ components is updated. An appropriate active converter alarm signals that a restart is required.

RDY	Explanation of LED displays
	Firmware of the connected DRIVE-CLiQ components being updated. • Do not switch off the converter supply voltage. • Do not interrupt the DRIVE-CLiQ connection between the converter and the DRIVE-CLiQ component.
	Firmware of the DRIVE-CLiQ components has been updated: • Remedy: Switch off the DRIVE-CLiQ component supply voltage and then on again.

Result

The converter firmware has been updated.

If a BIOS update was included in the firmware, then the BIOS of the converter has also been updated.

The web server or Startdrive displays the firmware version of the converter.

More information

Information about updating the firmware is provided in the Internet:

Updates and constraints, SINAMICS G220 (https://support.industry.siemens.com/cs/ww/en/view/109807094)

15.6.3 Firmware update of option module OM-IIoT

Requirement

The following preconditions apply when updating the firmware of option module OM-IIoT:

- You have downloaded a file with the firmware update from the Internet.
- The network settings of the OM-IIoT have been completely configured using Startdrive or the web server:
  - IP address
  - Subnet mask
  - Gateway
- A UMAC account for a user with one of the following authorizations has been created for the converter using Startdrive or the web server:
  - Drive Administrator
  - Drive Safety Engineer
  - Drive Engineer and Service

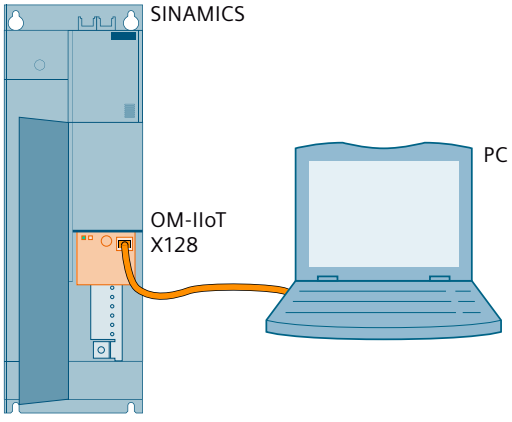
As example, the following data are used in the procedure:

- Login name for Startdrive or web server = xx0
- Authorization for Startdrive or web server = Drive Administrator
- IP address of the OM-IIoT = 169.254.1.42
- PC with Windows operating system and the storage location of the file for the firmware update D:\IIOT\IIoT_upgrade\

Procedure

Proceed as follows to update the firmware of option module OM-IIoT:

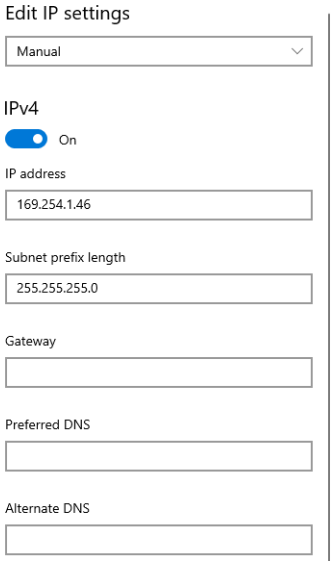
1. Save the file for the firmware update with name SINAMICS_IIoT_Module_firmware_Vxx_xx_xxx_xxx.zip in any folder on your PC.
2. Connect your PC to the digitalization interface X128 of the OM-IIoT using a network cable.



3. Switch on the converter power supply.
4. Wait until LED COM on the OM-IIoT lights up green.



5. Configure the IP address and the subnet mask of your PC.



PC and OM-IIoT must be in the same network segment.

6. In the file explorer of the PC, go to the folder in which you saved the upgrade package, e.g. D:\IIOT\IIoT_upgrade\
7. Enter "cmd" + < ↵ > in the address bar of the file explorer.



8. The PC opens the command prompt in a new window:
   `D:\IIOT\IIoT_upgrade> _`
9. Enter command "ping xxx.xxx.xxx.xxx" with the IP address of the OM-IIoT:
   `D:\IIOT\IIoT_upgrade> ping 169.254.1.42`
10. If the PC and OM-IIoT are connected with one another, then the PC displays:

```
Pinging 169.254.1.42 with 32 bytes of data:
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Ping statistics for 169.254.1.42:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 11 ms, Maximum = 22ms, Average = 13ms
```

11. Enter command "sftp xx0@xxx.xxx.xxx.xxx":
```
D:\IIOT\IIoT_upgrade> sftp xx0@169.254.1.42
xx0@169.254.1.42's password:
```
12. Enter the password for your UMAC account.
13. If the connection has been successfully established, the PC displays:
```
D:\IIOT\IIoT_upgrade> sftp xx0@169.254.1.42
xx0@169.254.1.42's password:
Connected to 169.254.1.42.
sftp> _
```
14. Enter command "cd p4":
```
sftp> cd p4
sftp> _
```
15. Load the file with the firmware update to the user partition of the OM-IIoT using command "put -f SINAMICS_IIoT_Module_firmware_Vxx_xx_xxx_xxx.zip".
"SINAMICS_IIoT_Module_firmware_Vxx_xx_xxx_xxx.zip" is the file name of the firmware update:
```
sftp> put -f SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
```
16. When loading the file, LED COM on the OM-IIoT flashes red and orange alternating:



17. Wait until the converter has completely loaded the file for the firmware update:
```
sftp> put -f SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
Uploading SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip to /p4/
SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
                100% 1170MB 10.2MB/s   01:54
sftp> _
```
After loading, LED COM on the OM-IIoT lights up green:



18. Enter command "bye":
```
sftp> bye
D:\IIOT\IIoT_upgrade> _
```
19. Switch off the converter supply voltage.
20. Wait until all LEDs on the converter are dark.
21. Switch on the converter supply voltage again.
22. The LED COM on the OM-IIoT temporarily lights up orange:



23. If the firmware versions in the OM-IIoT and in the loaded file differ, then the OM-IIoT updates the firmware.
    It takes approximately 5 minutes to update the firmware.
    When updating the firmware, LED COM on the OM-IIoT flashes red and green alternating:



24. The firmware is updated in 2 phases. LED COM of the OM-IIoT is lit orange between the two phases:



25. Once the firmware has been updated, LED COM of the OM-IIoT lights up in red and green alternating:



26. Switch off the converter supply voltage.
27. Wait until all LEDs on the converter are dark.
28. Switch on the converter supply voltage again.

Result

The firmware of option module OM-IIoT has been updated.

The OM-IIoT completely deletes its user partition after the firmware update. The firmware file and all additional files, which were possibly saved on the user partition of the OM-IIoT, are deleted after the firmware update.

15.7 Deleting the Public Key of option module OM-IIoT

Overview

After commissioning, option module OM-IIoT is assigned to the converter and the edge device. You must cancel the OM-IIoT - edge device assignment if you wish to operate the OM-IIOT in another converter or at another edge device. You must delete the Public Key of the OM-IIoT to cancel the assignment.

Requirement

The following preconditions apply when deleting the Public Key in option module OM-IIoT:

- The network settings of the OM-IIoT have been completely configured using Startdrive or the web server:
  - IP address
  - Subnet mask
  - Gateway
- A user with one of the following authorizations has been created for the converter using Startdrive or the web server:
  - Drive Administrator
  - Drive Safety Engineer
  - Drive Engineer and Service

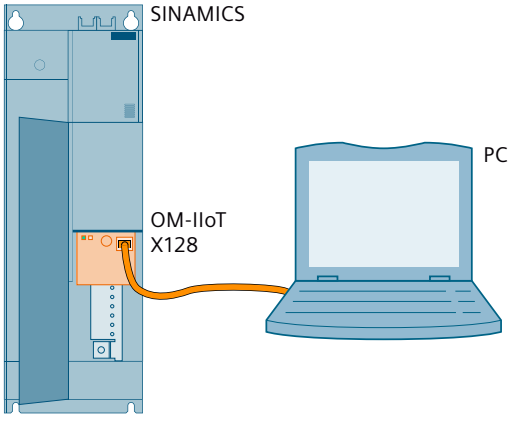
As example, the following data are used in the procedure:

- Login name for Startdrive or web server = xx0
- Authorization for Startdrive or web server = Drive Administrator
- IP address of the OM-IIoT = 169.254.1.42
- PC with Windows operating system and the storage location of file "clear_pairing" D:\IIOT\clear_public_key\

Procedure

Proceed as follows when deleting the Public Key in option module OM-IIoT:

1. In any folder on your PC, create an empty file with the "clear_pairing" file name, e.g. an empty text file clear_pairing.txt.
2. Delete the file name extension of the file:
   clear_pairing
3. Connect your PC to the digitalization interface X128 of the OM-IIoT using a network cable.

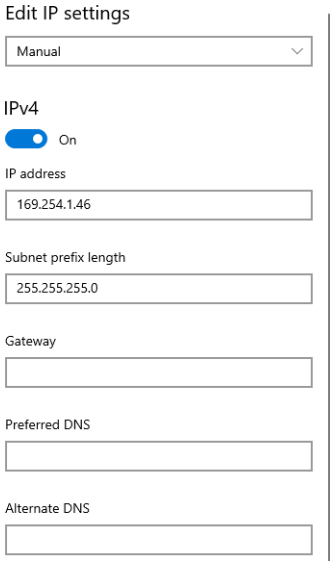


4. Switch on the converter power supply.

5. Wait until LED COM on the OM-IIoT lights up green.



6. Configure the IP address and the subnet mask of your PC.



   PC and OM-IIoT must be in the same network segment.

7. In the file explorer of the PC, go to the folder where you saved file "clear_pairing".
8. Enter "cmd" + < ↵ > in the address bar of the file explorer.



9. The PC opens the command prompt in a new window:
   ```
   D:\IIOT\clear_public_key> _
   ```
10. Enter command "ping xxx.xxx.xxx.xxx" with the IP address of the OM-IIoT:
    ```
    D:\IIOT\clear_public_key> ping 169.254.1.42
    ```
11. If the PC and OM-IIoT are connected with one another, then the PC displays:
    ```
    Pinging 169.254.1.42 with 32 bytes of data:
    Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
    Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
    Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
    Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
    Ping statistics for 169.254.1.42:
        Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 11 ms, Maximum = 22ms, Average = 13ms
    ```
12. Enter command "sftp xx0@xxx.xxx.xxx.xxx":
    ```
    D:\IIOT\clear_public_key> sftp xx0@169.254.1.42
    xx0@169.254.1.42's password:
    ```
13. Enter your password.

14. If the connection has been successfully established, the PC displays:
```
D:\IIOT\clear_public_key> sftp xx0@169.254.1.42
xx0@169.254.1.42's password:
Connected to 169.254.1.42.
sftp> _
```
15. Enter command "cd p4":
```
sftp> cd p4
sftp> _
```
16. Enter command "put -f clear_pairing" with the name of the file for the firmware update:
```
sftp> put -f clear_pairing
```
17. Wait until the converter has loaded file "clear_pairing":
```
sftp> put -f clear_pairing
Uploading clear_pairing to /p4/clear_pairing
clear_pairing
100% 1170MB 10.2MB/s  01:54
sftp> _
```
18. Enter command "bye":
```
sftp> bye
D:\IIOT\clear_public_key> _
```
19. Switch off the converter supply voltage.
20. Wait until all the LEDS on the converter are dark.
21. Switch on the converter supply voltage again.

Result

The Public Key in option module OM-IIoT has been deleted.

15.8 Safety Integrated acceptance test after component replacement

Overview

After a component has been replaced or the firmware updated, a reduced acceptance test of the safety functions must be performed.

Description

Depending on the measure performed, the following acceptance tests and documentation are required:

Measure	Converter message after component replacement[2)]	Reduced acceptance test	
		Acceptance test	Documentation
Converter replacement	Yes	• Testing the emergency stop function STO or SS1 • A general test of the actual value acquisition by switching on and operating briefly with traversing in both directions	• Supplement converter data • Supplement hardware version and firmware version in the converter data. • Log new checksums • Countersignature
Encoder replacement	Yes[1)]		
Power unit replacement	Yes		
Motor replacement	No		No change
Gearbox replacement	No		
Replacement of the OM-SMT option module	Yes	Test of the SMT function • Short-circuit, test sensor cable • Test wire break	• Supplement converter data • Log new checksums • Countersignature
Replacing safety-related I/O devices (e.g. EMERGENCY STOP button).	No	Check the control of the safety functions affected by the components that have been replaced.	No change
Converter firmware update	No	No	• Supplement firmware version in the converter data • Log new checksums • Countersignature

1) Replacing an encoder without a serial number (e.g. sin/cos encoder without digital interface at the SMC20) does not result in the converter issuing a message.

2) When a component is replaced, the message in Startdrive and the web server must be acknowledged.

15.9 Device replacement without removable data storage medium via PROFINET

Overview

The converter with PROFINET interface supports "Device replacement without removable data storage medium" if the topology of the PROFINET IO system with the IO devices involved has been configured in the higher-level control system.

Description

The converter can be replaced without having to insert a removable data storage medium (e.g. a memory card) with the saved device name in the converter. You also do not have to reassign the device name with the PG.

15.10 Spare parts

15.10.1 Spare parts service

Description

Spare parts can be ordered through the spare parts service.

Spares on Web also gives you the option of determining the article numbers of further spare parts.

More information

You can find more information on the Internet:

Spares on Web (https://www.sow.siemens.com)

15.10.2 Spare parts list

Spare parts	
Designation	**Article number**
Control Unit	6SL4900-0AC10-0AA0
SDI Standard (flex)	6SL4950-0AH12-2AA0
SDI Standard (flex) protective door IP55 (converter in IP55 degree of protection)	6SL4950-0AH71-0AA0
Supplementary fan for option modules	6SL4900-0AF00-0AA0

Spare parts	
Designation	**Article number**
Shield connection kit 1 IP20 FSA + expansion adapter for option modules	6SL4900-0AM20-0AA0
Shield connection kit 2 IP20 FSB	6SL4900-0AM20-1AA0
Shield connection kit 3 IP20 FSC	6SL4900-0AM20-2AA0
Shield connection kit 4 IP20 FSD1	6SL4900-0AM20-3AA0
Shield connection kit 5 IP20 FSD2	6SL4900-0AM20-4AA0
Shield connection kit 6 IP20 FSE	6SL4900-0AM20-5AA0

15.10.3 Spare parts, main fan, converter in degree of protection IP20

Spare parts, main fan for converters with housing version IP20	
Frame size	**Article number**
Replacement fan 1 IP20 FSA	6SL4900-0AF10-0AA0
Replacement fan 2 IP20 FSB	6SL4900-0AF10-1AA0
Replacement fan 3 IP20 FSC	6SL4900-0AF10-2AA0
Replacement fan 4 IP20 FSD1	6SL4900-0AF10-3AA0
Replacement fan 5 IP20 FSD2	6SL4900-0AF10-4AA0
Replacement fan 6 IP20 FSE	6SL4900-0AF10-5AA0

15.10.4 Spare parts, main fan and auxiliary fan, converter in degree of protection IP55

Spare parts, fan for converters with housing version IP55	
Frame size	**Article number**
Replacement fan 2 IP55 FSB	6SL4900-0AF20-1AA0
Replacement fan 3 IP55 FSC	6SL4900-0AF20-2AA0
Replacement fan 4 IP55 FSD1	6SL4900-0AF20-3AA0
Replacement fan 5 IP55 FSD2	6SL4900-0AF20-4AA0
Replacement fan 6 IP55 FSE	6SL4900-0AF20-5AA0
Replacement fan 2 IP55 FSB internal	6SL4900-0AF30-1AA0
Replacement fan 3 IP55 FSC internal	6SL4900-0AF30-2AA0
Replacement fan 4 IP55 FSD1 internal	6SL4900-0AF30-3AA0
Replacement fan 5 IP55 FSD2 internal	6SL4900-0AF30-4AA0
Replacement fan 6 IP55 FSE internal	6SL4900-0AF30-5AA0

15.11 Spare parts compatibility

Description

Converter components are being continuously developed within the scope of product maintenance.

Product maintenance includes, for example, measures to increase the ruggedness or hardware changes that become necessary as components are discontinued.

In the scope of such spare parts-compatible ongoing development, connectors or connection positions are sometimes slightly modified. This does not result in any problems when the component is used as intended. Please take this fact into consideration in special installation situations (e.g. allow sufficient reserve regarding the cable length).

15.12 Replacing the Control Unit or SINAMICS SDI components, converters with degree of protection IP20

Overview

The Control Unit, the SINAMICS SDI Standard and SINAMICS SDI blind cover can be replaced as spare part.

SINAMICS SDI Standard can be replaced with the SINAMICS SDI blind cover.

The description shows removing the Control Unit and SINAMICS SDI Standard based on a converter, frame size FSC as example.

Precondition



⚠ WARNING

Electric shock when live parts are touched

Contact with live parts can result in death or serious injury.

- Before starting any work, switch off the power supply at terminals X1:L1, L2, L3.
- Wait for 5 minutes before you check that the device really is in a no-voltage condition and start work.
- Check that there is no voltage present.

The following requirements apply to the replacement:

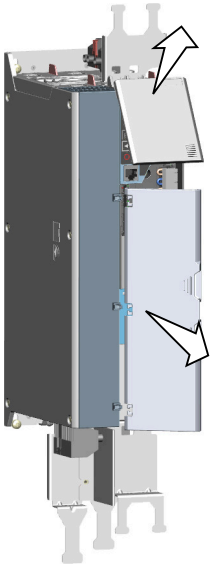
- Replacement only by qualified personnel in compliance with the ESD regulations
- The new Control Unit must have at least the same firmware version as the Control Unit to be replaced.
- The power supply at terminals X1:L1, L2, L3 is switched off.
- If present, the external 24 V supply is switched off.

- The power supply to the digital outputs is switched off.
- Required tools:
  - 1 Torx screwdriver TX 20
  - 1 slotted screwdriver with blade length 4 ... 6 mm
  - Pointed pliers (1 unit)

Procedure

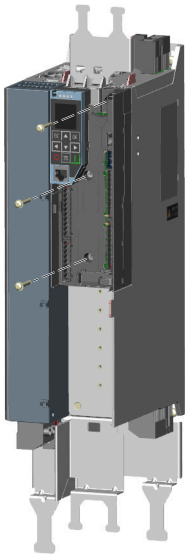
To remove the Control Unit and the SINAMICS SDI standard from the converter, proceed as follows:

1. Remove the front cover and front flap from the converter with frame size FSA.
   Remove the front door and front flap from the converter with frame size FSB or larger.

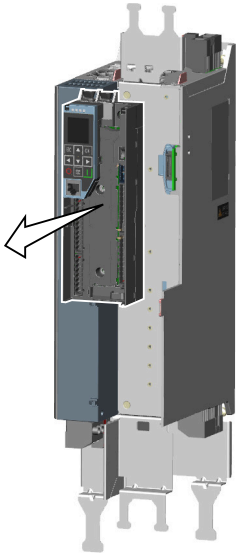


2. Remove the connector with the control lines and the communication cables from the Control Unit.
3. Remove the plugged-in option modules.
4. Use pointed pliers to remove the cover caps of the on the Control Unit and on the communication module.

5. Release the 3 screws using a Torx screwdriver.



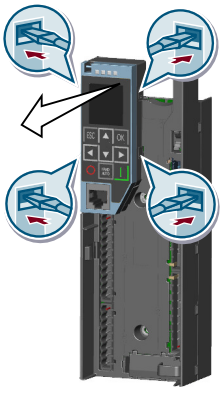
6. Remove the Control Unit from the converter.



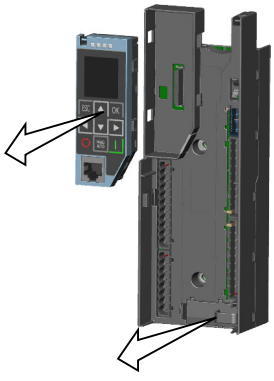
7. Pull the communication module out of the Control Unit.



8. Use a screwdriver or another suitable tool to loosen the locking hooks of the SINAMICS SDI Standard one after the other.



9. Pull the SINAMICS SDI Standard out of the Control Unit.



10. If present, remove the auxiliary fan for the option modules.

To install the Control Unit and the SINAMICS SDI Standard or the SINAMICS SDI blind cover in the converter, proceed as follows:

1. If available, plug the auxiliary fan into the Control Unit.
2. Insert SINAMICS SDI Standard or the SINAMICS SDI blind cover onto the new Control Unit until it audibly snaps into place.
3. Insert the communication module flush into the Control Unit.
4. Plug the Control Unit flush onto the converter.
5. Tighten the 3 screws of the Control Unit and the communication module using a Torx screwdriver.
   Tightening torque: 2 Nm.
6. Press the cover caps onto the fixing screws.
7. Mount the option modules.
8. Plug the connectors with the control lines and the communication cables onto the Control Unit.
9. Attach the front cover and front flap to the converter with frame size FSA.
   Attach the front door and front flap to the converter with frame size FSB or larger.

Result

You have replaced the Control Unit, the SINAMICS SDI Standard or the SINAMICS SDI blind cover.

After replacing the Control Unit, restore the backed-up drive data or recommission the converter.

15.13 Replacing the Control Unit or SINAMICS SDI components, converters with degree of protection IP55

15.13.1 Remove and install housing cover, converter with IP55 degree of protection

Overview

To connect cables, mount shield plates or replace converter components, you must remove the converter housing cover.

The description uses a graphic of a converter with frame size FSC as example

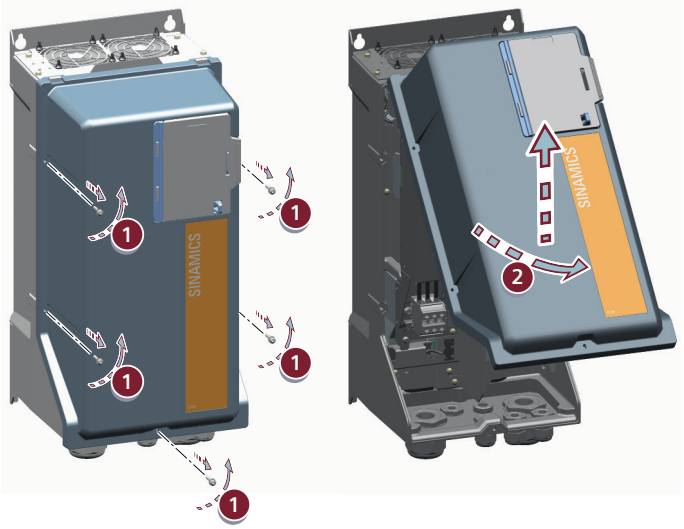
Requirement

The following requirements apply when attaching and removing the housing cover:

- Comply with ESD regulations.
- Tool required: Torx screwdriver TX 20 or TX 25
  Torx size and tightening torque depend on the converter frame size.

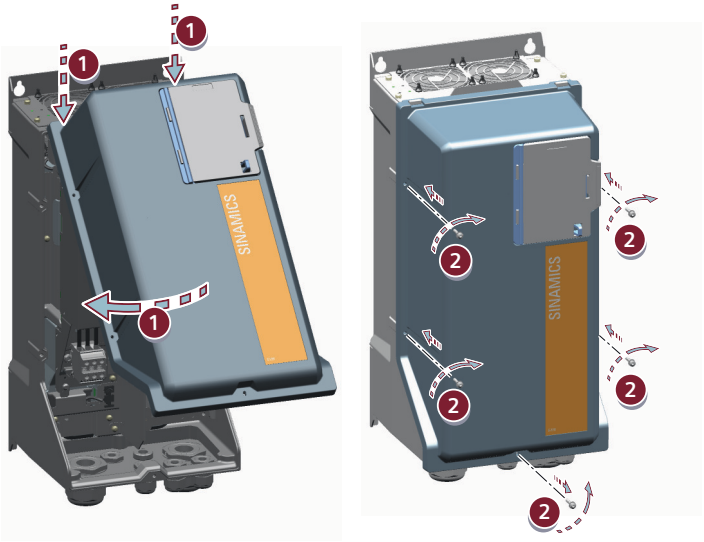
Procedure

Proceed as follows to remove the housing cover:



1. Using a torx screwdriver, release the fixing screws of the housing cover.
   The screws are connected to the housing cover and are captive.
2. Swivel the housing cover towards the front and then lift the housing cover upward.

Proceed as follows to install the housing cover:



1. Place the housing cover with the recess at the converter housing and swivel the housing cover downward.
2. Using a torx screwdriver, tighten the fixing screws of the housing cover.

Converter frame size	Fixing screws		Tightening torque in Nm	Torx screwdriver
	Quantity	Type		
FSB	5	M4x20	2	TX 20
FSC				
FSD1	7	M5x18	3	TX 25
FSD2				
FSE	10			
FSF1	12	M5x20		

15.13.2 Replacing the Control Unit and SINAMICS SDI components

Overview

The Control Unit, the SINAMICS SDI Standard and SINAMICS SDI blind cover can be replaced as spare part.

SINAMICS SDI Standard can be replaced with the SINAMICS SDI blind cover.

The description shows removing the Control Unit and SINAMICS SDI Standard based on a converter, frame size FSC as example.

Precondition



⚠ WARNING

Electric shock when live parts are touched

Contact with live parts can result in death or serious injury.

- Before starting any work, switch off the power supply at terminals X1:L1, L2, L3.
- Wait for 5 minutes before you check that the device really is in a no-voltage condition and start work.
- Check that there is no voltage present.

The following requirements apply to the replacement:

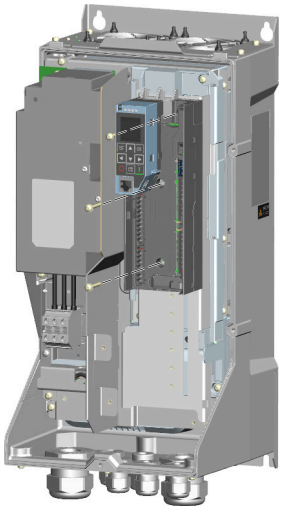
- Replacement only by qualified personnel in compliance with the ESD regulations
- The new Control Unit must have at least the same firmware version as the Control Unit to be replaced.
- The power supply at terminals X1:L1, L2, L3 is switched off.

- If present, the external 24 V supply is switched off.
- The power supply to the digital outputs is switched off.
- Required tools:
  - 1 Torx screwdriver TX 20
  - 1 slotted screwdriver with blade length 4 ... 6 mm
  - Pointed pliers (1 unit)

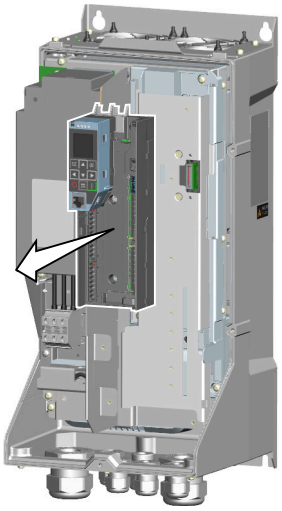
Procedure

To remove the Control Unit and the SINAMICS SDI standard from the converter, proceed as follows:

1. Remove the connector with the control lines and the communication cables from the Control Unit.
2. Remove the plugged-in option modules.
3. Use pointed pliers to remove the cover caps from the 2 fixing screws on the Control Unit and from the fixing screw on the communication module.
4. Release the 3 screws using a Torx screwdriver.



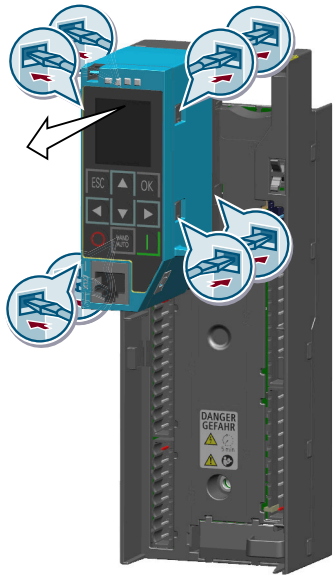
5. Remove the Control Unit from the converter.



6. Pull the communication module out of the Control Unit.



7. Use a screwdriver or another suitable tool to loosen the locking hooks of the SINAMICS SDI Standard and the SDI adapter one after the other.



8. Pull the SINAMICS SDI Standard and the SDI adapter out of the Control Unit.



9. If present, remove the auxiliary fan for the option modules.

To install the Control Unit and the SINAMICS SDI Standard or the SINAMICS SDI blind cover in the converter, proceed as follows:

1. If available, plug the auxiliary fan into the Control Unit.
2. Insert the SDI adapter and the SINAMICS SDI Standard or the SINAMICS SDI blind cover onto the new Control Unit until they audibly latch into place.
3. Insert the communication module flush into the Control Unit.
4. Plug the Control Unit flush onto the converter.

5. Tighten the 3 screws of the Control Unit and the communication module using a Torx screwdriver.
   Tightening torque: 2 Nm.
6. Press the cover caps onto the fixing screws.
7. Mount the option modules.
8. Plug the connectors with the control lines and the communication cables onto the Control Unit.

Result

You have replaced the Control Unit, the SINAMICS SDI Standard or the SINAMICS SDI blind cover.

After replacing the Control Unit, restore the backed-up drive data or recommission the converter.

15.14 Exchanging the SINAMICS SDI Standard mounting frame, converter with degree of protection IP55

Overview

For converters with degree of protection IP55, the mounting frame of the SINAMICS SDI Standard panel can be exchanged.

Requirement



⚠ WARNING

Electric shock when live parts are touched

Contact with live parts can result in death or serious injury.

- Before starting any work, switch off the power supply at terminals X1:L1, L2, L3.
- Wait for 5 minutes before you check that the device really is in a no-voltage condition and start work.
- Check that there is no voltage present.

The following requirements apply to the replacement:

- Replacement only by qualified personnel in compliance with the ESD regulations
- The power supply at terminals X1:L1, L2, L3 is switched off.
- If present, the external 24 V supply is switched off.

- The power supply to the digital outputs is switched off.
- Required:
  - SINAMICS SDI Standard protective door
  - Torx screwdriver TX 20

Procedure

Proceed as follows to exchange the mounting frame of the SINAMICS SDI Standard panel:

1. Identify the premounted mounting frame
2. Release the 4 screws that fasten the mounting frame.
3. Remove the mounting frame from the converter.
4. Place the new mounting frame in the converter.
5. To mount the mounting frame, tighten the four M4 screws with a tightening torque of 2.5 Nm.
6. Close the door of the panel.



Figure 15-13 Mounting the SINAMICS SDI Standard mounting frame, converter with degree of protection IP55

Result

The mounting frame of the SINAMICS SDI Standard panel has been replaced. The converter degree of protection IP55 is kept.

15.15 Replacing fans

15.15.1 Replacing the main fan, converters with degree of protection IP20

Overview

The main fan at the top of the converter must be replaced if it is defective or it has reached its maximum operating time.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the main fan has been removed, the live components of the converter are no longer protected from being touched. Contact with live parts can result in death or serious injury.

- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Before removing the main fan, carefully ensure that the device is in a no-voltage condition.
- Wait until the discharge time specified on the warning labels has elapsed.

The following requirements apply when replacing the main fan:

- Comply with ESD regulations.
- Only qualified personnel may replace the main fan.
- The cables connected at the top of the converter are removed.
- Required tools:
  - Torx screwdriver TX 20
  - Slotted screwdriver, 0.8 x 5.5 mm

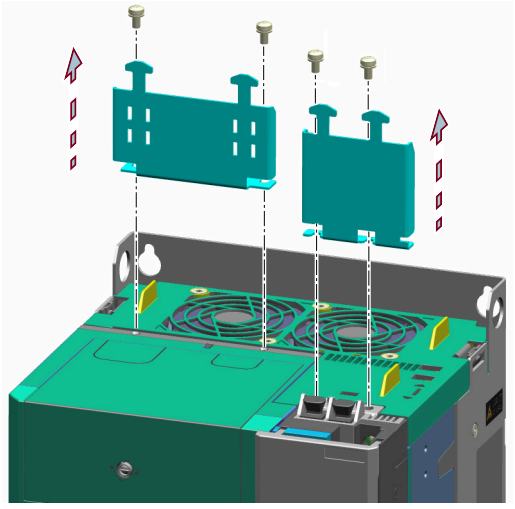
Procedure

The following procedure describes removing and installing the main fan using a converter, frame size FSE as example.

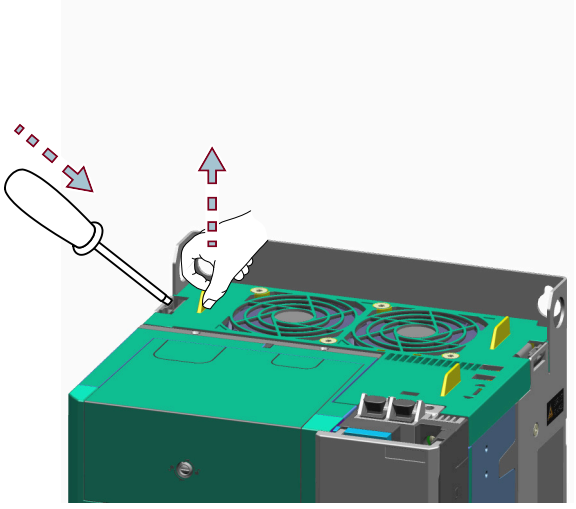
The procedure to remove and install the main fan is identical for all converter sizes. The main fan differs in terms of the size and the number of fans it is equipped with.

Proceed as follows to remove the main fan:

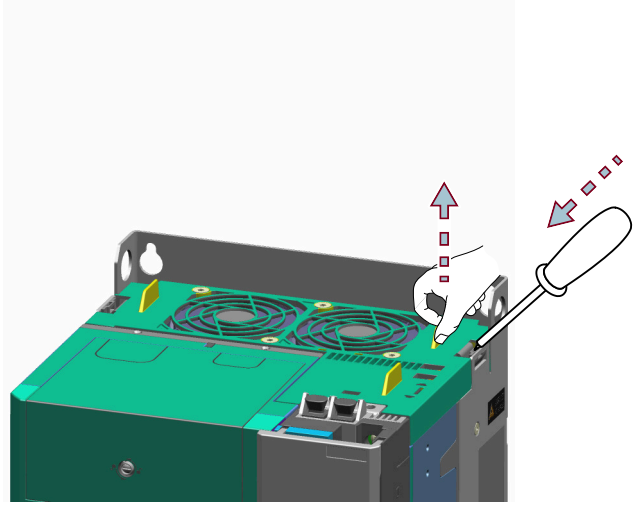
1. Remove the shield connection plate by undoing the 2 screws using a torx screwdriver.



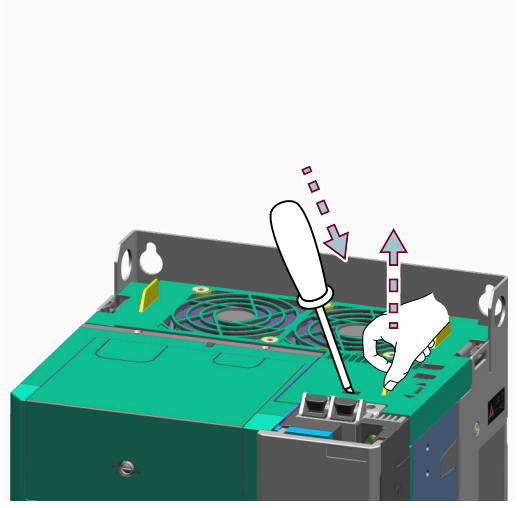
2. For converters, frame sizes FSA ... FSC, withdraw the connector for the braking resistor.
3. Press a slotted screwdriver against one of the two rear catches and at the same time pull the corresponding side of the main fan out of the housing using the lug.



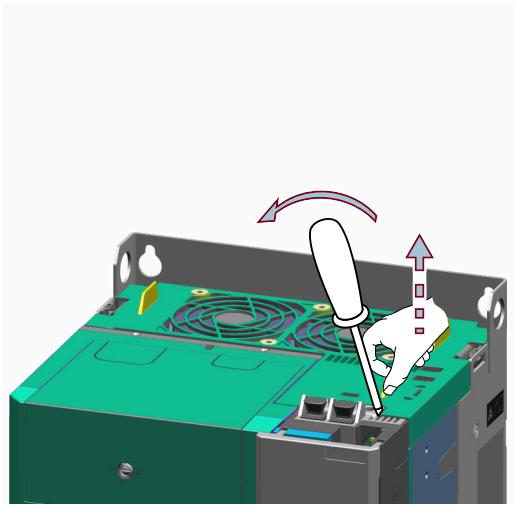
4. Press a slotted screwdriver against the other of the two rear catches and at the same time pull the corresponding side of the main fan out of the housing using the lug.



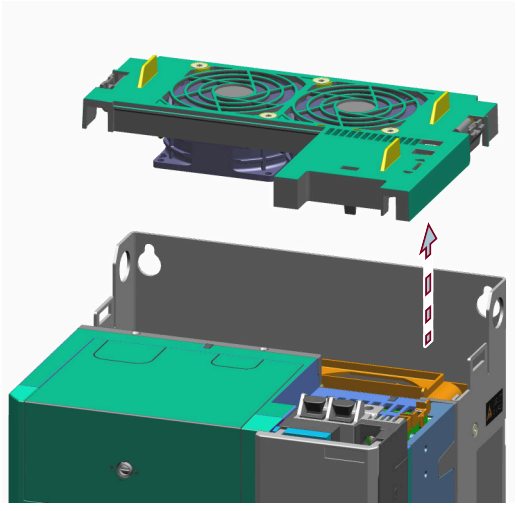
5. Press a slotted screwdriver against the front catch and at the same time pull the corresponding side of the main fan out of the housing using the lug.



6. Using the slotted screwdriver, lever the main fan out of the plug-in connection at the front.



7. Withdraw the main fan vertically upward out of the housing.



Proceed as follows to install the main fan:

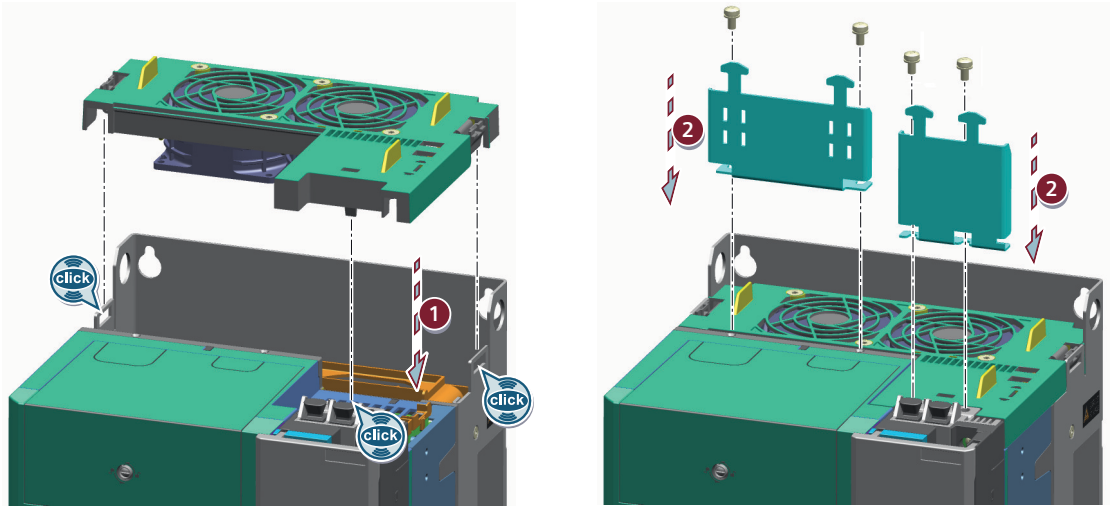


Figure 15-14 Installing the main fan

1. Insert the main fan in the converter housing.
   Press the main fan into the plug-in connection until the catches audibly snap into place.
2. Using a torx screwdriver, tighten the fixing screws of the shield connection plate. Tightening torque: 3 Nm.

15.15.2 Replacing the main fan, converters with degree of protection IP55, frame sizes FSB-FSC

Overview

The main fan at the top of the converter must be replaced if it is defective or it has reached its maximum operating time.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the main fan has been removed, the live components of the converter are no longer protected from being touched. Contact with live parts can result in death or serious injury.

- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Before removing the main fan, carefully ensure that the device is in a no-voltage condition.
- Wait until the discharge time specified on the warning labels has elapsed.

NOTICE
Damage to connection plug following incorrect removal The connection plug may be damaged if the main fan is removed incorrectly. • Release the main fan connection plug before completely removing the main fan from the converter.

The following requirements apply when replacing the main fan:

- Comply with ESD regulations.
- Only qualified personnel may replace the main fan.
- Required tools:
  - Torx screwdriver TX 20

Procedure

The following procedure describes removing and installing the main fan using a converter, frame size FSC as example.

The procedure for removing and installing the main fan is identical for frame sizes FSB and FSC.

Proceed as follows to remove the main fan:

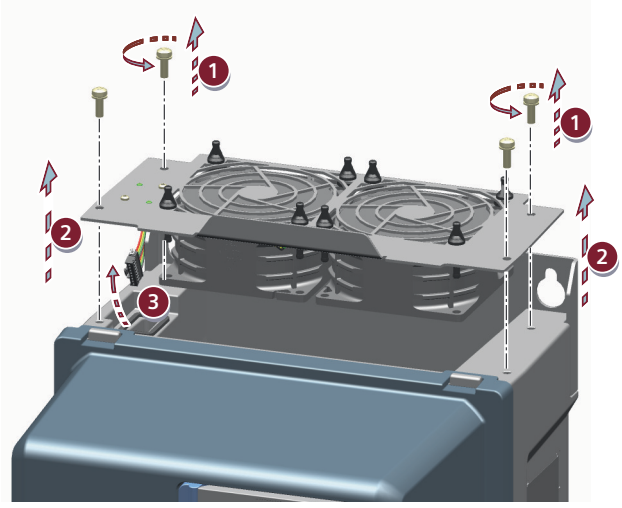


Figure 15-15 Removing the main fan

1. Using a torx screwdriver, release the 4 fixing screws of the main fan and remove the fixing screws.
2. Slightly lift the main fan.
3. Release the catch of the connection plug and withdraw the plug upwards. Remove the main fan:

Proceed as follows to install the main fan:

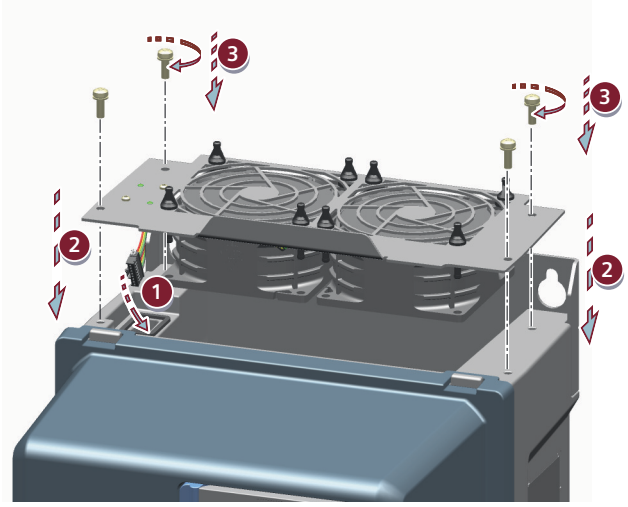


Figure 15-16 Installing the main fan

1. Insert the connector for the electrical connection of the main fan into the socket in the converter housing. Carefully ensure that the connector audibly snaps into place. The power supply for the main fan is therefore established.
2. Insert the main fan in the converter housing.
3. Using a torx screwdriver, tighten the 4 fixing screws of the main fan. Tightening torque: 2 Nm.

15.15.3 Replacing the main fan, converters with degree of protection IP55, frame sizes FSD1-FSE

Overview

The main fan at the top of the converter must be replaced if it is defective or it has reached its maximum operating time.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the main fan has been removed, the live components of the converter are no longer protected from being touched. Contact with live parts can result in death or serious injury.

- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Before removing the main fan, carefully ensure that the device is in a no-voltage condition.
- Wait until the discharge time specified on the warning labels has elapsed.

NOTICE
Damage to connection plug following incorrect removal The connection plug may be damaged if the main fan is removed incorrectly. • Release the main fan connection plug before completely removing the main fan from the converter.

The following requirements apply when replacing the main fan:

- Comply with ESD regulations.
- Only qualified personnel may replace the main fan.
- The converter housing cover has been removed.
- Required tools:
  - Torx screwdriver TX 20

Procedure

The following procedure describes removing and installing the main fan using a converter, frame size FSD2 as example.

The procedure for removing and installing the main fan is identical for frame sizes FSD1, FSD2 and FSE. The main fan differs in terms of the size, the number of fans it is equipped with and the number of fixing screws.

Proceed as follows to remove the main fan:

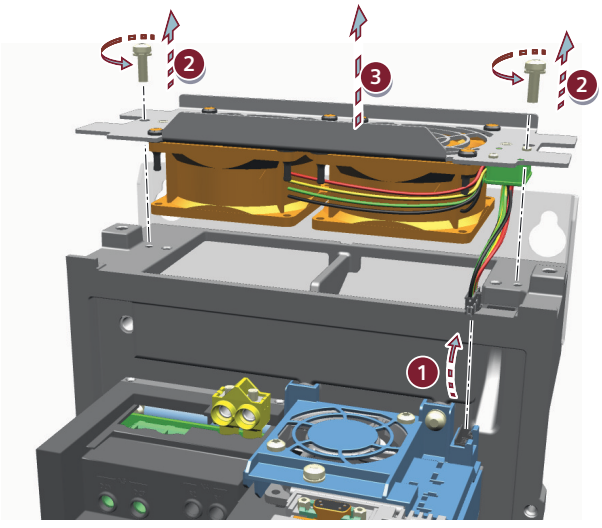


Figure 15-17 Removing the main fan

1. Release the catch of the connection plug and withdraw the plug upwards.
2. Using a torx screwdriver, release the fixing screws of the main fan and remove the fixing screws.
3. Pull the connection plug through its opening by slowly moving the main fan upwards.

Proceed as follows to install the main fan:

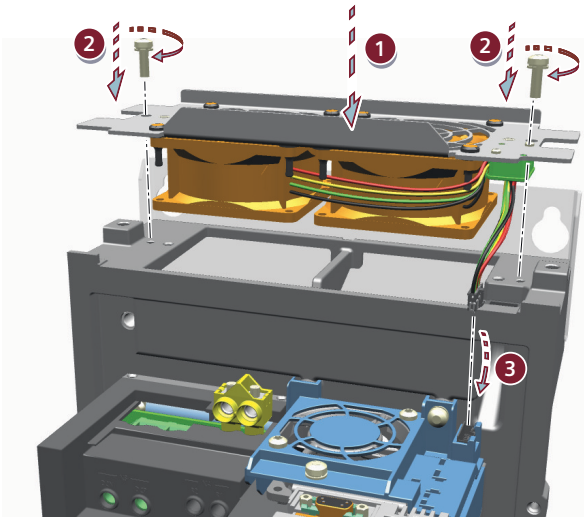


Figure 15-18 Installing the main fan

1. Push the connection plug through its opening by slowly moving the main fan downwards to install it.
2. Using a torx screwdriver, tighten the fixing screws of the main fan. Tightening torque: 3 Nm.
3. Insert the connector for the electrical connection of the main fan into the socket in the converter housing. Carefully ensure that the connector audibly snaps into place.

15.15.4 Replacing the auxiliary fan, converters with degree of protection IP55

15.15.4.1 Replacing the auxiliary fan, converters with degree of protection IP55, frame sizes FSB-FSC

Overview

The auxiliary fan must be replaced if it is defective or it has reached its maximum operating time.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the auxiliary fan has been removed, the live components of the converter are no longer protected from being touched. Contact with live parts can result in death or serious injury.

- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Before removing the auxiliary fan, carefully ensure that the device is in a no-voltage condition.
- Wait until the discharge time specified on the warning labels has elapsed.

The following requirements apply when replacing the auxiliary fan:

- Comply with ESD regulations.
- Only qualified personnel may install spare parts.
- The converter housing cover has been removed.
- Required tools:
  - Torx screwdriver TX 20

Procedure

The following procedure describes removing and installing the auxiliary fan for frame sizes FSB and FSC using a converter of frame size FSC as example.

The procedure for removing and installing the auxiliary fan is identical for frame sizes FSB and FSC. The auxiliary fan differs in terms of the position and number of the fixing screws.

Proceed as follows to remove the auxiliary fan:

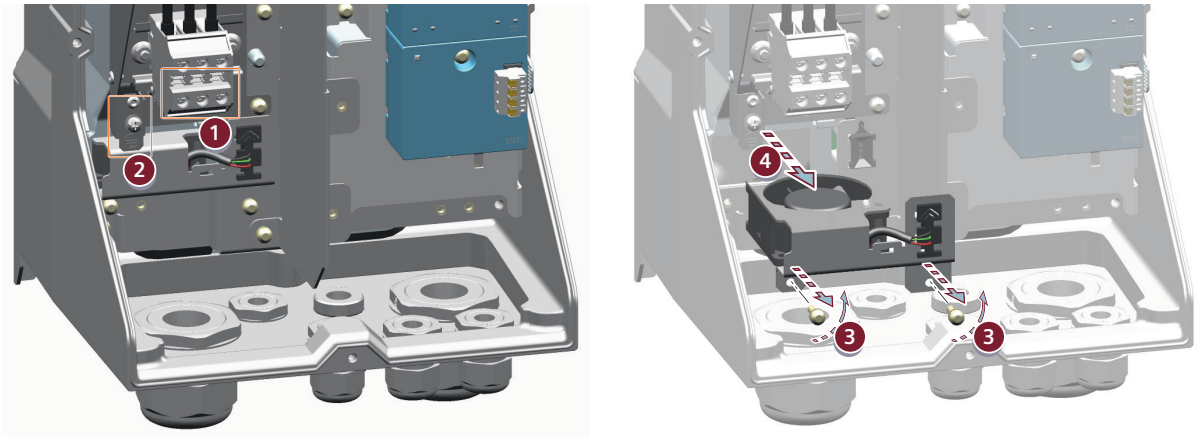


Figure 15-19 Removing the auxiliary fan

1. Release the power supply cable and slightly withdraw the power supply cable.
2. Using a torx screwdriver, release the protective conductor and slightly withdraw the protective conductor.

3. Using a torx screwdriver, release the fixing screws of the auxiliary fan and remove the fixing screws.
4. Pull the auxiliary fan towards the front and out of the converter. Carefully ensure that the plug-in connection of the electrical connection does not skew when it is pulled out.

Proceed as follows to install the auxiliary fan:

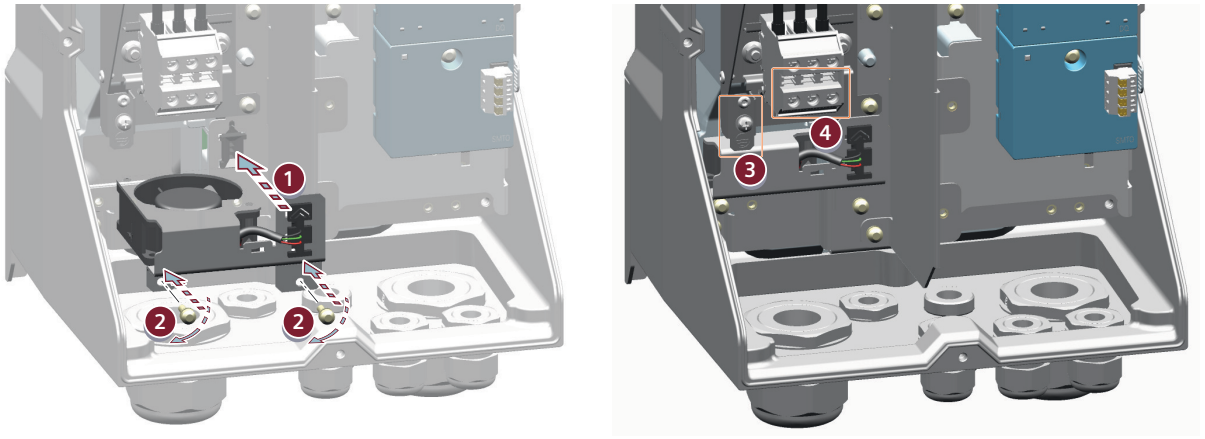


Figure 15-20 Installing the auxiliary fan

1. Insert the auxiliary fan in the converter.
2. Using a torx screwdriver, tighten the fixing screws of the auxiliary fan (depending on the size, 1 or 2 screws). Tightening torque: 2 Nm.
3. Connect the protective conductor.
4. Connect the power supply cable.

15.15.4.2 Replacing the auxiliary fan, converters with degree of protection IP55, frame sizes FSD1-FSE

Overview

The auxiliary fan must be replaced if it is defective or it has reached its maximum operating time.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the auxiliary fan has been removed, the live components of the converter are no longer protected from being touched. Contact with live parts can result in death or serious injury.

- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Before removing the auxiliary fan, carefully ensure that the device is in a no-voltage condition.
- Wait until the discharge time specified on the warning labels has elapsed.

The following requirements apply when replacing the auxiliary fan:

- Comply with ESD regulations.
- Only qualified personnel may install spare parts.
- The converter housing cover has been removed.
- Required tools:
  - Torx screwdriver TX 25

Procedure

The following procedure describes removing and installing the auxiliary fan for frame sizes FSD1, FSD2 and FSE using a converter of frame size FSD2 as example.

The procedure for removing and installing the auxiliary fan is identical for frame sizes FSD1, FSD2 and FSE. The auxiliary fan differs in terms of the position of the fixing screws.

Proceed as follows to remove the auxiliary fan:

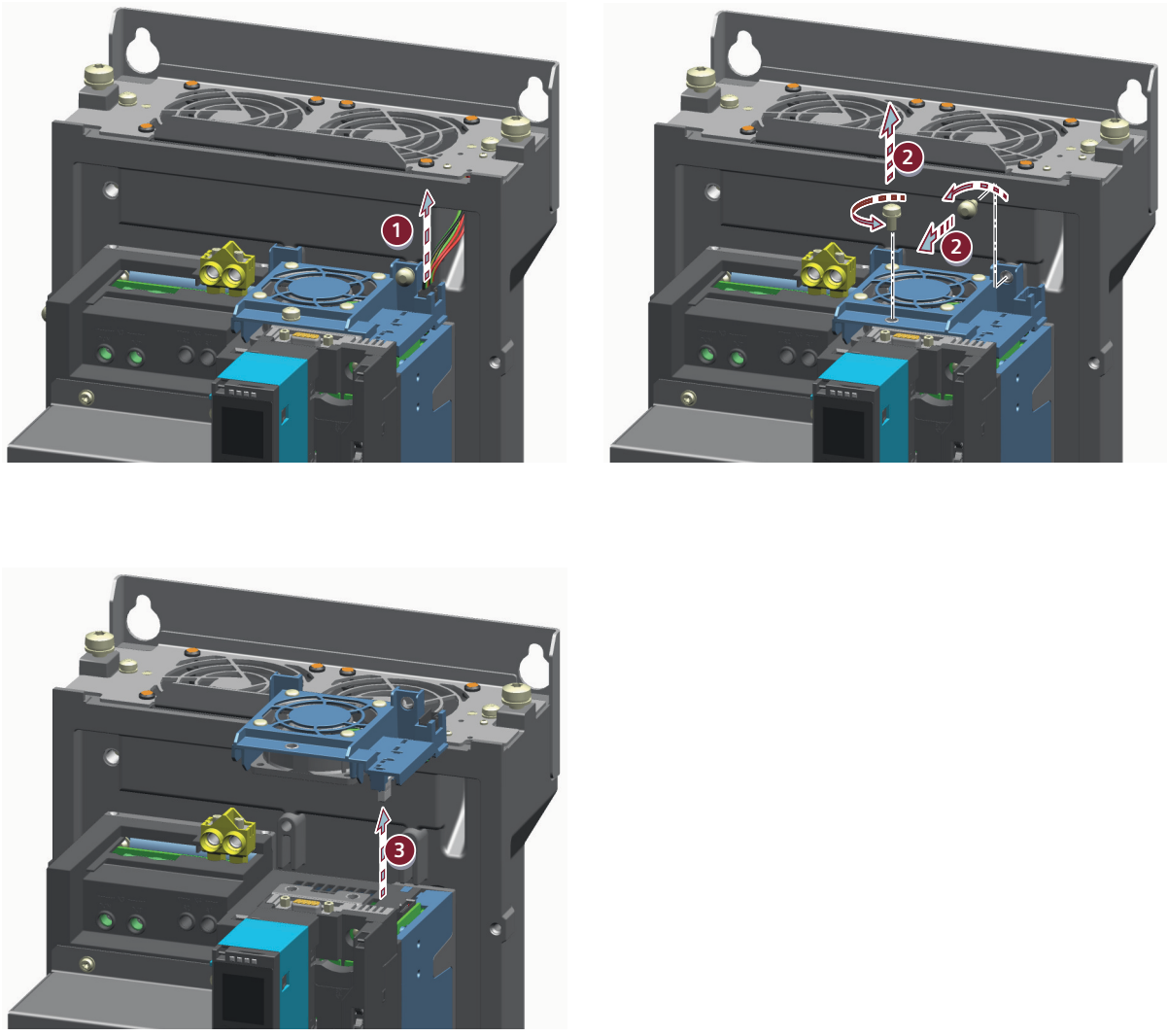


Figure 15-21 Removing the auxiliary fan

1. Release the plug-in connection of the auxiliary fan connecting cable.
2. Using a torx screwdriver, release the fixing screws of the auxiliary fan and remove the fixing screws.
3. Pull the auxiliary fan upwards and out of the converter. Carefully ensure that the auxiliary fan connector does not skew when it is removed.

Proceed as follows to install the auxiliary fan:

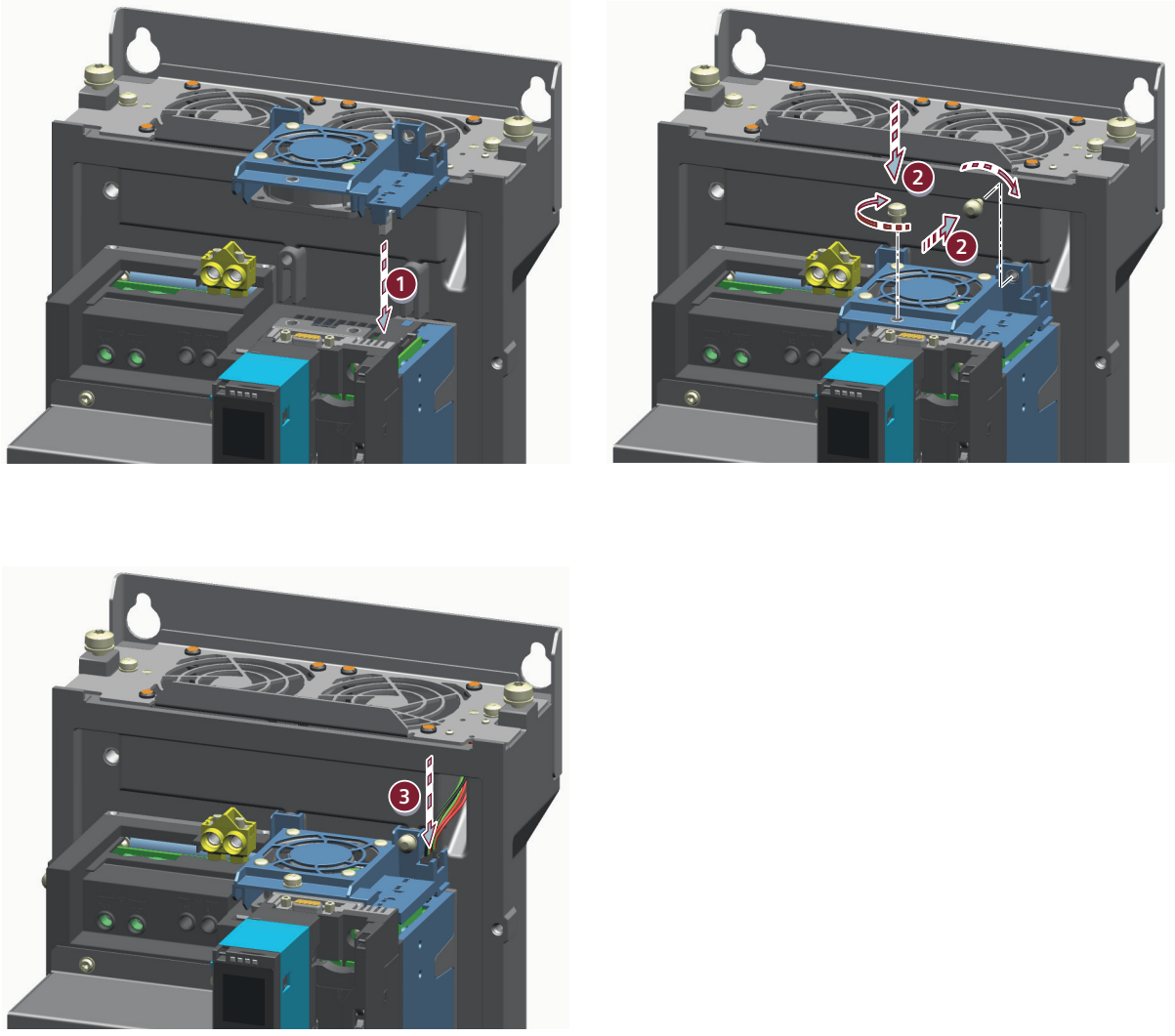


Figure 15-22 Installing the auxiliary fan

1. Insert the auxiliary fan from above in the converter housing.
2. Using a torx screwdriver, tighten the fixing screws of the auxiliary fan.
   Tightening torque: 3 Nm.
3. Push the auxiliary fan connector into the converter socket until the connector engages with a click.

Technical data

16

16.1 General technical specifications

Technical data

Table 16-1 General data of the converter

Property	Value
Line voltage	3 AC 200 V ... 240 V -20% ... 10% 3 AC 380 V ... 415 V -20% ... 10% 3 AC 440 V ... 500 V -20% ... 10%
Input frequency	50/60 Hz (47 ... 63 Hz)
R_{SCE} of the line [1]	> 25
Switching frequency of the line voltage (pre-charging frequency)	120 s Minimum time period between two line voltage switch-on operations to the de-energized converter.
Output voltage	3 AC 0 V ... 0.95 · line voltage Clean Power converter: 3 AC 0 V ... line voltage
Output frequency	0 ... 550 Hz
Power factor λ	0.9 typical Clean Power converter: 1.0 typical
Offset factor cos φ	0.98 typical Clean Power converter: 1.0 typical
Type of cooling	Air cooling using an integrated fan
Service life of the fan	40000 h
Place of installation	Indoors, stationary
Degree of pollution	2 according to IEC 61800-5-1
Overvoltage category	III according to IEC 61800-5-1
Flicker	The flicker value of the converter depends on the line supply and the specific converter application. This means that the flicker value can only be measured when the converter is operational in the installation.

[1] Ratio between short-circuit power at the mains connection point to the fundamental frequency apparent power S of all connected devices

16.2 Environmental conditions

16.2.1 Mechanical environmental conditions

Technical data

Table 16-2 Resistance to mechanical environmental conditions

Usage phase	Classification	Description
Storage	Class 1M2 according to IEC 60721-3-1:1997	In the transport packaging
Transport	Class 2M3 according to IEC 60721-3-2:1997	In the transport packaging
Operation	Class 3M1 in accordance with IEC 60721-3-3 Ed. 2.2: 2002	Vibration test according to IEC 60068-2-6 test Fc (sinusoidal) • 9 ... 29 Hz: Amplitude: 0.3 mm • 29 ... 200 Hz: Acceleration: 1 g • 10 frequency cycles per axis
		Shock test according to IEC 60068-2-27 test Ea (half-sine) • Peak acceleration: 5 g • Duration: 30 ms • 3 shocks per direction

Table 16-3 Resistance to mechanically active substances

Usage phase	Classification	Description
Operation	Class 3S1 according to IEC 60721-3-3: Ed. 2.2: 2002	Conductive dusts are not permitted.

16.2.2 Chemical environmental conditions

Technical specifications

Table 16-4 Resistance to chemically active substances

Usage phase	Classification	Description
Storage	Class 1C2, according to IEC 60721-3-1: 1997	In the transport packaging
Transport	Class 2C2 according to IEC 60721-3-2:1997	In the transport packaging
Operation	Class 3C2 according to IEC 60721-3-3: 2002 Class 3C3, according to IEC 60721-3-3: 2002 for version with 3C3 coating	

16.2.3 Biological environmental conditions

Technical data

Table 16-5 Resistance to biologically active substances

Usage phase	Classification	Description
Storage	Class 1B1, according to IEC 60721-3-1: 1997	In the transport packaging
Transport	Class 2B1, according to IEC 60721-3-2: 1997	In the transport packaging
Operation	Class 3B1, according to IEC 60721-3-3: 2002	Mold, fungus, rodents, termites and other animal vermin are not permissible.

16.2.4 Climatic conditions

Technical data

Table 16-6 Resistance to climatic conditions

Usage phase	Classification	Description
Storage	Class 1K4 according to IEC 60721-3-1:1997	• In the transport packaging • Temperature -25 ... +55 °C • Relative humidity 5 ... 95 % (no condensation) • Storage altitude ≤ 4000 m • Condensation, splash water, icing, salt spray are not permissible.
Transport	Class 2K4 according to IEC 60721-3-2:1997	• In the transport packaging • Temperature -40 ... +70 °C • Relative humidity 5 ... 95 % (no condensation)
Operation	Class 3K3 in accordance with IEC 60721-3-3 Ed. 2.2: 2002	• With increased ruggedness with respect to relative humidity • Relative humidity 5 ... 95 % no condensation (better than Class 3K3) • Ultraviolet radiation not permissible • IP20 degree of protection: – With HO: without derating (surrounding air temperature -20 ... 50°C) With reduction of the permissible output current by 2.5 % per K (> 50 ... 60 °C) – With LO: without derating (surrounding air temperature -20 ... 45°C) With reduction of the permissible output current by 1.5 % per K (> 45 ... 50 °C) With reduction of the permissible output current by 2.5 % per K (> 50 ... 60 °C) – Ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted. • IP55 degree of protection: – With HO: without temperature derating (ambient temperature -20 ... 45 °C) With reduction of the permissible output current by 1.5 % per K (> 45 ... 50 °C) – With LO: without temperature derating (ambient temperature -20 ... 40 °C) With reduction of the permissible output current by 1.5 % per K (> 40 ... 50 °C) – Formation of ice, condensation are not permissible.

16.3 Rated power, input current, output current

16.3.1 3 AC 200 V ... 240 V

Technical data

The rated converter power is the mechanical shaft power of a typical 8-pole induction motor, which can be operated at the converter at its rated operating point without overloading the converter.

Table 16-7 Power and currents, 3 AC 200 V ... 240 V according to IEC

Property		Unit	Article number: 6SL4112-...☐☐-...0						
			05	06	08	10	11	12	13
Rated power at 230 V	With Low Overload	kW	0.55	0.75	1.10	1.50	2.20	3.00	4.00
	With High Overload	kW	0.37	0.55	0.75	1.10	1.50	2.20	3.00
Input current:									
Base load value	With Low Overload	A	3.2	3.9	5.4	7.1	10.1	13.1	17.7
	With High Overload	A	2.6	3.6	4.3	6.1	8.6	11.0	14.9
Output current:									
Rated value	Without Overload	A	4.1	4.9	6.7	8.8	11.3	14.9	19.5
Base load value	With Low Overload	A	3.9	4.7	6.5	8.5	11.0	14.5	19.0
	With High Overload	A	2.9	3.9	4.7	6.5	8.5	11.0	14.5
Maximum		A	5.9	7.8	9.8	13.0	17.0	22.0	29.0

Table 16-8 Power and currents, 3 AC 200 V... 240 V according to IEC

Property		Unit	Article number: 6SL4112-...☐☐-...0						
			15	16	17	18	20	21	23
Rated power at 230 V	With Low Overload	kW	5.50	7.50	11.0	15.0	18.5	22.0	30.0
	With High Overload	kW	4.00	5.50	7.50	11.0	15.0	18.5	22.0
Input current:									

Property		Unit	Article number: 6SL4112-...☐☐-...0						
			15	**16**	**17**	**18**	**20**	**21**	**23**
Base load value	With Low Overload	A	21.7	29.5	41.8	53.9	66.5	76.0	103.2
	With High Overload	A	16.9	25.8	40.0	43.2	61.4	69.6	91.1
Output current:									
Rated value	Without Overload	A	27.7	34.9	47.2	64.7	77.0	92.4	114.9
Base load value	With Low Overload	A	27.0	34.0	46.0	63.0	75.0	90.0	112.0
	With High Overload	A	19.0	27.0	40.0	46.0	63.0	75.0	90.0
Maximum		A	40.5	54.0	80.0	94.5	126.0	150.0	180.0

Table 16-9 Power and currents, 3 AC 200 V... 240 V according to IEC

Property		Unit	Article number: 6SL4112-...☐☐-...0		
			24	**26**	**27**
Rated power at 230 V	With Low Overload	kW	37.0	45.0	55.0
	With High Overload	kW	30.0	37.0	45.0
Input current:					
Base load value	With Low Overload	A	131.2	156.2	188.7
	With High Overload	A	107.6	144.5	171.6
Output current:					
Rated value	Without Overload	A	153.9	182.7	220.6
Base load value	With Low Overload	A	150.0	178.0	215.0
	With High Overload	A	112.0	150.0	178.0
Maximum		A	225	300.0	356.0

Table 16-10 Power and currents, 3 AC 200 V ... 240 V according to NEC

Property		**Unit**	**Article number: 6SL4112-...□□-...0**						
			05	**06**	**08**	**10**	**11**	**12**	**13**
Rated power at 240 V	With Low Overload	hp	0.75	1.00	1.50	2.00	3.00	4.00	5.00
	With High Overload	hp	0.50	0.75	1.00	1.50	2.00	3.00	4.00
Input current:									
Base load value	With Low Overload	A	3.0	3.7	5.1	6.4	9.3	11.9	14.7
	With High Overload	A	2.3	3.1	4.0	6.3	7.3	10.1	13.3
Output current:									
Rated value	Without Overload	A	3.3	4.4	6.2	7.0	9.9	12.8	15.6
Base load value	With Low Overload	A	3.2	4.2	6.0	6.8	9.6	12.4	15.2
	With High Overload	A	2.2	3.2	4.2	6.0	6.8	9.6	12.4
Maximum			4.8	6.4	9.0	12.0	14.4	19.2	24.8

Table 16-11 Power and currents, 3 AC 200 V ... 240 V according to NEC

Property		**Unit**	**Article number: 6SL4112-...□□-...0**						
			15	**16**	**17**	**18**	**20**	**21**	**23**
Rated power at 240 V acc. to NEC	With Low Overload	hp	7.50	10.0	15.0	20.0	25.0	30.0	40.0
	With High Overload	hp	5.00	7.50	10.0	15.0	20.0	25.0	30.0
Input current:									
Base load value	With Low Overload	A	20.1	26.6	39.5	49.7	62.5	72.1	96.1
	With High Overload	A	15.3	22.9	29.0	42.4	54.4	67.3	81.1
Output current:									
Rated value	Without Overload	A	22.6	28.8	43.1	55.4	69.8	82.1	106.7
Base load value	With Low Overload	A	22.0	28.0	42.0	54.0	68.0	80.0	104.0
	With High Overload	A	15.2	22.0	28.0	42.0	54.0	68.0	80.0
Maximum		A	33.0	44.0	63.0	84.0	108.0	136.0	160.0

Table 16-12 Power and currents, 3 AC 200 V ... 240 V according to NEC

Property		Unit	Article number: 6SL4112-...□□-...0		
			24	26	27
Rated power at 240 V	With Low Overload	hp	50.0	60.0	75.0
	With High Overload	hp	40.0	50.0	60.0
Input current:					
Base load value	With Low Overload	A	121.8	143.7	178.0
	With High Overload	A	107.1	133.1	156.9
Output current:					
Rated value	Without Overload	A	133.4	158.0	197.0
Base load value	With Low Overload	A	130.0	154.0	192.0
	With High Overload	A	104.0	130.0	154.0
Maximum		A	208.0	260.0	308.0

16.3.2 380 V ... 415 V 3 AC / 440 V ... 500 V 3 AC

Technical data

The rated converter power is the mechanical shaft power of a typical 8-pole induction motor, which can be operated at the converter at its rated operating point without overloading the converter.

Table 16-13 Power and currents, 3 AC 380 V .... 415 V according to IEC

Property		Unit	Article number: 6SL4113-...□□-...0						
			08	10	11	12	13	15	16
Rated power at 400 V	With Low Overload	kW	1.10	1.50	2.20	3.00	4.00	5.50	7.50
	With High Overload	kW	0.75	1.10	1.50	2.20	3.00	4.00	5.50
Input current:									
Base load value	With Low Overload	A	3.3	4.1	5.6	7.3	9.6	12.9	17.3 15.2[1)]
	With High Overload	A	2.7	3.8	4.6	6.3	8.2	10.8	14.7 12.8[1)]
Output current:									
Rated value	Without Overload	A	4.1	4.9	6.7	8.8	11.3	14.9	19.5

Property		Unit	Article number: 6SL4113-...□□-...0						
			08	10	11	12	13	15	16
Base load value	With Low Overload	A	3.9	4.7	6.5	8.5	11.0	14.5	19.0
	With High Overload	A	2.9	3.9	4.7	6.5	8.5	11.0	14.5
	for synchronous-reluctance motors	A	3.9	4.7	6.5	8.5	11.0	14.5	19.0
Maximum		A	5.9	7.8	9.8	13.0	17.0	22.0	29.0

1) The data apply to Clean Power converters

Table 16-14 Power and currents, 3 AC 380 V .... 415 V according to IEC

Property		Unit	Article number: 6SL4113-...□□-...0							
			17	18	20	21	23	24	26	27
Rated power at 400 V	With Low Overload	kW	11.0	15.0	18.5	22.0	30.0	37.0	45.0	55.0
	With High Overload	kW	7.50	11.0	15.0	18.5	22.0	30.0	37.0	45.0
Input current:										
Base load value	With Low Overload	A	23.3	31.3	37.8	44.9	59.9	72.6	86.7	105.9
			20.6[1)]	28.0[1)]	33.5[1)]	40.1[1)]	52.9[1)]	65.3[1)]	77.5[1)]	95.1[1)]
	With High Overload	A	18.1	27.5	35.4	43.0	48.1	67.7	79.4	93.5
			16.0[1)]	24.5[1)]	31.4[1)]	38.4[1)]	42.4[1)]	60.3[1)]	71.0[1)]	84.0[1)]
Output current:										
Rated value	Without Overload	A	27.7	34.9	41.1	47.2	64.7	77.0	92.4	114.9
Base load value	With Low Overload	A	27.0	34.0	40.0	46.0	63.0	75.0	90.0	112.0
	With High Overload	A	19.0	27.0	34.0	40.0	46.0	63.0	75.0	90.0
	for synchronous-reluctance motors	A	27.0	35.0	43.0	50.0	69.0	85.0	103.0	123.0
Maximum		A	40.5	54.0	68.0	80.0	94.5	126.0	150.0	180.0

1) The data apply to Clean Power converters

Table 16-15 Power and currents, 3 AC 380 V .... 415 V according to IEC

Property		Unit	Article number: 6SL4113-...□□-...0				
			30	31	33	35	36
Rated power at 400 V	With Low Overload	kW	75.0	90.0	110	132	160
	With High Overload	kW	55.0	75.0	90.0	110	132
Input current:							
Base load value	With Low Overload	A	145.7	172.3	208.5	256.2	310.9
			130.6[1)]	154.9[1)]	188.1[1)]	224.1[1)]	255[1)]
	With High Overload	A	119.5	159.3	189.6	237.2	280.7
			107.1[1)]	143.3[1)]	171.0[1)]	207.4[1)]	230.3[1)]
Output current:							
Rated value	Without Overload	A	153.9	182.7	220.6	261.6	318.1

Property		Unit	Article number: 6SL4113-...□□-...0				
			30	**31**	**33**	**35**	**36**
Base load value	With Low Overload	A	150.0	178.0	215.0	255.0	310.0
	With High Overload	A	112.0	150.0	178.0	215.0	255.0
	for synchronous-reluctance motors	A	173.0	205.0	245.0	290.0	343.0
Maximum		A	225.0	300.0	356.0	430.0	510.0

1) The data apply to Clean Power converters

Table 16-16 Power and currents, 3 AC 440 V .... 500 V according to NEC

Property		Unit	Article number: 6SL4113-...□□-...0						
			08	**10**	**11**	**12**	**13**	**15**	**16**
Rated power at 480 V	With Low Overload	hp	1.50	2.00	3.00	4.00	5.00	7.50	10.0
	With High Overload	hp	1.00	1.50	2.00	3.00	4.00	5.00	7.50
Input current:									
Base load value	With Low Overload	A	3.0	3.7	4.9	6.1	7.3	11.0	14.0 12.3[1)]
	With High Overload	A	2.4	3.6	3.9	5.3	6.6	8.4	12.1 10.6[1)]
Output current[2)]:									
Rated value	Without Overload	A	3.1	3.5	5.0	6.4	7.8	11.3	14.4
Base load value	With Low Overload	A	3.0	3.4	4.8	6.2	7.6	11.0	14.0
	With High Overload	A	2.1	3.0	3.4	4.8	6.2	7.6	11.0
Maximum		A	4.5	6.0	7.2	9.6	12.4	16.5	22.0

1) The data apply to Clean Power converters

2) Rated value in the second voltage range

Table 16-17 Power and currents, 3 AC 440 V .... 500 V according to NEC

Property		Unit	Article number: 6SL4113-...□□-...0							
			17	**18**	**20**	**21**	**23**	**24**	**26**	**27**
Rated power at 480 V	With Low Overload	hp	15.0	20.0	25.0	30.0	40.0	50.0	60.0	75.0
	With High Overload	hp	10.0	15.0	20.0	25.0	30.0	40.0	50.0	60.0
Input current:										
Base load value	With Low Overload	A	19.6 17.5[1)]	25.4 23.2[1)]	31.6 28.5[1)]	37.5 34.4[1)]	49.8 44.5[1)]	59.9 55.7[1)]	71.3 65.6[1)]	88.3 82.0[1)]
	With High Overload	A	14.3 12.9[1)]	21.7 20.0[1)]	27.6 25.0[1)]	35.0 32.2[1)]	42.1 37.6[1)]	53.8 49.1[1)]	66.2 60.8[1)]	77.8 72.3[1)]
Output current[2)]:										
Rated value	Without Overload	A	21.6	27.7	34.9	41.1	53.4	66.7	79.0	98.5

Property		Unit	Article number: 6SL4113-...□□-...0							
			17	18	20	21	23	24	26	27
Base load value	With Low Overload	A	21.0	27.0	34.0	40.0	52.0	65.0	77.0	96.0
	With High Overload	A	14.0	21.0	27.0	34.0	40.0	52.0	65.0	77.0
Maximum		A	31.5	42.0	54.0	68.0	80.0	104.0	130.0	154.0

1) The data apply to Clean Power converters

2) Rated value in the second voltage range

Table 16-18 Power and currents, 3 AC 440 V .... 500 V according to NEC

Property		Unit	Article number: 6SL4113-...□□-...0				
			30	31	33	35	36
Rated power at 480 V	With Low Overload	hp	100	125	150	175	200
	With High Overload	hp	75.0	100	125	150	175
Input current:							
Base load value	With Low Overload	A	118.6	145.8	172.5	208.5	237.5
			109.5[1)]	136.0[1)]	161.7[1)]	187.4[1)]	202.7[1)]
	With High Overload	A	100.7	127.2	164.2	199.0	224.8
			93.1[1)]	118.7[1)]	154.0[1)]	178.9[1)]	191.9[1)]
Output current[2)]:							
Rated value	Without Overload	A	127.3	160.1	184.7	212.4	246.3
Base load value	With Low Overload	A	124.0	156.0	180.0	207.0	240.0
	With High Overload	A	96.0	124.0	156.0	180.0	207.0
Maximum		A	192.0	248.0	312.0	360.0	414.0

1) The data apply to Clean Power converters

2) Rated value in the second voltage range

16.4 Pulse frequency as a function of the rated power

Technical data

Table 16-19 Pulse frequency as a function of the rated power, 3 AC 200 V ... 240 V

Rated power	Pulse frequency		
	Factory setting	Min.	Max.
in kW	in kHz	in kHz	in kHz
<55	4	2	16
≥55	2	2	8

Table 16-20 Pulse frequency as a function of the rated power, 3 AC 380 ... 415 / 3 AC 440 ... 500 V

Rated power	Pulse frequency		
	Factory setting	Min.	Max.
in kW	in kHz	in kHz	in kHz
<110	4	2	16
≥110	2	2	8

16.5 Current reduction

16.5.1 Current reduction as a function of the installation altitude and ambient temperature, IP20

Technical data

The permissible output current of the converter depends on the installation altitude and the ambient temperature.

Continuous operation above the permissible output current leads to a converter malfunction due to overtemperature.

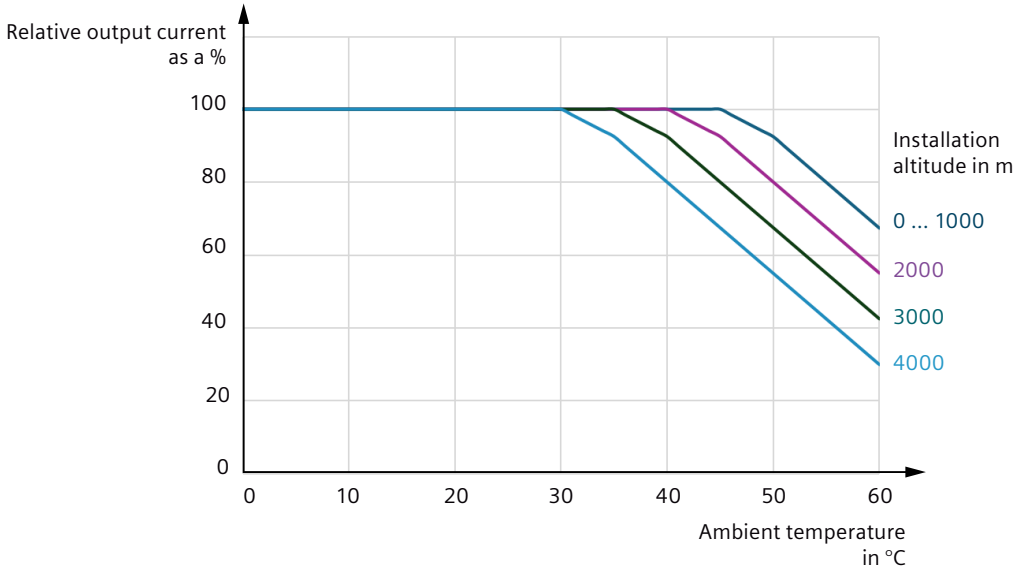


Figure 16-1 Current reduction according to "Low Overload" duty cycle

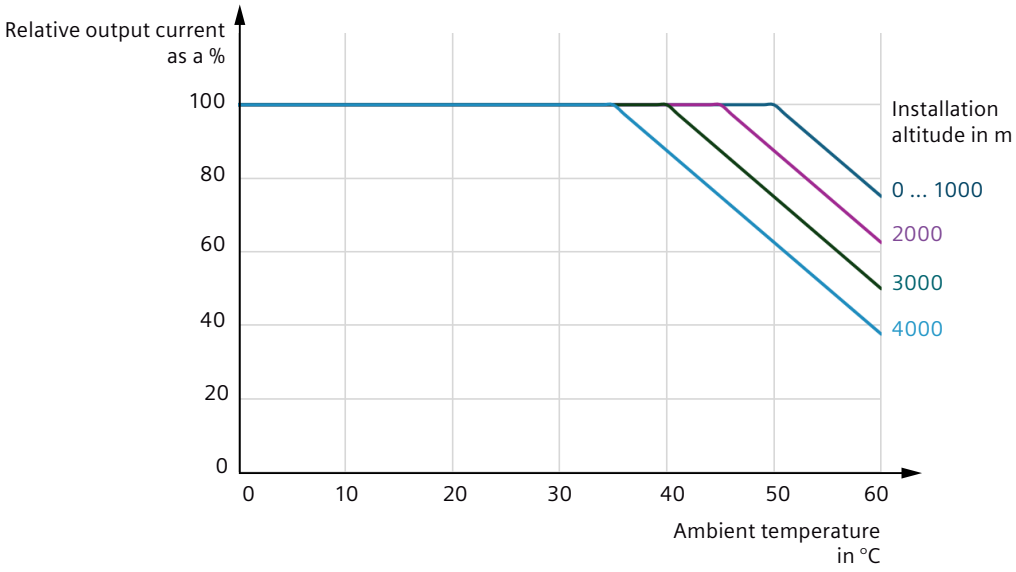


Figure 16-2 Current reduction according to "High Overload" duty cycle

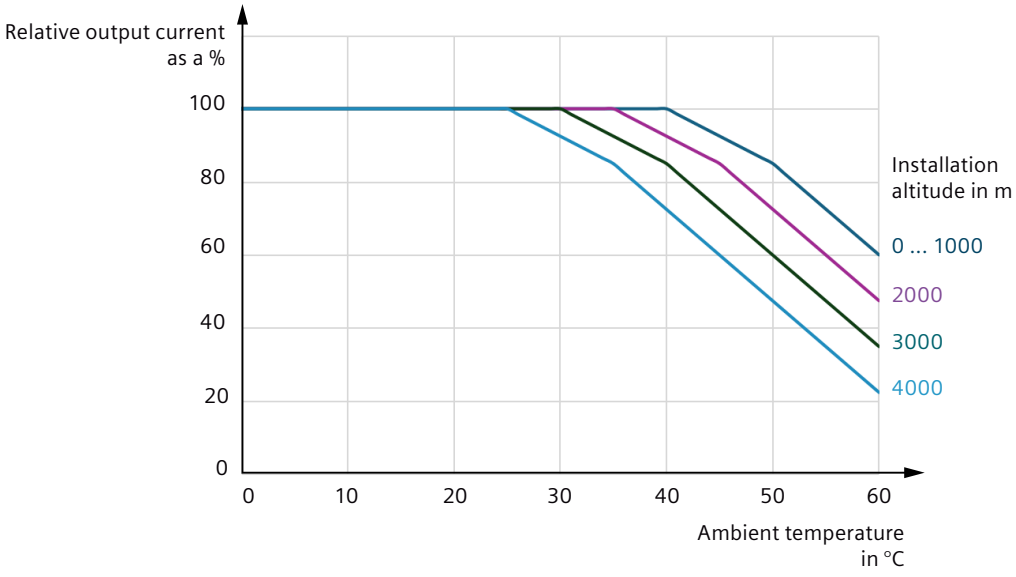


Figure 16-3 Current reduction with a synchronous reluctance motor

The relative output current is the quotient of the permissible output current and the rated output current.

16.5.2 Current reduction as a function of the installation altitude and ambient temperature, IP55

Technical data

The permissible output current of the converter depends on the installation altitude and the ambient temperature.

Continuous operation above the permissible output current leads to a converter malfunction due to overtemperature.

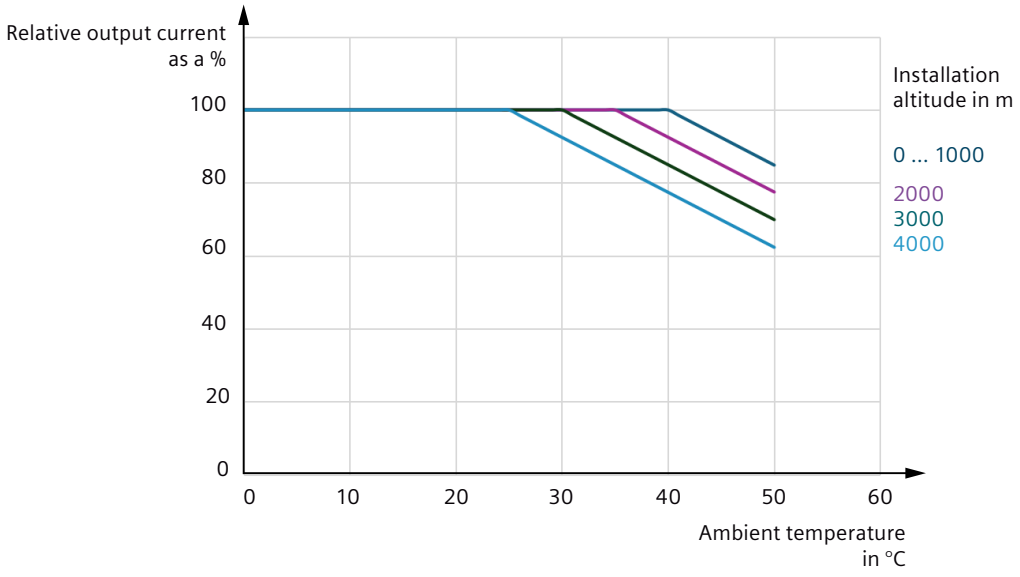


Figure 16-4 Current reduction according to "Low Overload" duty cycle

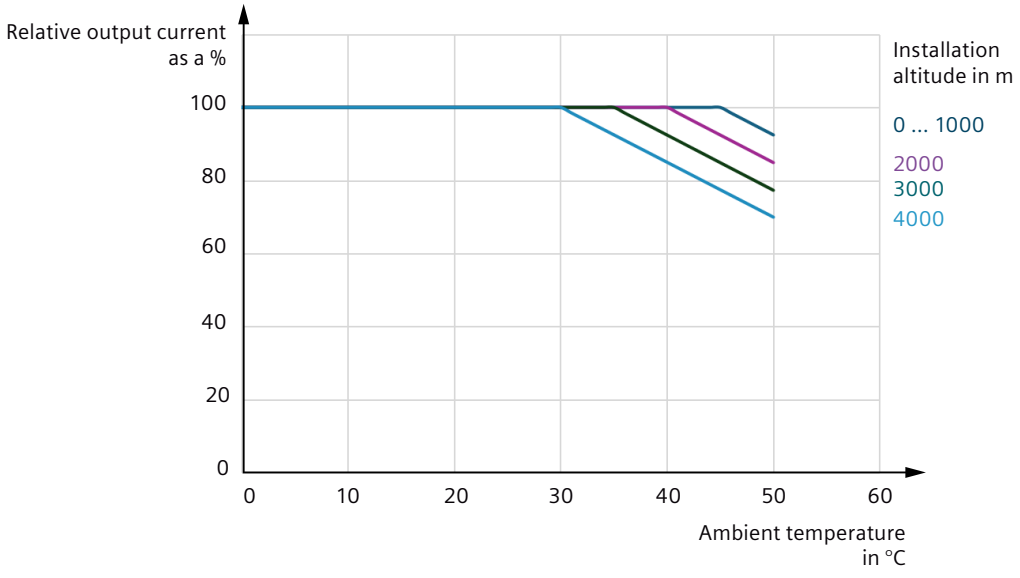


Figure 16-5 Current reduction according to "High Overload" duty cycle

The relative output current is the quotient of the permissible output current and the rated output current.

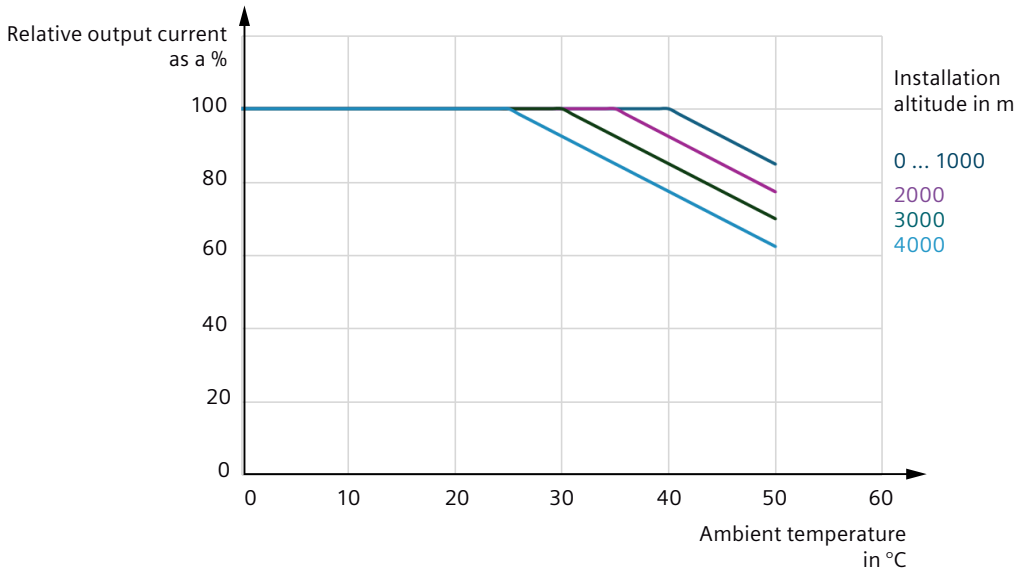


Figure 16-6 Current reduction with a synchronous reluctance motor

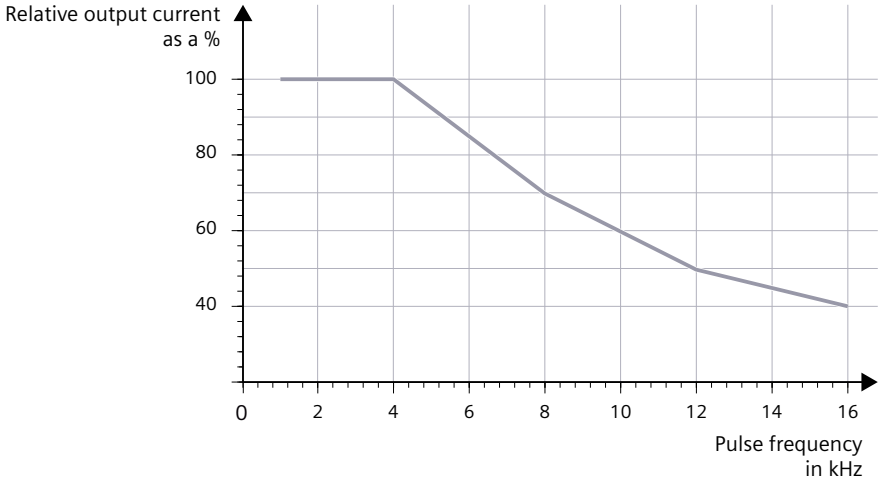
16.5.3 Current derating depending on the pulse frequency

Technical specifications

The following diagrams show the relationship between the pulse frequency and the relative output current.

The relative output current is the quotient of the permissible output current and the rated output current.

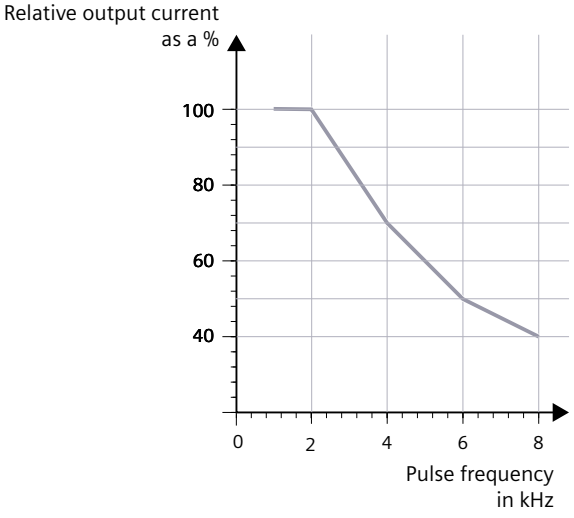
The current reduction depends on the rated power of the converter.



Rated power ≤ 45 kW with low overload (line voltage 3 AC 200 V ... 240 V)

Rated power ≤ 90 kW with low overload (line voltage 3 AC 380 V ... 415 V and 3 AC 440 V ... 500 V)

Figure 16-7 Current reduction as a function of the pulse frequency



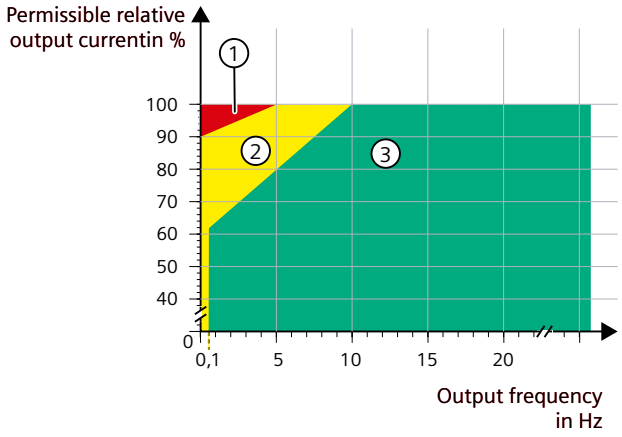
Rated power ≥ 55 kW with low overload (line voltage 3 AC 200 V ... 240 V)

Rated power ≥ 110 kW with low overload (line voltage 3 AC 380 V ... 415 V and 3 AC 440 V ... 500 V)

Figure 16-8 Current reduction as a function of the pulse frequency

16.5.4 Current reduction at lower output frequencies

Technical data



① Operation with sporadic short-time loading
② Operation with short-time loading
③ Operation with continuous loading

Figure 16-9 Permissible output current at low output frequencies

Explanation of terms:

- Constant loading is an operating state that is permissible for the entire operating time.
- Short-time loading is an operating state that is permissible for less than 2 % of the operating time.
- Sporadic short-time loading is an operating state that is permissible for less than 0.1 % of the operating time.

16.6 Permissible motor cable length as a function of the pulse frequency

Technical data

Table 16-21 Maximum permissible motor cable length as a function of the pulse frequency, 380 V ... 415 V and 200 V ... 240 V

Frame size	Pulse frequency			
	4 kHz	8 kHz	12 kHz	16 kHz
FSA	200 m	200 m	50 m	25 m
FSB	200 m	200 m	150 m	50 m
FSC	200 m	200 m	200 m	75 m

Table 16-22 Maximum permissible motor cable length as a function of the pulse frequency, 440 V ... 500 V

Frame size	Pulse frequency			
	4 kHz	8 kHz	12 kHz	16 kHz
FSA	200 m	100 m	25 m	5 m
FSB	200 m	200 m	100 m	25 m
FSC	200 m	200 m	100 m	50 m

From frame size FSD1 and higher, the pulse frequency has no influence on the maximum permissible motor cable length.

16.7 Current harmonics

16.7.1 Current harmonics

Technical data

At rated power, the converter generates the following typical current harmonics:

Table 16-23 Current harmonic I5 ... I25 and THC

R_{SCE}	$I5/I_{Ref}$	$I7/I_{Ref}$	$I11/I_{Ref}$	$I13/I_{Ref}$	$I17/I_{Ref}$	$I19/I_{Ref}$	$I23/I_{Ref}$	$I25/I_{Ref}$	THC/I_{Ref}
33	30.7%	11.6%	7.3%	5.1%	3.5%	2.5%	2%	1.7%	33.2%
120	34.5%	17.6%	8%	5.2%	4.5%	3.3%	3%	2.4 %	40.3%

R_{SCE} = "Short-Circuit Ratio" Ratio of the short-circuit power of the supply source to the rated apparent power on the line side of the converter

I_{Ref} = rated input current at 400 V line voltage for "Low Overload"

THC = Total Harmonic Current: Total rms value of the current harmonics I2 ... I40

More information

More information on current harmonics is available in the Internet:

EMC Design Guidelines Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/60612658)

16.7.2 Current harmonics with Clean Power converter

Technical data

The Clean Power converter corresponds to requirements according to IEC 61000-3-12.

At rated power, the converter generates the following typical current harmonics:

Table 16-24 Current harmonic I5 ... I25 and THC

R_{SC}	$I5/I_{Ref}$	$I7/I_{Ref}$	$I11/I_{Ref}$	$I13/I_{Ref}$	$I17/I_{Ref}$	$I19/I_{Ref}$	$I23/I_{Ref}$	$I25/I_{Ref}$	THC/I_{Ref}
33	1.1 %	1.0 %	0.2 %	0.2 %	0.2 %	0.1 %	0.1 %	0.1 %	1.8 %

R_{SC} = Relative Short-Circuit power: Ratio of the short-circuit power of the supply source to the rated apparent power on the line side of the converter

I_{Ref} = rated input current at 400 V line voltage for "Low Overload"

THC = Total Harmonic Current: Total rms value of the current harmonics I2 ... I40

More information

More information on current harmonics is available in the Internet:

EMC Design Guidelines Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/60612658)

16.8 Power loss

16.8.1 3 AC 200 V ... 240 V, IP20 degree of protection

Technical data

Table 16-25 Power loss according to IEC

Article number 6SL4112-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 230 V, 50 Hz	
	in kW	in W	in W
05	0.55	66.9	15.6
06	0.75	78.6	15.6
08	1.1	107	15.6
10	1.5	144	15.6
11	2.2	191	15.6
12	3	202	19.2
13	4	277	19.2
15	5.5	373	21.6
16	7.5	498	21.6
17	11	566	28.8
18	15	842	30.0

Article number 6SL4112-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 230 V, 50 Hz	
	in kW	in W	in W
20	18.5	1060	30.0
21	22	1150	34.8
23	30	1530	34.8
24	37	1570	44.0
26	45	2000	44.0
27	55	2380	44.0

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-26 Power loss according to NEC

Article number 6SL4112-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 240 V, 60 Hz	
	in kW	in W	in W
05	0.55	58.1	15.6
06	0.75	71.5	15.6
08	1.1	98.6	15.6
10	1.5	112	15.6
11	2.2	166	15.6
12	3	174	19.2
13	4	213	19.2
15	5.5	296	21.6
16	7.5	392	21.6
17	11	511	28.8
18	15	694	30.0
20	18.5	935	30.0
21	22	1000	34.8
23	30	1390	34.8
24	37	1320	44.0
26	45	1670	44.0
27	55	2050	44.0

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 55 kW: Pulse frequency = 4 kHz
- Rated power ≥ 55 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.2 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP20

Technical data

Table 16-27 Power loss according to IEC

Article number 6SL4113-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 400 V, 50 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
08	1.1	77.2	78.3	14.3
10	1.5	90.6	92.2	14.3
11	2.2	123	126	14.3
12	3	165	170	14.3
13	4	216	224	14.3
15	5.5	238	244	17.6
16	7.5	314	324	17.6
17	11	406	420	19.8
18	15	534	555	19.8
20	18.5	562	564	25.3
21	22	662	665	25.3
23	30	888	899	27.5
24	37	1110	1120	27.5
26	45	1230	1250	31.9
27	55	1600	1630	31.9
30	75	1920	1940	58.3
31	90	2400	2420	58.3
33	110	2620	2660	58.3

Article number 6SL4113-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 400 V, 50 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
35	132	-	C2: 3140 C3: 3120	67.9
36	160	-	C2: 4160 C3: 4130	67.9

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-28 Power loss according to NEC

Article number 6SL4113-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 480 V, 60 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
08	1.1	72.2	72.8	14.3
10	1.5	77.3	78.1	14.3
11	2.2	103	104	14.3
12	3	131	133	14.3
13	4	161	165	14.3
15	5.5	206	210	17.6
16	7.5	255	261	17.6
17	11	340	348	19.8
18	15	441	455	19.8
20	18.5	508	510	25.3
21	22	608	610	25.3
23	30	765	772	27.5
24	37	992	1000	27.5
26	45	1100	1120	31.9
27	55	1430	1450	31.9
30	75	1690	1700	58.3
31	90	2220	2240	58.3
33	110	2210	2230	58.3

Article number 6SL4113-0..□□-0..0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 480 V, 60 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
35	132	-	C2: 2470 C3: 2460	67.9
36	160	-	C2: 3020 C3: 3000	67.9

1) The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

2) Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 110 kW: Pulse frequency = 4 kHz
- Rated power ≥ 110 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.3 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, Clean Power, IP20 degree of protection

Technical data

Table 16-29 Power loss according to IEC

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in standby[2]
		@ 400 V, 50 Hz	
	in kW	in W	in W
16	7.5	456	32.2
17	11	590	32.2
18	15	781	32.2
20	18.5	794	32.2
21	22	936	32.2
23	30	1160	37.6
24	37	1440	37.6
26	45	1620	39.2
27	55	2130	39.2
30	75	2670	62.2

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in standby[2]
		@ 400 V, 50 Hz	
	in kW	in W	in W
31	90	3340	62.2
33	110	3810	67.1
35	132	4410	61.7
36	160	5800	61.7

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-30 Power loss according to NEC

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in standby[2]
		@ 480 V, 60 Hz	
	in kW	in W	in W
16	7.5	367	32.2
17	11	499	32.2
18	15	640	32.2
20	18.5	717	32.2
21	22	859	32.2
23	30	994	37.6
24	37	1290	37.6
26	45	1460	39.2
27	55	1890	39.2
30	75	2360	62.2
31	90	3110	62.2
33	110	3230	65.3
35	132	3560	81.0
36	160	4340	81.0

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 110 kW: Pulse frequency = 4 kHz
- Rated power ≥ 110 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.4 3 AC 200 V ... 240 V, IP55 degree of protection

Technical data

Table 16-31 Power loss according to IEC

Article number 6SL4112-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 230 V, 50 Hz	
	in kW	in W	in W
08	1.1	108	25.2
10	1.5	135	25.2
11	2.2	166	25.2
12	3	214	25.2
13	4	290	25.2
15	5.5	409	31.2
16	7.5	540	31.2
17	11	566	38.4
18	15	840	38.4
20	18.5	1060	38.4
21	22	1160	44.4
23	30	1540	44.4
24	37	1590	68.2
26	45	2030	68.2
27	55	2410	68.2

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-32 Power loss according to NEC

Article number 6SL4112-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 240 V, 60 Hz	
	in kW	in W	in W
08	1.1	101	25.2
10	1.5	112	25.2
11	2.2	150	25.2
12	3	186	25.2
13	4	225	25.2
15	5.5	328	31.2
16	7.5	429	31.2

Article number 6SL4112-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 240 V, 60 Hz	
	in kW	in W	in W
17	11	522	38.4
18	15	692	38.4
20	18.5	933	38.4
21	22	1010	44.4
23	30	1400	44.4
24	37	1340	68.2
26	45	1700	68.2
27	55	2080	68.2

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 55 kW: Pulse frequency = 4 kHz
- Rated power ≥ 55 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.5 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP55

Technical data

Table 16-33 Power loss according to IEC

Article number 6SL4113-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 400 V, 50 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
08	1.1	85.5	85.8	23.1
10	1.5	96.8	97.3	23.1
11	2.2	123	124	23.1
12	3	156	158	23.1
13	4	193	196	23.1
15	5.5	249	254	23.1
16	7.5	325	334	23.1

Article number 6SL4113-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 400 V, 50 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
17	11	440	448	28.6
18	15	573	585	28.6
20	18.5	557	560	29.7
21	22	655	660	29.7
23	30	887	895	35.2
24	37	1100	1120	35.2
26	45	1240	1240	40.7
27	55	1620	1630	40.7
30	75	1950	2000	82.5
31	90	2420	2450	82.5
33	110	2650	2680	82.5

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-34 Power loss according to NEC

Article number 6SL4113-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 480 V, 60 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
08	1.1	82.2	82.4	23.1
10	1.5	86.5	86.8	23.1
11	2.2	108	109	23.1
12	3	131	132	23.1
13	4	156	157	23.1
15	5.5	217	220	23.1
16	7.5	266	271	23.1
17	11	371	375	28.6
18	15	476	483	28.6
20	18.5	505	507	29.7
21	22	603	607	29.7
23	30	764	770	35.2
24	37	990	1000	35.2
26	45	1110	1120	40.7
27	55	1440	1450	40.7

Article number 6SL4113-0..□□-...0	Rated power	Absolute power loss at operating point (90/100)[1]		Absolute power loss in standby[2]
		@ 480 V, 60 Hz		
		Without line filter	With line filter	
	in kW	in W	in W	in W
30	75	1710	1720	82.5
31	90	2250	2270	82.5
33	110	2230	2260	82.5

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 110 kW: Pulse frequency = 4 kHz
- Rated power ≥ 110 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.6 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, Clean Power, IP55 degree of protection

Technical data

Table 16-35 Power loss according to IEC

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in standby[2]
		@ 400 V, 50 Hz	
	in kW	in W	in W
16	7.5	461	37.2
17	11	596	37.2
18	15	786	37.2
20	18.5	799	37.2
21	22	941	37.2
23	30	1160	43.6
24	37	1450	43.6
26	45	1630	47.2
27	55	2140	47.2
30	75	2700	85.3

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 400 V, 50 Hz	
	in kW	in W	in W
31	90	3360	85.3
33	110	3830	88.4

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Table 16-36 Power loss according to NEC

Article number 6SL4113-2..□□-2..0	Rated power	Absolute power loss at operating point (90/100)[1]	Absolute power loss in stand-by[2]
		@ 480 V, 60 Hz	
	in kW	in W	in W
16	7.5	372	37.2
17	11	495	37.2
18	15	645	37.2
20	18.5	722	37.2
21	22	864	37.2
23	30	1000	43.6
24	37	1300	43.6
26	45	1470	47.2
27	55	1900	47.2
30	75	2380	85.3
31	90	3140	85.3
33	110	3260	88.4

[1] The operating point (90/100) means: relative motor stator frequency 90%, relative torque current 100%

[2] Standby means: The power and electronics power supply are switched on, the motor is switched off.

Depending on the rated power of the converter, the power loss values apply under the following conditions:

- Rated power < 110 kW: Pulse frequency = 4 kHz
- Rated power ≥ 110 kW: Pulse frequency = 2 kHz
- The converter uses space-vector modulation to generate the output voltage. In the factory setting, modulator mode "Space-vector modulation" is active for the specified operating point.

16.8.7 Data regarding the power loss in partial load operation

Description

The energy efficiency and power loss data of SINAMICS frequency converters are compliant with the ecodesign standard IEC 61800-9-2 and the ecodesign regulation (EU) 2019/1781.

The standard IEC 61800-9-2 defines the ecodesign requirements for drive systems in the low-voltage range, based on an electrically driven machine in frequency converter operation.

Data regarding the power loss in partial load operation are documented in the converter data sheet. The data sheet is provided in the Siemens Product Configurator in the Internet.

SPC (https://mall.industry.siemens.com/spice/cloudcm/dashboard)

16.9 Measuring-surface sound-pressure level

Technical data

The table lists the maximum measuring-surface sound pressure level of standard converters and Clean Power converters.

Table 16-37 Maximum measuring-surface sound-pressure level, converter in degree of protection IP20/closed control cabinet and IP55

Frame size	Unit	1 m measuring-surface sound-pressure level
FSA	dB	55
FSB	dB	63
FSC	dB	67
FSD1	dB	70
FSD2	dB	70
FSE	dB	70
FSF1	dB	72
FSF2	dB	72

16.10 Inputs and outputs

Technical data

Table 16-38 Technical data of inputs and outputs

Property	Data
24 V supply	There are 2 options for the 24 V supply: • Internal power supply The converter generates its 24 V power supply internally from the line voltage. • External power supply Contact-safe SELV power supply via terminal strip X124 with 20.4 V - 28.8 V DC Maximum current consumed: 3 A The supply voltage must not exceed 60 V in the event of a fault. Voltages in excess of 60 V will permanently damage the converter.
Output voltages	• 24 V Maximum output current 200 mA • 10 V ± 0.5 V Maximum output current 10 mA
Digital input	Type 3 according to IEC 61131-2 Isolated using an optocoupler Maximum permissible input voltage 30 V Input voltage for "low" state: < 5 V Input voltage for state "high" > 11 V Current for state "high" 2.5 ... 4.0 mA Response time 0.25 ms
Rapid input	DI 5 Pulse frequency when used as pulse train input 32 kHz Response time when used as measurement sensing input 0.01 ms
Analog input	Differential input 16-bit resolution Response time 4 ms Overvoltage protection up to ±35 V Operating mode selection: • 0 V ... 10 V or -10 V ... 10 V: Input resistance 100 kΩ, maximum voltage 35 V • 0 mA ... 20 mA, 4 mA ... 20 mA: Input resistance 120 Ω, maximum voltage 8 V, maximum current 65 mA
Digital output	Transistor output DO 0 Reverse polarity protection Response time 3 ms 30 V DC / ≤ 0.5 A
	Relay outputs DO 1 and DO 2 Response time 3 ms 30 V DC / ≤ 0.5 A for a resistive load

Property	Data				
Analog output AO 0	16-bit resolution Operating mode selection: • 0 V ... 10 V, minimum load 10 kΩ • 0 mA ... 20 mA, maximum load 500 Ω Minimum response time: 0.25 ms < 50 mV offset at 0%				
Temperature sensor	Measuring current 2 mA				
		Short-circuit monitoring	Overtemperature	Wire-break monitoring	Remark
	Bimetal	-	-	-	For an overtemperature condition, the contact must open
	PTC	< 20 Ω	> 1650 Ω	-	Rated value
		< 35 Ω	> 1620 Ω	-	Rated value incl. maximum tolerance
	KTY84	< 50 Ω	-	> 1630 Ω	Rated value
		< 65 Ω	-	> 1600 Ω	Rated value incl. maximum tolerance
	Pt1000	< 603 Ω	-	> 1720 Ω	Rated value
		< 620 Ω	-	> 1690 Ω	Rated value incl. maximum tolerance
	Pt100	< 30 Ω	-	> 375 Ω	Rated value
Failsafe Digital Input F-DI 0	Type 3 according to IEC 61131-2 Input voltage ≤ 30 V Minimum response time 1 ms				
Failsafe Digital Output F-DO	Minimum load resistance 48 Ω Maximum load resistance 130000 Ω Short-circuit protection Overload protection Minimum response time 1 ms				

16.11 DVC properties of the connections

Technical data

Table 16-39 DVC classification of the connections

Connection	DVC classification according to IEC 61800-5-1
External +24 V power supply Terminal strip X124	DVC A
10 V output voltage Terminal strip X132	DVC A

Connection	DVC classification according to IEC 61800-5-1
24 V supply VS1 and VS2 Terminal strip X130	DVC A
(Fail-safe) digital inputs DI 0 ... DI 4 Terminal strip X131	DVC A
Rapid input DI 5 Terminal strip X131	DVC A
Analog inputs AI 0 and AI 1 Terminal strip X132	DVC A
Digital outputs Transistor output DO 0 Relay outputs DO 1 and DO 2 Terminal strip X133	DVC A
Fail-safe digital output F-DO 0 Terminal strip X130	DVC A
Analog output AO 0 Terminal strip X132	DVC A
Temperature sensor	DVC A
Fail-safe digital output F-DI 0 Terminal strip X130	DVC A
Line connection Terminals X1	DVC C
Motor connection Terminals X2	DVC C
Braking resistor connection Terminals X3 up to frame size FSC Terminals X4 from frame size FSD1	DVC C
Auxiliary contact of the maintenance switch for converters with IP55 degree of protection	DVC C
CM-PN communications module X150	DVC A
CM-DP communications module X126	DVC A
CM-RS485 communications module X125	DVC A

Connection		DVC classification according to IEC 61800-5-1
Option module OM-SMT X230, X500, X501		DVC B
Option module OM-IIoT X128, X500, X501		DVC A
Option module OM-DQ X501, X502		DVC A
Option module OM-DIO	X235	DVC A
	X236, X237	DVC A at 30 V DC DVC C at 250 V AC
	X500, X501	DVC A
Option Module OM-AIO X233, X234, X500, X501		DVC A
Expansion rack for option modules (ER-OM) X524		DVC A

The connections are exclusively intended for use in dry environments.

16.12 Safety Integrated Functions

16.12.1 Monitoring cycle and PROFIsafe cycle

Description

The Safety Integrated Functions are executed in the monitoring cycle (p9500).

The PROFIsafe telegrams are evaluated in the monitoring cycle.

16.12.2 Definition of WCDT and OFDT

Description

Two different response times are relevant for the Safety Integrated Functions:

- Worst Case Delay Time (WCDT):
  Maximum response time until stop response in fault-free drive system.
- One Fault Delay Time (OFDT):
  When the drive system has an active fault, a safety function is requested during the few milliseconds in which the converter has still not detected the fault or is still responding to the fault.

16.12.3 Response times when controlling via PROFIsafe

Technical data

The response times are converter-internal response times. Program runtimes in the F-CPU and the transmission time via PROFINET have not been taken into account. Consider the following with regard to the calculation of the response times between F-CPU and converter: Safety Integrated Functions are only selected after the PROFIsafe monitoring time (F_WD_Time) has elapsed, e.g. due to communication faults. The PROFIsafe monitoring time (F_WD_Time) must therefore also be included as a relevant component in the calculation when an error occurs. If the response time is to be determined based on control via PROFIsafe, then F_WD_Time must be added to the times specified here.

Notes regarding understanding the following table

The specified response times for a fault and worst case response time are applicable for the time from when the PROFIsafe telegram is received up until when the function is initiated.

Device Acknowledgement Time (DAT): Time between receiving a PROFIsafe telegram and sending a response to this telegram

State change at the failsafe digital input (F-DI): Response time when switching an F-DI up to sending the F-DI state in the PROFIsafe telegram to the F-CPU.

Table 16-40 Technical data - Response times

Response time	Value
DAT	2 · p9500 + t_K1 + t_K2
State change F-DI	p10017 + 2 · p9500 + 3.5 ms + t_K2

Function	Unit	Delayed response time when a fault occurs	Worst case response time	Final state
STO	ms	3 · p9500 + t_K1 + 0.5ms	2 · p9500 + t_K1 + 0.5ms	STO active
SS1 and SS2	ms	3 · p9500 + t_K1 + 2ms	2 · p9500 + t_K1 + 2ms	Brake ramp started
SS1E and SS2E	ms	3 · p9500 + t_K1	2 · p9500 + t_K1	Bit is set in the SIC

p9500: Monitoring cycle (factory setting: 4 ms)

If an isochronous PROFIsafe telegram is used, and synchronism with the F-CPU is optimally set, then p9500 can be reduced from 2 cycles to one cycle. Optimally matched: bus clock cycle = p9500. The F-CPU receives one PROFIsafe telegram per cycle from the converter, and the converter receives one PROFIsafe telegram per cycle from the F-CPU.

p10017: Input filter of the F-DI (factory setting: 4 ms)

t_K_1: Time for the internal converter communication when receiving a PROFIsafe telegram
- For isochronous communication: $t_K_1 = T_o$. Determine T_o from the bus configuration on the control side.
- For non-isochronous communication: $t_K_1 = 4$ ms

t_K_2: Time for the internal converter communication when sending a PROFIsafe telegram
- For isochronous communication: t_K_2 = bus cycle time.
  The bus cycle time is the send clock of the PROFINET controller.
- For non-isochronous communication: $t_K_2 = 4$ ms

16.12.4 Response times when controlling via terminals

Technical data

The following response times are applicable for stop functions for control via terminals of the failsafe digital input (F-DI). The response time of a stop function is the time between the selection of the stop function and the initiation of a stop response.

Table 16-41 Technical data - Response times

Function	Unit	Delay time when a fault occurs	Worst case delay time	Final state
STO	ms	p10017 + 3 · p9500 + 3.5 ms	p10017 + 2 · p9500 + 3.5 ms	STO active
SS1 and SS2	ms	p10017 + 3 · p9500 + 5.5 ms	p10017 + 2 · p9500 + 5.5 ms	Brake ramp started
SS1E and SS2E	ms	p10017 + 3 · p9500 + 3.5 ms	p10017 + 2 · p9500 + 3.5 ms	Bit is set in the Safety Info Channel

p10017: F-DI input filter (factory setting: 4 ms)
p9500: Monitoring cycle (factory setting: 4 ms)

16.12.5 Response times with encoder - independent of the control type

Technical data

The following response times apply for actual value acquisition with encoder.

The following response times of the monitoring functions are independent of the control type.

The response times of the individual Safety Integrated Functions are defined as follows:

- Safe Direction (SDI), Safely-Limited Speed (SLS), Safety Operating Stop (SOS) and Safety Limited Acceleration (SLA): The response time is the time between a limit value being violated and initiating the respective stop function.
- Safe Speed Monitor (SSM): The response time is the time between a limit value being violated up to sending the information via PROFIsafe.

Over-travel can be calculated using the calculated response time. It is also possible to measure over-travel according to ISO 13855.

Function	Unit	Response time when a fault occurs	Worst case response time
SOS and SDI	ms	3 · p9500 + t_R	2 · p9500 + t_R
SLS	ms	3.5 · p9500 + t_R	2.5 · p9500 + t_R
SSM	ms	3.5 · p9500 + p9545 [1] + t_K2	2.5 · p9500 + p9545 [1] + t_K2
SLA	ms	4 · p9500 + p9576 [1] + t_R	3 · p9500 + p9576 [1] + t_R

[1] The signal filters used are also included in the response times. However, the delay depends on the characteristic of the actual value. In a first approximation (e.g. for a ramp-shaped signal increase), the value of the filter time itself can be used as basis for the calculation.

p9500: Monitoring cycle (factory setting: 4 ms)

t_R: t_R depends on the relevant stop response initiated after the limit is breached:
- STO: 0.5 ms
- SS1/SS2: 2 ms

p9545: SSM filter time

t_K_2: Time for the internal converter communication when sending a PROFIsafe telegram
- For isochronous communication: $t_K_2 = T_{dp}$. Determine T_{dp} from the bus configuration on the control side.
- For non-isochronous communication: t_K_2 = 4 ms

p9576: SLA filter time

16.12.6 Response times encoderless - independent of the control type

Technical data

The following response times apply for encoderless actual value acquisition

The following response times of the monitoring functions are independent of the control type.

The response times of the individual Safety Integrated Functions are defined as follows:

- Safe Direction (SDI), Safely-Limited Speed (SLS), Safe Speed Monitor (SSM) und Safe Acceleration Monitor/Safe Braking Ramp (SAM/SBR): The response time is the time between a limit value being violated and initiating the respective stop function.
- Safe Speed Monitor (SSM): The response time is the time between a limit value being violated up to sending the information via PROFIsafe.

Over-travel distances can be calculated using the calculated response time. It is also possible to measure over-travel according to ISO 13855.

Table 16-42 Standard

Function	Response time when a fault occurs	Worst case response time
SDI	3 · p9500 + p9587 + 32 ms + t_R	2 · p9500 + p9587 + 6 ms + t_R
SLS	3.5 · p9500 + p9587 + 32 ms + t_R	2.5 · p9500 + p9587 + 6 ms + t_R
SSM	3.5 · p9500 + p9545 [1)]+ p9587 + 32 ms + t_K2	2.5 · p9500 + p9545 + p9587 + 6 ms + t_K2
SAM / SBR	4 · p9500 + p9587 + 32 ms + t_R	3 · p9500 + p9587 + 6 ms + t_R

Table 16-43 Start phase

Function	Response time when a fault occurs	Worst case response time
	Start phase	**Start phase**
SDI	3 · p9500 + p9587 + p9586 + 32 ms + t_R	2 · p9500 + p9587 + p9586 + 6 ms + t_R
SLS	3.5 · p9500 + p9587 + p9586 + 32 ms + t_R	2.5 · p9500 + p9587 + p9586 + 6 ms + t_R
SSM	3.5 · p9500 + p9545 + p9587 + p9586 + 32 ms + t_K2	2.5 · p9500 + p9545 + p9587 + p9586 + 6 ms + t_K2
SAM / SBR	4 · p9500 + p9587 + p9586 + 32 ms + t_R	3 · p9500 + p9587 + p9586 + 6 ms + t_R

p9500: Monitoring cycle (factory setting: 4 ms)

p9586: Actual value acquisition delay time (factory setting: 100 ms)

p9587: Actual value acquisition without encoder filter time (factory setting: 25 ms)

p9545: SSM filter time (factory setting: 0 ms)

t_R: t_R depends on the relevant stop response initiated after the limit is breached:
- STO: 0.5 ms
- SS1: 2 ms

t_K_2: Time for the internal converter communication when sending a PROFIsafe telegram
- For isochronous communication: $t_K_2 = T_{dp}$. Determine T_{dp} from the bus configuration on the control side.
- For non-isochronous communication: $t_K_2 = 4$ ms

Standard: This behavior applies when the pulses have already been enabled.

Start phase: This behavior is applicable after switching on (ON command with previously canceled pulses).

A different behavior applies as when p9586 is used, the encoderless actual value acquisition after pulse enable can only be activated with a delay.

16.13 SINAMICS SDI Standard

Technical data

Table 16-44 Technical data for SINAMICS SDI Standard

Property	Description
Display	1.4" Color 128 x 160 pixels
Converter service interface	X127 service interface (1 RJ45)
Supported languages	English, German, Chinese, Italian, French, Spanish

16.14 Option modules

16.14.1 Option module OM-SMT

Technical specifications

Table 16-45 Technical specifications Option Module OM-SMT

Property	Value
Temperature sensor	Type A according to IEC 60947-8 and EN 50495
Overtemperature message	
• No overtemperature	R < 1100 Ω
• Overtemperature	R > 2100 Ω
Short-circuit detection	
• No short-circuit	R > 20 Ω
• Short-circuit	R < 10 Ω
Max. delay time	
• Motor temperature or internal error	300 ms
• Short-circuit or wire break	1 s
Max. current consumption (at 24 V DC)	0.15 A

16.14.2 Option module OM-IIoT

Technical data

Table 16-46 Technical data option module OM-IIoT

Property	Value
Maximum transmission rate	100 Mbit/s
Max. current consumption (at 24 V DC)	0.30 A

16.14.3 Option module OM-DQ

Technical data

Table 16-47 Technical data option module OM-DQ

Property	Value
Max. current consumption (at 24 V DC)	0.75 A
Transfer rate	100 Mbit/s

16.14.4 OM-ENC option module

16.14.4.1 General technical specifications

Technical data

Table 16-48 General data of the option module

Property	Value
Net weight (g)	84
Degree of protection	IP20 according to IEC 60529/UL open type
Degree of pollution	2 according to IEC 61800-5-1
Overvoltage category	II according to IEC 61800-5-1
Safety insulation class	SELV
Power supply voltage (V_{DC})	24 (20.4 ... 28.8)
Max. current consumption without encoders (A_{DC})	0.1 at 24 V
Max. power loss without encoders (W)	2.4
Output voltage to encoders (V)	5 (with or without remote sense) or V_{DC} - 1 V
Max. current consumption with encoders (A_{DC})	0.45

Property	Value
Max. encoder current demand (A_{DC})	≤ 0.35
Max. power loss with encoders (W)	10.8
Encoder frequency that can be evaluated (kHz)	≤ 500
SSI baud rate (kbaud)	100 ... 1000

16.14.4.2 Technical data for encoder connection

Technical data

Encoder signal levels

Table 16-49 Encoder signal levels

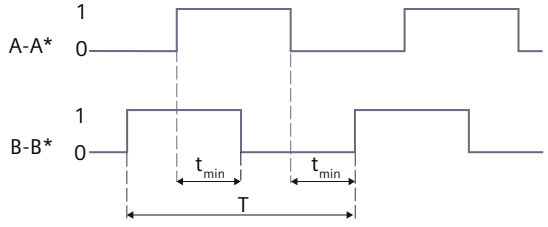
Encoder type	Signal level	Signal voltage (V)	
		Minimum	Maximum
TTL encoder (bipolar)[1]	High	2	5
	Low	-5	-2
HTL encoder (unipolar, with high threshold)[3]	High	17	V_{CC}[2]
	Low	0	7
HTL encoder (unipolar, with low threshold)[3]	High	10	V_{CC}[2]
	Low	0	2
HTL encoder (bipolar)	High	3	V_{CC}[2]
	Low	-V_{CC}[2]	-3
SSI encoder (bipolar)[1]	High	2	5
	Low	-5	-2

[1] Unspecified signal levels are defined according to the RS-422 standard.

[2] The signals are referenced to the encoder power supply voltage V_{CC}.

[3] The switching threshold is configurable via software.

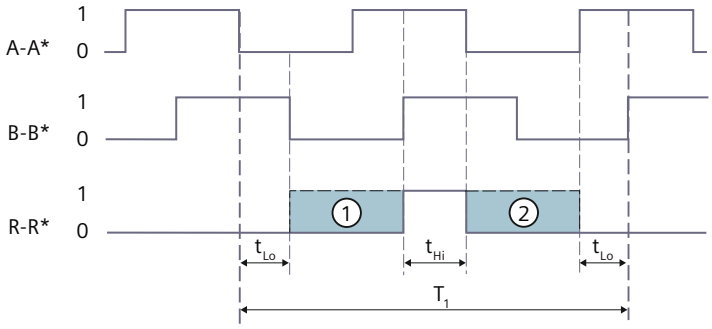
Phasing characteristics



T Time period of one cycle

T_{min} Edge clearance

Figure 16-10 Signal characteristics, without reference signal



T_1 Time interval between the falling edge of Channel A and the second subsequent rising edge of Channel B

t_{Lo} Zero pulse inactive time

t_{Hi} Zero pulse active time

① Tolerance range for the rising edge of the zero pulse

② Tolerance range for the falling edge of the zero pulse

Figure 16-11 Signal characteristics, with reference signal

Table 16-50 Signal characteristics

Property	Value (ns)
Edge clearance (t_{min})	≥ 100
Zero pulse inactive time (t_{Lo})	640 ... (T_1 - t_{Hi})/2
Zero pulse active time (t_{Hi})	640 ... T_1 - 2t_{Lo}

16.14.4.3 Technical data for temperature sensor connection

Technical data

Table 16-51 Technical data of temperature sensor connection

Property			Value
Measuring current			2 mA
PTC	Measuring accuracy		±5 °C
	Short-circuit monitoring	Rated value	< 20 Ω
		Rated value with maximum tolerance	< 35 Ω
	Overtemperature	Rated value	> 1650 Ω
		Rated value with maximum tolerance	> 1620 Ω
KTY84	Measuring accuracy		±7 °C
	Short-circuit monitoring	Rated value	< 50 Ω
		Rated value with maximum tolerance	< 65 Ω
	Wire-break monitoring	Rated value	> 1630 Ω
		Rated value with maximum tolerance	> 1600 Ω

Property			Value
Pt1000	Measuring accuracy		±5 °C[1)]
	Short-circuit monitoring	Rated value	< 603 Ω
		Rated value with maximum tolerance	< 620 Ω
	Wire-break monitoring	Rated value	> 1720 Ω
		Rated value with maximum tolerance	> 1690 Ω

1) Pt1000 tolerance class B acc. to DIN EN 60751

16.14.5 OM-DIO option module

16.14.5.1 General technical specifications

Technical data

Table 16-52 General data of the option module

Property	Value
Net weight (g)	97
Degree of protection	IP20 according to IEC 60529/UL open type
Degree of pollution	2 according to IEC 61800-5-1
Overvoltage category	According to IEC 61800-5-1 • X235: OVC II • X236 and X237: OVC III
Safety insulation class	SELV

16.14.5.2 Specific technical data

Technical data

Table 16-53 Specific data of the option module

Property	Explanation
Operating voltage	The option module is supplied by the following sources: • External supply via terminals X235:8 and X235:9 with 20.4 V ... 28.8 V DC • Internal supply from the converter or the ER-OM that the option module is mounted on
Max. current consumption (A_{DC})	• 0.1 at 24 V

Property		Explanation
Bidirectional digital inputs (DI 0 ... 3)		• Type 3 according to IEC 61131-2 • Isolated using an optocoupler • Maximum permissible input voltage 30 V • Input voltage for "low" state: < 5 V • Input voltage for state "high" > 11 V • Current for state "high" 2.5 mA ... 4.0 mA • Response time 0.25 ms • Support PNP wiring only
Digital outputs	Bidirectional digital outputs: DO 0...3	• Electrically isolated • Reverse polarity protection • 30 V DC/≤ 0.5 A with a resistive load • Output current for "low" state: ≤ 0.5 mA
	Relay outputs: DO 4...6	• 250 V AC/≤ 2 A with a resistive load • 30 V DC/≤ 2 A with a resistive load

16.14.6 Option Module OM-AIO

16.14.6.1 General technical data

Technical data

Table 16-54 General technical data of the option module

Property	Value
Net weight (g)	84
Degree of protection	IP20 according to IEC 60529/UL open type
Degree of pollution	2 according to IEC 61800-5-1
Overvoltage category	II according to IEC 61800-5-1
Safety insulation class	SELV

16.14.6.2 Specific technical data

Technical data

Table 16-55 Specific technical data of the option module

Property	Explanation
Max. current consumption (A_{DC})	0.1 at 24 V
Analog inputs (AI 0 ... 2)	• Differential inputs • Resolution: 16 bits + sign • Response time: 4 ms • Overvoltage protection up to ±35 V • Operating mode selection: – 0 V ... 10 V or -10 V ... 10 V: input resistance 100 kΩ, maximum voltage 35 V – 0 mA ... 20 mA, 4 mA ... 20 mA: input resistance 120 Ω, maximum voltage 8 V, maximum current 65 mA
Analog outputs (AO 0 ... 1)	• Resolution: 16 bits • Operating mode selection: – 0 V ... 10 V: minimum load 10 kΩ – 0 mA ... 20 mA: maximum load 500 Ω • Minimum response time: 0.25 ms • < 50 mV offset at 0%

16.15 Expansion Rack for Option Modules (ER-OM)

Technical data

Table 16-56 Technical data, Expansion Rack for Option Modules (ER-OM)

Property	Value
Degree of protection	IP20 according to IEC 60529/UL Open Type
Degree of pollution	2 according to IEC 61800-5-1 Condensation not permissible
Operating voltage	External power supply via terminal strip X542 • Touch-safe SELV power supply 20.4 V ... 28.8 V DC • OVC II according to IEC 61800-5-1
Current consumption (at 24V DC)	0.1 A

16.16 Communications modules

16.16.1 CM-PN communications module

Technical specifications

Table 16-57 Technical specifications of the CM-PN communications module

Property	Value
Maximum transmission rate	100 Mbit/s

16.16.2 CM-DP communications module

Technical specifications

Table 16-58 Technical specifications of the CM-DP communications module

Property	Value
Maximum transmission rate	12 Mbit/s
Maximum data transfer rate FSB, FSC, IP55	Reduction to 1.5 Mbit/s

16.16.3 CM-RS485 communications module

Technical specifications

Table 16-59 Technical specifications of the CM-RS485 communications module

Property	Value
Maximum transmission rate	187.5 kbit/s

16.17 Braking resistor

16.17.1 Connection for braking resistor

Technical data

Table 16-60 Connection for braking resistor

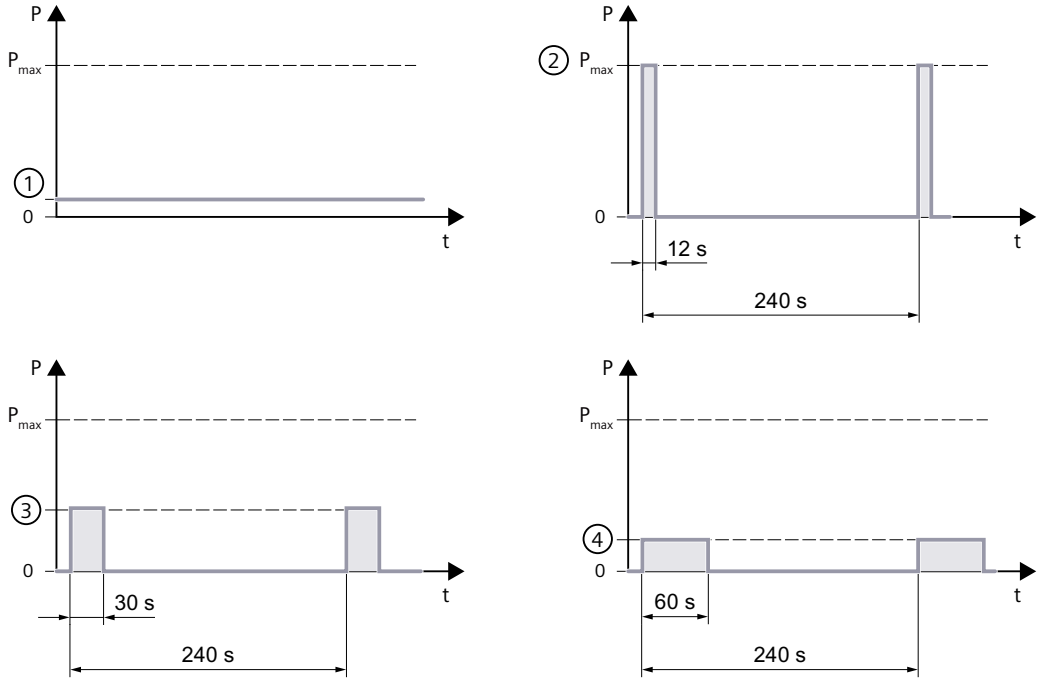
Property	Data	
	Frame sizes to FSC X3:DCP, R	Frame sizes from FSD1[1)] X4:R1, R2
Maximum braking power	100 % of the converter rated power with Low Overload	
Maximum load time with maximum braking power	240 s	120 s
Required cooling time in the 240 s load cycle	---	120 s
Overcurrent protection	Yes	

[1)] Internal braking chopper up to frame size FSF1

16.17.2 Current carrying capacity of the braking resistor

Description

The following overview shows examples for the load rating of the braking resistor as a function of the braking power.



P_{max} Maximum braking power

240 s Cycle time = running time + cooling time

Examples

① Rated braking power

② Maximum braking power = 20 times the rated braking power

Running time = cycle time / 20	12 s
Cooling time	228 s

③ Braking power = 8 times the rated braking power

Running time = cycle time / 8	30 s
Cooling time	210 s

④ Braking power = 4 times the rated braking power

Running time = cycle time / 4	60 s
Cooling time	180 s

Figure 16-12 Load rating of the braking resistor with different braking powers

16.17.3 Electrical data of the braking resistor

Technical data

Table 16-61 Electrical data for braking resistor, line voltage 3 AC 200 ... 240 V

Property	Unit	Article number		
		JJY:023151720007	JJY:023163720018	JJY:023433720001
Resistance	Ω	68	37	20
Maximum braking power P_{max}	kW	2.2	4.0	7.5
Rated braking power	kW	0.11	0.2	0.375

Table 16-62 Electrical data for braking resistor, line voltage 3 AC 200 ... 240 V

Property	Unit	Article number		
		JJY:023422620002	JJY:023423320001	JJY:023434020003
Resistance	Ω	7.5	4.5	2.5
Maximum braking power P_{max}	kW	18.5	30	55
Rated braking power	kW	0.93	1.5	2.75

Table 16-63 Electrical data braking resistor, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property	Unit	Article number		
		6SL3201-0BE14-3AA0	6SL3201-0BE21-0AA0	6SL3201-0BE21-8AA0
Resistance	Ω	370	140	75
Maximum braking power P_{max}	kW	1.5	4.0	7.5
Rated braking power	kW	0.075	0.2	0.375

Table 16-64 Electrical data braking resistor, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property	Unit	Article number		
		6SL3201-0BE23-8AA0	JJY:023422620001	JJY:023424020001
Resistance	Ω	30	25	15
Maximum braking power P_{max}	kW	18.5	22	37
Rated braking power	kW	0.925	1.1	1.85

Table 16-65 Electrical data braking resistor, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property	Unit	Article number		
		JJY:023434020001	JJY:023454020001	JJY:023464020001
Resistance	Ω	10.5	7.1	5.0
Maximum braking power P_{max}	kW	55	77	110
Rated braking power	kW	2.75	3.85	5.5

16.18 Electrical data dv/dt filters plus VPL

Technical data

Table 16-66 Electrical data du/dt filter plus VPL, line voltage 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property		Unit	Article number				
			JTA:TEF1203-0HB	JTA:TEF1203-0JB	JTA:TEF1203-0KB	JTA:TEF1203-0LB	JTA:TEF1203-0MB
Inductance		mH	1.2	0.9	0.53	0.37	0.22
Rated current	At 2 kHz pulse frequency [1]	A	45.2	66.7	103	146	260
	At 4 kHz pulse frequency [2]	A	27.1	40.0	61.8	87.6	156
Power loss at 50 Hz		W	324	438	415	519	1142
Maximum voltage rate of rise at the motor terminals		V/µs	< 500	< 500	< 500	< 500	< 500
Maximum voltage, phase to phase at the motor terminals	For line voltage 400 V	V	800	800	800	800	800
	For line voltage 500 V	V	1000	1000	1000	1000	1000
Maximum voltage, phase to ground at the motor terminals	For line voltage 400 V	V	650	650	650	650	650
	For line voltage 500 V	V	813	813	813	813	813

[1] If the du/dt filter plus VPL is activated in the converter, the converter reduces the pulse frequency to 2 kHz

[2] 4 kHz pulse frequency requires a reduction of the converter output current

16.19 Electrical data, sine-wave filter

Technical data

Table 16-67 Electrical data sine-wave filter, line voltage, IP 20, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property	Unit	Article No. 6SL3202-				
		0AE21-1SA0	0AE21-4SA0	0AE22-0SA0	0AE24-6SA0	0AE26-2SA0
Inductance	mH	3.5	2.7	2.4	0.8	0.6
Capacitance	µF	2.2	2.7	3.3	9.9	14.1
Power loss	W	0.052	0.085	0.099	0.185	0.152

Table 16-68 Electrical data sine-wave filter, line voltage, IP 20, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Property	Unit	Article No. 6SL3202-	
		0AE28-8SA0	0AE31-8SA0
Inductance	mH	0.4	0.2
Capacitance	µF	19.8	42.3
Power loss	W	0.251	0.47

Get more information

SINAMICS:
www.siemens.com/sinamics

SiePortal:
www.siemens.com/sieportal