Edition

12/2024

OPERATING INSTRUCTIONS

SINAMICS

G220

Converter

SIEMENS

SIEMENS

SINAMICS

G220
SINAMICS G220 converter

Operating Instructions

Edition 12/2024, Firmware V6.2

12/2024, FW V6.2
A5E51781573B AD

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING
Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens Aktiengesellschaft. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction 1

1.1 About SINAMICS

Description

With the SINAMICS converter series you can solve drive tasks in the low, medium and DC voltage range. All Siemens drive components, such as converters, motors, and controls, are matched to each other and can be integrated into your existing automation systems.

You can find more information via the SINAMICS YouTube playlist (https://www.youtube.com/playlist?list=PLw7ILwXw4H53rtHeTeifKtVMr2aXTYt0X).

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 relevant constraints of the respective product contained in the product documentation.

1.2.2 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

1.2.3 What's new?

Description

The most important supplements with respect to Edition 06/2024:

- The converter with IP55 or UL type 12 degree of protection has a separate connection for the protective conductor of the braking resistor from frame size FSD2.
  You can find more information in chapter "Connection overview, converter in degree of protection IP55 (Page 155)".
- Clean Power converter with IP55 or UL type 12 degree of protection
  - The hardware properties of the Clean Power converter are provided in the following chapters:
    "Weight, converter in degree of protection IP55 (Page 83)"
    "Current harmonics with Clean Power converter (Page 70)"
    "Achievable EMC category and maximum motor cable length (Page 71)"
    "Power loss (Page 812)"
  - For information about EMC-compliant installation, refer to chapter "EMC measures for braking resistor, Clean Power converter with degree of protection IP55 (Page 80)"
  - For information on mounting the shield plate for the braking resistor connecting cable, refer to chapter "Shield plate for converter with degree of protection IP55 (Page 93)".

Corrections with respect to Edition 06/2024:

- The vertical spacing of the holes for the converter with frame size FSA is 275 mm (not 272 mm).
  The corrected values are listed in chapter "Installation, converter in degree of protection IP20 (Page 124)".
- Minor corrections have been made to some of the specified converter dimensions.
  The corrected values are listed in chapter "Dimensions, converter in degree of protection IP20 (Page 123)".

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

This documentation contains recommendations relating to third-party products. Siemens accepts the fundamental suitability of these third-party products. You can use equivalent products from other manufacturers.

Siemens does not accept any warranty for the use of third-party products.

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 project documentation for the converter can be found on the Internet:

SiePortal Sinamics G220 (https://sieportal.siemens.com/su/bjRVw)

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	Content
Information about the converter	Operating instructions SINAMICS G220	Installing, commissioning and maintaining the converter
	List Manual SINAMICS G220	Meaning, setting options and dependencies of the parameters and messages of the converter
	Protective devices for SINAMICS G220	Suitable components for overcurrent protection of the converter Expansion of components contained in the operating instructions
General information	Industrial Cybersecurity Configuration Manual	Industrial Cybersecurity functions and safe operation of the converter
Information about the 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
	SINAMICS Smart Adapter operating instructions	Installing a local wireless network with the SINAMICS Smart Adapter to commission and diagnose the converter using an operating unit

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: SIOS (https://support.industry.siemens.com/cs/ww/en/)
  - App Industry Online Support (for Apple iOS and Android)

Product-specific information via ID link

The QR code on your product and on the product packaging contains the ID link.

ID link is a globally unique identifier according to IEC 61406-1.

You can use the ID link to access product data, manuals, Declarations of Conformity, certificates and other information about your product.

Figure 1-1 QR code with ID link included

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 online spare part service "Spares on Web (https://www.sow.siemens.com)" offers spare parts for the product.

1.5 Important product information

1.5.1 Intended use

Requirement

WARNING

Death or serious injury if not used as intended

Not using as intended 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.

- 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.

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

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.

1.5.2 Firmware updates and constraints

Description

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

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

1.5.3 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.

1.5.4 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 if there is no ground connection

For missing or incorrectly implemented protective conductor connection for devices with protection class I, high voltages can be present at open, exposed parts, which when touched, can result in death or severe injury.

- Ground the device in compliance 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 due to equipment damage

Improper handling 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.

- Ensure compliance with the limit values specified in the technical data during transport, storage and operation.
- Do not use any damaged devices.

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

Damage to equipment due to unsuitable tightening tools.

Unsuitable tightening tools or fastening methods can damage the screws of the equipment.

- Only use screw inserts that exactly match the screw head.
- 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.
- Adjust the tools used regularly.

NOTICE

Property damage due to loose power connections

Insufficient tightening torques or vibration can result in loose power connections. This can result in damage due to fire, device defects or malfunctions.

- Tighten all power connections to the prescribed torque.
- Check all power connections at regular intervals, 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 movement caused by radio devices or cellphones

Using radio devices, cellphones, or mobile WLAN devices in the immediate vicinity of the components can result in equipment malfunction or faults and damage to the devices. Malfunctions may impair the functional safety of machines and can therefore put people in danger or lead to property damage.

- Avoid operating radio devices, cellphones and mobile WLAN devices in the direct vicinity of converters and operating units.
- Scan the machine readable code, e.g. a QR code, from a greater distance or switch off the converter power supply before scanning.
- Only operate built-in devices with the control cabinet doors closed.
- When control cabinet doors are open, only qualified electrical personnel are allowed to carry out service and maintenance work.

⚠ CAUTION

Radio frequency interference in residential areas

When you operate EMC category C2 devices in residential areas, the devices can cause radio frequency interference.

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

- Do not operate EMC category C2 devices in residential areas.
- Do not operate EMC category C3 or C4 devices in public low-voltage networks supplying 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 overheating of components with subsequent fire and smoke. This can cause severe injury or even death. This can also result in increased downtime and reduced service lives for devices/systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

NOTICE

Overheating due to inadmissible mounting position

The device may overheat and therefore be damaged if mounted in an inadmissible position.

- Only operate the device in admissible 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
Device damage caused by incorrect insulation resistance tests
High test voltages can damage the device. • 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
Device damage caused by incorrect voltage tests
High test voltages can damage the device. Capacitive leakage currents can distort the test results. • Disconnect the components before carrying out a voltage test on the machine. 1)

1) The components are voltage tested 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 Equipment damage due to electric fields or electrostatic discharge

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.

NOTICE

Equipment damage due to electric fields or electrostatic discharge

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g conductive foam rubber of aluminum foil.
- Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, 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://new.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 by 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.

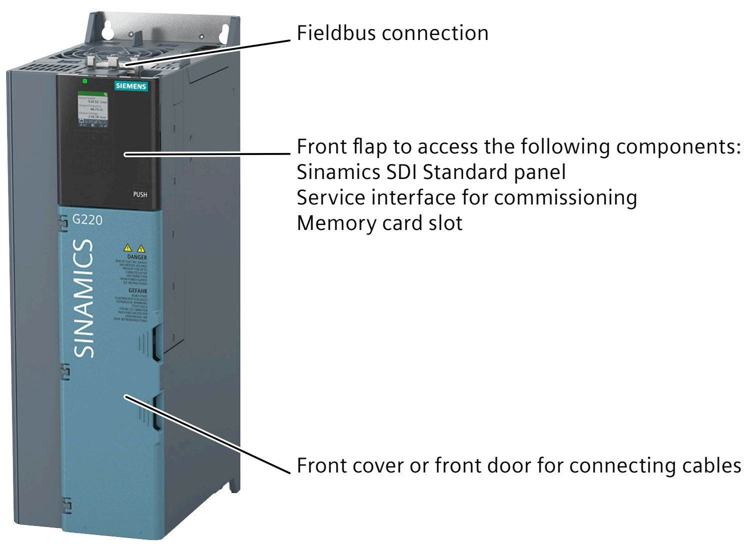


Figure 3-1 Converter FSC in degree of protection IP20

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 supplementary fan, if more than 2 option modules are installed in the converter ex factory
- 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

- For filtered converters:
  1 set of 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

Description

The converter in 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.

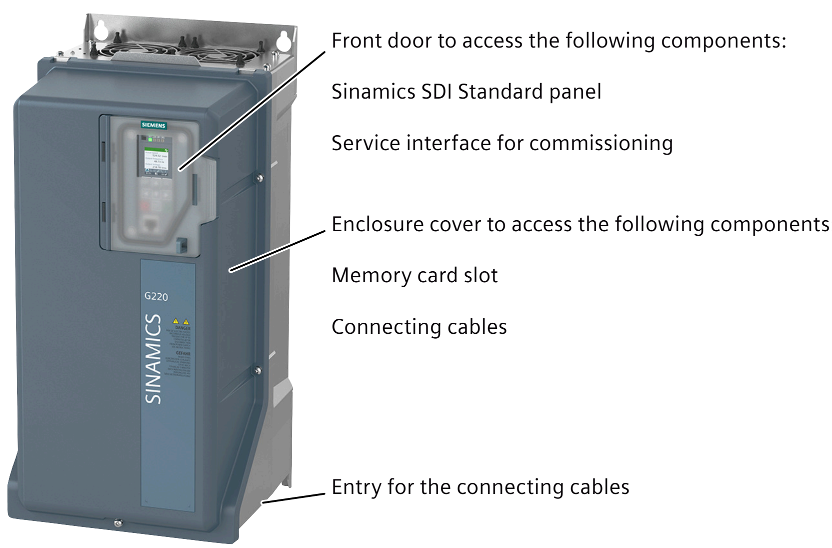


Figure 3-2 Converter in degree of protection IP55, frame size FSC

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" operating unit in the converter, the operating unit is correctly mounted when it is located in its 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 supplementary fan, if more than 2 option modules are installed in the converter in the factory
- Snap ferrites and toroidal cores for Clean Power converters:
  - 4 snap ferrites Würth WE 74271251 for frame size FSD1
  - 1 snap ferrite Würth WE 74271251 and 12 toroidal cores TDK B64290A0730X010 for frame size FSD2
  - 2 snap ferrites Würth WE 74271251 and 12 toroidal cores TDK B64290A0730X010 for frame size FSE
- 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 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	
											A		Converter without communication module
											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
						.	.						Coding for the rated power
					A								Basic version
					P								Gland plate for connecting cables with IP55 degree of protection 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, IP55 degree of protection, Class 3C2
				K									UL type 12, IP55 degree of protection, Class 3C3
				L									UL type 12, IP55 degree of protection, Class 3C2, maintenance switch (available soon)
				M									UL type 12, IP55 degree of protection, Class 3C3, maintenance switch (available soon)
			0										Converter in the standard version
			2										Clean Power Converter
	2												3 AC 200 ... 240 V
	3												3 AC 380 ... 500 V

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					

3.6 Optional components

3.6.1 Shield plates and replacement parts

3.6.1.1 Function of the shield plates

Description

The shield plates provide the option of connecting the shield directly at converters with degree of protection IP20. As a consequence, shield plates simplify EMC-compliant installation.

3.6.1.2 Ordering data for shield plates and spare parts

Option Module	
Designation	**Article number**
Shield connection kit 1 FSA + extension adapter for option modules + terminals	6SL4900-0AM20-0AA0
Shield connection kit 2 FSB + terminals	6SL4900-0AM20-1AA0
Shield connection kit 3 FSC + terminals	6SL4900-0AM20-2AA0
Shield connection kit 4 FSD1	6SL4900-0AM20-3AA0
Shield connection kit 5 FSD2	6SL4900-0AM20-4AA0
Shield connection kit 6 FSE	6SL4900-0AM20-5AA0

Kit 1 ... kit 3 also include the pluggable connection terminals as spare part for line supply, motor and braking resistor.

Kit 1 also includes the extension adapter for option modules.

3.6.2 Braking resistor

3.6.2.1 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

3.6.2.2 Order data for braking resistor, degree of protection IP21

Table 3-2 Order data, line voltage 3 AC 200 ... 240 V

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

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

Table 3-3 Order data, line voltage 3 AC 380 ... 480 V/500 V

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
18.5 kW ... 22 kW	JJY:023422620001
30 kW ... 37 kW	JJY:023424020001
45 kW ... 55 kW	JJY:023434020001

3.6.3 Memory card

3.6.3.1 Memory card function

Description of function

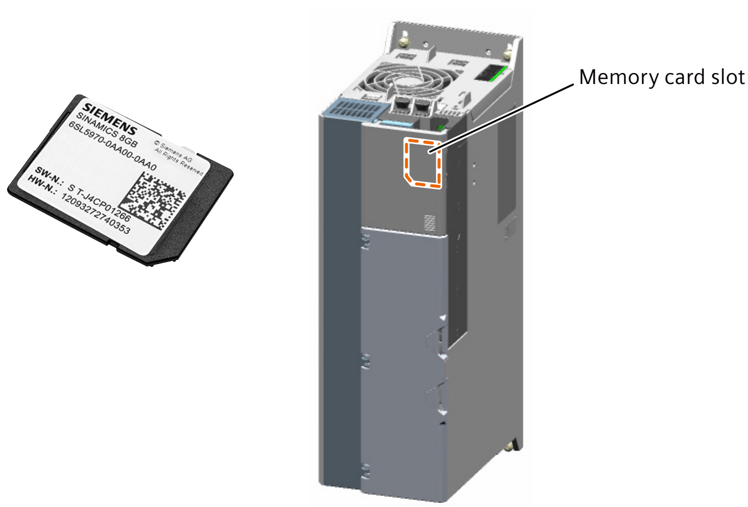


Figure 3-3 Memory card, slot based on example of converter in degree of protection IP20

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.

A memory card from Siemens or a third-party manufacturer is suitable for the following situations:

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

3.6.3.2 Memory card ordering data

Memory card (SD card)	
Memory card content	**Article number**
empty	6SL5970-0AA00-0AA0
License "Motor Control Extended"	6SL5970-0AA00-0AA0-Z H01
License "Safety Integrated Extended Functions"	6SL5970-0AA00-0AA0-Z F01
Licenses "Motor Control Extended" and "Safety Integrated Extended Functions"	6SL5970-0AA00-0AA0-Z H01+F01
Firmware V6.2	6SL4170-1GC00-0AA0
Firmware V6.2 + license "Motor Control Extended"	6SL4170-1GC00-0AA0-Z H01
Firmware V6.2 + license "Safety Integrated Extended Functions"	6SL4170-1GC00-0AA0-Z F01
Firmware V6.2 + licenses "Motor Control Extended" and "Safety Integrated Extended Functions"	6SL4170-1GC00-0AA0-Z H01+F01
License "Motor Control Extended" (Download)	6SL5977-0AA00-1DA0
License "Safety Integrated Extended Functions" (download)	6SL5977-0AA00-2HA0

3.6.4 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 explosive areas.

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 3-4 Option Module OM-SMT

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.

3.6.5 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 24V power supply at converter terminal strip X124 is required to operate option module OM-IIoT.

Description

Figure 3-5 Option module OM-IIoT

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

3.6.6 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

Terminal strip X124 of the converter must be supplied with 24 V to use the 24 V supply of the DRIVE-CLiQ interface.

Description

Figure 3-6 Option module OM-DQ

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

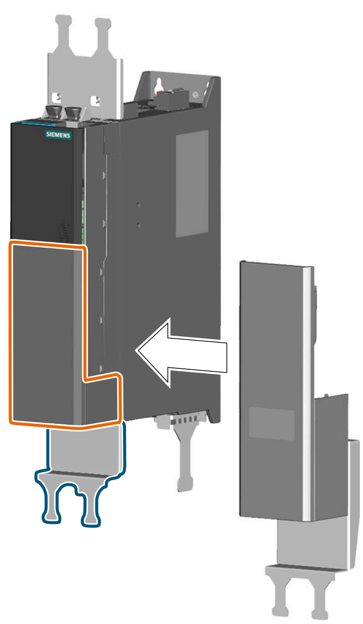
3.6.7 Ordering data for option modules

Option Module	
Designation	**Article number**
Option Module OM-SMT	6SL4950-0AL00-0FA0
Option Module OM-IIoT	6SL4950-0AL00-0EA0
Option Module OM-DQ	6SL4950-0AL00-0BA0

3.6.8 Expansion adapter for option modules

3.6.8.1 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.

3.6.8.2 Order data, expansion adapter for option modules

Expansion adapter for option modules	
Designation	**Article number**
Expansion adapter for option modules	6SL4960-0AM01-0AA0

3.6.9 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 option module OM-DQ:

- DRIVE-CLiQ encoder
- SMC20 Sensor Module
  Article number 6SL3055-0AA00-5BA3
- SMC30 Sensor Module
  Article number 6SL3055-0AA00-5CA2

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.

3.6.10 SINAMICS Smart Adapter

3.6.10.1 Function of the SINAMICS Smart Adapter

Description

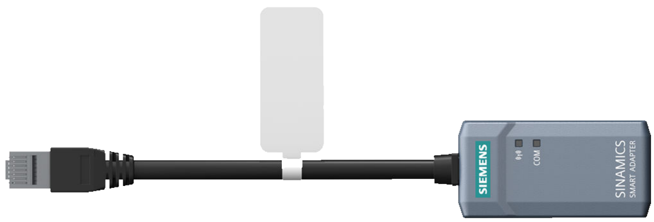


Figure 3-7 SINAMICS Smart Adapter

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.

3.6.10.2 SINAMICS Smart Adapter ordering data

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

3.6.11 SINAMICS SDI Pro 5.5"

3.6.11.1 Function of the SINAMICS SDI Pro 5.5"

Description

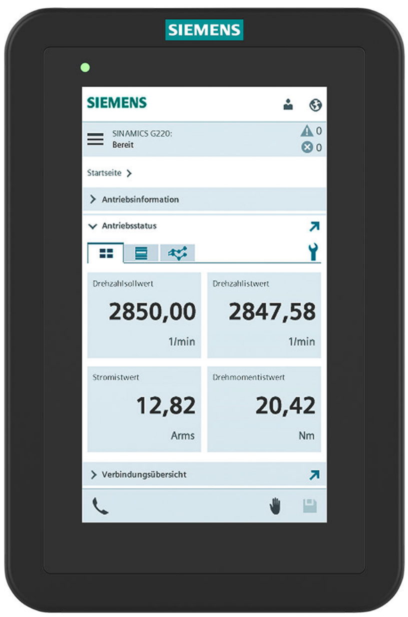


Figure 3-8 SINAMICS SDI Pro 5.5"

The SINAMICS SDI Pro 5.5" control panel can be used to commission and diagnose the drive.

3.6.11.2 SINAMICS SDI Pro 5.5" order data

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

3.6.12 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)

3.7 Directives and standards

EC Declaration of Conformity

European Machinery Directive

The converters fulfill the requirements stipulated in the Machinery Directive 2006/42/EC, if they are covered by the application area of this directive.

However, the use of the converters in a typical machine application has been fully assessed for compliance with the main regulations in this directive concerning health and safety.

European Low-Voltage Directive

The converter fulfills the requirements stipulated in the Low-Voltage Directive 2014/35/EU, insofar as they are covered by the application area of this directive.

Directive 2011/65/EU

The converters fulfill the requirements stipulated in Directive 2011/65/EU relating to the restriction of the use of certain hazardous substances in electrical and electronic devices (RoHS).

European EMC Directive

The compliance of the converter with the regulations of the Directive 2014/30/EU has been demonstrated by full compliance with IEC/EN 61800-3.

Ecodesign Directive 2009/125/EC

The converter meets the requirements of Ecodesign Directive 2009/125/EC.

UKCA Declaration of Conformity

The converter 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.

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)

Converters provided with the test symbols displayed fulfil the requirements stipulated for the North American market as a component of drive applications.

Australia and New Zealand (RCM)

Converters with the symbols shown comply with requirements relating to electromagnetic compatibility for Australia and New Zealand.

EMC requirements for South Korea

Converters with the KC marking on the nameplate fulfill the EMC requirements relating to electromagnetic compatibility for South Korea.

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다. For sellers or other users, please bear in mind that this device is an A-grade electromagnetic wave device. This device is intended to be used in areas other than at home.

Standard SEMI F47-0706

The converter fulfills the requirements of standard SEMI F47-0706.

China Compulsory Certification

The converters do not fall in the area of validity of the China Compulsory Certification (CCC).

Eurasian conformity

The converters fulfill the requirements of the Russia/Belarus/Kazakhstan customs union (EAC).

ISO 9001 and ISO 14001 quality systems

Siemens AG employs a quality management system that complies with 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 converters comply with the requirements laid down in Directive 2012/19/EU with regard to returning and recycling scrap electrical and electronic equipment.

Certificates for download

You can find the certificates and manufacturer declarations for the converter on the Internet:

EU Declaration of Conformity (http://database.ul.com/cgi-https://support.industry.siemens.com/cs/ww/en/view/109827335)

UK Declaration of Conformity (https://support.industry.siemens.com/cs/ww/en/view/109827530)

Safety Manufacturer's Declaration (https://support.industry.siemens.com/cs/ww/en/view/109827532)

Additional certificates (https://support.industry.siemens.com/cs/ww/en/ps/28308/cert)

3.8 Motors that can be operated

Requirement

Induction motors are permissible with a motor power in the range of 25% ... 125% of the converter power.

Synchronous motors are permissible with a motor power in the range of 50% ... 125% of the converter power.

NOTICE
Insulation failure for an unsuitable third-party motor A higher load occurs on the motor insulation in converter operation than with line (DOL) operation. Damage to the motor winding may occur as a result. • Comply with the notes in the System Manual "Requirements placed on third-party motors".

Description

The converter supports the operation of the following motors:

- Siemens synchronous motors 1FG1, 1FK7, 1FT22, 1FT23, 1PH8, 1FW3, 1FW4
- Siemens synchronous-reluctance motors 1FP, 1PH8
- Siemens induction motors 1PH3, 1PH8, 1PC7
- Innomotics synchronous motors 1FZ
- Innomotics induction motors 2KJ3, 2KJ4, 1LE1, 1LE5
- Third-party motors:
  - Synchronous motors
  - Induction motors
  - Reluctance motors

More information

You can find more information on the Internet:

Requirements placed on third-party motors (https://support.industry.siemens.com/cs/ww/en/view/109792187)

The System Manual is also valid for SINAMICS G220.

3.9 Multi-motor operation

Description

Multi-motor operation involves simultaneously operating several identical motors on 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 drive (https://support.industry.siemens.com/cs/ww/en/view/84049346)

4 Application planning

4.1 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

You may not operate converters with active Safety Integrated Functions for longer than 20 years. The 20 years starts when the device is delivered. The service life cannot be extended. This is the case even if a service department checks the converter – or in the meantime, the converter was decommissioned.

A defective converter with active Safety Integrated Functions cannot be repaired and must be replaced by a brand new converter.

4.2 Protection of persons from electromagnetic fields

Requirement

⚠ 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 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 in 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 in degree of protection IP55**
0 mm (0 inch)	250 mm (10 inch)	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.

4.3 Protection against the spread of fire

Description

The converter with degree of protection IP20 may be operated only in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used. The installation of the converter in a metal control cabinet or the protection with another equivalent measure must prevent the spread of fire and emissions outside the control cabinet.

4.4 Protection against condensation and conductive pollution

Description

Protect the converter with degree of protection IP20 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.

4.5 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.

Requirement

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.

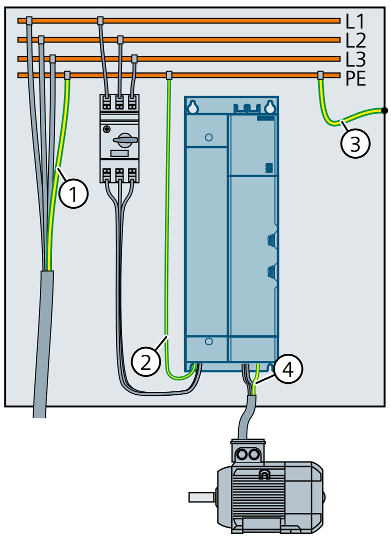
- Comply with the requirements for the protective conductor.

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

The minimum cross-section of the protective conductors ① ... ④ depends on the cross-section of the power supply or motor connection cable:

- Power supply or motor connection cable ≤ 16 mm^2
  ⇒ Minimum cross-section of the protective conductor = cross-section of the power supply or motor connection cable
- 16 mm^2 < power supply or motor connection cable ≤ 35 mm^2
  ⇒ Minimum cross-section of the protective conductor = 16 mm^2
- Power supply or motor connection cable > 35 mm^2
  ⇒ Minimum cross-section of the protective conductor = ½ cross-section of the power supply or motor connection cable

Additional requirements placed on the protective conductor ① according to IEC 60204-1:

- For permanent connection, the protective conductor must fulfill at least one of the following conditions:
  - 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.
  - As a conductor of a multi-conductor cable, the protective conductor has a cross-section ≥ 2.5 mm² Cu.
  - For an individual conductor, the protective conductor has a cross-section ≥ 10 mm² Cu.
  - The protective conductor consists of 2 individual conductors with the same cross-section.
- When connecting a multi-conductor cable using an industrial plug connector according to EN 60309, the protective conductor must have a cross-section of ≥ 2.5 mm² Cu.
- Observe the local regulations for protective conductors subject to a high leakage current at the operating location.

4.6 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.

Requirement

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.

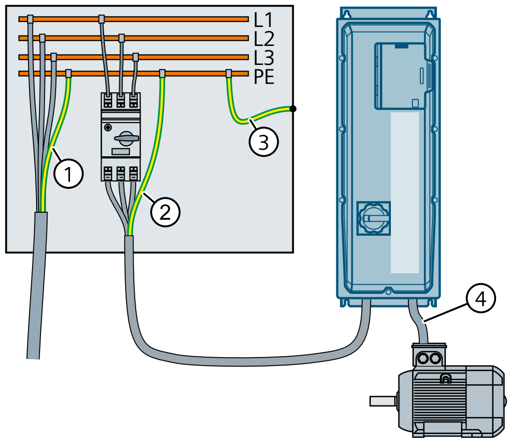
- Comply with the requirements for the protective conductor.

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

The minimum cross-section of the protective conductors ① ... ④ depends on the cross-section of the power supply or motor connection cable:

- Power supply or motor connection cable ≤ 16 mm²
  ⇒ Minimum cross-section of the protective conductor = cross-section of the power supply or motor connection cable
- 16 mm² < power supply or motor connection cable ≤ 35 mm²
  ⇒ Minimum cross-section of the protective conductor = 16 mm²
- Power supply or motor connection cable > 35 mm²
  ⇒ Minimum cross-section of the protective conductor = ½ cross-section of the power supply or motor connection cable

Additional requirements placed on the protective conductors ① and ② according to IEC 60204-1:

- For permanent connection, the protective conductor must fulfill at least one of the following conditions:
  - 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.
  - As a conductor of a multi-conductor cable, the protective conductor has a cross-section ≥ 2.5 mm² Cu.
  - For an individual conductor, the protective conductor has a cross-section ≥ 10 mm² Cu.
  - The protective conductor consists of 2 individual conductors with the same cross-section.
- When connecting a multi-conductor cable using an industrial plug connector according to EN 60309, the protective conductor must have a cross-section of ≥ 2.5 mm² Cu.
- Observe the local regulations for protective conductors subject to a high leakage current at the operating location.

4.7 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)

4.8 Operation on a TN system

Overview

The converter is suitable for connection to a TN system.

Requirement

The following applies to the connection of converters to a TN system:

- Converter with integrated or external line filter:
  - Operation on TN systems with grounded neutral point is 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, the neutral point is grounded in a TN system. There are versions of a TN system with grounded line conductor, e.g. with grounded L1.

The TN system can transfer the neutral conductor N and the PE protective conductor either separately or combined.

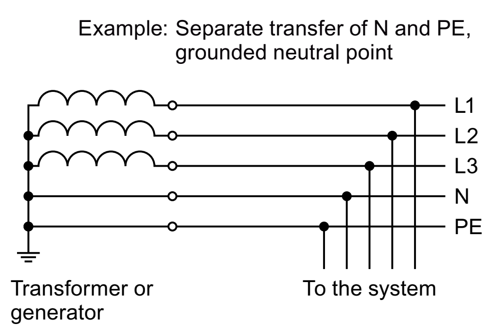


Figure 4-1 TN system

4.9 Operation on a TT system

Overview

The converter is suitable for connection to a TT system.

Requirement

The following applies to the connection of converters to a TT system:

- Operation in installations according to IEC and UL
  - For installations according to IEC, operation on TT systems is permissible.
  - 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 is permissible
  - Operation on TT systems without grounded neutral point is 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.

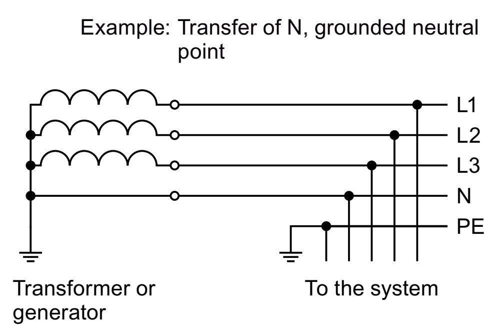


Figure 4-2 Example: Transfer of the neutral conductor, grounded neutral point

4.10 Operation on an IT system

Overview

The converter is suitable for connection to an IT system.

Requirement

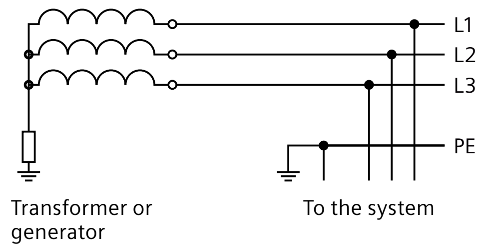
If the converter has an integrated line filter, the integrated line filter must be deactivated.

Description

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

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

Example: IT network without neutral conductor



Example: IT network with neutral conductor

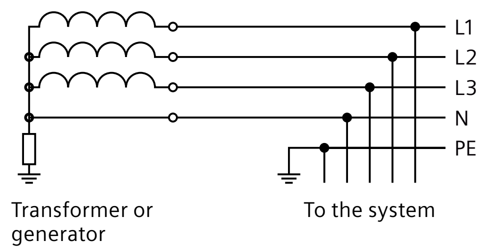


Figure 4-3 IT system

4.11 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 + 10 % - 20 %	Connection to a TN or TT system with upstream isolation transformer Connection to an IT system with upstream isolating transformer with the secondary side grounded at the neutral point
3 AC 380 V ... 415 V + 10 % - 20 % 3 AC 440 V ... 500 V + 10 % - 20 %	Connection to an IT system with upstream isolating 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

4.12 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

4.13 Star connection of the motor or 87 Hz delta connection

Overview

The motor can be operated on the converter in either a star connection or delta connection.

In the star connection, the rated values of the motor apply.

In the delta connection, the motor delivers a higher power than its rated power.

Description of function

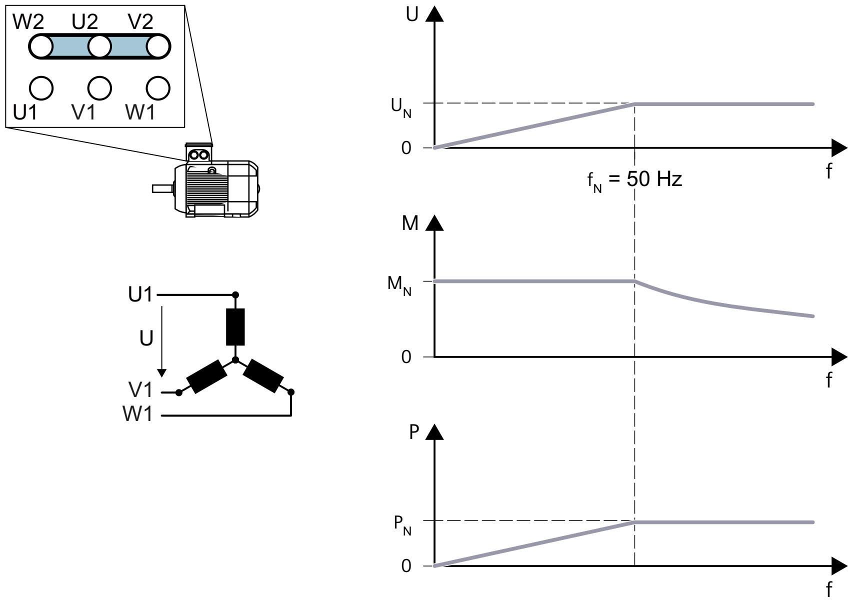


Figure 4-4 Motor in star connection

In a star connection, the motor can be loaded with its rated torque M_N in the range 0 ... rated frequency f_N.

The rated voltage U_N is available 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.

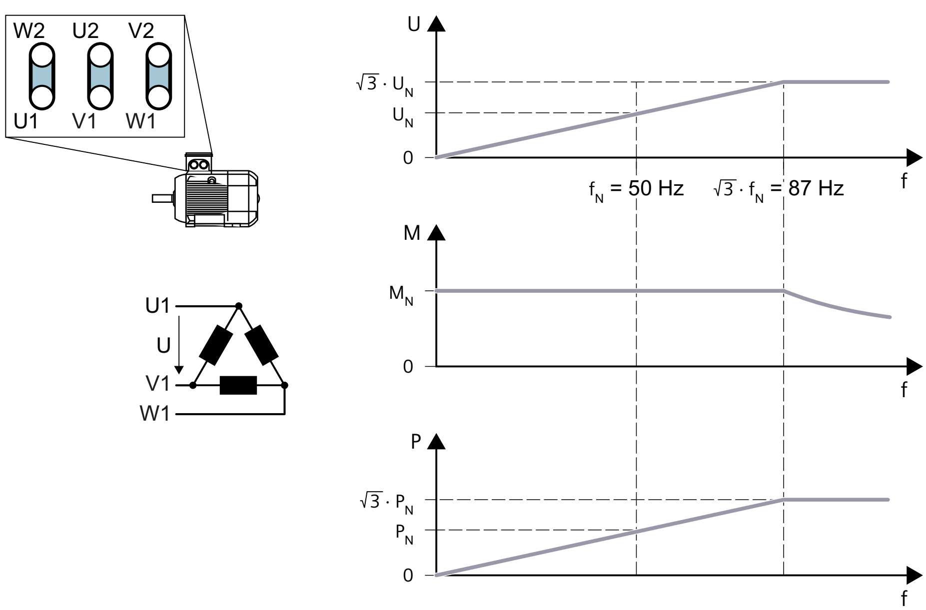


Figure 4-5 Motor in delta connection with 87 Hz characteristic

In a delta connection, the motor is operated with a voltage and frequency above its rated values. As a consequence, the motor power output is increased by the factor √3 ≈ 1.73.

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

The maximum voltage √3 · U_N is available at frequency f = √3 · 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.

4.14 Electromagnetic compatibility (EMC)

4.14.1 Electromagnetic compatibility (EMC)

Description

Interference suppression measures increase the electromagnetic compatibility (EMC).

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

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)

4.14.2 Current harmonics

Technical specifications

The converter generates the following typical current harmonics:

Table 4-3 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}
120	34.5%	17.6%	8%	5.2%	4.5%	3.3%	3%	2.4%	40.3%
33	30.7%	11.6%	7.3%	5.1%	3.5%	2.5%	2%	1.7%	33.2%

R_{SC} = Relative Short-Circuit power: Ratio between short-circuit power at the mains connection point to the fundamental frequency apparent power S of the connected converters

I_{Ref} = The reference current is the fundamental harmonic current of the converter

THC = Total Harmonic Current: Total rms value of the current harmonics I2 ... I40

4.14.3 Current harmonics with Clean Power converter

Technical specifications

The Clean Power converter generates the following typical current harmonics:

Table 4-4 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	0.9 %	0.9 %	0.2 %	0.2 %	0.2 %	0.1 %	0.1 %	0.1 %	1.3 %

R_{SC} = Relative Short-Circuit power: Ratio between short-circuit power at the mains connection point to the fundamental frequency apparent power S of the connected converters

I_{Ref} = The reference current is the fundamental harmonic current of the converter

THC = Total Harmonic Current: Total rms value of the current harmonics I2 ... I40

4.14.4 EMC limit values in South Korea

Description

이 기기는 업무용(A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
For sellers or users, please keep in mind that this device is an A-grade electromagnetic wave device. This device is intended to be used in areas other than home.

The EMC limit values to be observed for Korea correspond to the limit values of the EMC product standard for variable-speed electric drives EN 61800-3 of category C2 or the limit value class A, Group 1 to KN11.

By implementing appropriate additional measures, the limit values according to category C2 or limit value class A, Group 1, are observed.

Additional measures, such as the use of an additional RFI suppression filter (EMC filter), may be necessary.

In addition, measures for EMC-compliant configuration of the plant or system are described in detail in this manual.

The final statement on compliance with the applicable standard is given by the respective label attached to the individual device.

4.15 EMC-compliant installation

4.15.1 Achievable EMC category and maximum motor cable length

Requirement

Reliable and disturbance-free converter operation is only ensured when it is installed in an EMC-compliant way.

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.

Application environment		**Achievable EMC category**	
		C2	**C4** 4)
		Converter with integrated line filter 3) **and Clean Power converter**	**Converter without integrated line filter**
Cable length	Motor	≤ 150 m shielded CY cable	≤ 200 m shielded
			≤ 300 m unshielded
	Braking resistor	≤ 10 m shielded CY cable	≤ 10 m shielded
Installation location	Residential environment	No	No
	Light industry and commerce	Yes	No
	Heavy industry	Yes	Yes 2)

Application environment		Achievable EMC category	
		C2	**C4** [4]
		Converter with integrated line filter [3] **and Clean Power converter**	**Converter without integrated line filter**
Line supply	Public	Yes [1]	No
	Non-public	Yes	Yes [2]
Permissible line system configuration		TN or TT system with grounded neutral point	Any

1) Corresponds to IEC 61000-3-12, Table 4, for RSC ≥120. The compatibility level for harmonic voltage distortions at the line connection point must be taken into consideration

2) Complex, large-scale industrial applications and/or IT supply networks. An EMC plan must be drawn up.

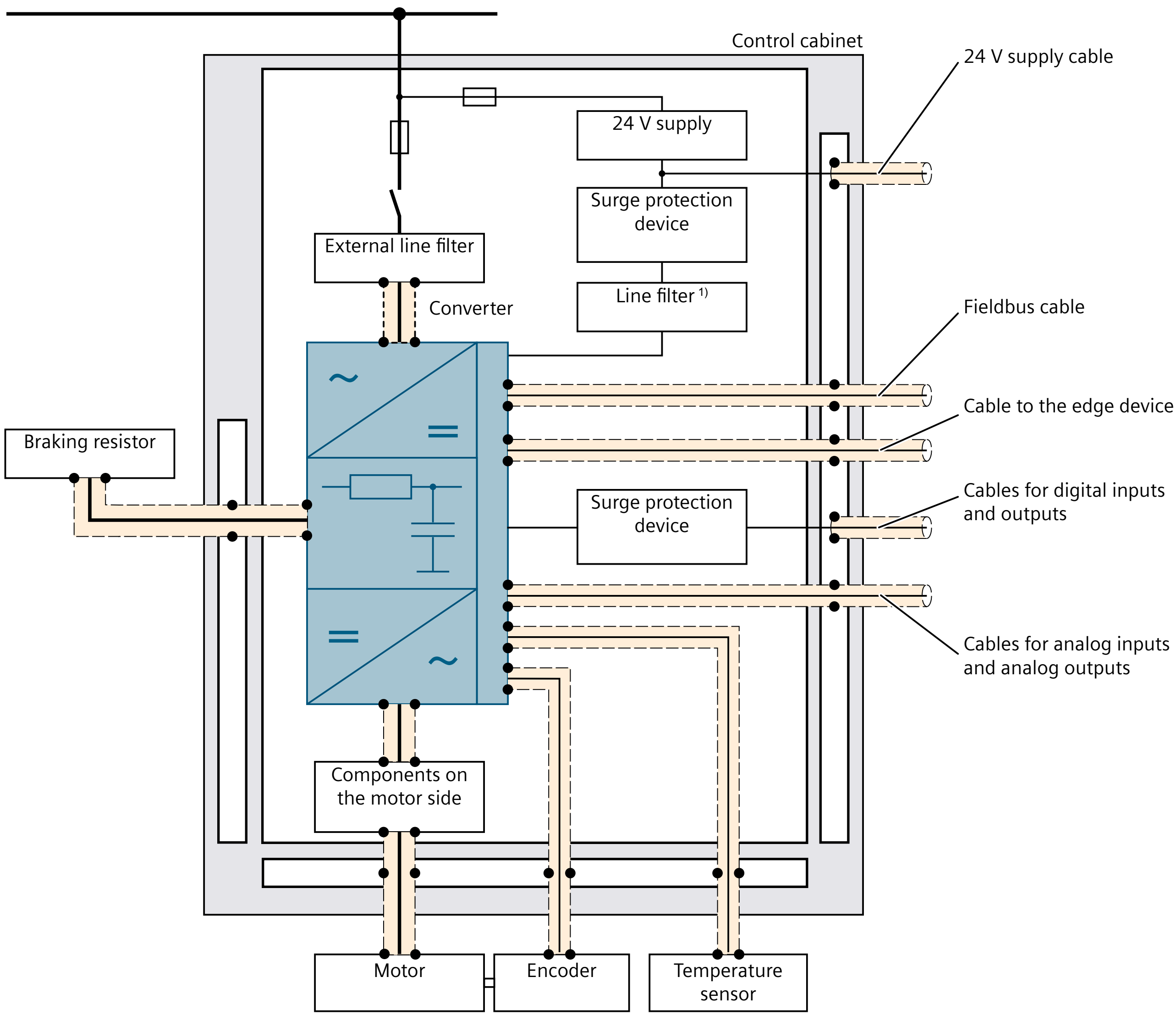
3) Operation with the default pulse frequency or with reduced pulse frequency

4) An external line filter is required to comply with the requirements relating to CE certification.

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.

4.15.2 Shielded cables, converter in degree of protection IP20

Description



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

Figure 4-6 EMC-compliant cable shielding

The following cables must be shielded to comply with EMC 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

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

Technical specifications

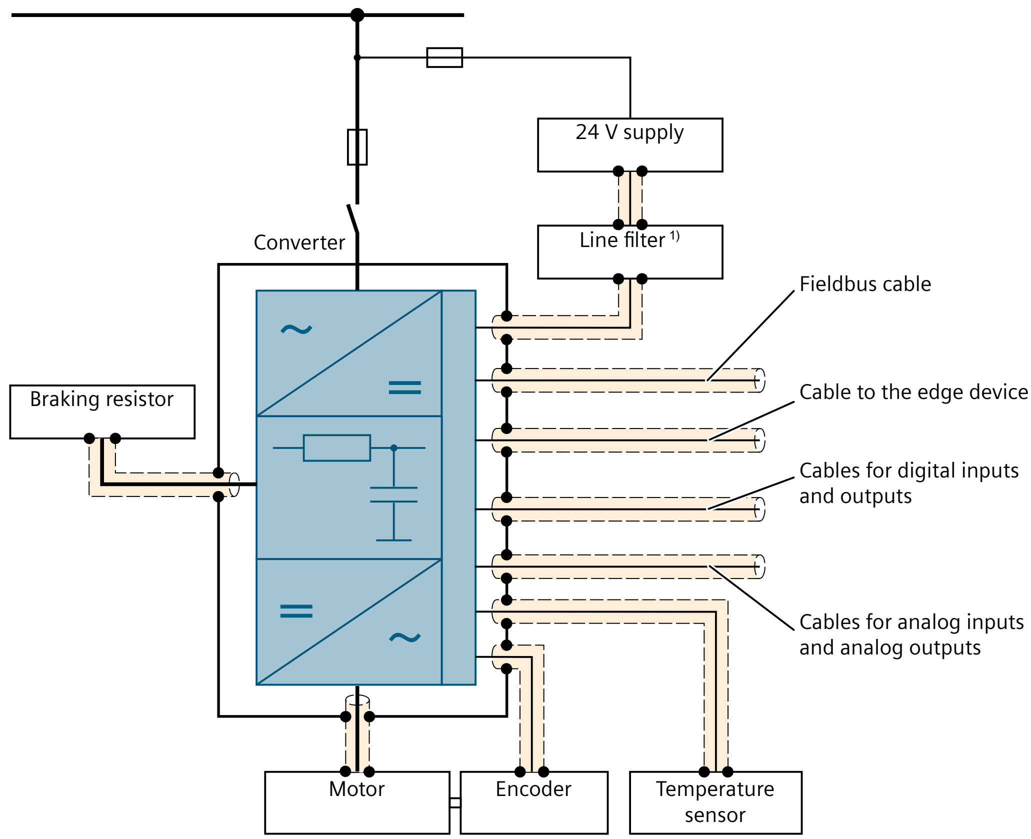
Table 4-5 Maximum permissible signal cable lengths, IP20

Connection at the converter	Cable length
24 V supply (terminals X124:1... 4)	We recommend using a Schurter FPBB 3-103-715 line filter in the following cases. • 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. We recommend surge protection device BCO CL2 E 48, Article No. DEHN 927989.
Digital input Fail-safe digital input	The maximum permissible connecting cable length is 1000 m. A surge protection device is required for connection cables longer than 30 m. We recommend surge protection device BCO CL2 BE 24, Article No. DEHN 927924.
Digital output DO 0	The maximum permissible connecting cable length is 1000 m. A surge protection device is required for connection cables longer than 30 m. We recommend surge protection device BCO CL2 BE 24, Article No. DEHN 927924.

Connection at the converter	Cable length
Relay output DO 1, DO 2 Fail-safe digital output	The maximum permissible connecting cable length is 1000 m. A surge protection device is required for connection cables longer than 30 m. We recommend that the following surge protection devices are connected in series: • BCO CL2 BE 24, Order No. DEHN 927924 • BCO CL2 BD 24, Order No. DEHN 927944
Temperature sensor	The maximum permissible connection cable length is 300 m.
Analog input Analog output 10 V output voltage	The maximum permissible connection cable length is 30 m.
24 V output voltage	The maximum permissible connecting cable length is 1000 m. A surge protection device is required for connection cables longer than 30 m. We recommend surge protection device BCO CL2 BE 24, Article No. DEHN 927924.
Fieldbus	The maximum permissible connection cable length is 100 m.
DRIVE-CLiQ	The maximum permissible connection cable length is 100 m.

4.15.4 Shielded cables, converter in degree of protection IP55

Description



1) Optional external line filter

Figure 4-7 EMC-compliant cable shielding

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

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

Technical data

Table 4-6 Maximum permissible signal cable lengths, IP55

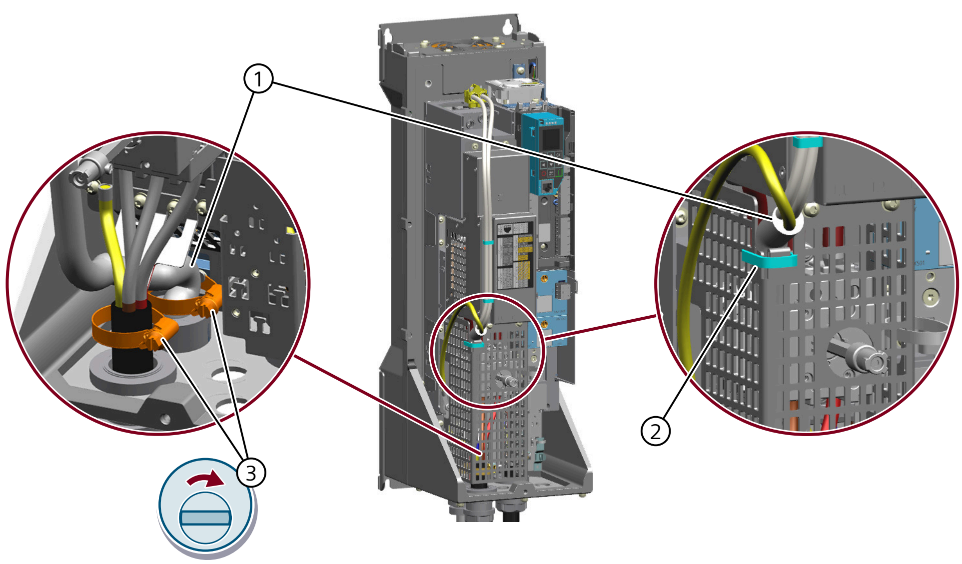
Connection at the converter	Cable length
24 V supply (terminals X124:1... 4)	If conducted disturbances occur on the 24V cable, we recommend using a Schurter FPBB 3-103-715 line filter
Digital input Failsafe digital input Digital output DO 0 Relay output DO 1, DO 2 Failsafe digital output	The maximum permissible connecting cable length is 1000 m.
Temperature sensor	The maximum permissible connection cable length is 300 m.
Analog input Analog output 10 V output voltage	The maximum permissible connection cable length is 30 m.
24 V output voltage	The maximum permissible connecting cable length is 1000 m.
Fieldbus	The maximum permissible connection cable length is 100 m.
DRIVE-CLiQ	The maximum permissible connection cable length is 100 m.

4.15.6 EMC measures when connecting a braking resistor

4.15.6.1 EMC measures for braking resistor, converter with degree of protection IP55

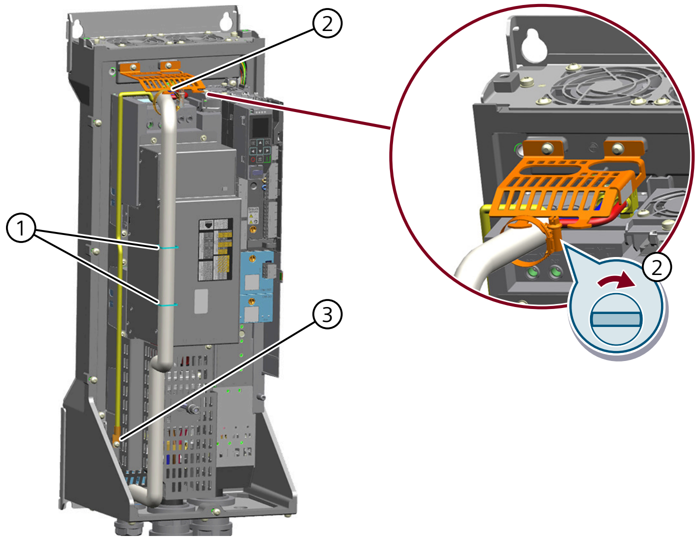
Description

From frame size FSD1, we recommend the measures set out below to secure conformance with EMC standards:



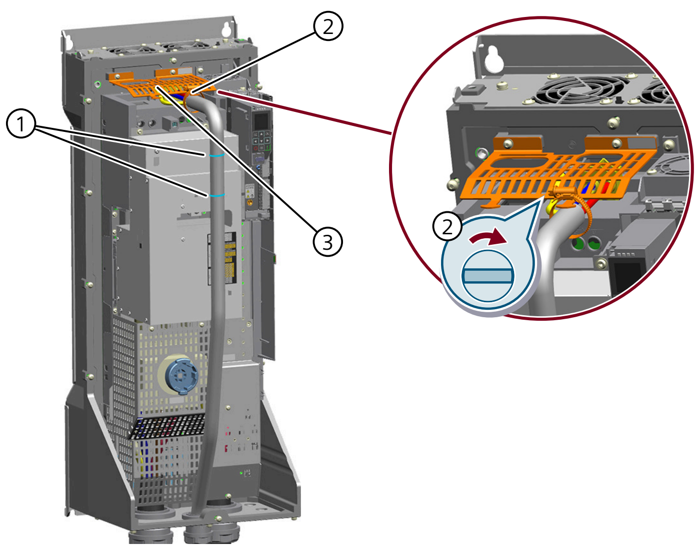
① Exposed shield of the braking resistor cable
② Shield support of the braking resistor cable with cable tie
③ Shield support of the braking resistor cable with cable tie
Attaching the line supply cable using a shield clamp

Figure 4-8 EMC measures when connecting a braking resistor, frame size FSD1



① Attaching the braking resistor with cable ties
② Shield support of the braking resistor cable with cable tie
③ Connecting the protective conductor

Figure 4-9 EMC measures when connecting a braking resistor, frame size FSD2



① Attaching the braking resistor with cable ties
② Shield support of the braking resistor cable with cable tie
③ Connecting the protective conductor

Figure 4-10 EMC measures when connecting a braking resistor, frame size FSE

4.15.6.2 EMC measures for braking resistor, Clean Power converter with degree of protection IP55

Description

From frame size FSD1, we recommend the following measures to secure conformance 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
- Select suitable snap ferrites or toroidal cores
- Mount the snap ferrites or toroidal cores as shown below
- Shield support of the braking resistor cable as shown below

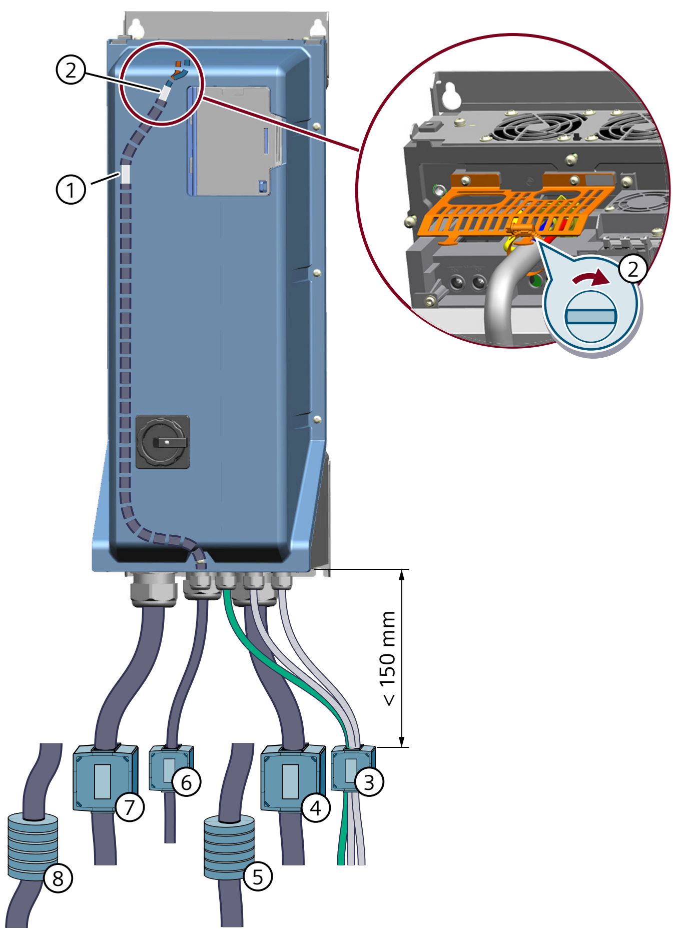


Figure 4-11 EMC measures when connecting a braking resistor to the Clean Power converter

EMC measure		Frame size		
		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	---	✓	✓
③	Snap ferrite on an I/O cable and fieldbus cable	Würth WE 74271251	Würth WE 74271251	Würth WE 74271251
④	Snap ferrite on a motor cable	Würth WE 74271251	---	---
⑤	Toroidal core on a motor cable	---	6 · TDK B64290A0730X010	6 · TDK B64290A0730X010
⑥	Snap ferrite or toroidal core on a braking resistor cable	Würth WE 74271251	---	Würth WE 74271251
⑦	Snap ferrite on a line supply cable	Würth WE 74271251	---	---
⑧	Toroidal core on a line supply cable	---	6 · TDK B64290A0730X010	6 · TDK B64290A0730X010

4.15.7 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.

Installation 5

5.1 Weight, converter in degree of protection IP20

Technical specifications

Table 5-1 Weight of converter without option modules

Property		Unit	FSA	FSB	FSC	FSD1	FSD2	FSE
Converter 3 AC 200 … 240 V		kg	4	6.5	9.0	---	22.5	32.5
Converter 3 AC 380 V … 415 V / 3 AC 440 V … 500 V	Without integrated filter		4	6.5	9.0	16.5	22.5	33
	With integrated filter		4.5	7.0	10	18	25.5	36.5
	Clean Power		---	---	---	16.9	24.8	34.3

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 specifications

Table 5-2 Weight of converter without option modules

Property			Unit	FSB	FSC	FSD1	FSD2	FSE
Converter 3 AC 200 … 240 V	Without maintenance switch		kg	17.3	21.1	---	34	47
	With maintenance switch			17.4	21.2	---	33.9	48.1
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
		With maintenance switch		16.8	21.4	25	34.5	49.1
	With integrated filter	Without maintenance switch		17.2	22	26.8	37.4	54.5
		With maintenance switch		18	22.2	26.7	37.2	55.4
	Clean Power	Without maintenance switch		---	---	25.8	36.4	54
		With maintenance switch		---	...	25.8	36.5	55.4

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

5.3 Unpacking the converter, delivered without pallet

Requirement

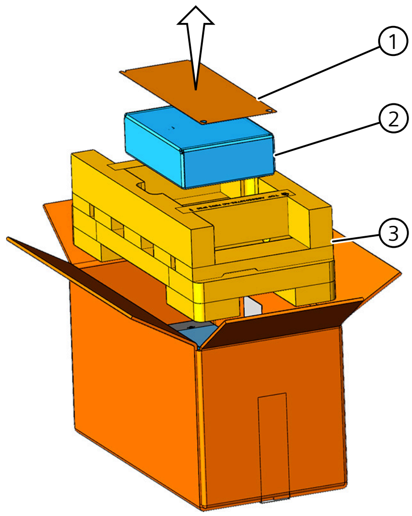
Tool required: A knife to open the packaging

Procedure

Procedure to unpack the converter:

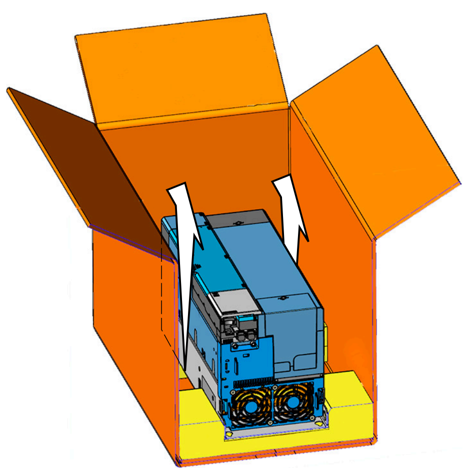
1. Place the packed converter on a stable surface with the underside down.
2. Open the packaging on the upper side.

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

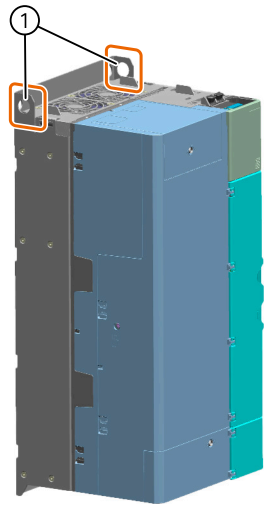
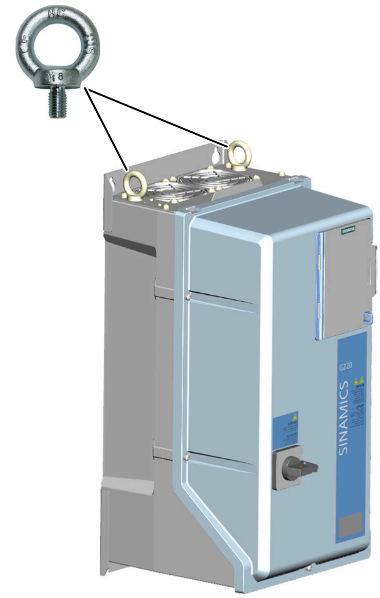


① Hole drilling template
② Accessories
③ Packaging material

4. Grasp the bottom of the converter on both sides at the center and lift the converter out of the packaging.



For converters with IP20 degree of protection from frame size FSD1 and converters with IP55 degree of protection from frame size FSC and higher, we recommend that the packaging is completely cut away and lifting equipment is attached to the converter attachment points.

Converter in degree of protection IP20	Converter in 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.

5.4 Unpacking the converter, delivered on pallets

Requirement

Tool required:

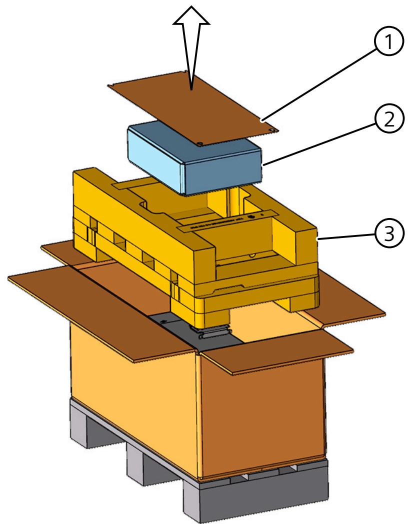
- A knife to open the packaging
- A Torx screwdriver

Procedure

Procedure to unpack the converter:

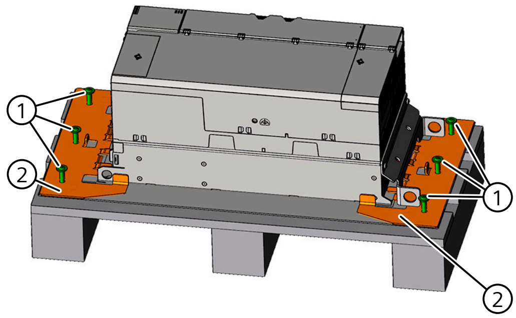
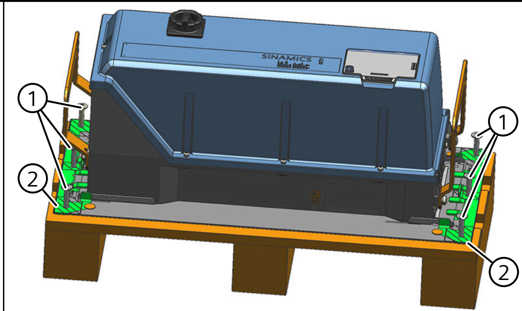
1. Place the packed converter on a stable surface with the underside down.
2. Open the packaging on the upper side.

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

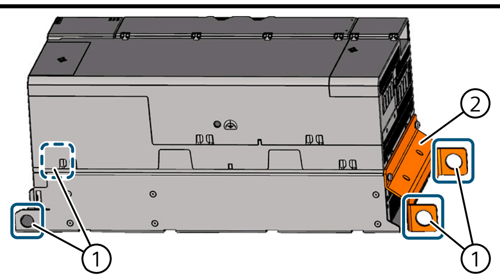
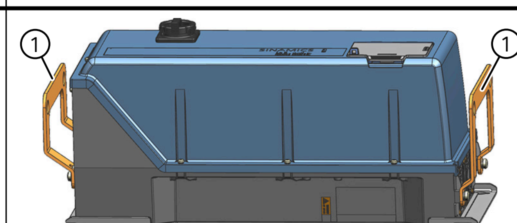


① Hole drilling template
② Accessories
③ Packaging material

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

Converter in degree of protection IP20	Converter in 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 in degree of protection IP20	Converter in 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.

5.5 Shield plates for converter with IP20 degree of protection

5.5.1 Weight, shield plate

Technical specifications

Table 5-3 Weight

Converter frame size	Weight of the shield plates without packaging
FSA	0.20 kg
FSB	0.22 kg

Converter frame size	Weight of the shield plates without packaging
FSC	0.52 kg
FSD1	0.63 kg
FSD2	0.68 kg
FSE	0.87 kg

5.5.2 Mount the upper shield plates

Requirement

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

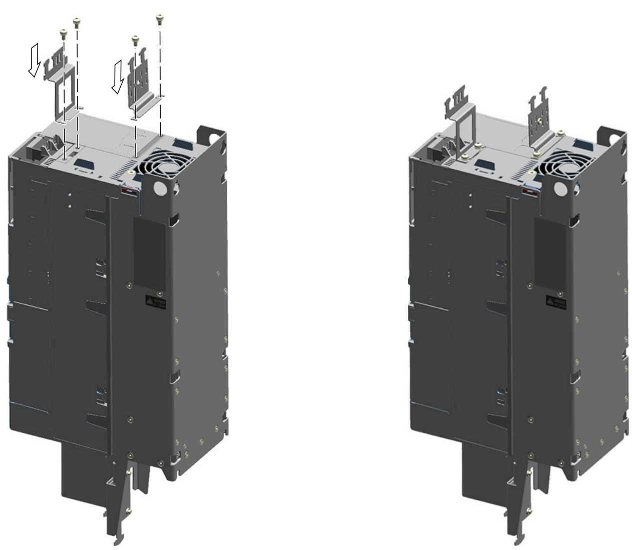
- Pozidrive or slotted screwdriver for frame sizes FSA ... FSC
- Torx screwdriver TX 25 from frame size FSD1

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 5-1 Mounting the upper shield plates (frame size FSD1 in this example)

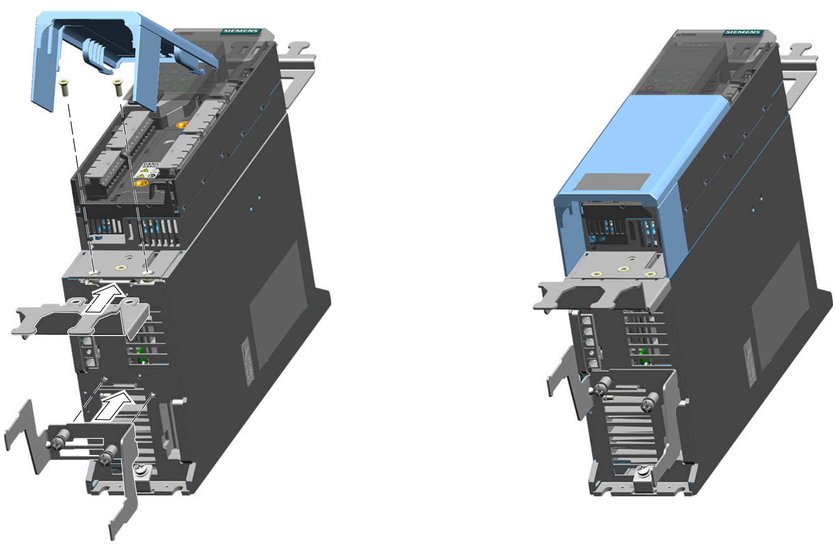
5.5.3 Mount the lower shield plates

Requirement

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

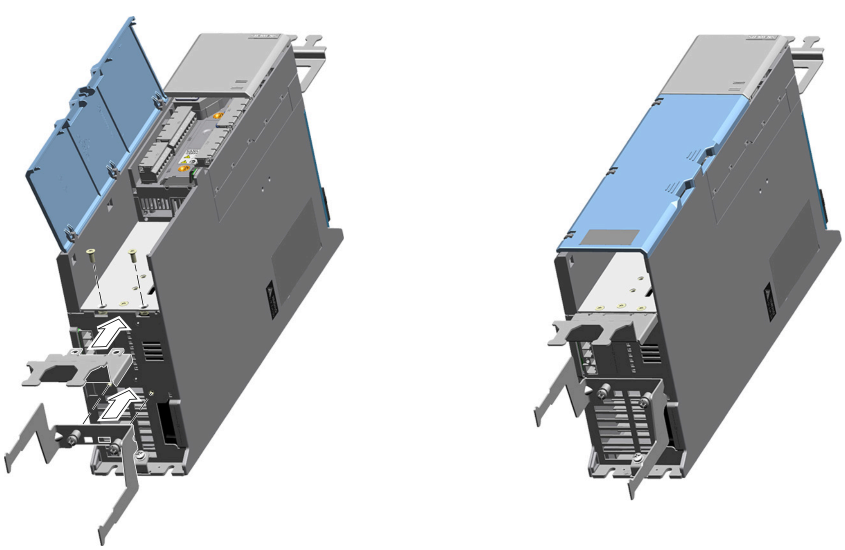
- T20 torx screwdriver and pozidrive or slotted screwdriver for frame sizes FSA ... FSC
- T25 torx screwdriver from frame size FSD1

Procedure



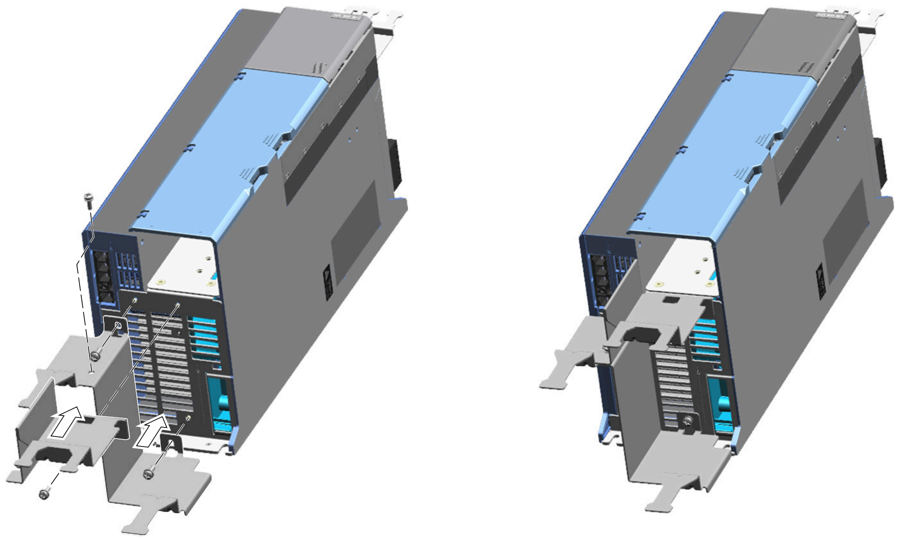
Tightening torque: 2 Nm

Figure 5-2 Mounting the lower shield plates, frame size FSA



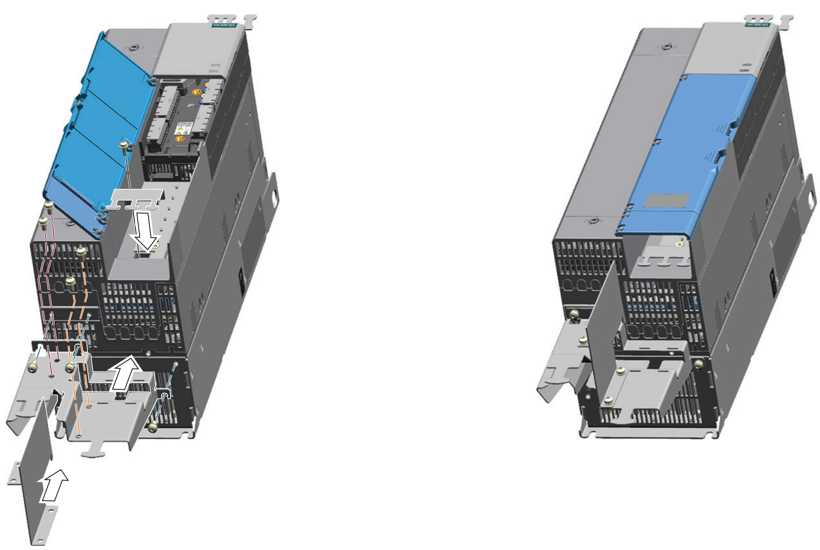
Tightening torque: 2 Nm

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



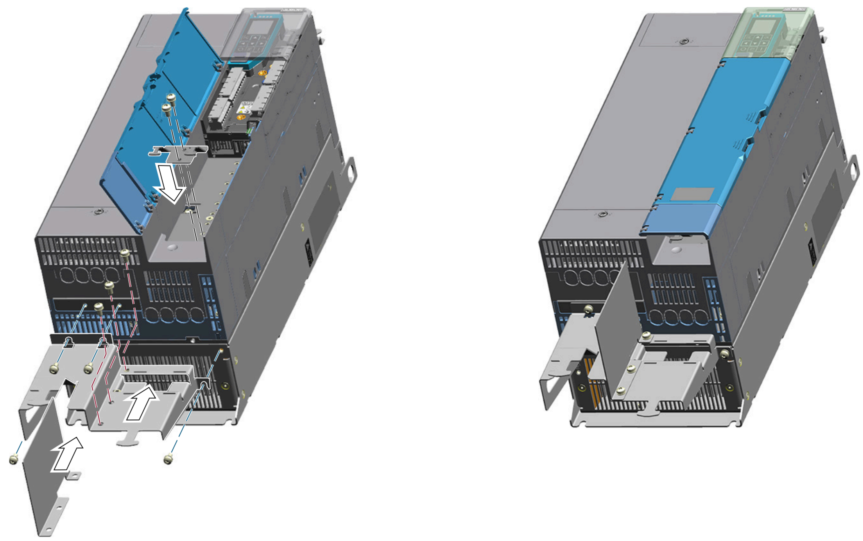
Tightening torque: 2 Nm

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



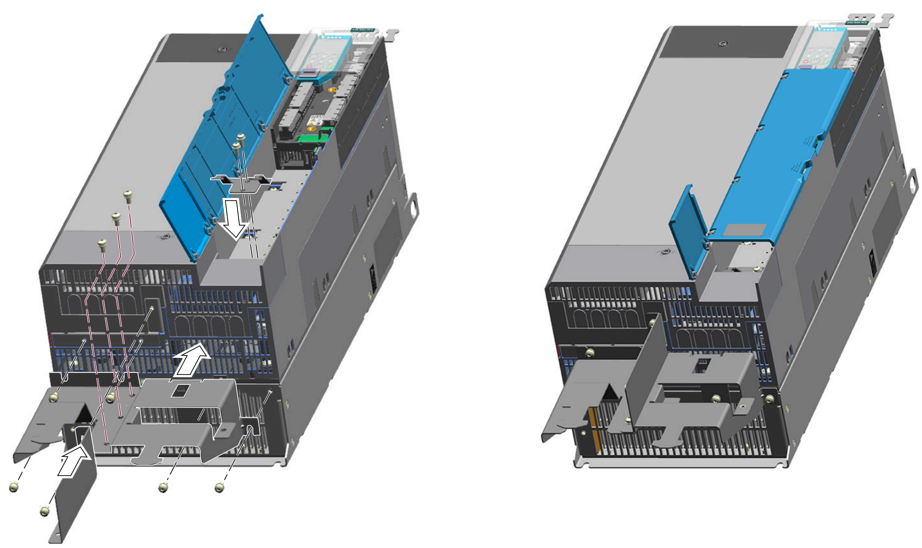
Tightening torque: 3 Nm

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



Tightening torque: 3 Nm

Figure 5-6 Mounting the lower shield plates, frame size FSD2



Tightening torque: 3 Nm

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

5.6 Shield plate for converter with degree of protection IP55

5.6.1 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.

Removing and installing the housing cover is identical for all converter frame sizes.

The following procedure describes removing and installing the housing cover using a converter, frame size FSC as example.

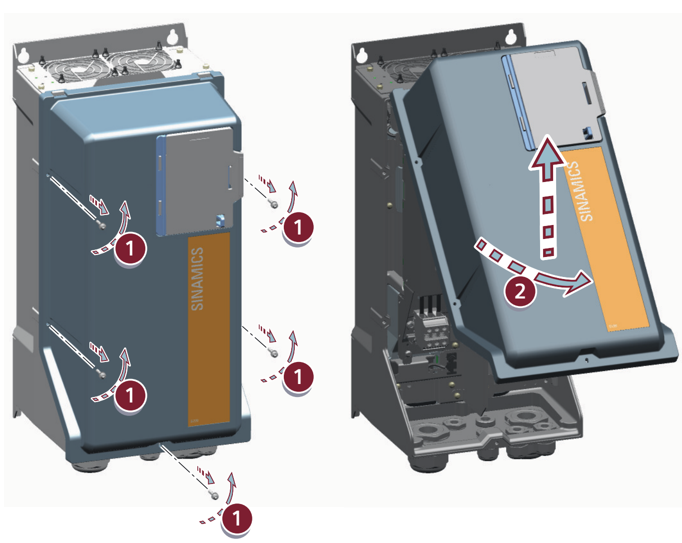
Requirement

The following requirements apply when the housing cover is removed:

- Comply with ESD regulations.
- Required tools:
  - Torx screwdriver TX 20

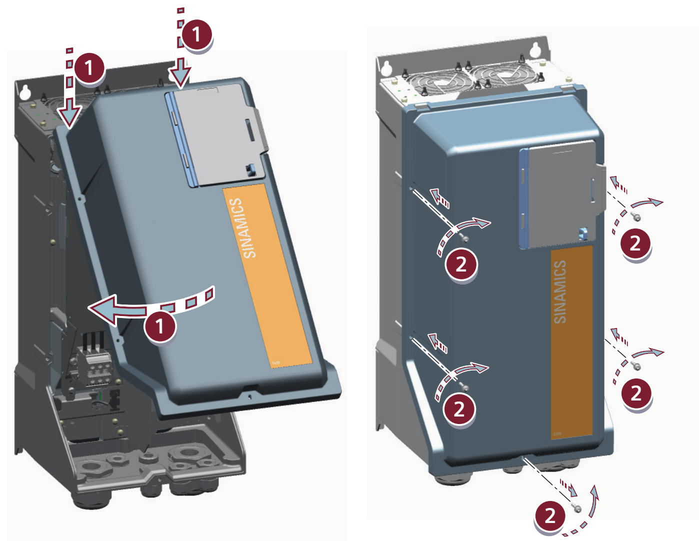
Procedure

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. Tightening torque: 2 Nm

5.6.2 Mounting shield plate for braking resistor, converter with degree of protection IP55

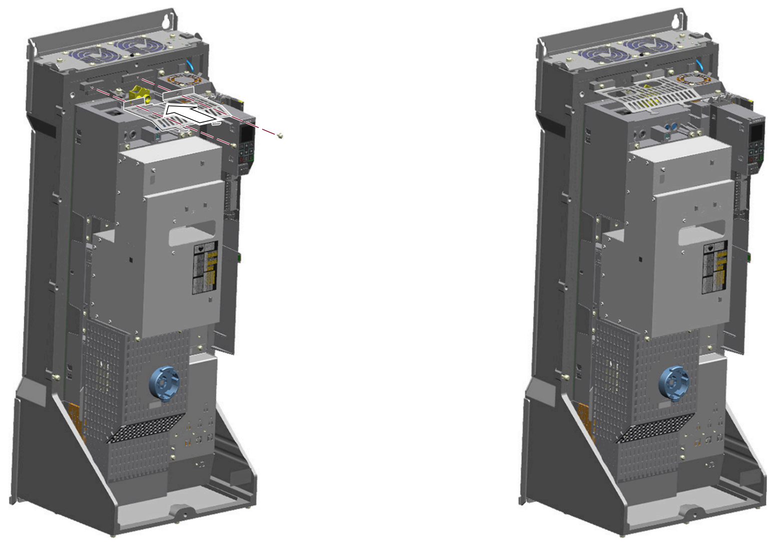
Requirement

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 5-8 Mounting shield plates for braking resistor (frame size FSE in this example)

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

5.7.1 Mount the gland plate for connecting cables

Overview

In the delivery state, the underside of the converter is protected by a metal plate. For the cable to pass through, the metal plate must be replaced by the gland plate. The gland plate has different holes for the cable gland of the connecting cables.

Requirement

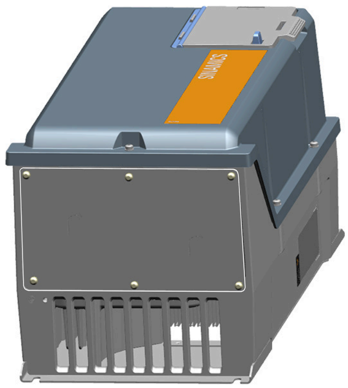
You need the following torx screwdriver to mount the gland plate:

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

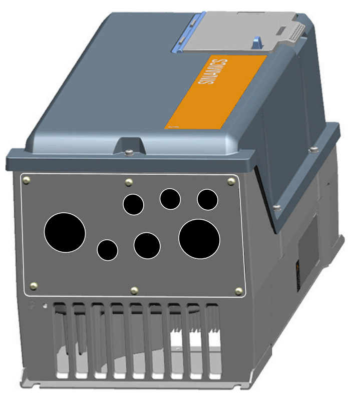
Procedure

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



5.7.2 Dimension drawing of gland plate for connecting cables

Dimensioned drawing

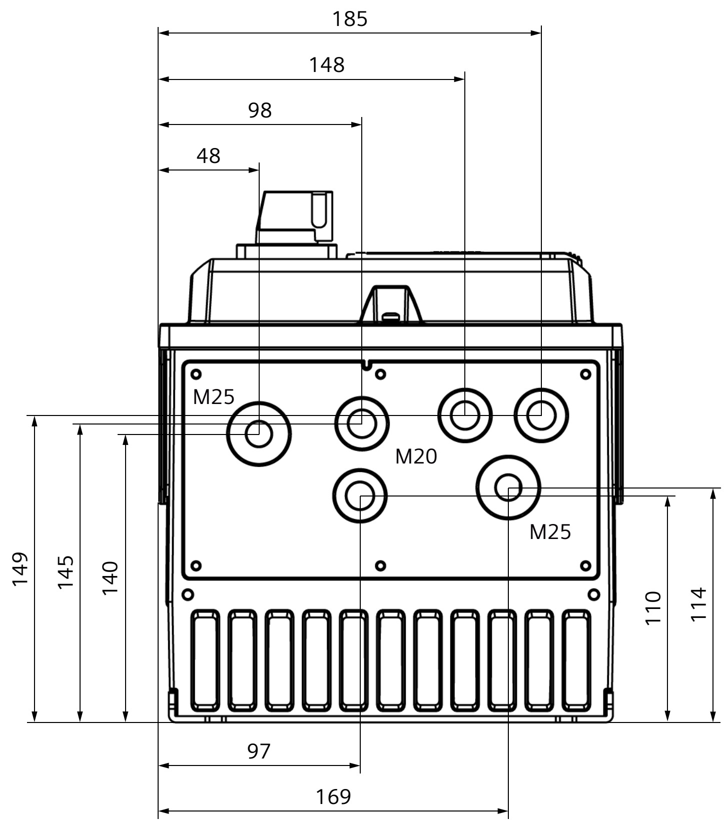


Figure 5-9 Frame size FSB

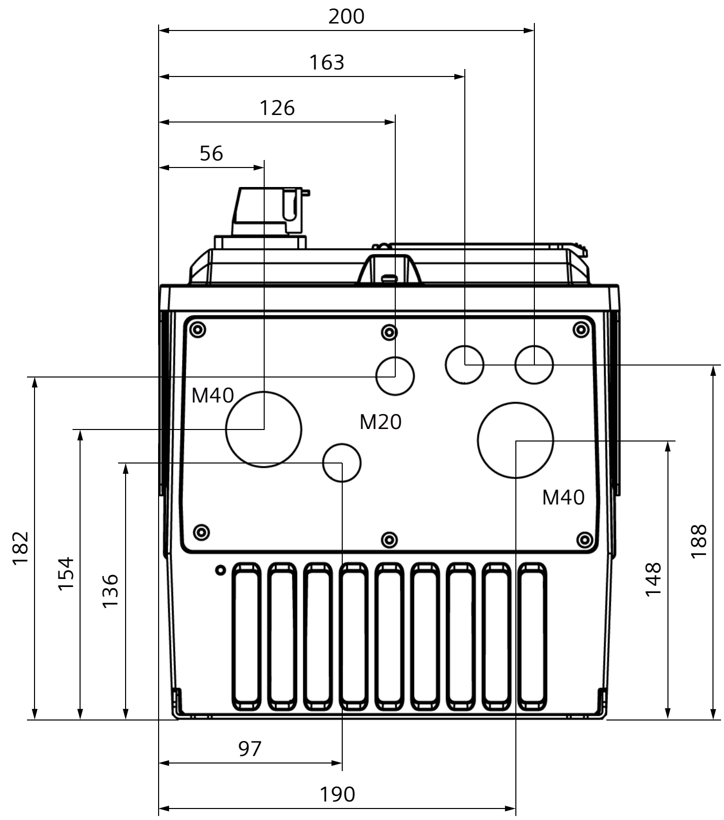


Figure 5-10 Frame size FSC

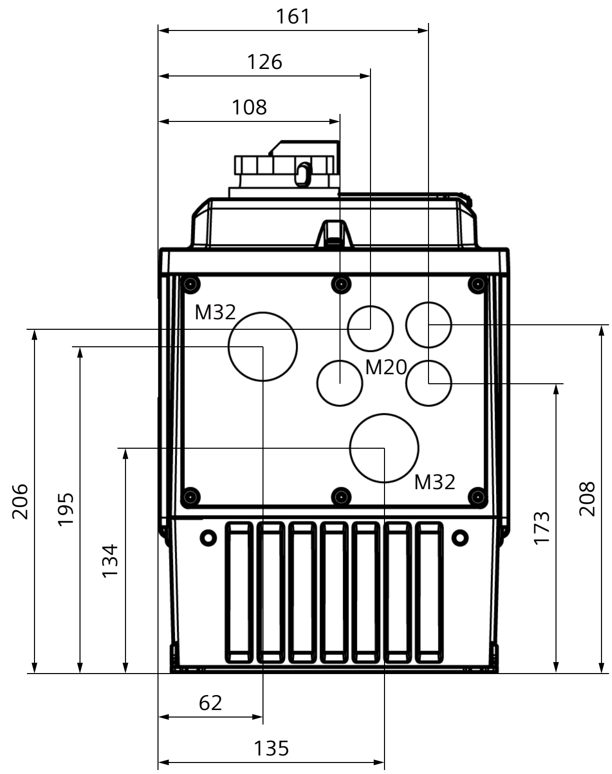


Figure 5-11 Frame size FSD1

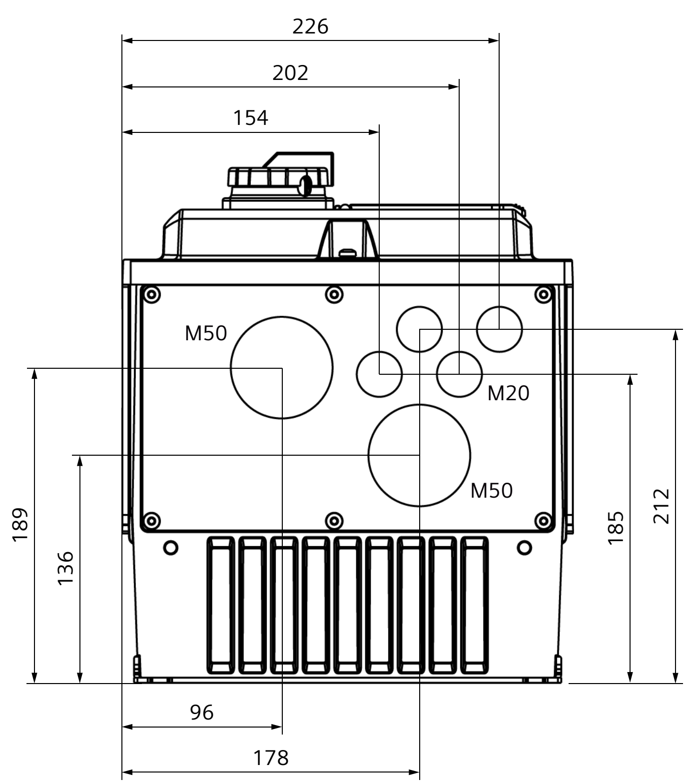


Figure 5-12 Frame size FSD2

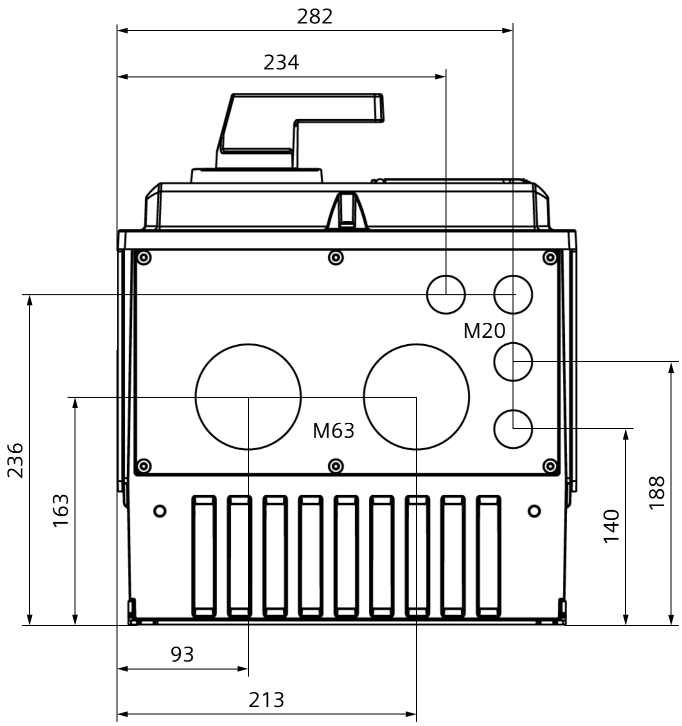


Figure 5-13 Frame size FSE

5.8 Option modules

5.8.1 Maximum number of option modules in the converter

Description

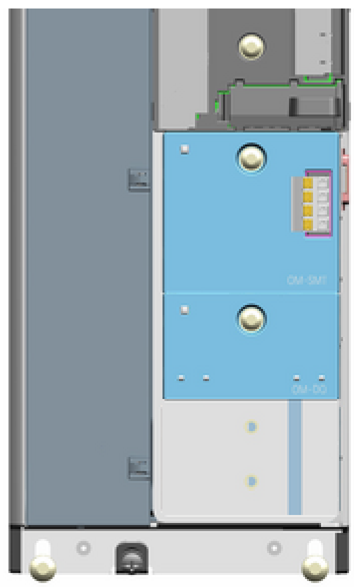


Figure 5-14 Example: IP20 converter, frame size FSC, with option modules OM-SMT and OM-DQ

The option modules are inserted in the option slots of the converter one below the other.

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 5-4 Combination of option modules

Number of option modules	Converter frame size			
	FSA	FSA with expansion adapter for option modules	FSB ... FSD	FSE
1 option module	OM-DQ	Every option module is permissible	Every option module is permissible	Every option module is permissible
2 option modules	Not possible	OM-IIoT and OM-DQ OM-SMT and OM-DQ	Every option module combination is permissible	Every option module combination is permissible
3 option modules	Not possible	Not possible	Not possible	Permissible

5.8.2 Weight, option modules

Technical data

Table 5-5 Weight

Component	Weight without packaging
Option module OM-SMT	0.082 kg
Option module OM-IIoT	0.073 kg
Option module OM-DQ	0.071 kg
Expansion adapter for option modules	0.25 kg

5.8.3 Mounting the expansion adapter for option modules

Overview

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

Requirement

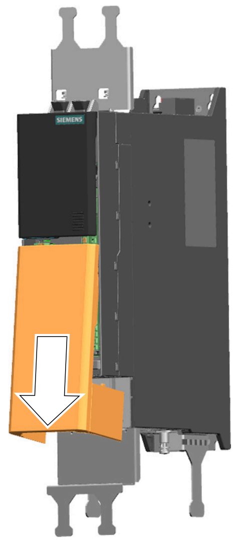
Requirements:

- 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

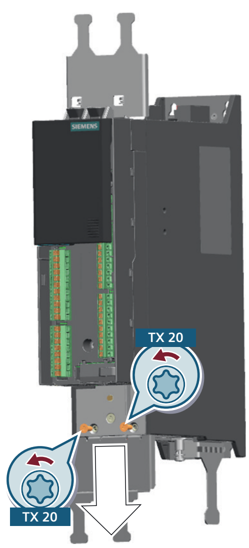
Procedure

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

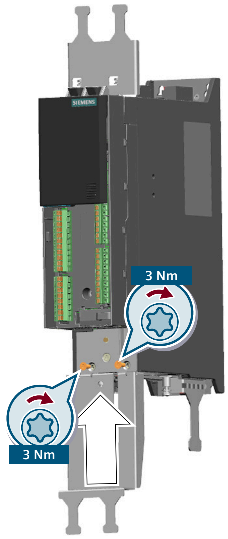
1. Pull down the front cover of the converter.



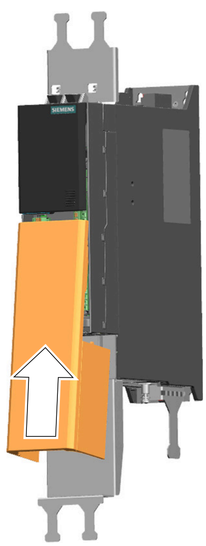
2. Release the 2 screws of the lower shield plate and remove the shield plate.



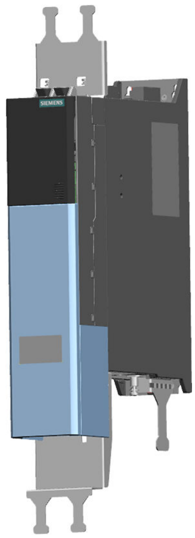
3. Mounting the shield plate of the expansion adapter.



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



Result



The expansion adapter for option modules has been mounted.

5.8.4 Mounting option module OM-SMT, converter in degree of protection IP20

Overview

Option module OM-SMT is mounted in the option slot of the converter.

Requirement

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

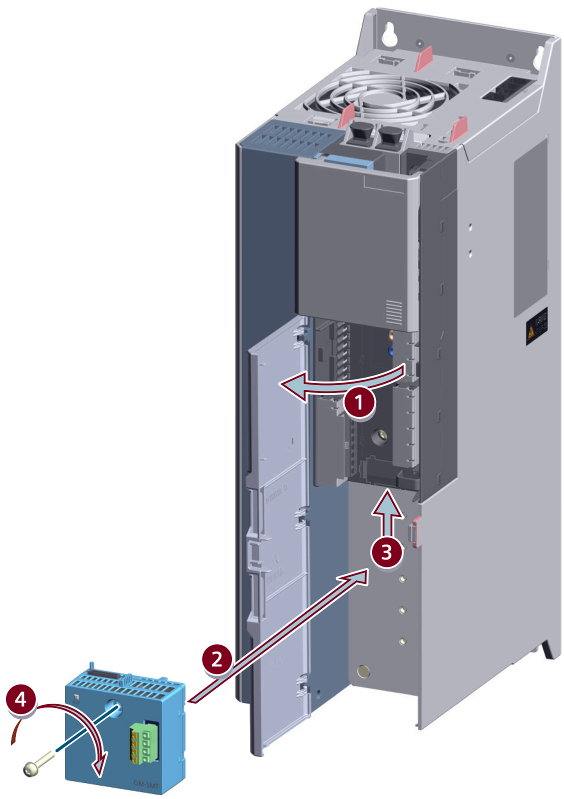


Figure 5-15 Mounting option module OM-SMT in the option slot of the IP20 converter

Proceed as follows to mount option module OM-SMT in the option slot of the IP20 converter:

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

Result

Option module OM-SMT is connected to the converter.

5.8.5 Mounting option module OM-SMT, converter in degree of protection IP55

Overview

Option module OM-SMT is mounted in the option slot of the converter.

Requirement

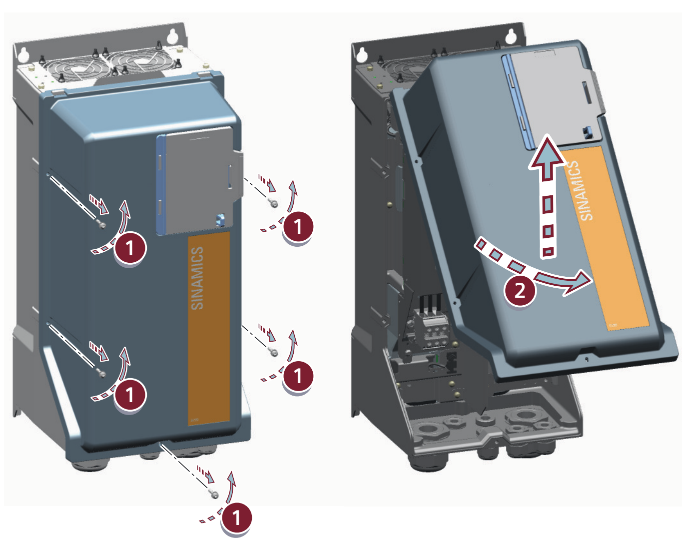
NOTICE
Damage to the option module by withdrawing and inserting under voltage (hot swapping)
Withdrawing and inserting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction. • Switch off the converter power supply before you withdraw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

You require a TX 20 torx screwdriver.

Procedure

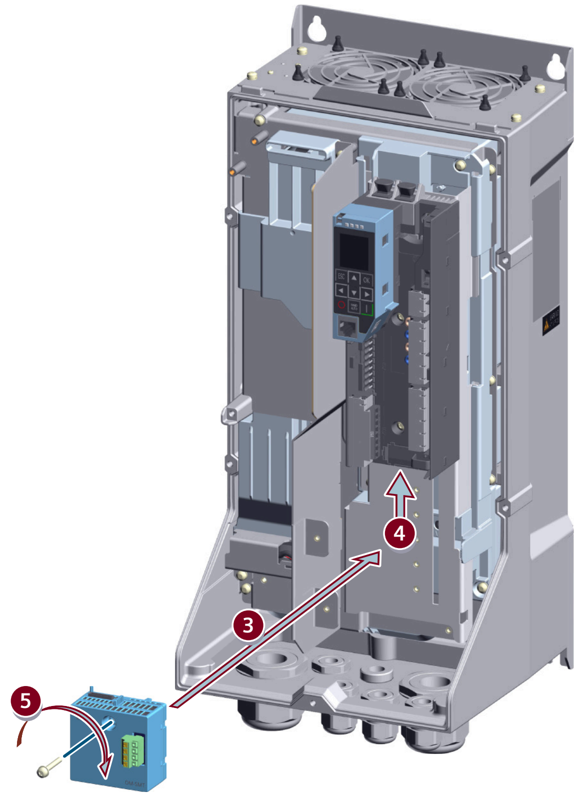
Proceed as follows to mount option module OM-SMT in the option slot of the IP55 converter:

1. Release the screws of the housing cover using a TX 20 torx screwdriver.



2. Swivel the housing cover slightly upward and then lift the housing cover off in an upward direction.

3. Insert option module OM-SMT into the option slot of the converter.



4. Push option module OM-SMT up 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.
7. Re-attach the housing cover and tighten the screws using a TX 20 torx screwdriver with a tightening torque of 2 Nm.

Result

Option module OM-SMT is connected to the converter.

5.8.6 Dimension drawing OM-SMT

Dimension drawing

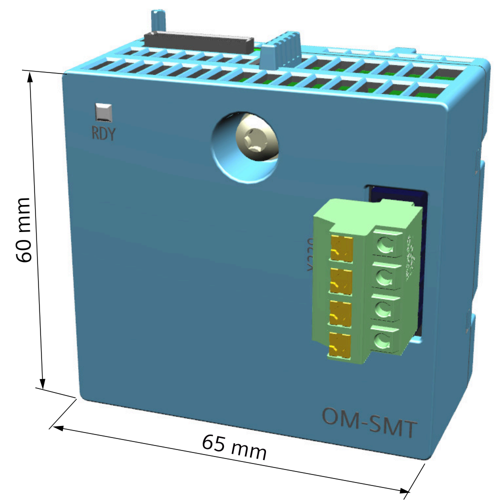


Figure 5-16 Dimensions of Option Module OM-SMT

5.8.7 Mounting option module OM-IIoT, converter in degree of protection IP20

Overview

Option module OM-IIoT is mounted in the option slot of the converter.

Requirement

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

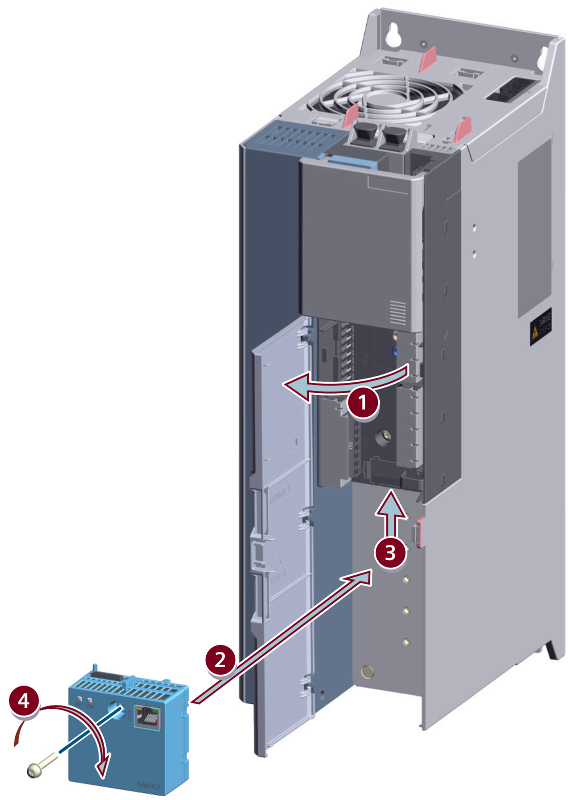


Figure 5-17 Mounting option module OM-IIoT in the option slot of the IP20 converter

Proceed as follows to mount option module OM-IIoT in the option slot of the converter:

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

Result

Option module OM-IIoT is connected to the converter.

5.8.8 Mounting option module OM-IIoT, converter in degree of protection IP55

Overview

Option module OM-IIoT is mounted in the option slot of the converter.

Requirement

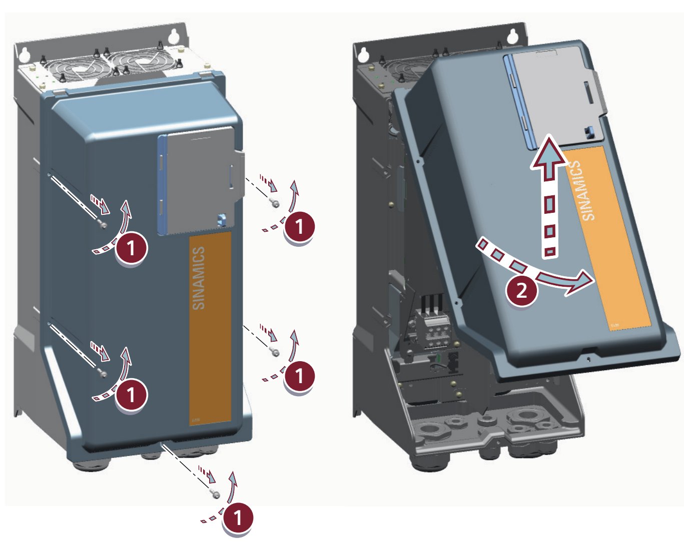
NOTICE
Damage to the option module by withdrawing and inserting under voltage (hot swapping)
Withdrawing and inserting the option module when the power supply is switched on can damage the option module or cause the option module to malfunction. • Switch off the converter power supply before you withdraw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

You require a TX 20 torx screwdriver.

Procedure

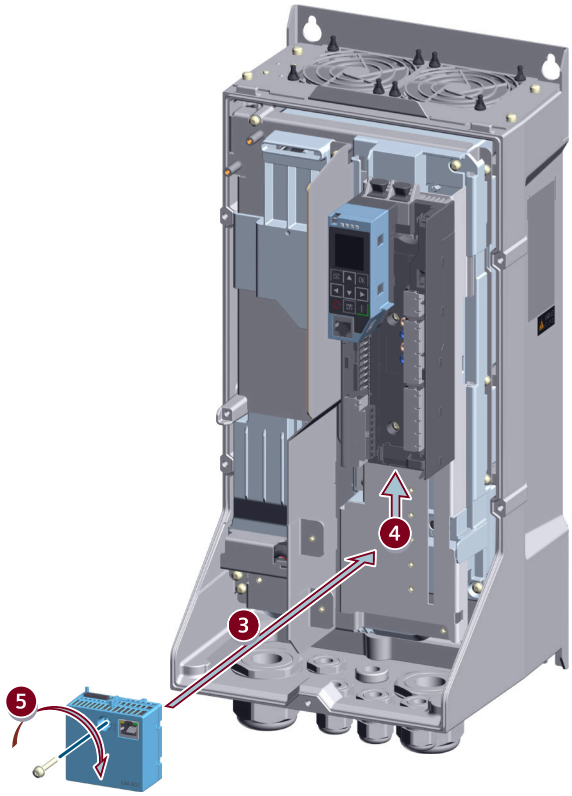
Proceed as follows to mount option module OM-IIoT in the option slot of the IP55 converter:

1. Release the screws of the housing cover using a TX 20 torx screwdriver.



2. Swivel the housing cover slightly upward and then lift the housing cover off in an upward direction.

3. Insert option module OM-IIoT into the option slot of the converter.



4. Push option module OM-IIoT up 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.
7. Re-attach the housing cover and tighten the screws using a TX 20 torx screwdriver with a tightening torque of 2 Nm.

Result

Option module OM-IIoT is connected to the converter.

5.8.9 Dimension drawing OM-IIoT

Dimension drawing

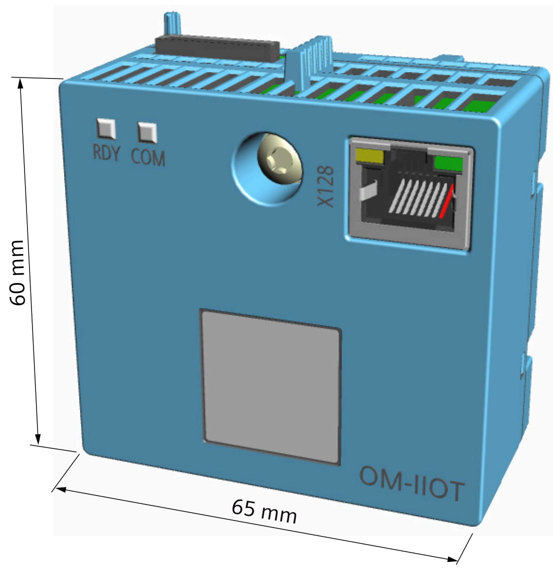


Figure 5-18 Dimensions of Option Module OM-IIoT

5.8.10 Mounting option module OM-DQ, converter in degree of protection IP20

Overview

Option module OM-DQ is mounted in the option slot of the converter.

Requirement

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.

Option module OM-DQ must be mounted as the lowermost module in the option slot of the converter as this module does not have a connector for other option modules.

You require a TX 20 torx screwdriver.

Procedure

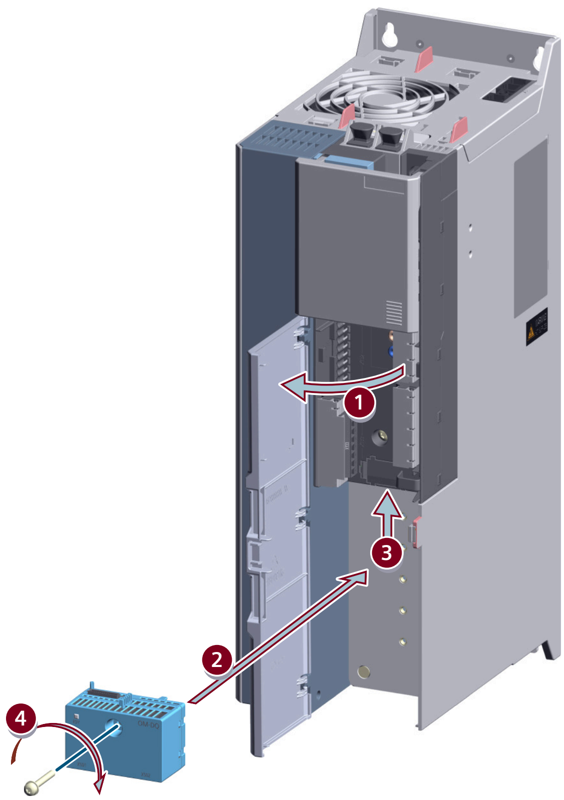


Figure 5-19 Mounting option module OM-DQ in the option slot of the IP20 converter

Proceed as follows to mount option module OM-DQ in the option slot of the converter:

1. Remove the front cover (frame size FSA) or open the front door of the converter.
2. Push option module OM-DQ up until it snaps in flush.
3. Tighten the fixing screw using a TX 20 torx screwdriver with a tightening torque of 2 Nm.
4. Press the cover cap onto the fixing screw.
5. Place the front cover (frame size FSA) on the converter or close the front door of the converter.

Result

Option module OM-DQ is connected to the converter.

5.8.11 Mounting option module OM-DQ, converter in degree of protection IP55

Overview

Option module OM-DQ is mounted in the option slot of the converter.

Requirement

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.

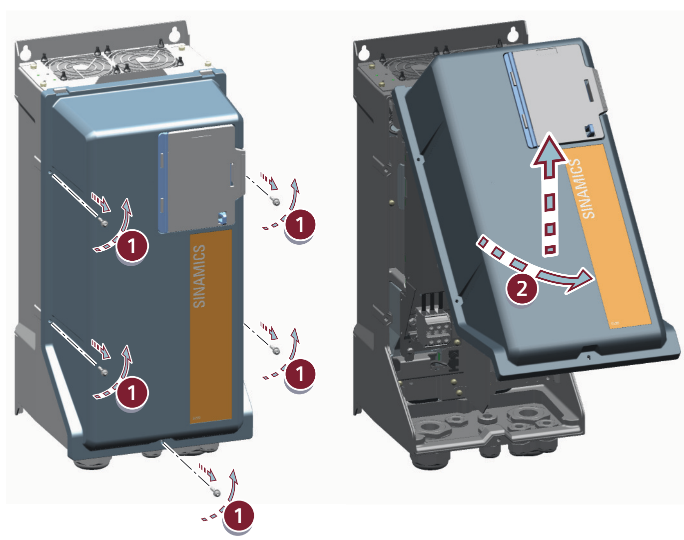
Option module OM-DQ must be mounted as the lowermost module in the option slot of the converter because this module does not have a connector for other option modules.

You require a TX 20 torx screwdriver.

Procedure

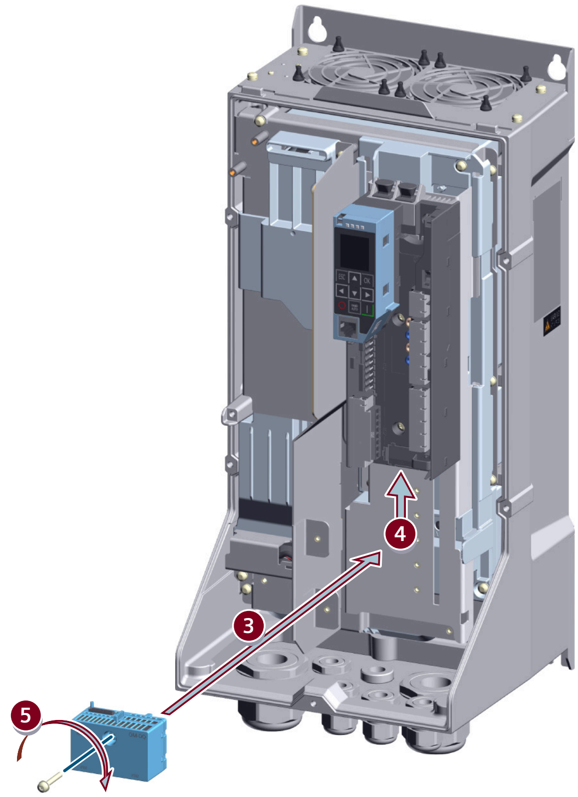
Proceed as follows to mount option module OM-DQ in the option slot of the IP55 converter:

1. Release the screws of the housing cover using a TX 20 torx screwdriver.



2. Swivel the housing cover slightly upward and then lift the housing cover off in an upward direction.

3. Insert option module OM-DQ into the option slot of the converter.



4. Push option module OM-DQ up 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.
7. Re-attach the housing cover and tighten the screws using a TX 20 torx screwdriver with a tightening torque of 2 Nm.

Result

Option module OM-DQ is connected to the converter.

5.8.12 Dimension drawing OM-DQ

Dimension drawing

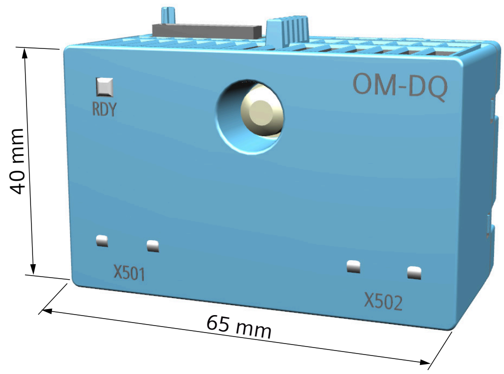


Figure 5-20 Dimensions of Option Module OM-DQ

5.8.13 Supplementary fan for option modules, converter in degree of protection IP20

Overview

The supplementary fan is not mounted in the factory. Under certain requirements, you must subsequently mount the supplementary fan to cool the converter.

Requirement

The supplementary fan is delivered together with the converter.

The supplementary fan is required if the two subsequent conditions occur:

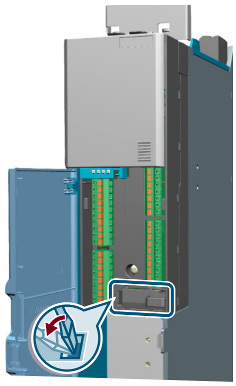
- Ambient temperature > 50 °C
- More than 1 option module is mounted in the converter.

Procedure

Proceed as follows to mount the supplementary fan:

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

4. Using a suitable tool, e.g. a slotted screwdriver, release the cover for the supplementary fan slot.



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

5.8.14 Supplementary fan for option modules, converter in degree of protection IP55

Overview

The supplementary fan is not mounted in the factory. Under certain requirements, you must subsequently mount the supplementary fan to cool the converter.

Requirement

The supplementary fan is delivered together with the converter.

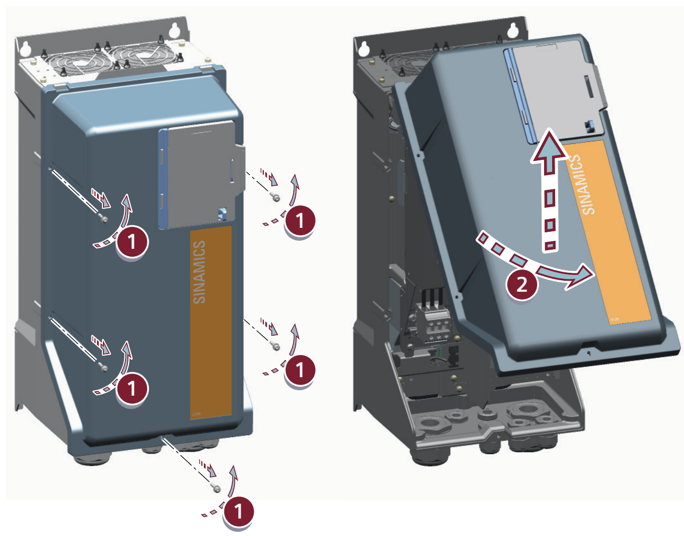
The supplementary fan is required if the two subsequent conditions occur:

- Ambient temperature > 45 °C
- More than 1 option module is mounted in the converter.

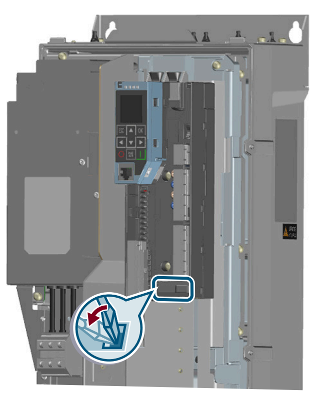
Procedure

Proceed as follows to mount the supplementary fan:

1. Switch off the converter supply voltage.
2. Release the screws of the housing cover using a TX 20 torx screwdriver.



3. Swivel the housing cover slightly upward and then lift the housing cover off in an upward direction.
4. If required, temporarily remove the control cables that prevent the supplementary fan from being mounted.
5. Using a suitable tool, e.g. a slotted screwdriver, release the cover for the supplementary fan slot.



6. Withdraw the cover from the converter.
7. Insert the supplementary fan into its slot until the supplementary fan interlock audibly snaps into place.
8. Reconnect all of the converter control cables if you removed the control cables.
9. Re-attach the housing cover and tighten the screws using a TX 20 torx screwdriver with a tightening torque of 2 Nm.

10. Press the cover caps onto the fixing screws.
11. Switch on the converter supply voltage.

Mounting

6

⚠ 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 Devices with an open construction (built-in devices) can cause a fire or a pressure wave in the event of a fault, which can result in severe personal injury and damage to property. The higher the power rating of a converter, the more dangerous the effects of an arc or pressure wave. • Install the devices in a robust metal control cabinet that is designed to prevent fire from escaping. • Only operate the devices with the control cabinet doors closed. • When control cabinet doors are open, only qualified electrical personnel are allowed to carry out service and maintenance work. • Comply with the minimum control cabinet volume.

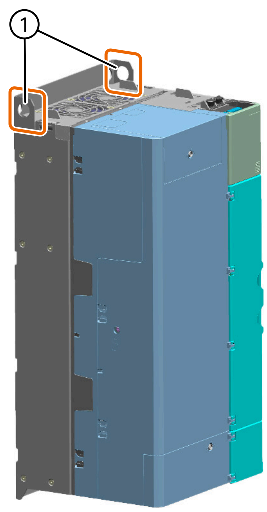
Information on the minimum control cabinet volume is available on the Internet:

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

6.1.1 Installation aid

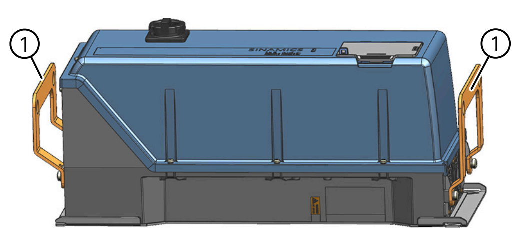
Description

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

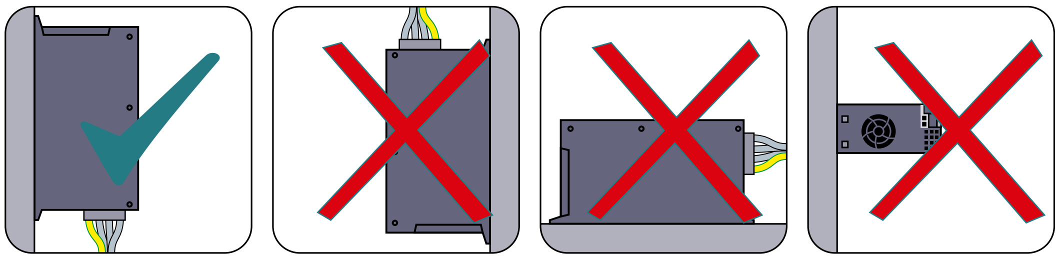
6.1.2 Mounting position

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

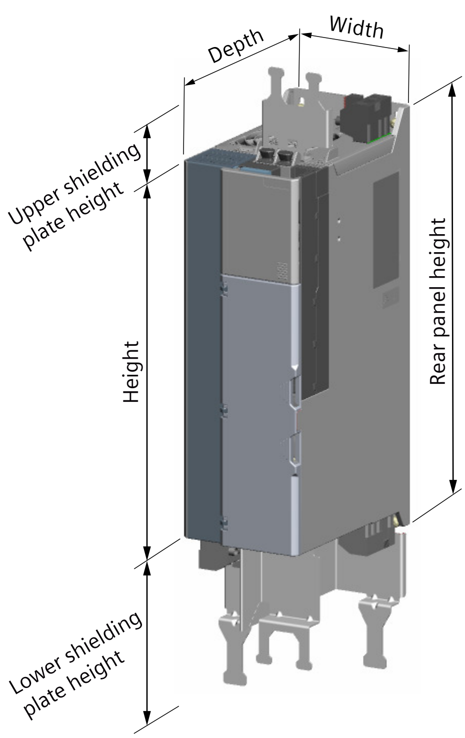


Figure 6-3 Dimensions, degree of protection IP20

Table 6-1 Dimensions

Property	Unit	FSA	FSB	FSC	FSD1	FSD2	FSE
Height	mm	250	355	355	400	442	520
Height with expansion adapter for option modules	mm	310	---	---	---	---	---
Width	mm	73	85	125	150	200	250
Depth	mm	208	208	209	245	245	245
Upper shield plate height	mm	85	85	85	90	90	90
Lower shield plate height	mm	85	108	149	160	160	193
Rear panel height	mm	288	395	395	443	492	566

6.1.4 Installation, converter in degree of protection IP20

Description

The converter is intended to be mounted on a rear control cabinet panel.

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

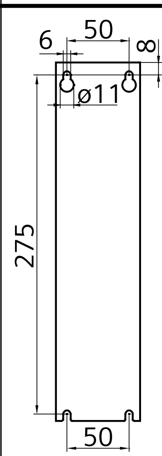
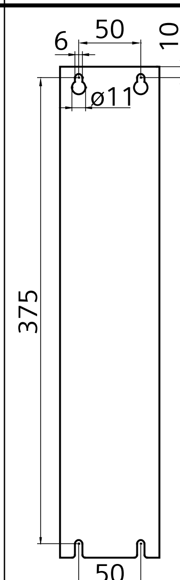
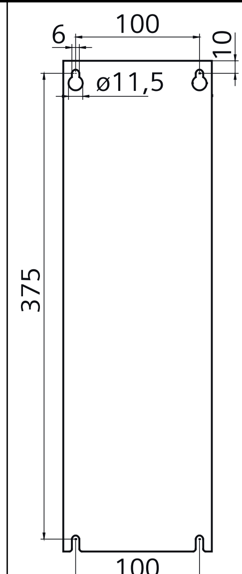
	FSA	FSB	FSC
Rear view of the converter All dimensions in mm			
Mounting parts	4 × M4 screws 4 × M4 washers	4 × M5 screws 4 × M5 washers	4 × M5 screws 4 × M5 washers
Tightening torque	6 Nm	6 Nm	6 Nm

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

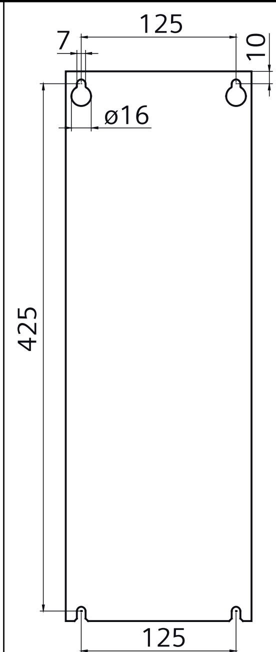
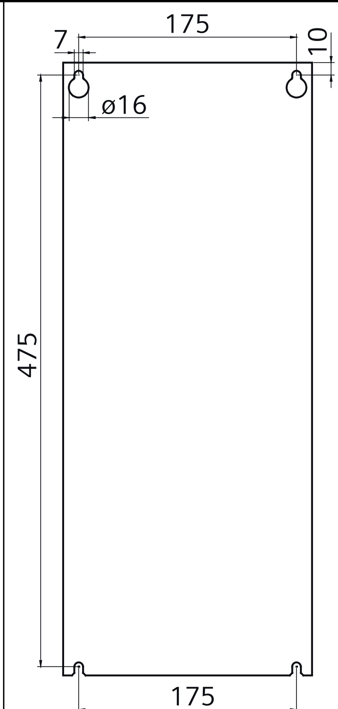
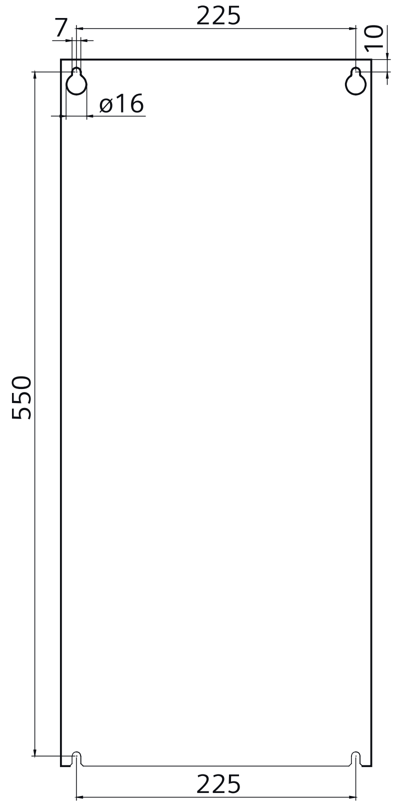
	FSD1	FSD2
Rear view of the converter All dimensions in mm		
Mounting parts	4 × M6 screws 4 × M6 washers	4 × M6 screws 4 × M6 washers
Tightening torque	10 Nm	10 Nm

Table 6-4 Rear view of the converter and mounting parts, frame size FSE, IP20

	FSE	
Rear view of the converter All dimensions in mm		
Mounting parts	4 × M6 screws 4 × M6 washers	
Tightening tor-que	10 Nm	

6.1.5 Minimum clearances, converter in degree of protection IP20

Dimension drawing

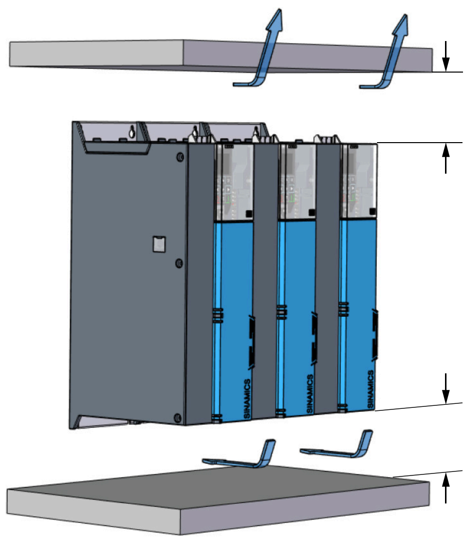


Figure 6-4 IP20 minimum clearances

Table 6-5 Minimum clearances

	Unit	FSA	FSB	FSC	FSD1	FSD2	FSE
Minimum ventilation clearance above	mm	85	85	85	90	90	90
Minimum ventilation clearance below	mm	85	108	149	160	160	193
Minimum ventilation clearance below with extended shielding plate	mm	147	---	---	---	---	---
Recommended minimum clearance at the front	mm	10	10	10	10	10	10

6.1.6 Cooling air flow, converter with IP20 degree of protection

Technical specifications

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

Frame size	Unit	Value	Unit	Value
FSA	m^3/s	0.010	ft^3/s	0.4
FSB	m^3/s	0.016	ft^3/s	0.6
FSC	m^3/s	0.036	ft^3/s	1.3
FSD1	m^3/s	0.039	ft^3/s	1.4
FSD2	m^3/s	0.050	ft^3/s	1.8
FSE	m^3/s	0.067	ft^3/s	2.4

6.1.7 Dimensions, converter in degree of protection IP55

Dimension drawing

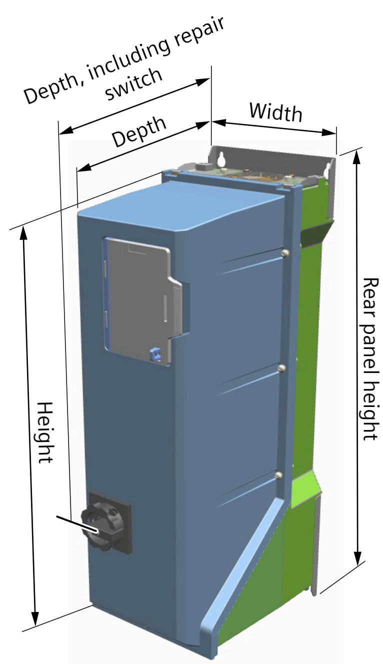


Figure 6-5 Dimensions, IP55 degree of protection

Table 6-7 Dimensions

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

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 6-8 Rear view of the converter and mounting parts, frame sizes FSB ... FSD1, degree of protection IP55

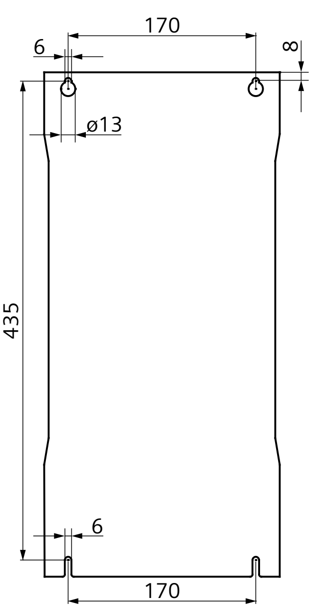
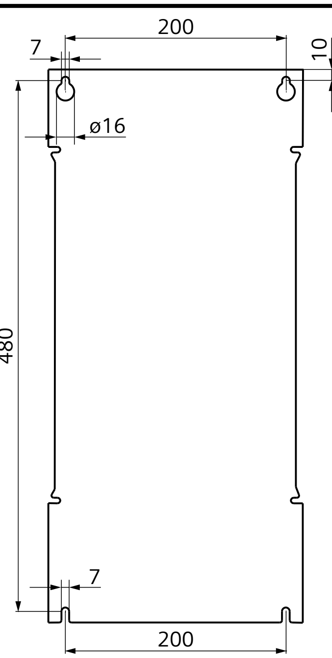
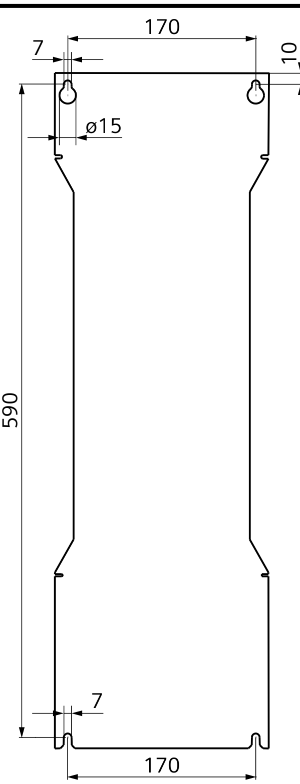
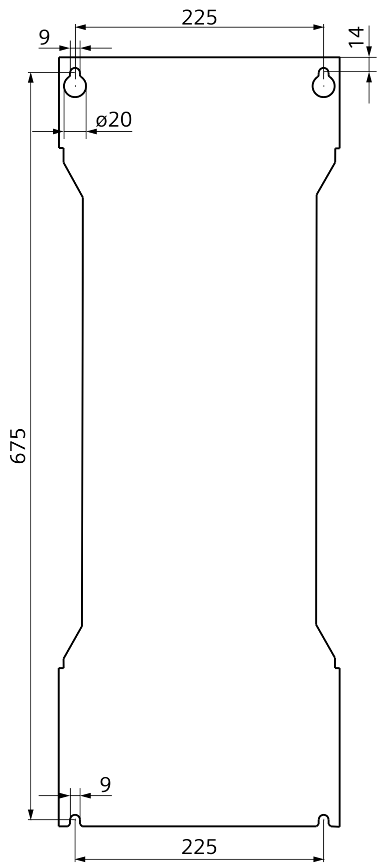
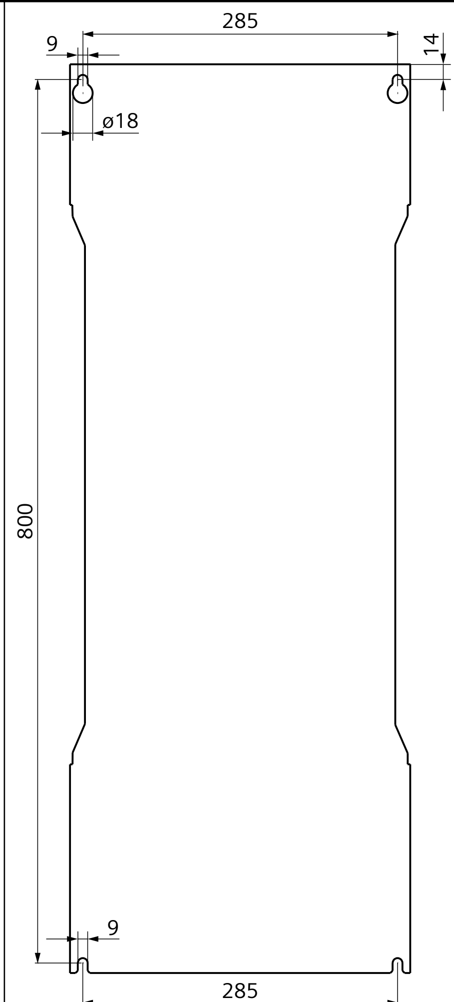
	FSB	FSC	FSD1
Rear view of the converter [mm]			
Mounting parts	4 × M5 screws 4 × M5 washers	4 × M6 screws 4 × M6 washers	4 × M6 screws 4 × M6 washers
Tightening torque	6 Nm	10 Nm	10 Nm

Table 6-9 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

6.1.9 Minimum clearances, converter in degree of protection IP55

Dimension drawing

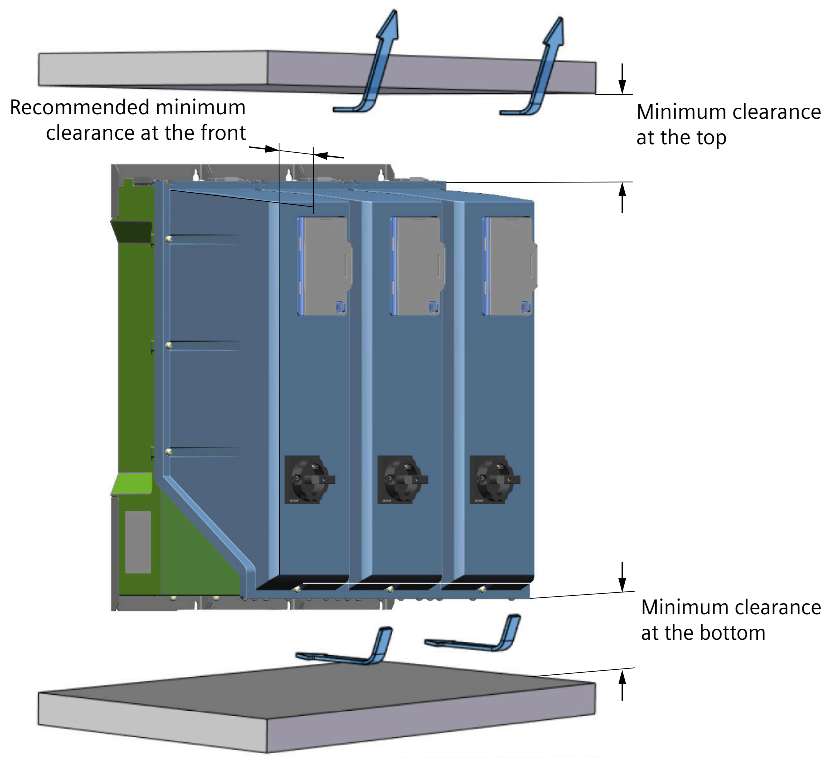


Figure 6-6 IP55 minimum clearances

Table 6-10 Minimum clearances

	Unit	FSB	FSC	FSD1	FSD2	FSE
Minimum ventilation clearance above	mm	103	115	143	163	195
Minimum ventilation clearance below	mm	103	115	143	163	195
Recommended minimum clearance at the front	mm	40	40	40	45	75

6.1.10 Cooling air flow, converter with IP55 degree of protection

Technical specifications

Table 6-11 Cooling air flow, converter with IP55 degree of protection

Frame size	Unit	Value	Unit	Value
FSB	m^3/s	0.050	ft^3/s	1.8
FSC	m^3/s	0.036	ft^3/s	1.3
FSD1	m^3/s	0.038	ft^3/s	1.3
FSD2	m^3/s	0.058	ft^3/s	2.0
FSE	m^3/s	0.065	ft^3/s	2.3

6.2 Braking resistor

6.2.1 Mounting position

Requirement

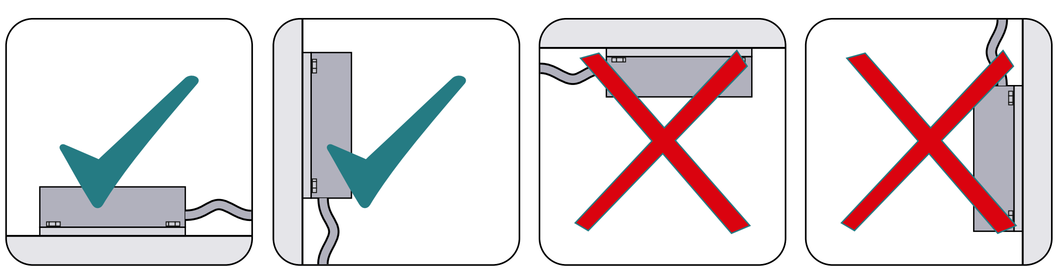
NOTICE

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 Weight, braking resistor in degree of protection IP21

Technical data

Table 6-12 Weight, line voltage 3 AC 200 ... 240 V

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

Table 6-13 Weight, line voltage 3 AC 380 ... 480 V/500 V

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

6.2.3 Dimensions, braking resistor in degree of protection IP21

Dimensions

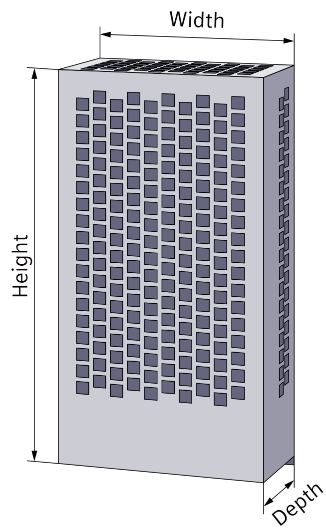


Figure 6-7 Dimensions, degree of protection IP21

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

Table 6-15 Dimensions, line voltage 3 AC 380 ... 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 ‖ JJY:023434020001	mm mm	220 630	180 350	470 630
JJY:023464020001 1)				
JJY:023434020001 ‖ JJY:023434020001	mm mm	630 630	350 350	630 630

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

6.2.4 Minimum clearances, braking resistor in degree of protection IP21

Requirement

CAUTION

Risk of burns and damage from hot surface

The braking resistor surface can assume temperatures exceeding 100 °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 from other devices and components must be maintained on account of the surface temperature of the braking resistor during operation.

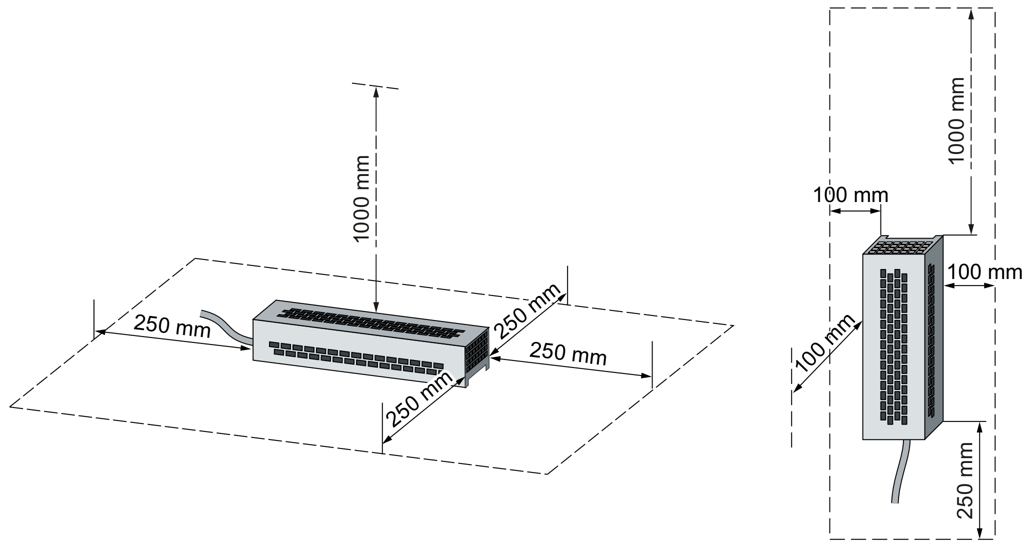


Figure 6-8 Minimum clearances for horizontal and vertical installation

6.2.5 Installation, braking resistor in degree of protection IP21

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.

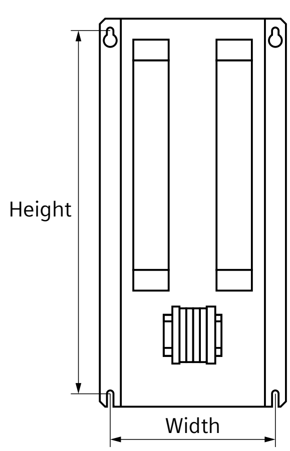


Table 6-16 Fixing, line voltage 3 AC 200 ... 240 V

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 Fixing, line voltage 3 AC 380 ... 480/500 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 ‖ JJY:023434020001	mm mm	187 317	430 570	M5 / 6 Nm M5 / 6 Nm
JJY:023464020001 [1)] JJY:023434020001 ‖ JJY:023434020001	mm mm	317 317	570 570	M5 / 6 Nm M5 / 6 Nm

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

6.3 Attaching the label for the North American market

Requirement

The converter is supplied with a 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.

DANGER - Risk of electrical shock. Discharge time of DC capacitors to a level below 50V is 5 minutes.

WARNING - The opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electrical shock, current carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current elements of an overload relay occurs, the complete overload relay must be replaced.

The supply circuit's maximum short circuit current capability and voltage rating depends on type and rating of the overcurrent protection device.
Refer to the user manual for details.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code, the Canadian Electrical Code, Part1, respectively, additional local Codes and the Manufacturer´s Instructions.

Integral motor overload protection included. Refer to user manual for initial setting and adjustments.

DANGER - Risque de choc électrique. Une tension dangereuse peut être présentée jusqu'à 5 minutes après avoir coupé l'alimentation.

ATTENTION - Le déclenchement du dispositif de protection du circuit de dérivation peut être dû à une coupure qui résulte d'un courant de défaut. Pour limiter le risque d'incendie ou de choc électrique, examiner les pièces porteuses de courant et les autres éléments du contrôleur et les remplacer s'ils sont endommagés.
En cas de grillages de l'élément traversé par le courant dans un relais de surcharge, le relais tout entier doit être remplacé.

Le courant nominal de court-circuit du circuit d'alimentation et sa tension assignée dépendent du type et des caractéristiques assignées du dispositif de protection contre les surcharges. Pour plus de détails, voir manuel.

La protection intégrée contre les courts-circuits n'assure pas la protection de la dérivation. La protection de la dérivation doit être exécutée conformément au le National Electrical Code (NEC) ou le Code Canadien de L'électricité, première partie, et dans le respect des prescriptions locales et des instructions du fabricant.

Protection de surcharge moteur incluse. Voir manuel pour les paramètres d'origine et les réglages.

Figure 6-9 Label for the North American market

Connecting 7

7.1 Line system, motor 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

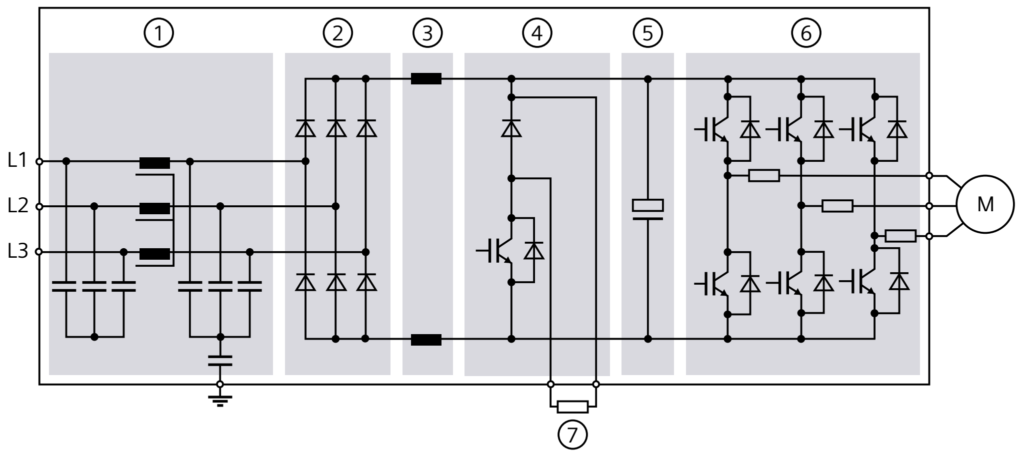
Electric shock caused by damaged cables

The electric cables between the line supply, converter, braking resistor and motor are at hazardous voltage levels. For damaged electric cables, there is a risk of death when cables are touched.

- Protect cables that are at hazardous voltage levels against damage or inadvertent access.

7.1.1 G220 block diagram

Block diagram

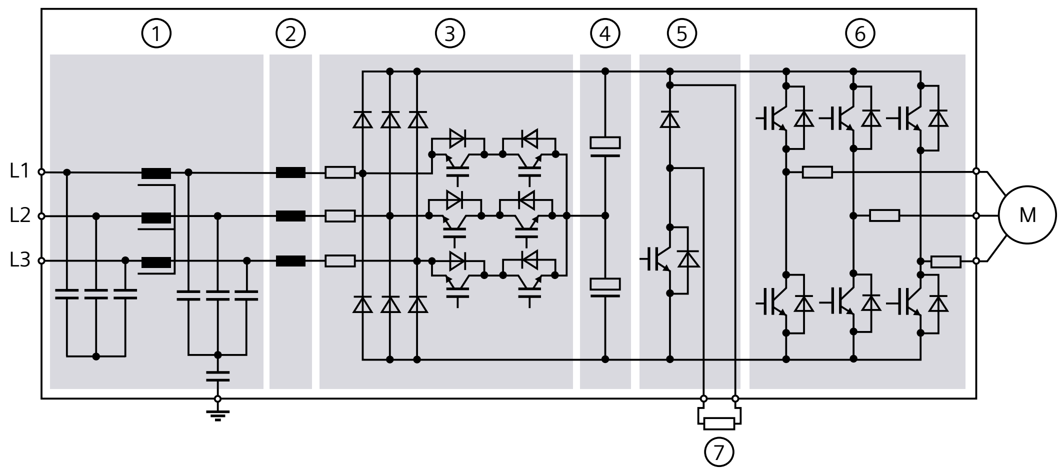


① Optional line filter
② Rectifier
③ DC link reactor
④ Braking module
⑤ DC link capacitors
⑥ Inverter
⑦ External braking resistor

Figure 7-1 Block diagram of the converter

7.1.2 G220 Clean Power block diagram

Block diagram



① Line filters
② Line reactor
③ Clean Power infeed
④ DC link capacitors
⑤ Braking module
⑥ Inverter
⑦ External braking resistor

Figure 7-2 Block diagram of the Clean Power converter

7.1.3 Connecting up the converter, degree of protection IP20

7.1.3.1 Connection overview, converter in degree of protection IP20

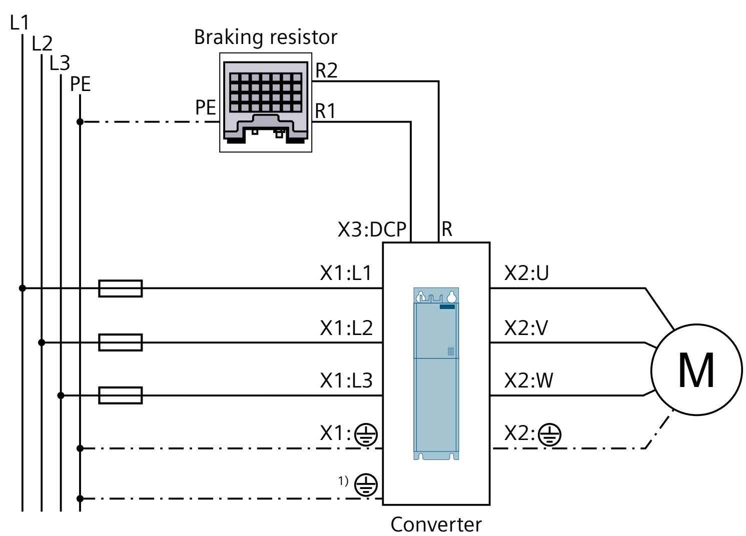
Requirement

When connecting up, only copper cables are permitted.

In installations for the North American market, in compliance with UL/cUL, connecting cables must have a thermal stability of 75 °C.

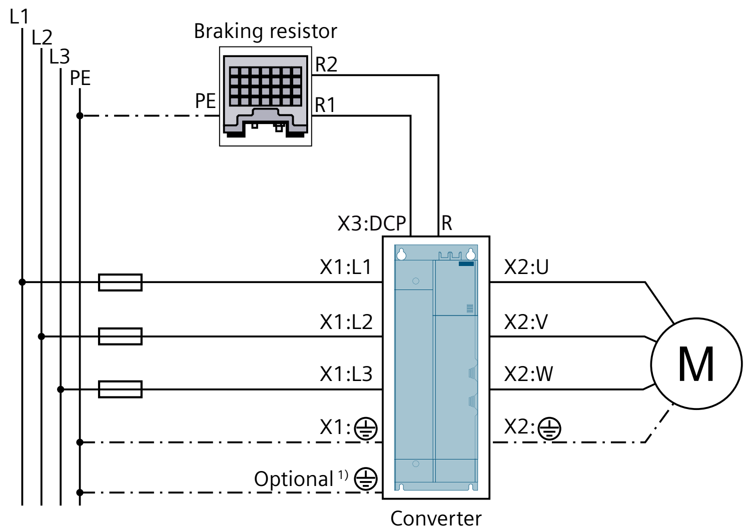
⚠ WARNING
Electric shock as a result of missing protective conductor
When only connecting a protective conductor to the converter, frame size FSA, high voltages can be present at the housing, which when touched, can result in death or severe injury.
• For converters, frame size FSA, connect a protective conductor to the heat sink as well as to line supply terminal X1.

Converter in degree of protection IP20



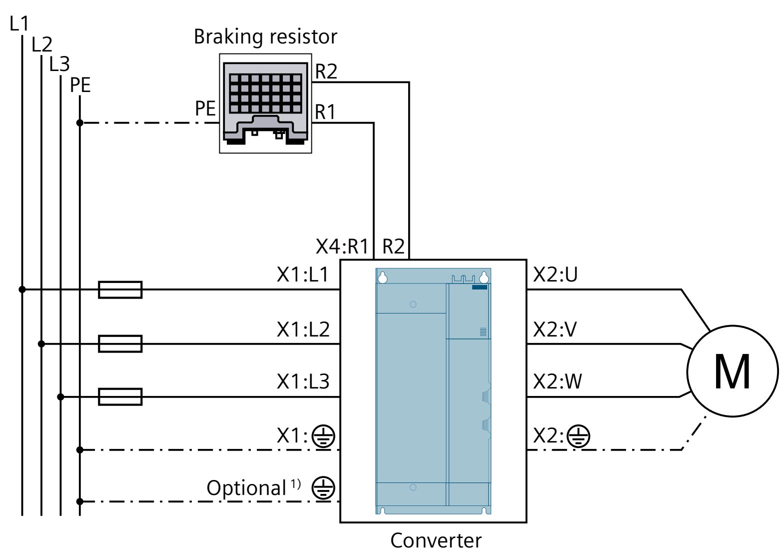
1) For converters of frame size FSA, a line protective conductor should be connected at X1 and at the heat sink.

Figure 7-3 Connection overview, frame size FSA



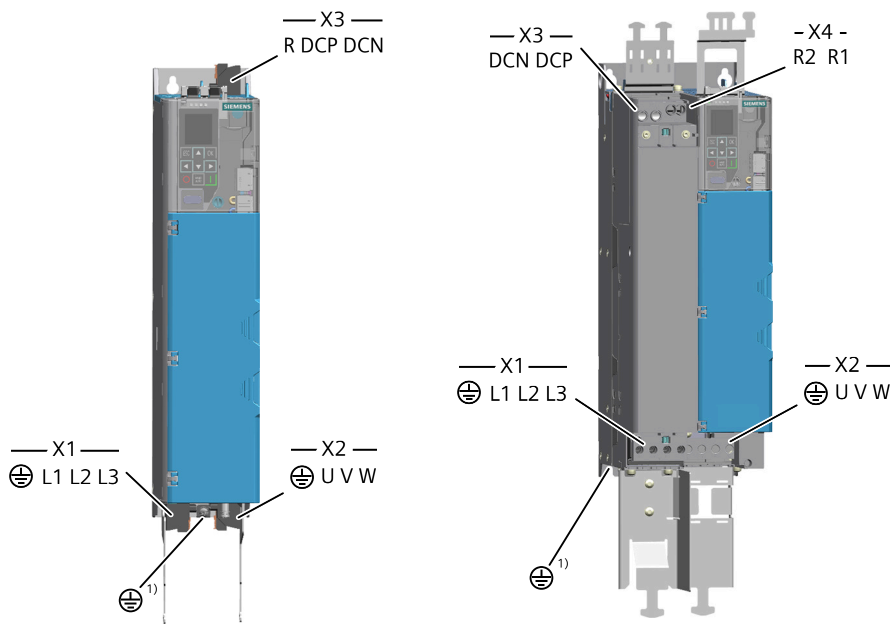
1) For converters frame sizes FSB and FSC, connecting the line protective conductor at the heat sink is optional.

Figure 7-4 Connection overview, frame sizes FSB and FCC



1) For converters frame size FSD1, connecting the line protective conductor at the heat sink is optional.

Figure 7-5 Connection overview from frame size FSD1



1) Additional connection options for a protective conductor at the heat sink

Figure 7-6 Power connections up to frame size FSC and from frame size FSD1

7.1.3.2 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 conductor cross-section in order to guarantee the IP20 degree of protection.

Requirement

Tool required:

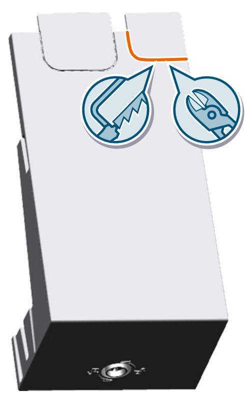
- Slotted screwdriver
- Diagonal cutter or fine saw

Procedure

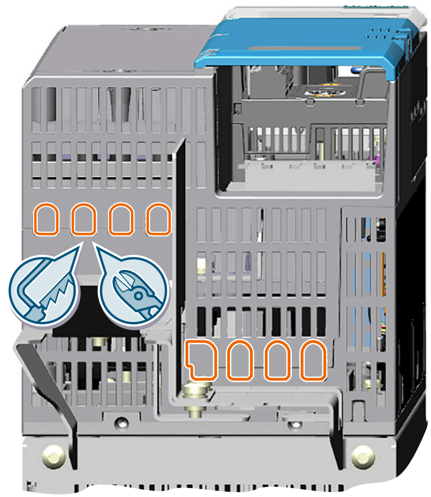
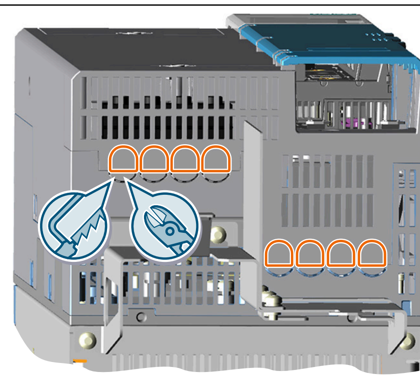
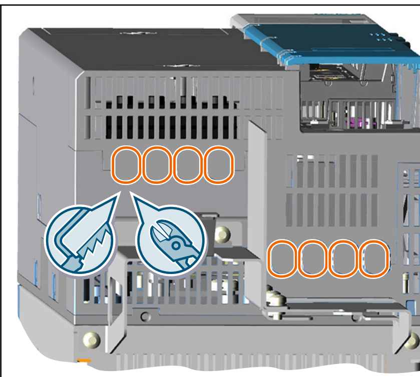
Proceed as follows, to access the converter power connections from frame size FSD1:

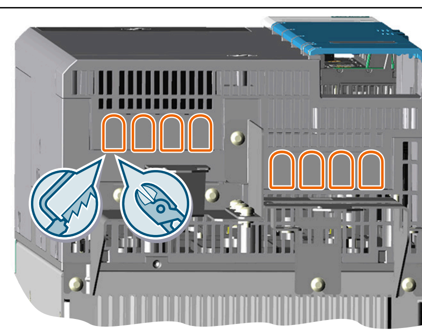
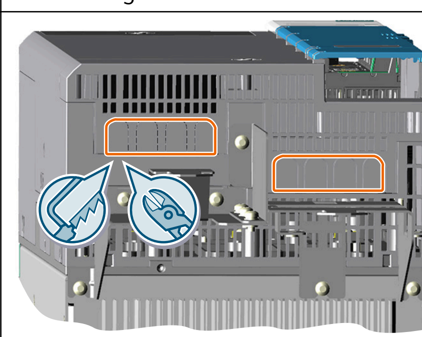
1. Remove the converter connection covers.

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.



3. Break-out or saw-out the openings for the line and motor connection from the lower connection cover.

<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>

4. Re-attach the converter connection covers to the converter.

7.1.3.3 Connection, converter in degree of protection IP20, 3 AC 200 ... 240 V

Description

Rigid as well as flexible cables can be connected.

Table 7-1 Line connection (line voltage 3 AC 200 ... 240 V, IP 20)

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	A	0.55... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	B	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	C	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (5.3 ... 17.7)	12 (0.5)	Screw terminal
17 ... 20	D2	11 ... 18.5	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	E	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

Table 7-2 Motor connection (line voltage 3 AC 200 ... 240 V, IP 20)

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	A	0.55 ... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	B	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	C	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (5.3 ... 17.7)	12 (0.5)	Screw terminal
17 ... 20	D2	11 ... 18.5	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	E	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

Table 7-3 Connection at the converter for the braking resistor (line voltage 3 AC 200 ... 240 V, IP 20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			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**
05 ... 11	A	0.55 ... 2.2	1.5 ... 4 (16 ... 12)	0.50 (4.4)	7 (0.3)	Screw terminal
12 ... 13	B	3 ... 4	1.5 ... 6 (16 ... 10)	0.60 (5.3)	12 (0.5)	Screw terminal
15 ...16	C	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10.6 ... 13.3)	12 (0.5)	Screw terminal
17 ... 20	D2	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	E	22 ... 30	16 ... 35 (6 ... 2)	3.7 ... 4.5 (32.7 ... 39.8)	18 (0.7)	Screw terminal

1) Conductor with end sleeve

Table 7-4 Additional connection option for a protective conductor at the heat sink (line voltage 3 AC 200 ... 240 V, IP 20)

Converter 6SL4112-.C.□□-...0 6SL4112-.D.□□-...0			Protective conductor connection at the heat sink		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
05 ... 11	A	0.55... 2.2	1.5 ... 4 (16 ... 11)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
12 ... 13	B	3 ... 4	1.5 ... 6 (16 ... 9)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
15 ...16	C	5.5 ... 7.5	1.5 ... 16 (16 ... 6)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
17 ... 20	D2	11 ... 18.5	10 ... 50 (7 ... 1)	4.0 ... 5.0 (35.4 ... 44.3)	Ring cable lug for M5 screw
21 ... 23	E	22 ... 30	35 ... 95 (2 ... 3/0)	4.0 ... 5.0 (35.4 ... 44.3)	Ring cable lug for M5 screw

7.1.3.4 Connection, converter in degree of protection IP20, 3 AC 380 ... 480 V/500 V

Description

Rigid as well as flexible cables can be connected.

Table 7-5 Line connection (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP 20)

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	A	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	B	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10 ... 17.7)	12 (0.5)	Screw terminal
20 ... 21	D1	18.5 ... 22	6 ... 35 (10 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
23 ... 24	D2	30 ... 37	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	E	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

Table 7-6 Motor connection (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP 20)

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	A	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	B	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10 ... 17.7)	12 (0.5)	Screw terminal
20 ... 21	D1	18.5 ... 22	6 ... 35 (10 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
23 ... 24	D2	30 ... 37	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.3 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	E	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106)	25 (1)	Screw terminal

Table 7-7 Connection at the converter for the braking resistor (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP 20)

Converter **6SL4113-.C.□□-...0** **6SL4113-.D.□□-...0**			**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**
08 ... 13	A	1.1... 4	1.5 ... 4 (16 ... 12)	0.5 (4.4)	7 (0.3)	Screw terminal
15 ... 16	B	5.5 ... 7.5	1.5 ... 6 (16 ... 10)	0.6 (5.3)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ... 6)	1.2 ... 2.0 (10.6 ... 13.3)	12 (0.5)	Screw terminal
20 ... 21	D1	18.5 ... 22	6 ... 16 (10 ... 6)	1.2 ... 1.5 (10.6 ... 13.3)	12 (0.5)	Screw terminal
23 ... 24	D2	30 ... 37	10 ... 16 (8 ... 6)	1.2 ... 1.5 (10.6 ... 13.3)	10 (0.4)	Screw terminal
26 ... 27	E	45 ... 55	16 ... 35 (6 ... 2)	3.7 ... 4.5 (32.7 ... 39.8)	18 (0.7)	Screw terminal

Table 7-8 Additional connection option for a protective conductor at the heat sink (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP 20)

Converter **6SL4113-.C.□□-...0** **6SL4113-.D.□□-...0**			**Protective conductor connection at the heat sink**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 13	A	1.1... 4	1.5 ... 4 (16 ... 11)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
15 ... 16	B	5.5 ... 7.5	1.5 ... 6 (16 ... 9)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
17 ...18	C	11 ... 15	1.5 ... 16 (16 ... 6)	2.0 ... 3.0 (17.7 ... 26.6)	Ring cable lug for M4 screw
20 ... 21	D1	18.5 ... 22	6 ... 35 (9 ... 2)	4.0 ... 5.0 (35.4 ... 44.3)	Ring cable lug for M5 screw
23 ... 24	D2	30 ... 37	10 ... 50 (7 ... 1)	4.0 ... 5.0 (35.4 ... 44.3)	Ring cable lug for M5 screw
26 ... 27	E	45 ... 55	35 ... 95 (2 ... 3/0)	4.0 ... 5.0 (35.4 ... 44.3)	Ring cable lug for M5 screw

7.1.4 Connecting up the converter, degree of protection IP55

7.1.4.1 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.

Removing and installing the housing cover is identical for all converter frame sizes.

The following procedure describes removing and installing the housing cover using a converter, frame size FSC as example.

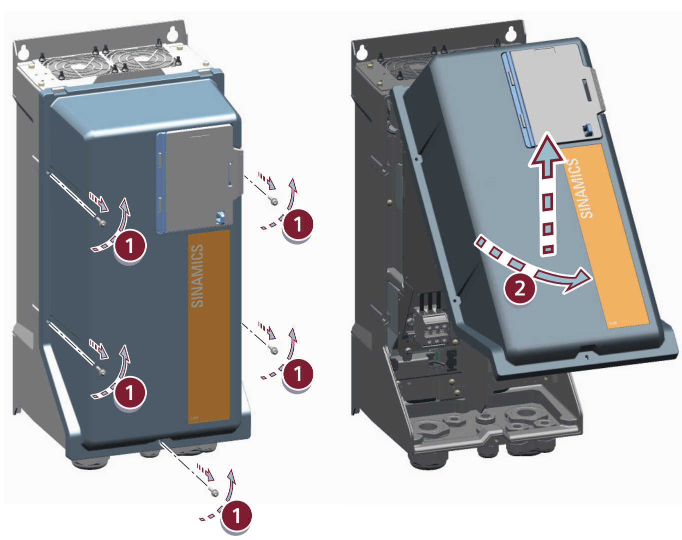
Requirement

The following requirements apply when the housing cover is removed:

- Comply with ESD regulations.
- Required tools:
  – Torx screwdriver TX 20

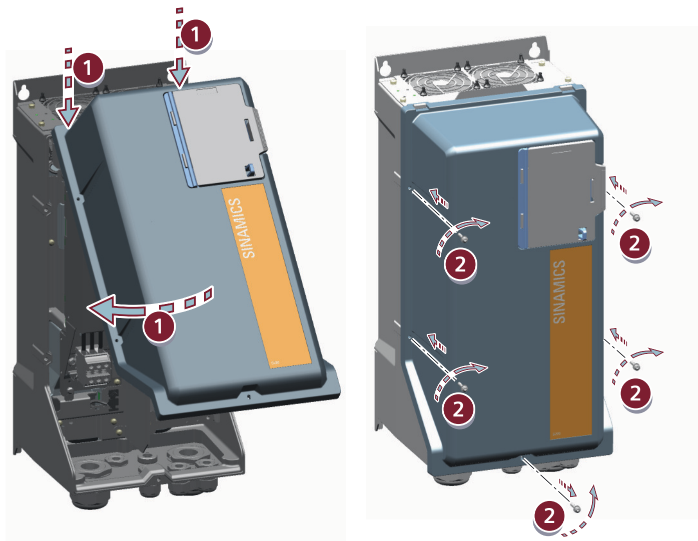
Procedure

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. Tightening torque: 2 Nm

7.1.4.2 Accessing power connections, converters with degree of protection IP55

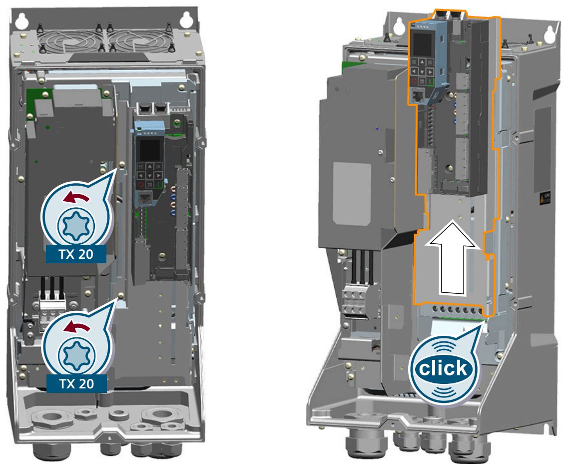
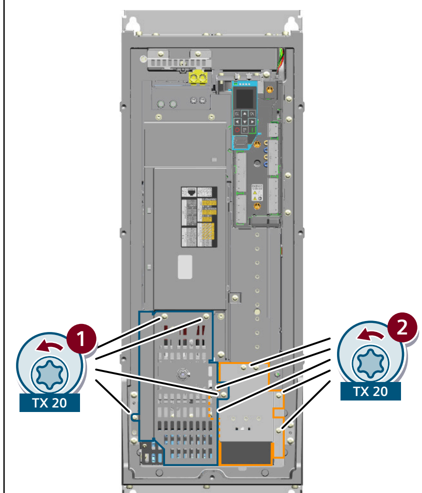
Requirement

The housing cover has been removed.

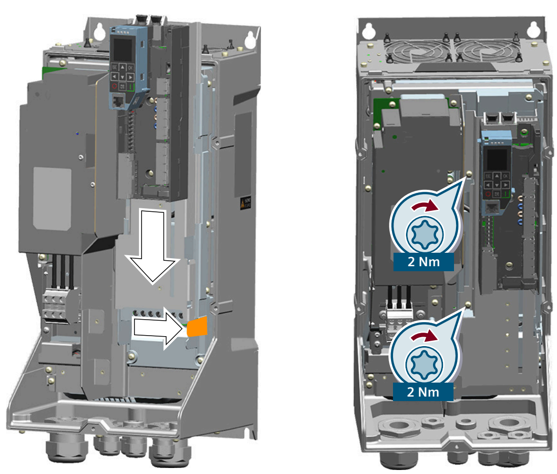
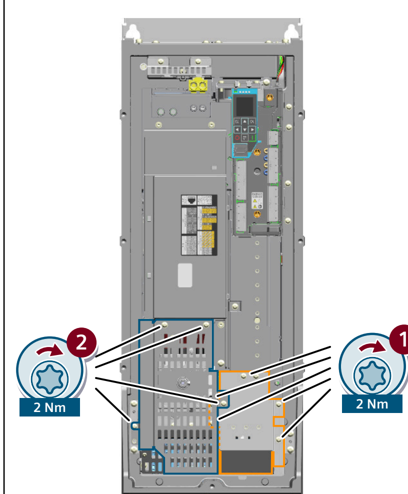
Tool required: Torx screwdriver TX 20

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:  Unfasten the screws of the terminal covers and remove the terminal covers.

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:  Mount the terminal covers.

7.1.4.3 Connection overview, converter in degree of protection IP55

Requirement

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 outside the enclosure at the heat sink

Connecting the line protective conductor at the heat sink is optional.

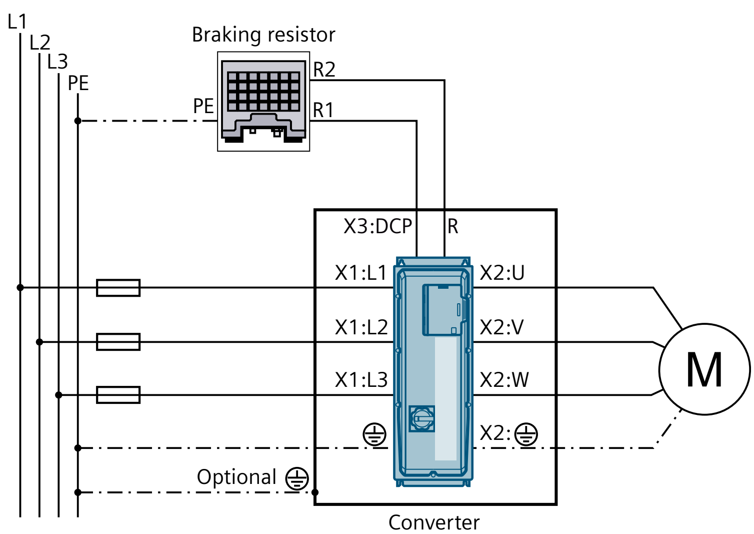


Figure 7-7 Connection overview up to frame size FSC

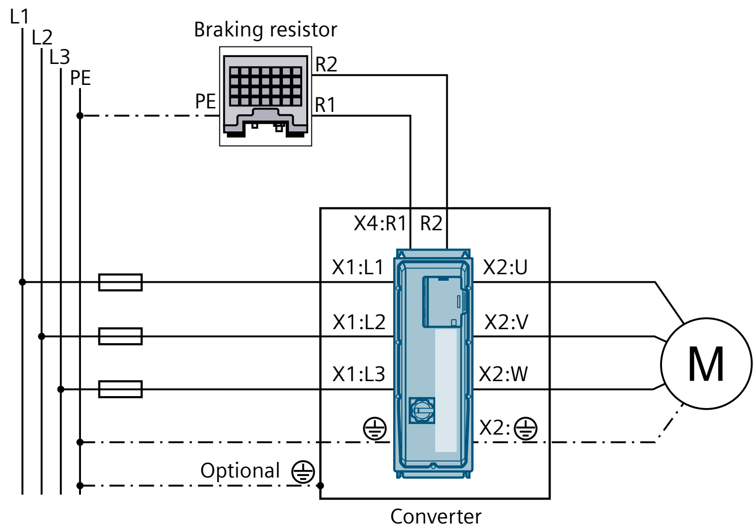


Figure 7-8 Connection overview for frame size FSD1

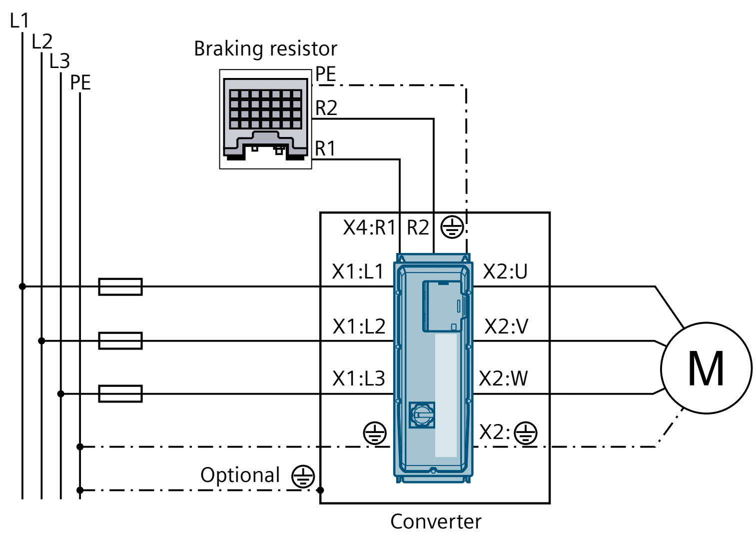


Figure 7-9 Connection overview from frame size FSD2 and higher

Converters from frame size FSD2 and higher have a separate connection option for the protective conductor of the braking resistor.

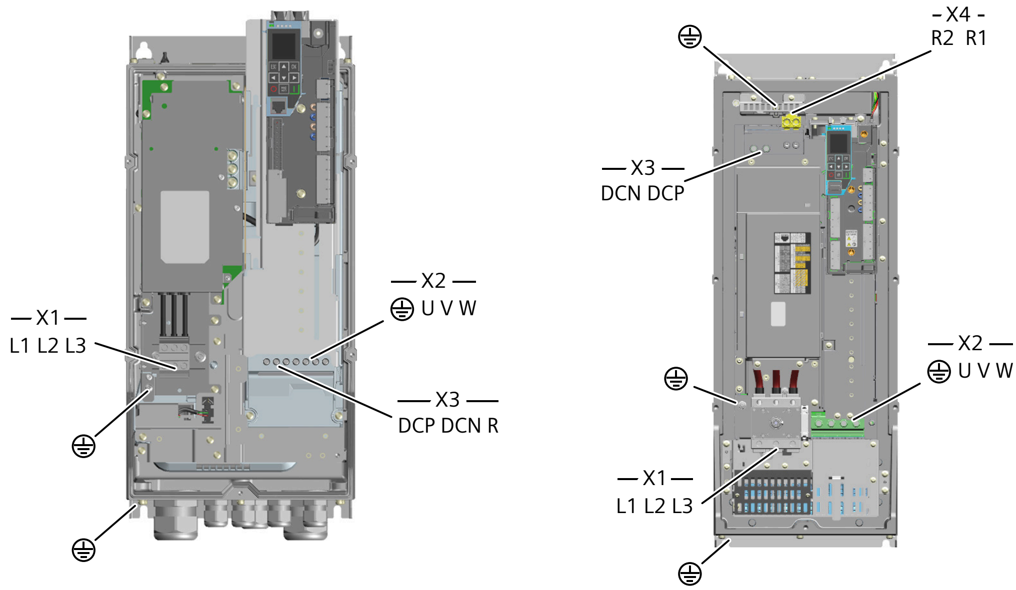


Figure 7-10 Power connections up to frame size FSC and from frame size FSD1

7.1.4.4 Connection, converter in degree of protection IP55, 3 AC 200 ... 240 V

Description

Rigid as well as flexible cables can be connected.

Table 7-9 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**
05 ... 13	B	0.55 ... 4	1.5 ... 6 (16 ...10)	1.2 (10.6)	12 (0.5)	Screw terminal
15 ... 16	C	5.5 ... 7.5	2.5 ... 16 (14... 6)	2.5 ... 3.4 (22.1 ... 30.1)	14 (0.6)	Screw terminal
17 ... 20	D2	11 ... 18.5	16 ... 50 (6 ... 2) 2) 16 ... 50 (6 ... 1) 3)	5.6 (49.6)	25 (1)	Screw terminal
21 ... 23	E	22 ... 30	35 ... 70 (2 ... 2/0) 1) 35 ... 95 (2 ... 3/0) 2)	10.2 (90.3)	30 (1.2)	Screw terminal

1) Finely stranded conductor with end sleeve

2) Rigid conductor

3) Finely stranded conductor

Table 7-10 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**
05 ... 13	B	0.55 ... 4	2.5 ... 6 (14 ... 10)	2.0 ... 2.5 (17.7 ... 22.1)	9.5 (0.4)	Screw terminal
15 ... 16	C	5.5 ... 7.5	2.5 ... 16 (14 ...6)	2.0 ... 2.5 (17.7 ... 22.1)	14 (0.6)	Screw terminal
17 ... 20	D2	11 ... 18.5	10 ... 35[1)] (8 ... 1) 10 ... 50[2)] (8 ... 1)	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
21 ... 23	E	22 ... 30	35 ... 95 (1 ... 3/0)	9.5 ... 10 (84.1 ... 88.5)	15 (0.6)	Screw terminal

1) Finely stranded conductor with end sleeve

2) Rigid conductor

Table 7-11 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**
05 ... 13	B	0.55 ... 4	1.5 ... 6 (16 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
15 ... 16	C	5.5 ... 7.5	1.5 ... 16 (16 ... 6)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
17 ... 20	D2	11 ... 18.5	2.5 ... 50 (13 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M6 stud
21 ... 23	E	22 ... 30	4 ... 95 (11 ... 3/0)	8.0 ... 9.0 (70.8 ... 79.6)	Ring cable lug for M8 stud

Table 7-12 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**
05 ... 13	B	0.55 ... 4	2.5 ... 6 (14 ... 10)	1.3 (11.5)	12 (0.5)	Screw terminal
15 ... 16	C	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.3 ... 1.4 (1.3 ... 12.4)	12 (0.5)	Screw terminal

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
17 ... 20	D2	11 ... 18.5	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	19 (0.7)	Screw terminal
21 ... 23	E	22 ... 30	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

Table 7-13 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			
-...□□-	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 ... 13	B	0.55 ... 4	2.5 ... 6 (14 ... 10)	1.3 (11.5)	12 (0.5)	Screw terminal
15 ... 16	C	5.5 ... 7.5	2.5 ... 16 (14 ... 6)	1.3 ... 1.4 (11.5 ... 12.4)	12 (0.5)	Screw terminal
17 ... 20	D2	11 ... 18.5	2.5 ... 16 (14 ... 6)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
21 ... 23	E	22 ... 30	16 ... 50 (6 ... 1)	8.0 ... 9.0 (70.8 ... 79.7)	13 (0.5)	Screw terminal

Table 7-14 Additional connection option for a protective conductor at the heat sink (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 heat sink		
-...□□-	Frame size	Rated power in kW	Conductor cross-section in mm² (AWG)	Tightening torque in Nm (lbf in)	Connection type
05 ... 13	B	0.55 ... 4	1.5 ... 6 (16 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
15 ... 16	C	5.5 ... 7.5	1.5 ... 16 (16 ... 6)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
17 ... 20	D2	11 ... 18.5	2.5 ... 50 (13 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M8 screw
21 ... 23	E	22 ... 30	4 ... 95 (11 ... 3/0)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M8 screw

7.1.4.5 Connection, converter in degree of protection IP55, 3 AC 380 ... 480 V/500 V

Description

Both rigid and flexible cables can be connected.

Table 7-15 Line connection without maintenance switch (line voltage 3AC 380 ... 415 / 3AC 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	B	1.1 ... 7.5	1.5 ... 6 (16 ...10)	1.2 (10.6)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14... 6)	2.5 ... 3.4 (22.1 ... 30.1)	14 (0.6)	Screw terminal
20 ... 21	D1	18.5 ... 22	16 ... 35 (6 ... 2)	5.6 (49.6)	25 (1)	Screw terminal
23 ... 24	D2	30 ... 37	16 ... 50 (6 ... 2) [2)] 16 ... 50 (6 ... 1) [3)]	5.6(49.6)	25 (1)	Screw terminal
26 ... 27	E	45 ... 55	35 ... 70[1)] (2 ... 2/0) 35 ... 95[2)] (2 ... 3/0)	10.2 (90.3)	30 (1.2)	Screw terminal

1) Finely stranded conductor with end sleeve
2) Rigid cable
3) Finely stranded conductor

Table 7-16 Line connection with maintenance switch (line voltage 3AC 380 ... 415 / 3AC 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	B	1.1 ... 7.5	2.5 ... 6 (14 ... 10)	2.0 ... 2.5 (17.7 ... 22.1)	9.5 (0.4)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ...6)	2.0 ... 2.5 (17.7 ... 22.1)	14 (0.6)	Screw terminal
20 ... 21	D1	18.5 ... 22	6 ... 16[1)] (10 ... 6) 6 ... 35[2)] (10 ... 2)	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
23 ... 24	D2	30 ... 37	10 ... 35[1)] (8 ... 1) 10 ... 50[2)] (8 ... 1)	2.5 ... 3 (22.1 ... 26.6)	14 (0.6)	Screw terminal
26 ... 27	E	45 ... 55	35 ... 95 (1 ... 3/0)	9.5 ... 10 (84.1 ... 88.5)	15 (0.6)	Screw terminal

1) Finely stranded conductor with end sleeve
2) Rigid cable

Table 7-17 Protective conductor for line connection (line voltage 3AC 380 ... 415 / 3AC 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	B	1.1 ... 7.5	1.5 ... 6 (16 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
17 ...18	C	11 ... 15	1.5 ... 16 (16 ... 6)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
20 ... 21	D1	18.5 ... 22	2.5 ... 50 (13 ... 1)	3.5 ... 4.0 (31.0 ... 35.4)	Ring cable lug for M6 stud
23 ... 24	D2	30 ... 37	2.5 ... 50 (13 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M6 stud
26 ... 27	E	45 ... 55	4 ... 95 (11 ... 3/0)	8.0 ... 9.0 (70.8 ... 79.6)	Ring cable lug for M8 stud

Table 7-18 Motor connection (line voltage 3AC 380 ... 415 / 3AC 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	B	1.1 ... 7.5	2.5 ... 6 (14 ... 10)	1.3 (11.5)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ... 6)	1.3 ... 1.4 (11.5 ... 12.4)	12 (0.5)	Screw terminal
20 ... 21	D1	18.5 ... 22	6 ... 35 (10 ... 2)	3.8 ... 4.5 (33.6 ... 39.8)	18 (0.7)	Screw terminal
23 ... 24	D2	30 ... 37	10 ... 50 (8 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	19 (0.7)	Screw terminal
26 ... 27	E	45 ... 55	35 ... 95 (2 ... 3/0)	10 ... 12 (88.5 ... 106.2)	25 (1)	Screw terminal

Table 7-19 Connection at the converter for the braking resistor (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP55)

Converter **6SL4113-0J.□□-...0** **6SL4113-0K.□□-...0** **6SL4113-0L.□□-...0** **6SL4113-0M.□□-...0**			**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**
08 ... 16	B	1.1 ... 7.5	2.5 ... 6 (14 ... 10)	1.3 (11.5)	12 (0.5)	Screw terminal
17 ...18	C	11 ... 15	2.5 ... 16 (14 ... 6)	1.3 ... 1.4 (11.5 ... 12.4)	12 (0.5)	Screw terminal
20 ... 21	D1	18.5 ... 22	2.5 ... 16 (14 ... 6)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
23 ... 24	D2	30 ... 37	2.5 ... 16 (14 ...6)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
26 ... 27	E	45 ... 55	16 ... 50 (6 ...1)	8.0 ... 9.0 (70.8 ... 79.7)	13 (0.5)	Screw terminal

Table 7-20 Connection at the Clean Power converter for braking resistor (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP55)

Converter **6SL4113-2J.□□-...0** **6SL4113-2K.□□-...0** **6SL4113-2L.□□-...0** **6SL4113-2M.□□-...0**			**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	D1	18.5 ... 22	2.5 ... 4 (14 ... 11)	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
23 ... 24	D2	30 ... 37	2.5 ... 16 (14 ...6) [1]	1.5 ... 2.5 (13.3 ... 22.1)	10 (0.4)	Screw terminal
26 ... 27	E	45 ... 55	16 (6) [1] [2]	8.0 ... 9.0 (70.8 ... 79.7)	13 (0.5)	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 7-21 Additional connection option for a protective conductor at the heat sink (line voltage 3AC 380 ... 415 / 3AC 440 ... 500 V, IP55)

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0** **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Protective conductor at the heat sink**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
08 ... 16	B	1.1 ... 7.5	1.5 ... 6 (16 ... 9)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw
17 ...18	C	11 ... 15	1.5 ... 16 (16 ... 6)	1.5 ... 1.7 (13.3 ... 15.0)	Ring cable lug for M4 screw

Converter **6SL4113-.J.□□-...0** **6SL4113-.K.□□-...0** **6SL4113-.L.□□-...0** **6SL4113-.M.□□-...0**			**Protective conductor at the heat sink**		
-...□□-	**Frame size**	**Rated power in kW**	**Conductor cross-section in mm² (AWG)**	**Tightening torque in Nm (lbf in)**	**Connection type**
20 ... 21	D1	18.5 ... 22	2.5 ... 50 (13 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M8 screw
23 ... 24	D2	30 ... 37	2.5 ... 50 (13 ... 1)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M8 screw
26 ... 27	E	45 ... 55	4 ... 95 (11 ... 3/0)	5.0 ... 6.0 (44.2 ... 53.1)	Ring cable lug for M8 screw

7.1.5 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.

Requirement

Switch off the converter power supply.

> ⚠ **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

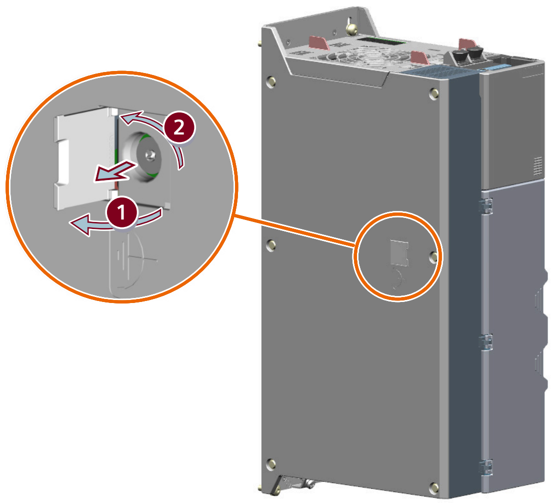


Figure 7-11 Removing the screw for functional grounding (example: Converter with frame size FSC)

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.

7.1.6 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.

Requirement

The following requirements apply when the housing cover is removed:

- Switch off the converter power supply.
- Comply with ESD regulations.
- Required tools:
  - Torx screwdriver TX 20

⚠ 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

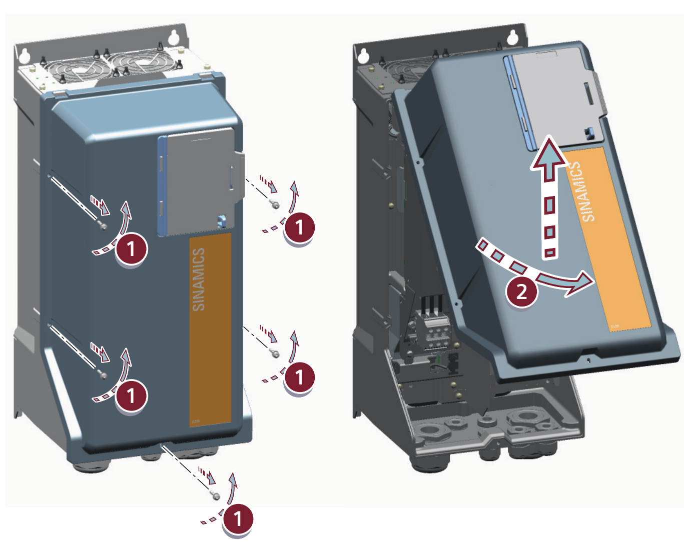
After the power supply has been switched off, it takes up to 5 min. until the capacitors in the converter have discharged so that the residual charge is at a non-hazardous level. Touching live components can result in death or severe injury.

- Check that there is absolutely no voltage between any of the power connections, or between them and the protective conductor connection.

Procedure

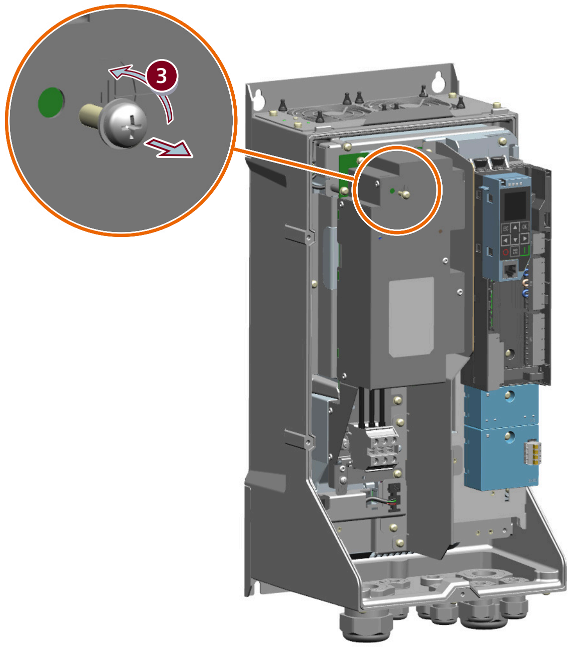
Proceed as follows to open the ground connection of the integrated line filter:

1. Release the screws of the converter housing cover.
   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. Using a torx screwdriver, tighten the fixing screws of the housing cover. Tightening torque: 2 Nm (17.7 lbf in).

7.1.7 Overcurrent protection and fault current protection

7.1.7.1 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)

7.1.7.2 Overcurrent protection, 3 AC 200 ... 240 V

Description

Table 7-22 Standard fuses according to IEC standard, 3 AC 200 ... 240 V

Converter		Standard fuse				Minimal control cabinet envelope dimensions for converters with IP20 degree of protection	
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	3NA3805	16	0.4	100	0.192 m³	6.78 ft³
0.75	6SL4112-0..06-...0	3NA3805	16	0.4	100	0.192 m³	6.78 ft³
1.1	6SL4112-0..08-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
1.5	6SL4112-0..10-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
2.2	6SL4112-0..11-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
3	6SL4112-0..12-...0	3NA3807	20	0.5	100 5 [1]	0.24 m³	8.48 ft³
4	6SL4112-0..13-...0	3NA3810	25	0.62	100 5 [1]	0.24 m³	8.48 ft³
5.5	6SL4112-0..15-...0	3NA3817	40	1.0	100 5 [1]	0.12 m³	4.24 ft³
7.5	6SL4112-0..16-...0	3NA3820	50	1.25	100 5 [1]	0.12 m³	4.24 ft³
11	6SL4112-0..17-...0	3NA3824	80	2.0	100 5 [1]	0.36 m³	12.71 ft³
15	6SL4112-0..18-...0	3NA3824	80	2.0	100 5 [1]	0.36 m³	12.71 ft³
18.5	6SL4112-0..20-...0	3NA3830	100	2.5	100 5 [1]	0.36 m³	12.71 ft³
22	6SL4112-0..21-...0	3NA3832	125	3.12	100 10 [1]	0.384 m³	13.56 ft³
30	6SL4112-0..23-...0	3NA3836	160	4.0	100 10 [1]	0.384 m³	13.56 ft³

1) For converters with maintenance switch

Table 7-23 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 m^3	6.78 ft^3
1.1	6SL4112-0..06-...0	8	100	0.192 m^3	6.78 ft^3
1.5	6SL4112-0..08-...0	10	100 5 [2]	0.192 m^3	6.78 ft^3
2	6SL4112-0..10-...0	12	100 5 [2]	0.192 m^3	6.78 ft^3
3	6SL4112-0..11-...0	15	100 5 [2]	0.192 m^3	6.78 ft^3
4	6SL4112-0..12-...0	20	100 5 [2]	0.24 m^3	8.48 ft^3
5	6SL4112-0..13-...0	30	100 5 [2]	0.24 m^3	8.48 ft^3
7.5	6SL4112-0..15-...0	40	100 5 [2]	0.12 m^3	4.24 ft^3
10	6SL4112-0..16-...0	50	100 5 [2]	0.12 m^3	4.24 ft^3
15	6SL4112-0..17-...0	70	100 5 [2]	0.36 m^3	12.71 ft^3
20	6SL4112-0..18-...0	90	100 5 [2]	0.36 m^3	12.71 ft^3
25	6SL4112-0..20-...0	110	5 [2] 100	0.36 m^3	12.71 ft^3
30	6SL4112-0..21-...0	125	100 10 [2]	0.384 m^3	13.56 ft^3
40	6SL4112-0..23-...0	150	100 10 [2]	0.384 m^3	13.56 ft^3

[1] Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters of frame size A to C, 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)

7.1.7.3 Overcurrent protection, 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V

Description

Table 7-24 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 IP20 degree of protection	
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	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
1.5	6SL4113-0..10-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
2.2	6SL4113-0..11-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
3	6SL4113-0..12-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
4	6SL4113-0..13-...0	3NA3805	16	0.4	100 5 [1]	0.192 m³	6.78 ft³
5.5	6SL4113-0..15-...0	3NA3807	20	0.5	100 5 [1]	0.24 m³	8.48 ft³
7.5	6SL4113-0..16-...0	3NA3810	25	0.62	100 5 [1]	0.24 m³	8.48 ft³
11	6SL4113-0..17-...0	3NA3817	40	1.0	100 5 [1]	0.12 m³	4.24 ft³
15	6SL4113-0..18-...0	3NA3820	50	1.25	100 5 [1]	0.12 m³	4.24 ft³
18.5	6SL4113-0..20-...0	3NA3822	63	1.57	100 5 [1]	0.16 m³	5.65 ft³
22	6SL4113-0..21-...0	3NA3824	80	2.0	100 5 [1]	0.16 m³	5.65 ft³
30	6SL4113-0..23-...0	3NA3824	80	2.0	100 5 [1]	0.36 m³	12.71 ft³
37	6SL4113-0..24-...0	3NA3830	100	2.5	100 5 [1]	0.36 m³	12.71 ft³
45	6SL4113-0..26-...0	3NA3832	125	3.12	100 10 [1]	0.384 m³	13.56 ft³
55	6SL4113-0..27-...0	3NA3836	160	4.0	100 10 [1]	0.384 m³	13.56 ft³

[1] For converters with maintenance switch

Table 7-25 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 / kW	Article number	Rated current / A [1)]	SCCR / kA @ 500 V		
1.5	6SL4113-0..08-...0	6	100 5 [2)]	0.192 m^3	6.78 ft^3
2	6SL4113-0..10-...0	8	100 5 [2)]	0.192 m^3	6.78 ft^3
3	6SL4113-0..11-...0	10	100 5 [2)]	0.192 m^3	6.78 ft^3
4	6SL4113-0..12-...0	12	100 5 [2)]	0.192 m^3	6.78 ft^3
5	6SL4113-0..13-...0	15	100 5 [2)]	0.192 m^3	6.78 ft^3
7.5	6SL4113-0..15-...0	20	100 5 [2)]	0.24 m^3	8.48 ft^3
10	6SL4113-0..16-...0	30	100 5 [2)]	0.24 m^3	8.48 ft^3
15	6SL4113-0..17-...0	40	100 5 [2)]	0.12 m^3	4.24 ft^3
20	6SL4113-0..18-...0	50	100 5 [2)]	0.12 m^3	4.24 ft^3
25	6SL4113-0..20-...0	60	100 5 [2)]	0.16 m^3	5.65 ft^3
30	6SL4113-0..21-...0	70	100 5 [2)]	0.16 m^3	5.65 ft^3
40	6SL4113-0..23-...0	90	100 5 [2)]	0.36 m^3	12.71 ft^3
50	6SL4113-0..24-...0	110	100 5 [2)]	0.36 m^3	12.71 ft^3
60	6SL4113-0..26-...0	125	100 10 [2)]	0.384 m^3	13.56 ft^3
75	6SL4113-0..27-...0	150	100 10 [2)]	0.384 m^3	13.56 ft^3

[1)] Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters of frame size A to C, 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)

7.1.7.4 Overcurrent protection, Clean Power converter

Description

Table 7-26 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 IP20 degree of protection	
Rated power / kW	Article number	Article number	Rated current / A	$I_{CP,MR}$ / kA	I_{CC} / kA @ 500 V		
7.5	6SL4113-2.A16-2..0	3NA3810	25	0.62	100 5 [1]	0.16 m^3	5.65 ft^3
11	6SL4113-2.A17-2..0	3NA3817	40	1.0	100 5 [1]	0.16 m^3	5.65 ft^3
15	6SL4113-2.A18-2..0	3NA3820	50	1.25	100 5 [1]	0.16 m^3	5.65 ft^3
18.5	6SL4113-2.A20-2..0	3NA3822	63	1.57	100 5 [1]	0.16 m^3	5.65 ft^3
22	6SL4113-2.A21-2..0	3NA3824	80	2.0	100 5 [1]	0.16 m^3	5.65 ft^3
30	6SL4113-2.A23-2..0	3NA3824	80	2.0	100 5 [1]	0.36 m^3	12.71 ft^3
37	6SL4113-2.A24-2..0	3NA3830	100	2.5	100 5 [1]	0.36 m^3	12.71 ft^3
45	6SL4113-2.A26-2..0	3NA3832	125	3.12	100 10 [1]	0.384 m^3	13.56 ft^3
55	6SL4113-2.A27-2..0	3NA3836	160	4.0	100 10 [1]	0.384 m^3	13.56 ft^3

[1] For converters with maintenance switch

Table 7-27 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 / kW	Article number	Rated current / A [1]	SCCR / kA @ 500 V		
10	6SL4113-0..16-...0	30	100 5 [2]	0.16 m^3	5.65 ft^3
15	6SL4113-0..17-...0	40	100 5 [2]	0.16 m^3	5.65 ft^3
20	6SL4113-0..18-...0	50	100 5 [2]	0.16 m^3	5.65 ft^3
25	6SL4113-0..20-...0	60	100 5 [2]	0.16 m^3	5.65 ft^3

Converter		Fuses		Minimal control cabinet envelope dimensions for converters with degree of protection UL open type	
Rated power / kW	Article number	Rated current / A [1)]	SCCR / kA @ 500 V		
30	6SL4113-0..21-...0	70	100 5 [2)]	0.16 m^3	5.65 ft^3
40	6SL4113-0..23-...0	90	100 5 [2)]	0.36 m^3	12.71 ft^3
50	6SL4113-0..24-...0	110	100 5 [2)]	0.36 m^3	12.71 ft^3
60	6SL4113-0..26-...0	125	100 10 [2)]	0.384 m^3	13.56 ft^3
75	6SL4113-0..27-...0	150	100 10 [2)]	0.384 m^3	13.56 ft^3

1) Fuses of classes J, CF, T or L (JDDZ) are suitable
In converters of frame size A to C, 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)

7.1.7.5 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.

Requirement

WARNING

Fire or electric shock due to unsuitable residual-current devices

The converter can generate a current through 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.

- Use the protective and monitoring devices recommended in the documentation.

If the earth-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 additional residual current devices 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.

Description of function

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 based on 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 based on 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).

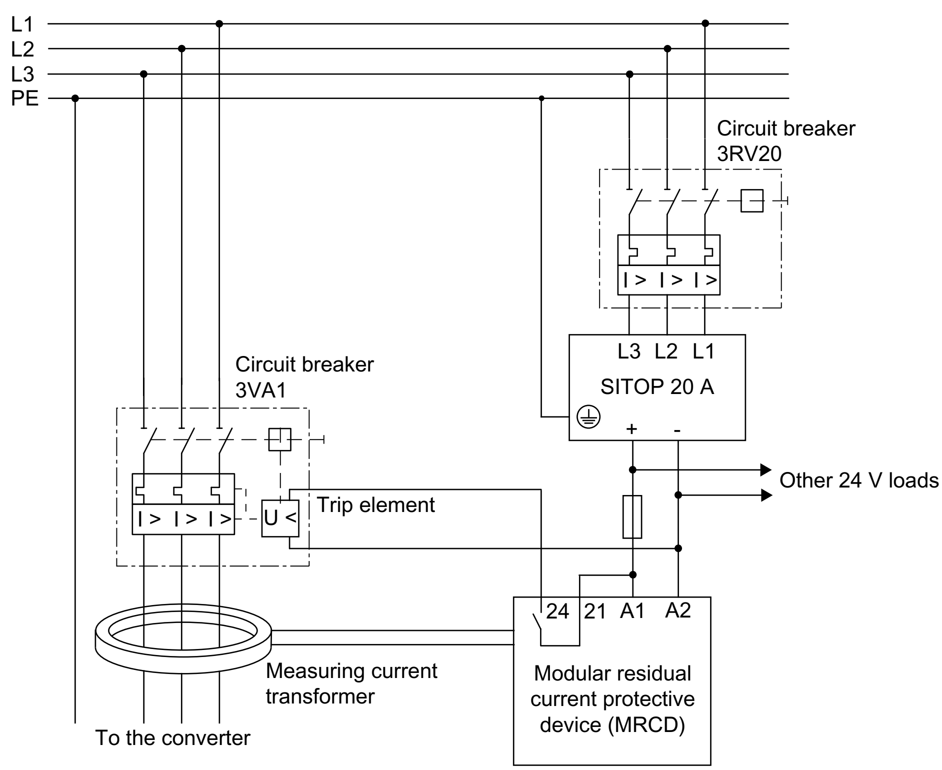


Figure 7-12 Modular residual-current device

7.2 Interfaces

7.2.1 Overview of interfaces, converter in degree of protection IP20

Requirement

NOTICE

Malfunction caused by electrostatic discharge

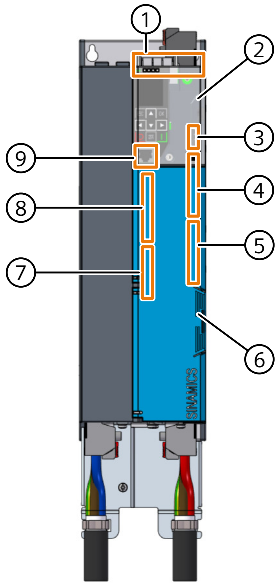
When the converter is operating, electrostatic discharge can result in malfunctions.

- 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



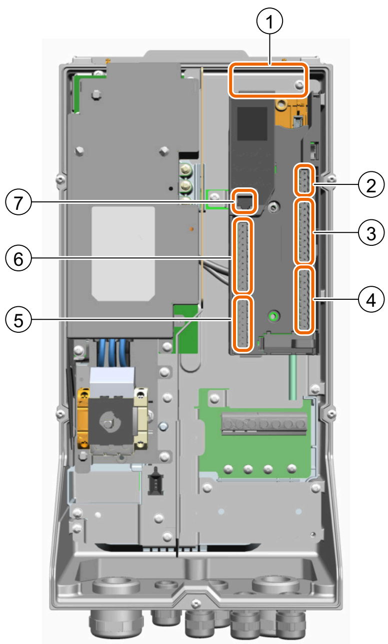
	Terminal strip	Designation		Terminal strip	Designation
①	X1xx	Communications module with fieldbus connection	⑥	---	Front cover or front door
②	---	Front flap	⑦	X133	Digital outputs
③	X124	External power supply	⑧	X132	Analog inputs, analog outputs, and temperature sensors
④	X130	Failsafe digital input, failsafe digital output	⑨	X127	Service interface for connecting an operating unit
⑤	X131	Digital inputs			

Figure 7-13 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	X133	Digital outputs
②	X124	External power supply	⑥	X132	Analog inputs, analog outputs, and temperature sensors
③	X130	Failsafe digital input, failsafe digital output	⑦	X127	Service interface (e.g. connection for the operating unit)
④	X131	Digital inputs			

Figure 7-14 Interfaces for the controller, converter with degree of protection IP55

7.2.3 Requirements relating to the fieldbus cable, converter with degree of protection IP55

Description

The restricted space between the fieldbus interface and the housing cover requires fieldbus cables with variable connector, e.g. the appropriate cables from the Harting company.

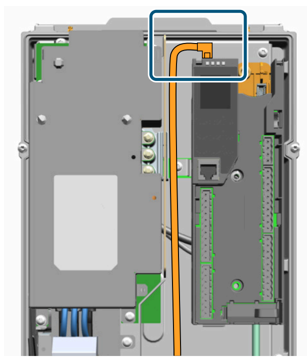


Figure 7-15 Fieldbus cable with variable connector

7.2.4 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

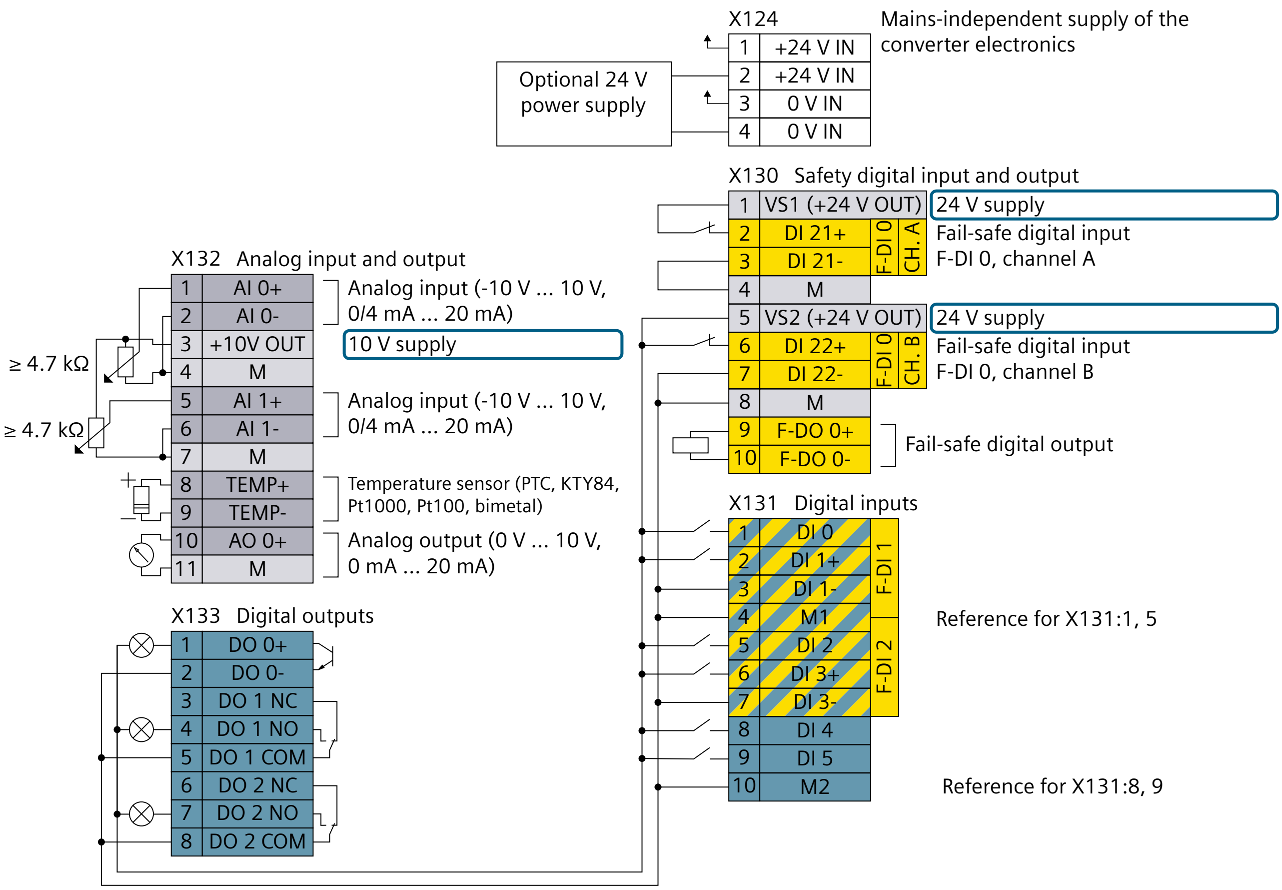


Figure 7-16 Connection example of terminal strips for internal converter supply voltages

Table 7-28 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
M	All terminals labeled "M" are internally connected with one another
M1, M2	Connect M1 and M2 to the M reference potential

7.2.5 Connection example with external supply voltage

Requirement

NOTICE
Damage to property due to overload of a digital output
Overload of a digital output can result in damage due to fire, device defects or malfunctions. • Ensure that a digital output is not loaded in excess of 500 mA. • Install a 500mA fuse or use the converter's internal 24V power supply.

Description

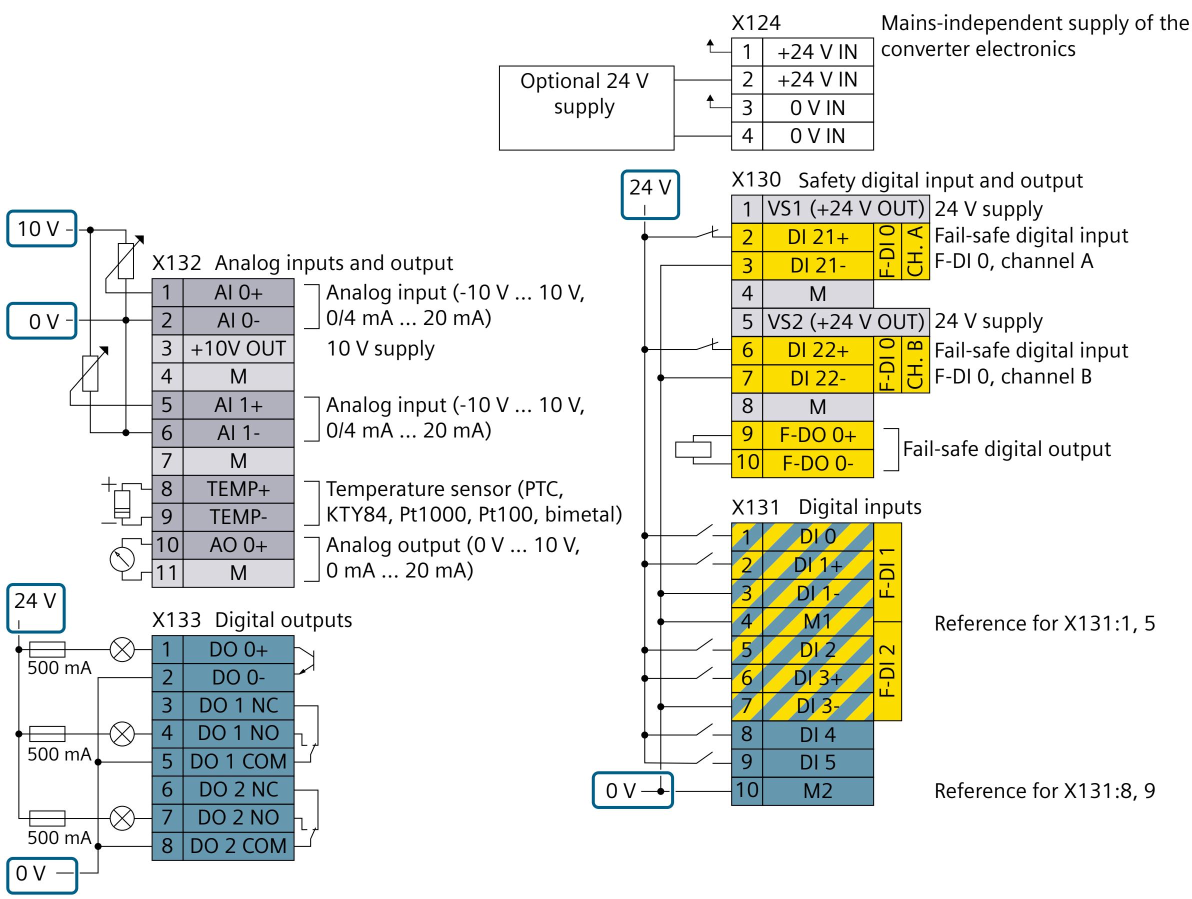


Figure 7-17 Connection example of a terminal strip for external converter supply voltages

Table 7-29 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

7.2.6 Control lines for terminal strip

Description

Rigid as well as flexible cables can be connected.

Several cables can be connected to each terminal.

Table 7-30 Signal cable cross-sections that can be connected

Connection type	Cross-section		Stripped length		Connection type
	Metric	Imperial	Metric	Imperial	
Without end sleeve	0.2 ... 2.5 mm²	24 ... 12 AWG	10 mm	0.4 inch	Terminal with push-in connection
End sleeve without plastic sleeve	0.25 ... 2.5 mm²	24 ... 12 AWG			
End sleeve with plastic sleeve	0.14 ... 2.5 mm²	26 ... 12 AWG			

7.2.7 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.

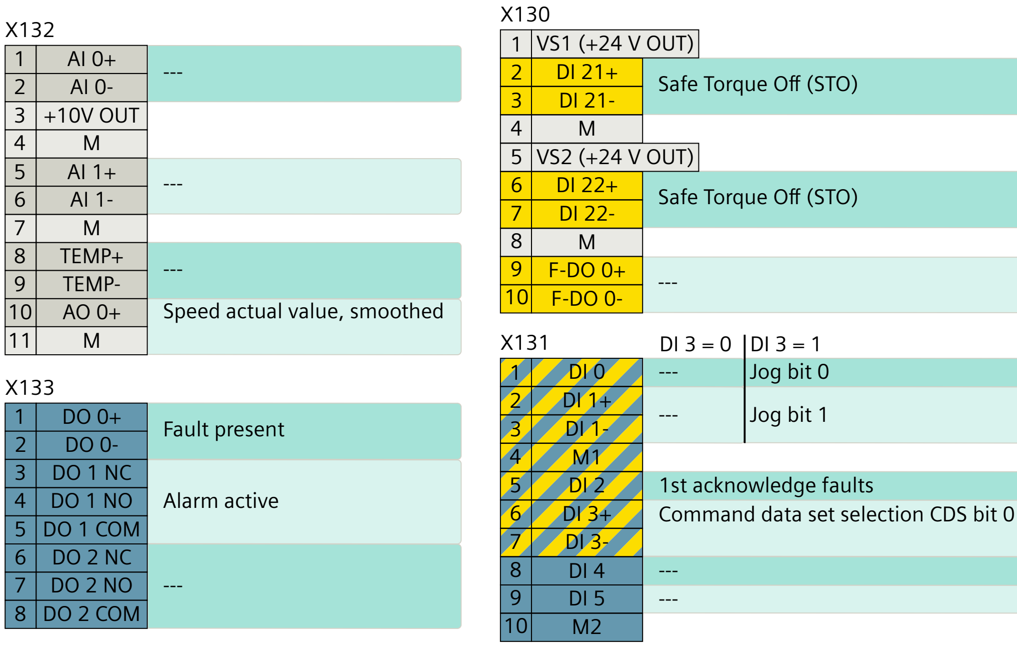


Figure 7-18 Factory settings of the terminal strip: I/O preset "Fieldbus with data set switchover"

7.2.8 Analog inputs as additional digital inputs

Description

Analog input terminals must be specifically connected to use analog inputs as additional digital inputs.

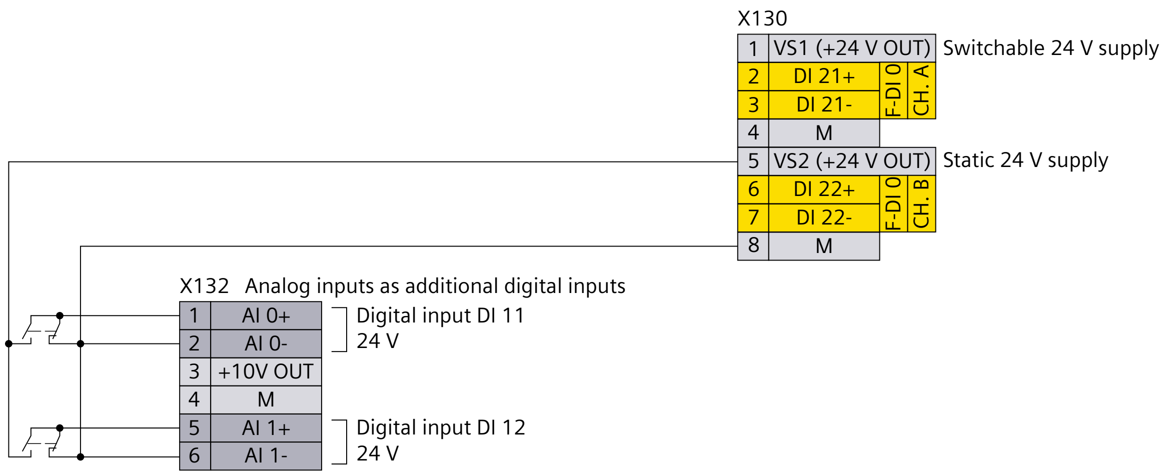


Figure 7-19 Using analog inputs as additional digital inputs connected to 24 V

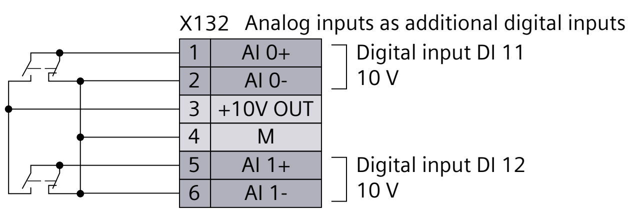


Figure 7-20 Using analog inputs as additional digital inputs connected to 10 V

7.2.9 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 failsafe digital input is suitable for connecting the following devices:

- Safety sensors, e.g. EMERGENCY STOP control devices and light curtains.
- Pre-processing devices, e.g. failsafe control systems and 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 7-31 Category that can be achieved according to EN 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 the 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 device (p10041 = 3)	Depending on the connected external device	

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 EN 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 EN 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.

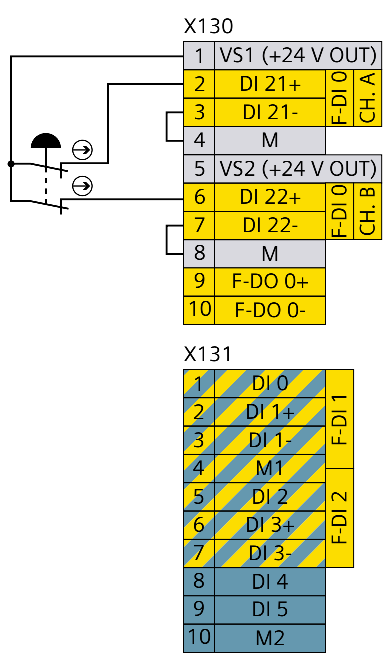


Figure 7-21 Connecting a sensor, e.g. EMERGENCY STOP button or limit switch, with protected cable routing

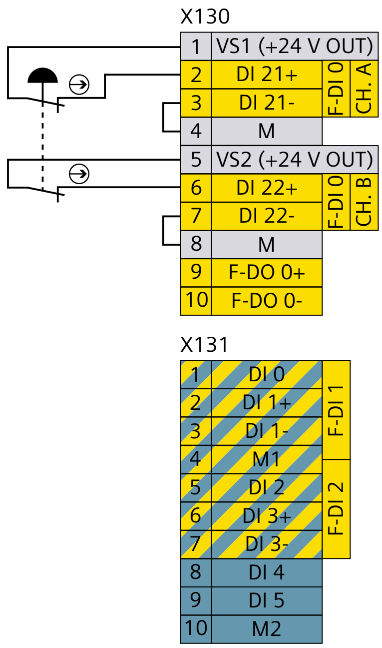


Figure 7-22 Connecting a sensor, e.g. EMERGENCY STOP button or limit switch, with unprotected cable routing

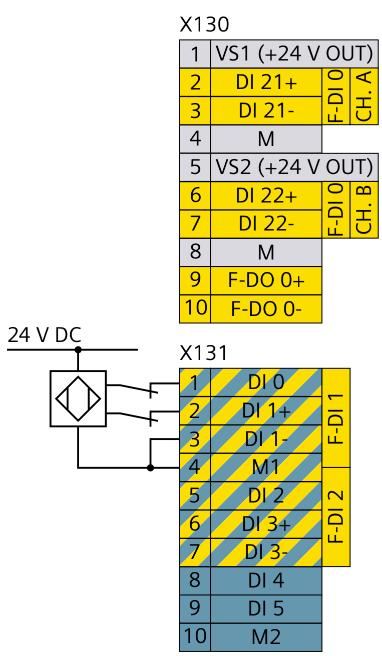
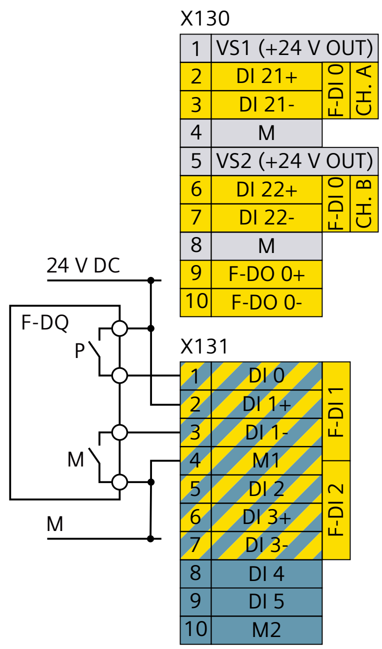


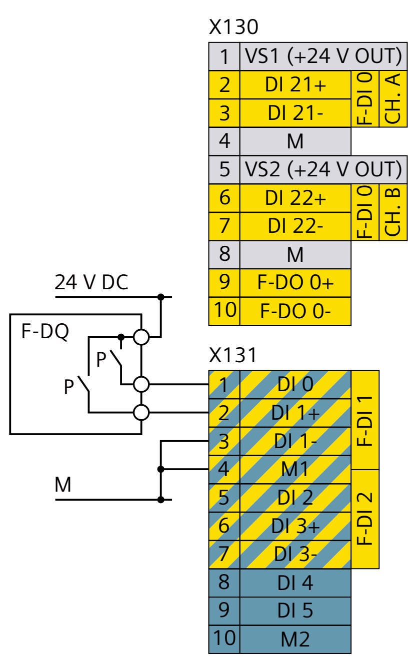
Figure 7-23 Connection of a sourcing/sourcing output OSSD sensor



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 7-24 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 7-25 Connection of a sourcing/sourcing output failsafe digital output

7.2.10 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 failsafe digital output is suitable for connecting the following devices:

- relay
- valve
- Sourcing/sinking failsafe input

Table 7-32 Achievable category according to EN 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 EN 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.

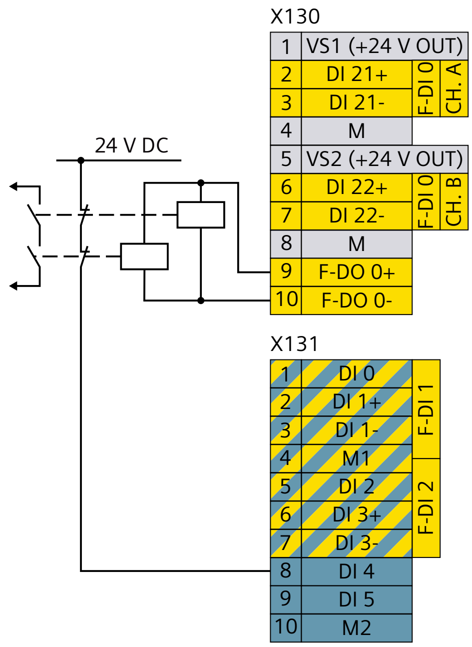


Figure 7-26 Parallel connection of two relays

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.

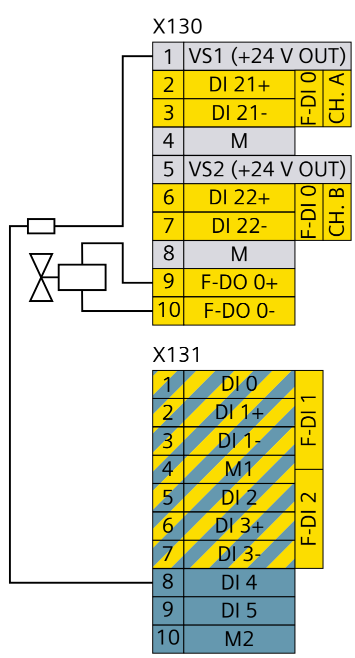


Figure 7-27 Connection of a valve with a feedback signal

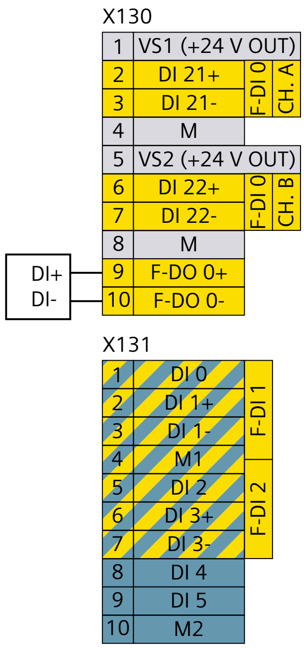


Figure 7-28 Connection of a failsafe digital input

To prevent unwanted interaction, the failsafe digital input must not perform its own self-test with dark pulses.

7.2.11 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

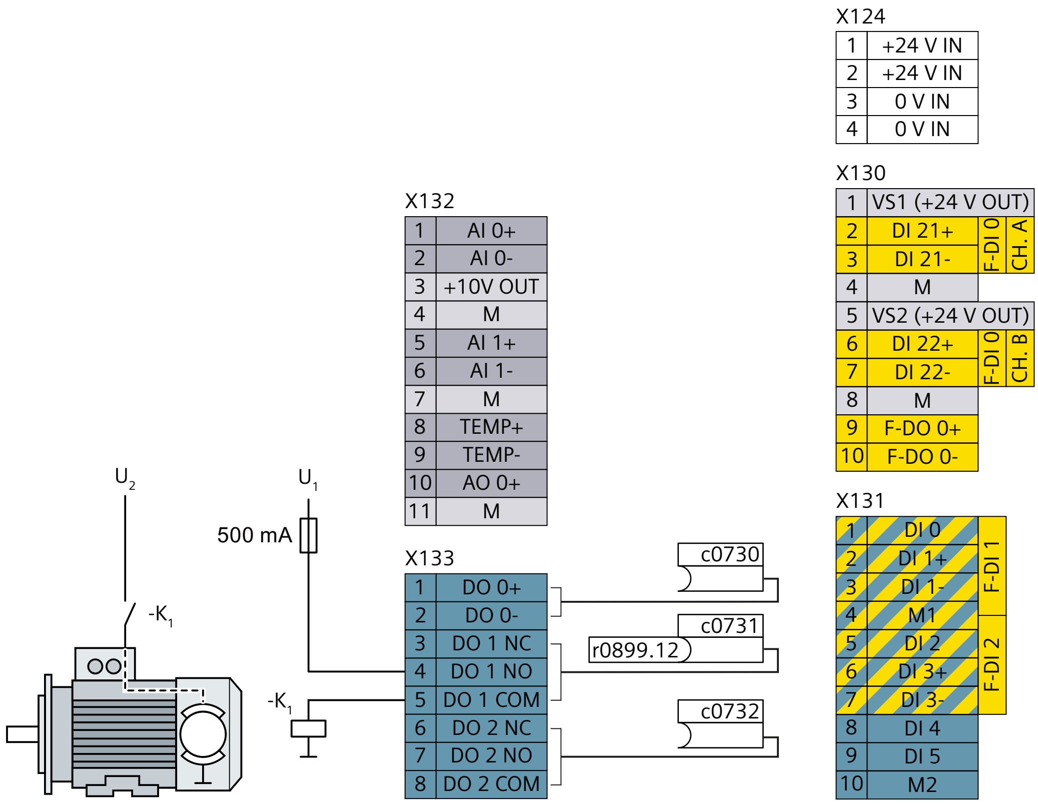
If the current or voltage rating of the digital output is not sufficient, you must control the motor holding brake via a coupling relay on the digital output.

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

Example

The following figure shows an example of the connection of the motor holding brake via a coupling relay on digital output DO 1 of the converter.



U_1	Voltage supply of the coupling relay
U_2	Voltage supply of the motor holding brake
K1	Coupling relay

7.2.12 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

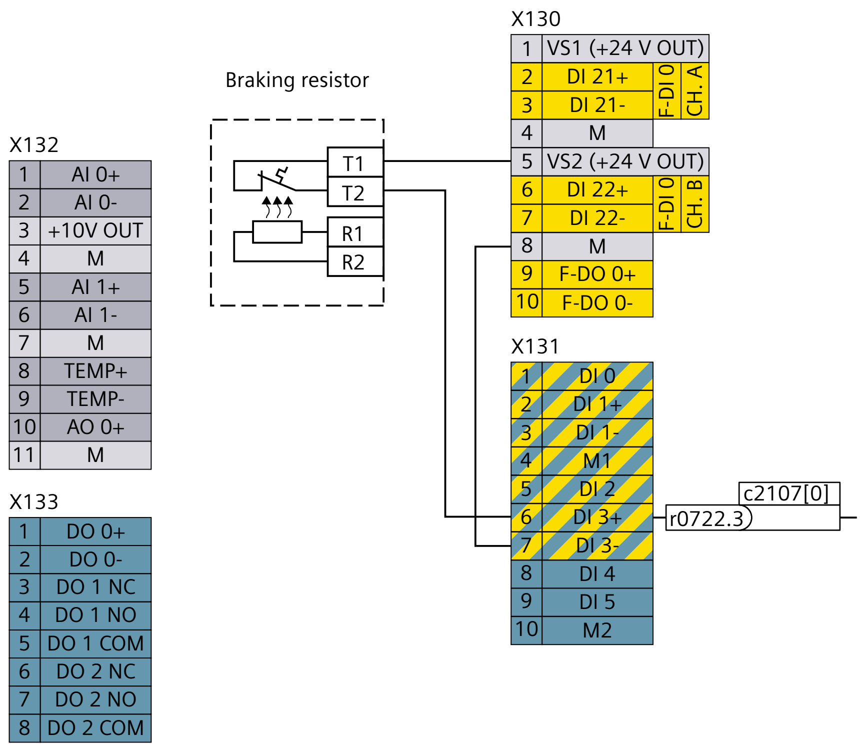
Please proceed as follows to monitor the temperature sensor of the braking resistor:

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.

7.2.13 Connecting the auxiliary contact of the repair switch

Procedure

To switch off the motor with the auxiliary contact of the repair switch, follow these steps:

1. Connect the auxiliary contact of the repair switch to a free digital input on the converter.
2. Assign the "OFF2" function to the digital input used.

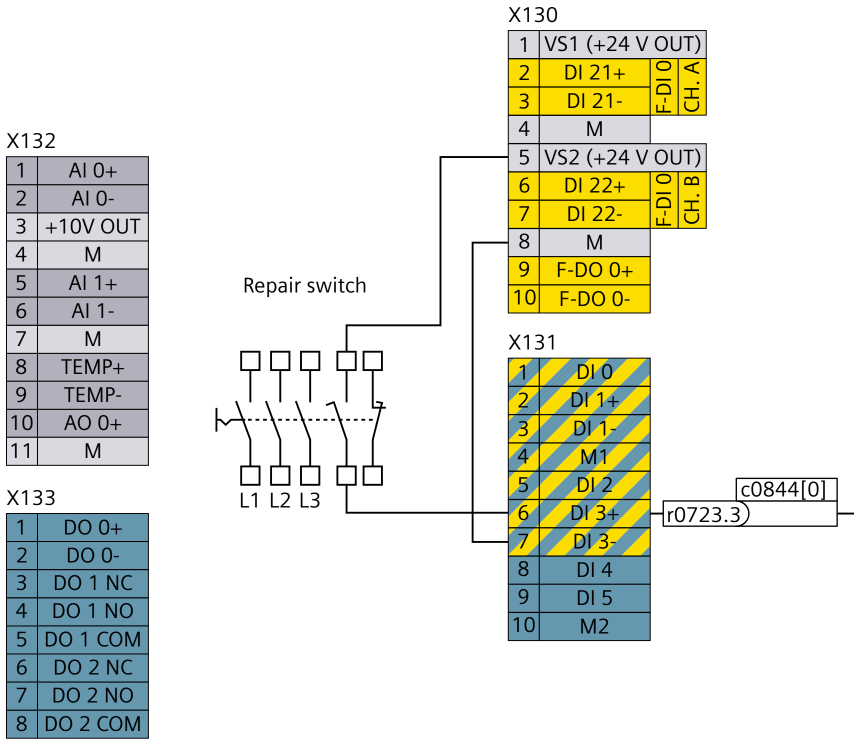
Result

When the repair switch is actuated, the converter receives the command to switch off the motor via the leading auxiliary contact, thus reducing the load on the repair switch.

Example

Monitoring the auxiliary contact via digital input DI 3 on the converter:

1. Connect the terminals of the auxiliary contact to the DI 3 digital input.



2. Interconnect binary signal sink c0844 with signal source r0722.3.

7.2.14 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 7-33 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)			

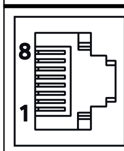
7.2.15 Communications module CM-PN, X150

Overview

Interface X150 connects the converter with fieldbuses PROFINET, EtherNet/IP or Modbus TCP.

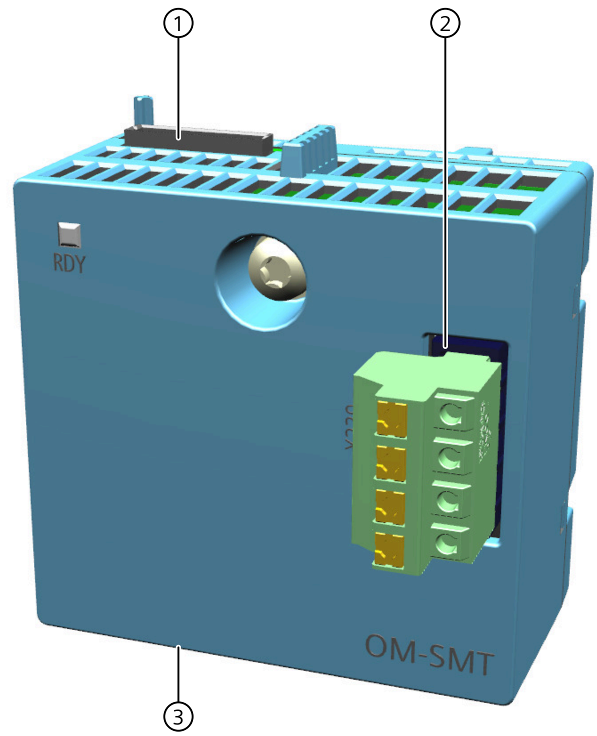
Description

Table 7-34 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

7.2.16 Overview of the interfaces at option module OM-SMT

Overview image



1 X500 internal interface (input)

2 X230 interface for PTC temperature sensor

3 X501 internal interface (output)

Figure 7-29 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 Option module OM-SMT, X230

Overview

The OM-SMT interface is designed for connecting two temperature sensors.

Requirement

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 unpacking, packing and installing the OM-SMT, carefully ensure that terminal strip X230 does not come 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, e.g. using a shrink-on sleeve 2-1193833-8 from the TE Connectivity company.
- 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.

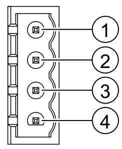
The PTC input connections must be safely electrically separated with respect to the SELV circuits.

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 7-35 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 100Ω resistor is included in the converter scope of delivery.

Example

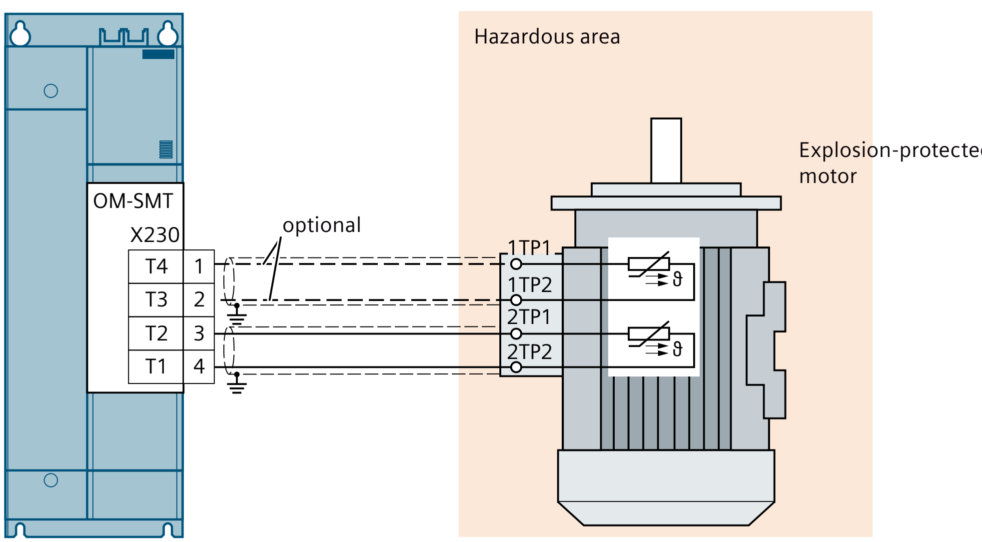
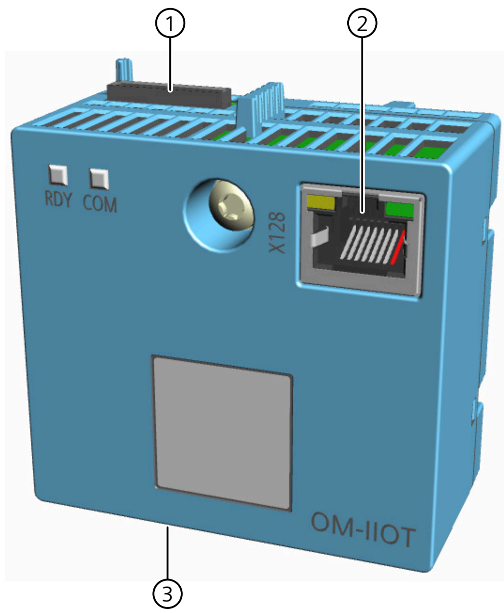


Figure 7-30 Connecting the PTC thermistor in the motor to the option module OM-SMT

7.2.18 Overview of the interfaces at option module OM-IIoT

Overview image



1 X500 internal interface (input)
2 RJ45 socket for Ethernet connection (X128)
3 X501 internal interface (output)

Figure 7-31 Option module OM-IIoT

The internal interfaces of the option module connect the option module to the converter or with other option modules.

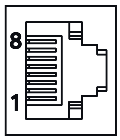
7.2.19 Option module OM-IIoT, X128

Overview

Interface X128 connects the converter with an Edge device.

Description

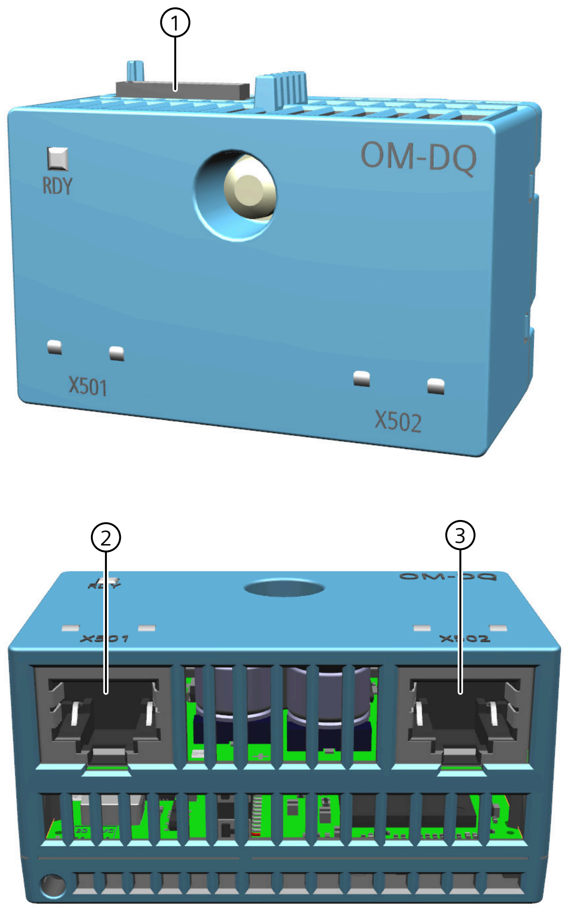
Table 7-36 Ethernet RJ45 socket X128

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

7.2.20 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) (RJ45 socket)

3 DRIVE-CLiQ interface 2 (X502) (RJ45 socket)

Figure 7-32 Option module OM-DQ

The internal interface of the option module connects the option module to the converter.

7.2.21 Option module OM-DQ, X501 and X502

Overview

Option module OM-DQ has two DRIVE-CLiQ interfaces.

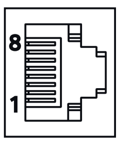
Requirement

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 7-37 DRIVE-CLiQ interface

X501 **X502**	**PIN**	**Signal**	**Explanation**
 8 1	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.

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.

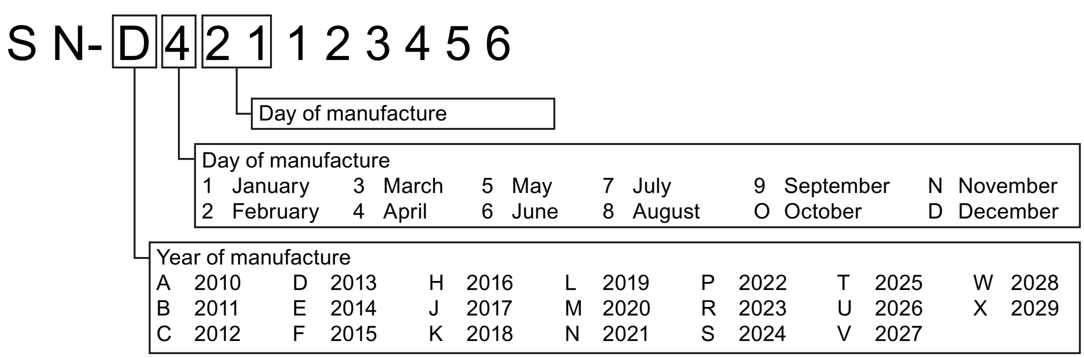


Figure 8-1 Date of manufacture in the serial number (example, April 21, 2013)

Procedure

- Form the DC link capacitors by connecting power to the converter as shown below:

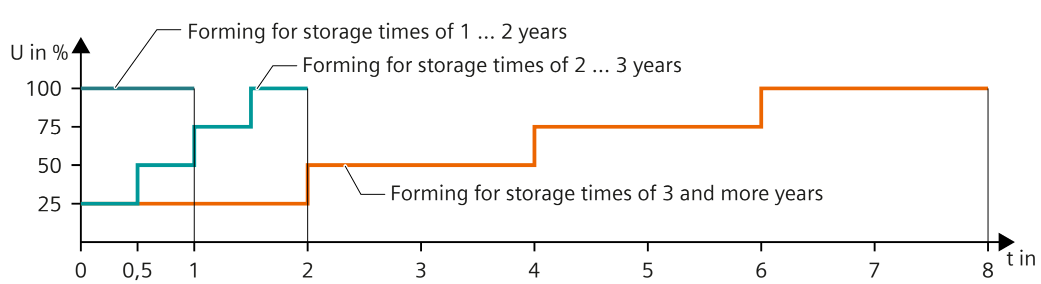


Figure 8-2 Forming the DC link capacitors

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]

Procedure

1. Note down the article number of the motor and the data from the nameplate of the motor.

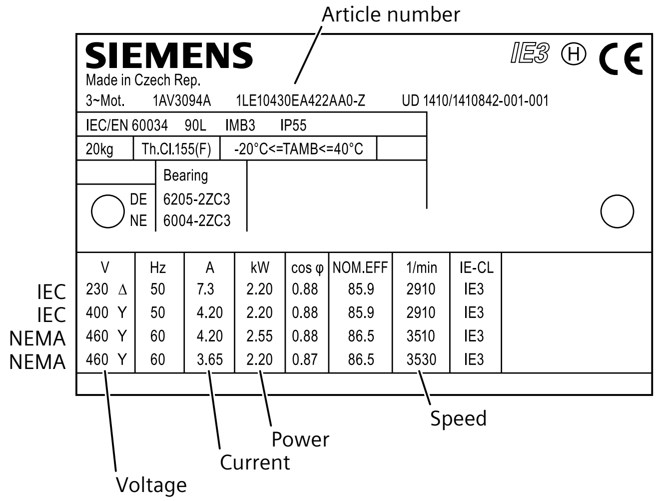


Figure 8-3 Example of a nameplate for a standard induction motor

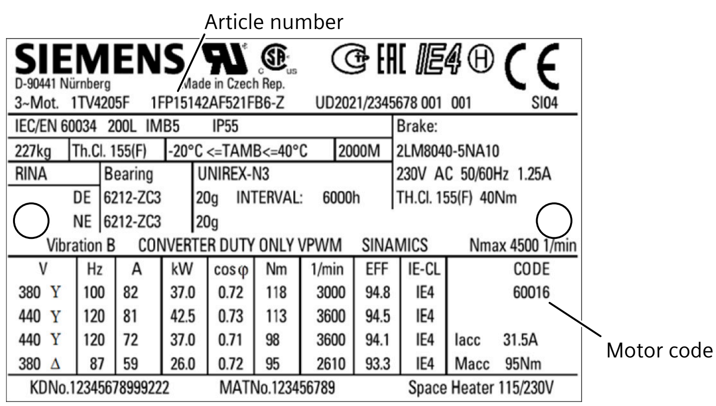


Figure 8-4 Example of a nameplate for a reluctance motor

2. If available, note down the motor code on the nameplate of the motor.

Software installation 9

9.1 Install Startdrive commissioning tool

Overview

Startdrive is the software for integrating SINAMICS drives into automation. Startdrive is a component of the Totally Integrated Automation Portal (TIA Portal).

You can download Startdrive from the Internet.

Procedure

Installing Startdrive:

1. Download the latest version of Startdrive from the Internet.
2. Install Startdrive by running the "Setup" file.

More information

Download Startdrive: SINAMICS Startdrive (www.siemens.com/startdrive)

9.2 TIA Portal Openness

Overview

TIA Portal Openness is a programming interface (API), to automate engineering tasks in the TIA Portal using programs that have been self-generated to address a specific user requirement.

Description of function

The TIA Portal Startdrive application supports TIA Portal Openness. You can write and use your own programs based on code examples.

The Openness functionality in Startdrive includes the following, for example:

- Access to drive settings
- Create drive devices and components
- Set selected drive parameters (offline and online, reading and writing)
- Create telegram configurations
- Download to the device (no upload)

More information

More information on TIA Portal Openness can be found on the Internet:

- SIMATIC TIA Portal Openness: API to automate engineering workflows (https://support.industry.siemens.com/cs/ww/en/view/109798533)
- Openness for SINAMICS Startdrive and DCC V15.1, V16, V17, V18 (https://support.industry.siemens.com/cs/ww/en/view/109763491)

Commissioning (web server) 10

10.1 Introduction

Description

The web server commissioning tool is integrated in the converter.

The web server supports you throughout the service life of the application:

- Online commissioning
- Diagnostics
- Operator control and monitoring
- Service and maintenance
- Support

The settings made are applied after commissioning has been completed and transferred to the converter.

The web server has multi-level Industrial Cybersecurity functionality.

More information

More information about industrial cybersecurity functionality is provided on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.2 Requirements for commissioning

Description

- You have correctly installed the converter and the motor.
- You have mounted the motor, including an encoder that might be required, onto the mechanical system.
- You have connected the motor to the converter.
- You have connected the converter and the operating unit via service interface X127 or PROFINET interface X150.
- You have switched on the converter supply voltage.
- The converter has ramped up.

10.3 Fundamentals

10.3.1 Supported operating units

Description

The web server supports the following operating units:

- Programming device, PC, notebook
- SINAMICS SDI Pro 5.5"
- SIMATIC HMI (IPC, Unified Comfort Panel)
- Tablet, smartphone

The optional component SINAMICS Smart Adapter connects mobile terminal devices to the converter.

10.3.2 Supported browsers

Description

The web server supports the following browsers:

Browser[1)]	**Version**
Apple Safari	≥ Version 15.0
Google Chrome	≥ Version 83
Microsoft Edge	≥ Version 88
Mozilla Firefox	≥ Version 91

1) Whichever browser you use, we recommend using the most up-to-date version.

10.3.3 Communication interfaces

Description

The following interfaces are available for accessing the converter:

Interface	Information
Service interface X127	Default access to Startdrive and the web server is via service interface X127.
	Ethernet interface X127 is intended for commissioning and diagnostics, which means that it must always be accessible. The SINAMICS Smart Adapter establishes a point-to-point connection to a mobile end device via WLAN.
	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: • Only local access is permitted. • Only local networking in a closed and locked electrical cabinet is permitted. • For remote access to the electrical cabinet, you must apply additional Industrial Cybersecurity measures to prevent misuse through sabotage, data manipulation by unqualified persons and interception of confidential data.
PROFINET interface X150	• Converters are connected to several components, such as an operating unit or a higher-level control system, via PROFINET interface X150. • The network at PROFINET interface X150 must be located in a secure protection zone. Access to cables and open connections must be implemented in a protected fashion, such as in a control cabinet. • The IP addresses of the service interface X127 and the PROFINET interface X150 must not be in the same subnet. • Configured IP addresses are stored in SINAMICS SDI Standard: "Support" menu > "Scan IP Address".

More information

More information about the supported protocols is available on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.4 Getting Started

10.4.1 Calling the web server

Overview

The converter is commissioned via the user interface of the web server.

Requirement

Before calling the web server, the following points apply:

- You have connected the converter to the operating unit via the service interface X127.
- Guest access to the web server is active.
  If guest access is not permitted, you must log on with your user name and password when calling the web server.

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".

More information

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.

10.4.2 Settings for brand-new converters

Overview

The basis settings are required before performing first commissioning for a brand-new converter.

Requirement

The operating unit is connected to the converter via service interface X127.

The web server can be accessed via service interface X127 using the configured IP address (default: 169.254.11.22).

Description of function

If the web server is called, a forwarding function starts automatically to define the basic settings. When doing, this several function views are run through.

The function views contain the following settings:

- Basic settings (Page 215)
- Security settings (Page 215)

10.4.3 Basic settings

Overview

Initial basic settings are defined in the function view.

Requirement

The web server is being called for the first time.

Description of function

The basic settings are as follows:

- Preferred language of the user interface
- Converter date and time; either manually or via NTP
  To synchronize the date and time with the NTP server of the control, the SNTP library must be integrated into the PLC.

After these entries have been made, using the "Next" button, you can continue to the Security Wizard.

10.4.4 Security Wizard

Overview

The Security Wizard offers the following settings:

- User Management & Access Control (UMAC)
- Access to the integrated web server via the fieldbus or service interface
- Drive data encryption

Requirement

NOTICE
Data manipulation due to inadequate protection An inadequately protected drive makes it easier for potential attackers to access the drive data. Data manipulation can cause the drive to malfunction or damage it. • Only use the low security settings in exceptional cases, and only if this can be justified after an information security risk analysis. • Configure the security settings for the converter for full protection.

Procedure

One of the following options can be selected:

- "Configure security settings"
  Comprehensive protection against data manipulation requires that security settings are configured.
- "Continue with low security settings"
  If you continue with low security settings, then UMAC is initially deactivated. We recommend that you configure the security settings before the converter goes into operation. You can also access the security settings via menu "Protection & Security (Page 266)".

Select "Configure security settings"

Define the settings for UMAC:

- "Activate User Management & Access Control"
  If UMAC is activated, UMAC can only be deactivated by completely restoring the converter factory settings.
  You can find more information about the full reset to factory settings in section "Full reset of all device settings (Page 768)".
- "Administrator setup"
  Specify the user name and password of the administrator.
  Runtime role "Drive Administrator" is assigned to the administrator.
- "Guest access configuration"
  Specify the following:
  – Without logging in, the user is allocated read rights.
  – Without logging in, the user may acknowledge messages.
- "Web server activation"
  Define the interface to the web server:
  – The factory setting to access the web server is service interface X127 with HTTPS protocol.
  – It is also possible to activate PROFINET interface X150 with HTTPS protocol.

  If both these interfaces are deactivated, it will not be possible to access the web server.

- "Drive data encryption"
  Assign an additional password for encryption of the drive data.
  The function encrypts the following data in the backup file and on the memory card of the converter:
  - UMAC user data
  - Passwords

  To use "Drive data encryption" independent of UMAC, deselect option "Activate UMAC for the drive " on page " Activate User Management & Access Control".
- "Summary"
  Check the configured settings.

More information

More information about "Drive data encryption" can be found on the Internet:

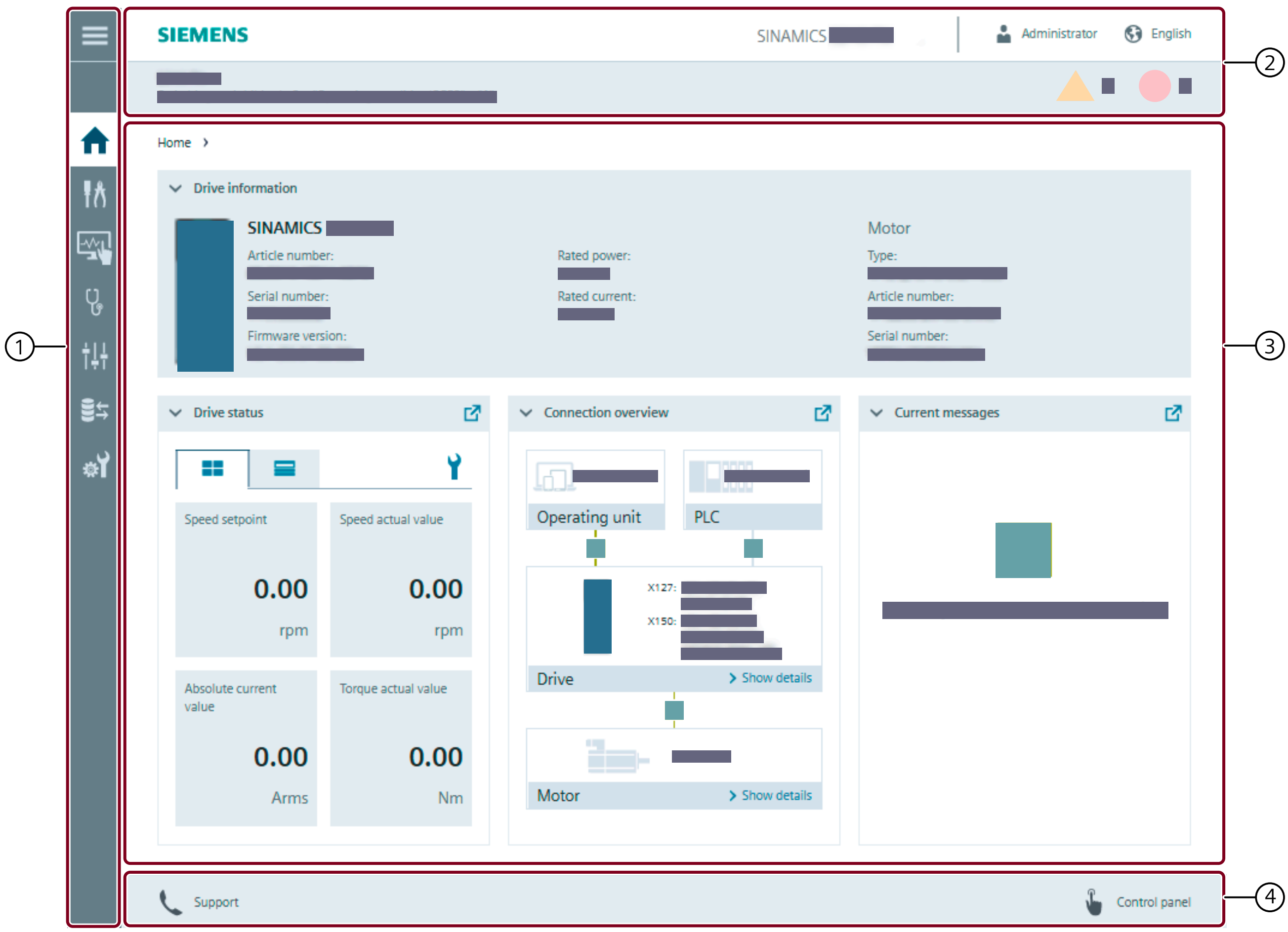
Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.4.5 Home page

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.

Product-specific information and settings 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 10-1 Structure of the web server

10.4.6 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.

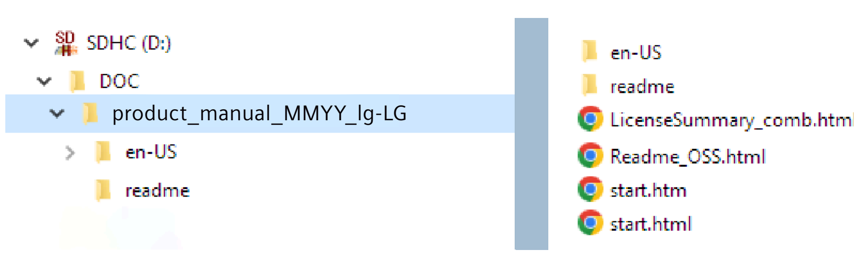
Procedure

To make the project documentation available for the web server information system, proceed as follows:

1. Download the product documentation to your PC
   The project documentation for the web server information system can be found on the Internet:
   Download (https://support.industry.siemens.com/cs/ww/en/view/109820984)
   ZIP archive "Multimedia document" is located under "Download".
   The multimedia document contains file "product_manual_MMYY_lg-LG.zip".

Explanation of file name "product_manual_MMYY_lg-LG.zip"		
	Example	**Explanation**
product	S200, G220	Abbreviated converter name
manual	op_instr (= operating instructions)	Abbreviated product documentation
MMYY	0324	Month and year that the manual was published
lg-LG	en-US (= US English)	Language code

2. Unzip the file into a folder with the ZIP file name, e.g. "product_manual_MMYY_lg-LG".
3. Insert a memory card into the SD card reader of your PC.
4. In the root directory of the memory card, create a folder called "DOC".
5. Copy the unzipped folder, e.g. "product_manual_MMYY_en-US", into directory "DOC" on the SD card.



6. Eject the memory card from the PC.
7. Remove the memory card from the reader.
8. 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.

10.4.7 Using the web server information system

Overview

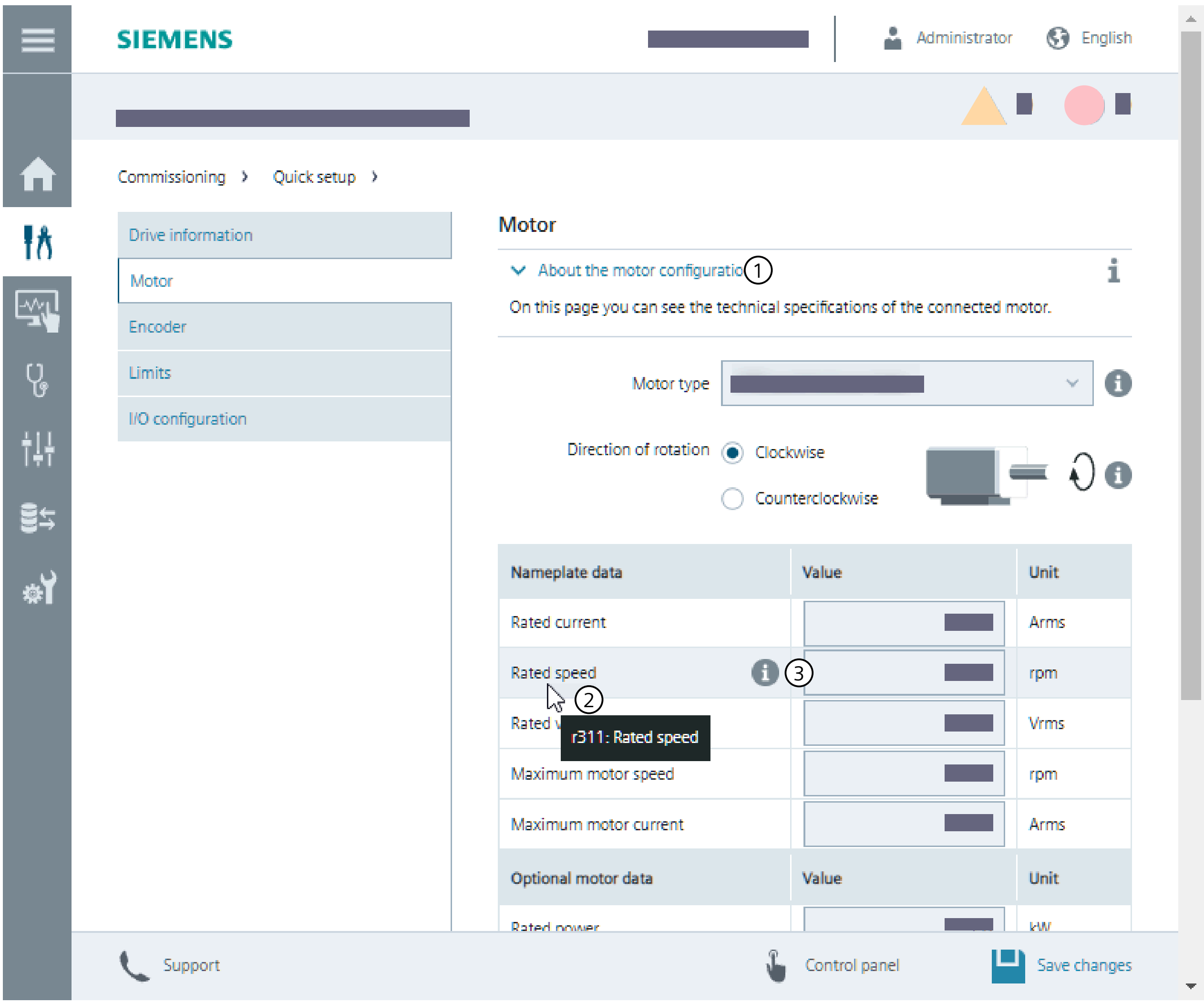
The web server supports you using an integrated multi-stage information system.

Requirement

If you have provided the product documentation for the web server information system, then the web server also displays linked content of the manual.

Description

Product-specific information and settings are covered over in the following diagrams.



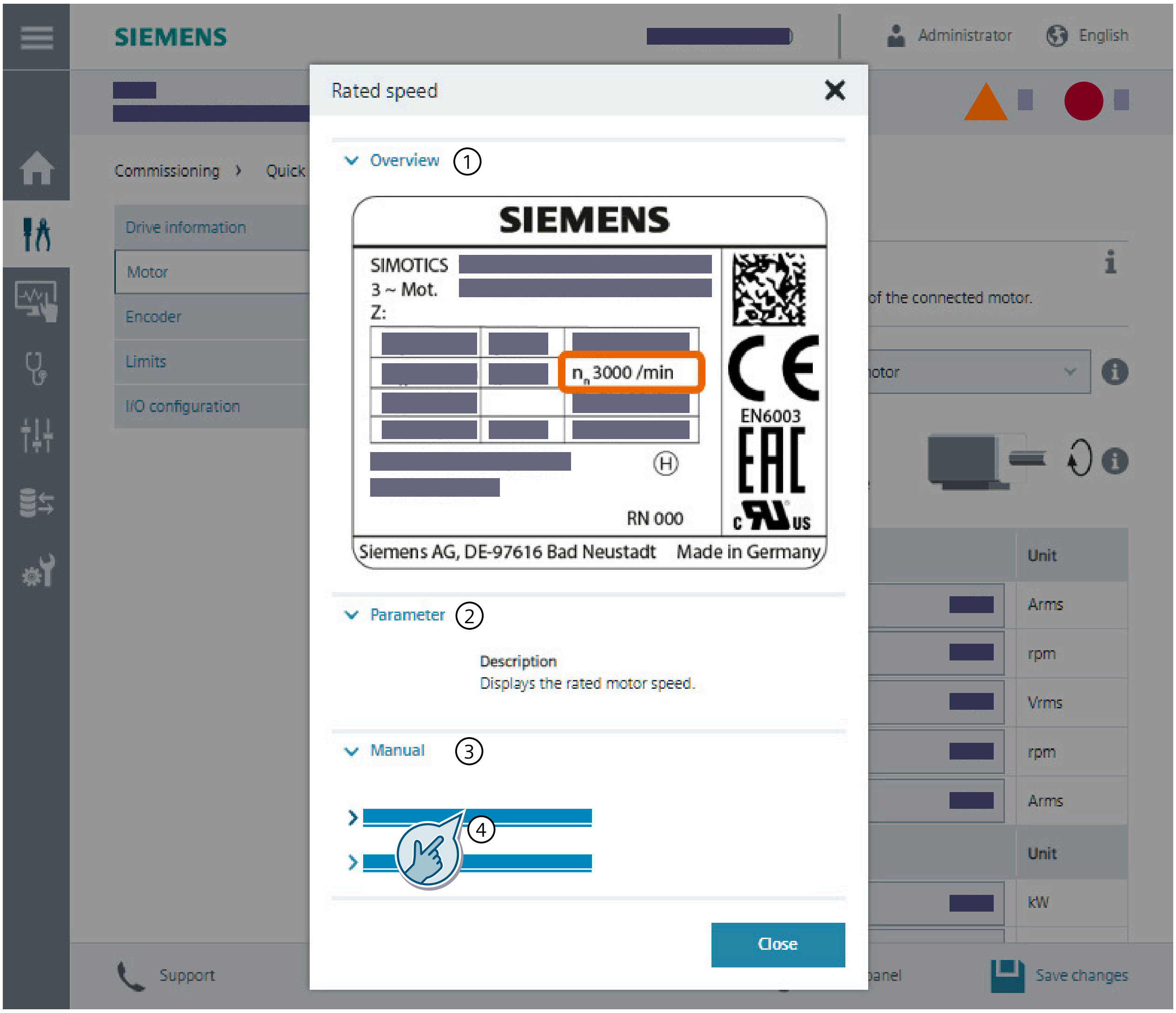
① Clicking or tapping on the header or on the associated icon displays or hides general information about the function of the current view.

② Point with the mouse pointer or tap on the setting you need information about.
The setting is highlighted and the assigned info icon appears.
If you hold the mouse pointer or keep the tap pressed on the setting for longer, a tooltip with the context-sensitive short information is displayed.

③ When you move the mouse pointer to the info icon, the icon and the mouse pointer change their appearance.
If you now click or tap on the info icon, a context-sensitive help window appears with detailed information.

Figure 10-2 Information in the current view

The web server provides more detailed information about a setting in a context-sensitive help window.



› ⌄ Clicking or tapping on the header or the associated icon does the following:

① Displays and hides general information about the meaning or function of the setting.

② Displays and hides detailed information about the parameter.

③ Displays and hides links to the operating instructions.

④ A click or tap on a link displays the linked information of the operating instructions.

Figure 10-3 Product-dependent information in a context-sensitive help window

10.4.8 Reloading pages

Procedure

If the web server does not respond, or if buttons are inactive or not labeled, although the converter is not fully utilized with internal calculations, then reload the web server pages.

Examples:

- At the PG/PC via <F5>
- At the tablet PC or smartphone via

10.5 Functions and menus

10.5.1 Commissioning

10.5.1.1 Commissioning sequence

Overview

The web server guides users step-by-step through the drive commissioning.

Description of function

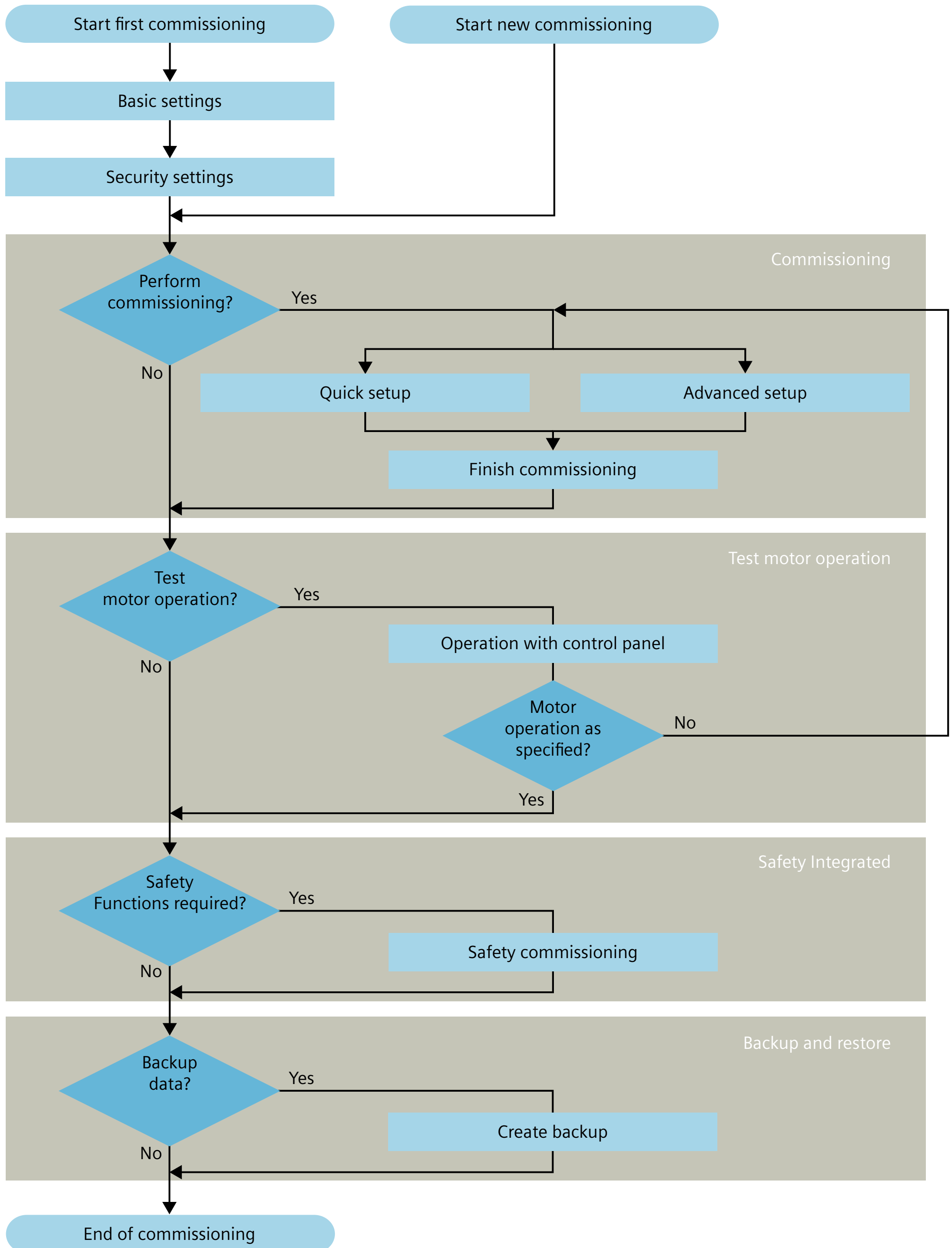


Figure 10-4 Commissioning sequence

Commissioning involves the following steps:

- Basic settings:
  If the converter has already been commissioned, then the web server jumps to the basic settings.
  The following settings are required for a brand-new converter:
  - Language, date, time
- Security settings:
  The settings are configured with the help of the Security Wizard.
  You can find more information in section "Security Wizard (Page 215)".
- Quick setup:
  Menu "Commissioning" > "Quick setup"
  - Entry or checking of motor and encoder data
  - Limit values and I/O configuration.
- Advanced setup:
  Menu "Commissioning" > "Advanced setup"
  Advanced setup includes all the quick setup settings plus additional options and drive functions.
- Optimize motor:
  Menu "Commissioning" > "Optimization"
  The Optimization function measures the mechanical drive train using short test signals and adapts the controller parameters to the mechanics installed.
- Safety Integrated commissioning:
  Menu "Commissioning" > "Safety Integrated"
  Setting of the Safety Integrated Functions
- Test motor operation:
  Action bar > "Control panel"
  Test of motor operation using the control panel in jog mode or continuous operation
- Backup:
  Menu "Backup and restore"
  We recommend backing up the drive settings after commissioning.

More information

Information about user management and the settings can be found on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.5.1.2 Quick setup

Overview

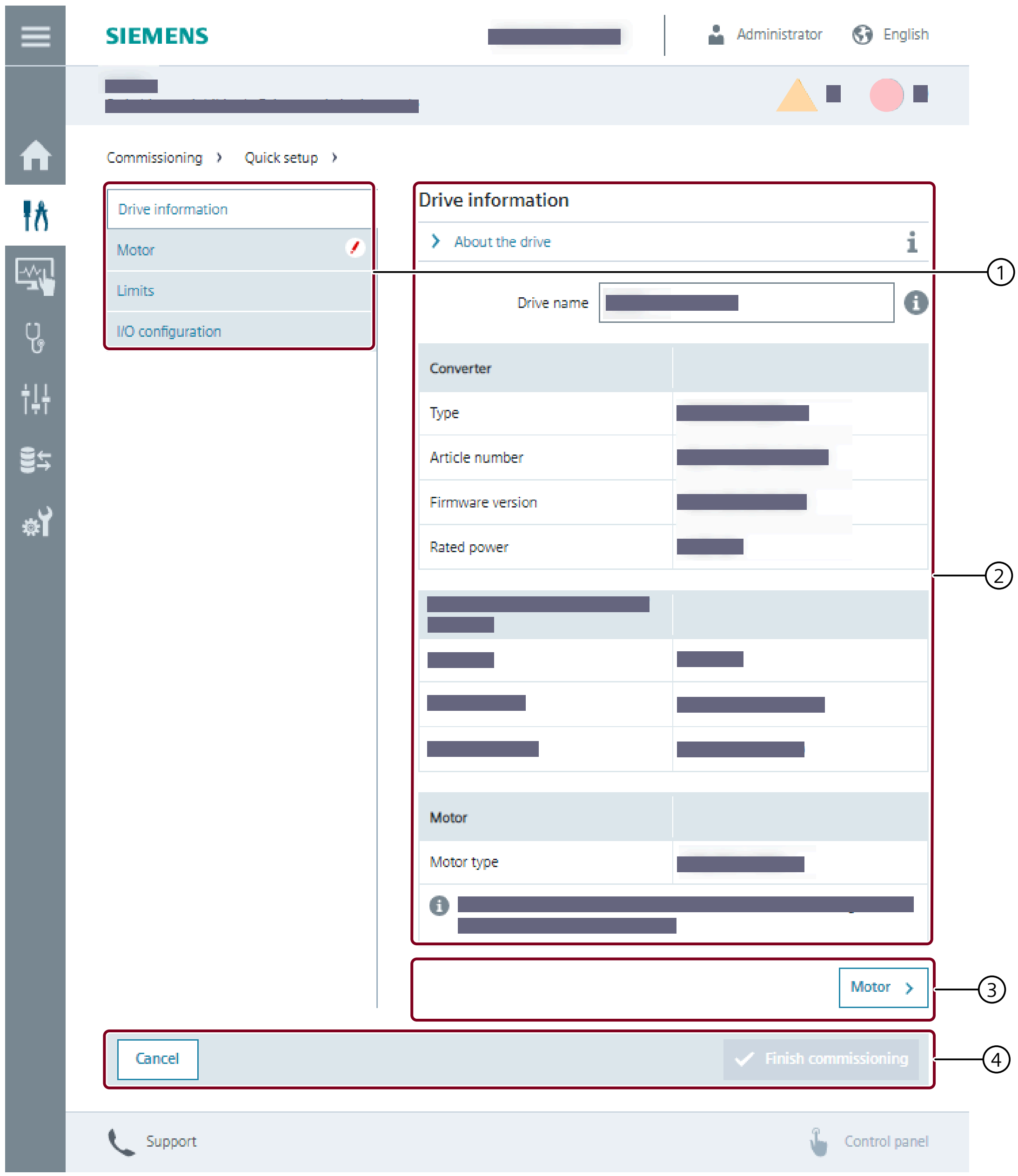
Quick setup comprises the basic settings that are required to commission the converter.

Requirement

- The drive has been installed. The components are wired.
- Web server access is active.
- Under one of the following conditions, the web server signals that quick setup is not possible:
  - Another user controls the converter via the control panel.
  - Another user has started commissioning.

Description of function

Product-specific information and settings are covered over in the diagram.



① Navigation menu for quick setup

② Display of the individual quick setup steps

③ Alternative navigation

④ Control bar to cancel or complete quick setup

Display if changes have been made to the factory settings

The values entered are valid.

Display for checking of the modified values

At least one of the values needs to be modified.
Mandatory to complete quick setup

Figure 10-5 Quick setup using the web server

The most important properties of the converter are configured in quick setup.

The converter creates a restore point when quick setup is started. The converter saves the changes after every commissioning step. The converter is reset to the restore point if quick setup is canceled.

The web server has a read-only mode for quick verification of the configuration data set.

Quick Setup Wizard

The Quick Setup Wizard performs the following steps:

- "Drive information"
- The function view contains information about the converter and field bus interface used and the motor type. Any Option Modules added to the converter are also shown here.
  The following data can be changed:
  - Drive name
    A specific drive name can be assigned.
- "Motor"
  If the motor is connected via the DRIVE-CLiQ connection, for example, this is detected during startup. The motor data is transferred directly.
  If the motor is not detected, the preset motor data is based on the drive information. The following options are provided for defining the motor configuration:
  - Check the preset motor data against the nameplate of the motor connected and correct if necessary
    Information about the data set can be retrieved using the symbol.
  - Specify the motor type used, for example by selecting or actually entering the motor ID

  Confirming that the motor data matches the motor connected continues the quick setup process.
  The motor data configuration encompasses the following parameters:
  - Standard
  - Motor type
  - Motor connection type
  - Direction of motor rotation
  - Properties of the motor
  - Optional settings

- "Limit values"
  The converter limit values are shown graphically and in a tabular form.
  The limit values must be configured on an application-specific basis.
- "I/O configuration"
  The function view offers the following configuration options:

Configuration	Description
Different assignment of command data sets 0 and 1	–
Assign functions to digital inputs/digital outputs and analog inputs/analog outputs	–
Select I/O presets	Changes to the preconfigured I/O presets are displayed with the prefix [changed].

10.5.1.3 Optimization

Overview

Optimization proceeds once quick setup is complete.

The optimization settings are preset and cannot be adjusted during quick setup. It is possible to configure desired settings as part of advanced setup.

Requirement

You have connected the motor.

Description of function

The optimization process includes motor data identification with stationary motor and starts the next time the motor is switched on.

10.5.1.4 Advanced setup

Overview

With the advanced setup, you define drive options and functions to suit your application. The advanced setup contains all settings of the quick setup, plus additional options and functions.

Requirement

Note

Commissioning cannot be started

If other users are accessing the converter via the web server and controlling the converter via the control panel or have started a commissioning operation, commissioning will not be possible. A corresponding message appears.

Description of function

The most important parameters of the converter are set during commissioning. Once commissioning has been completed, the converter knows, for example, the data of the connected motor and has adapted its control interfaces to the requirements.

Starting/canceling the advanced setup

The following options are available, depending on whether the converter has already been configured:

- Keep current settings and start commissioning
- Reset converter to factory settings and start commissioning

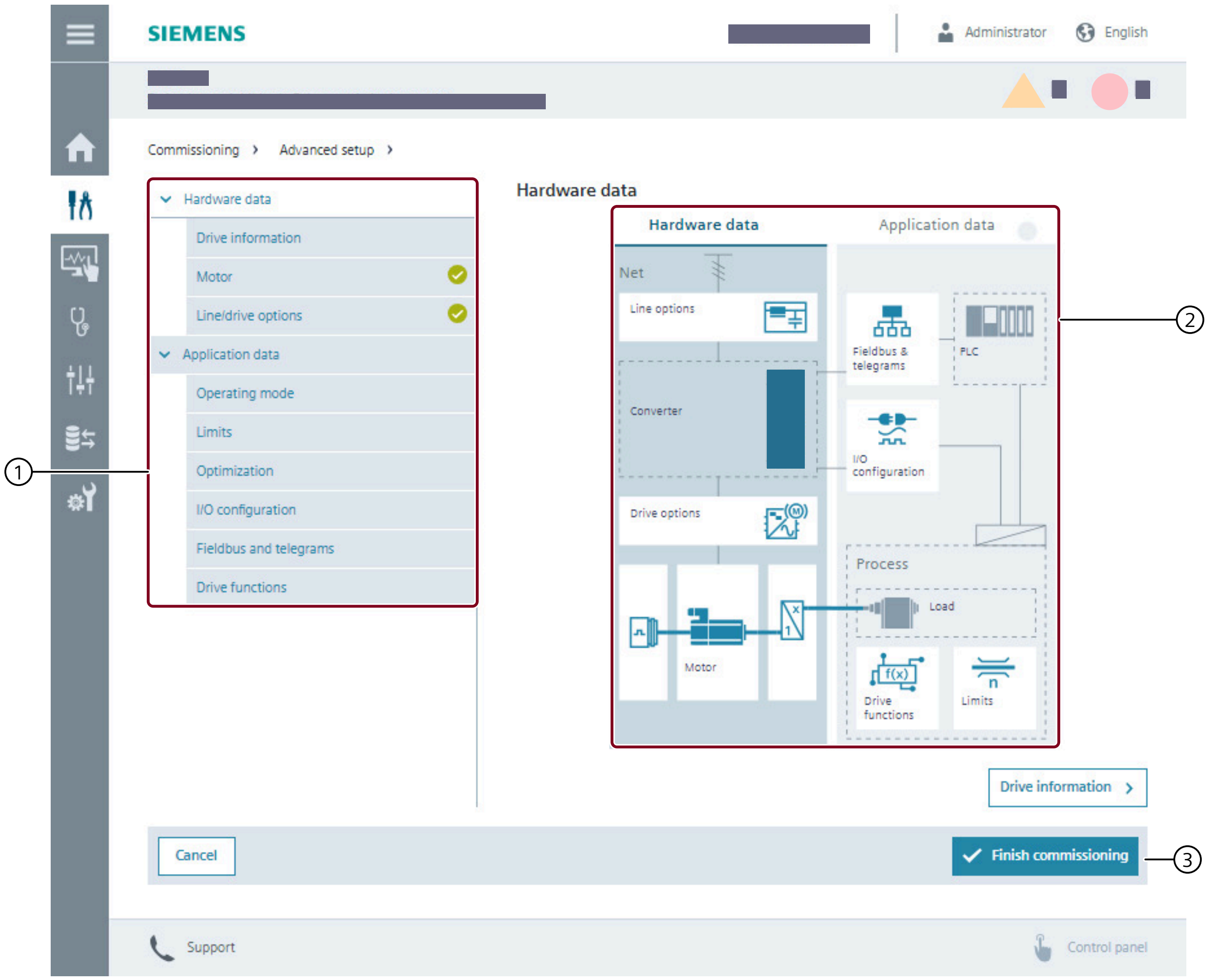
The converter creates a restore point when commissioning is started. The converter saves the changes after every commissioning step. If you cancel commissioning, then the converter is reset to the restore point.

Starting commissioning in read-only mode

To get to know the drive options and functions first, the commissioning can be started and run through in read-only mode.

Performing commissioning

Product-specific information and settings are covered over in the diagram.



① Individual function views are called up by clicking on the corresponding entry.

② Individual function views are called up by clicking on the corresponding field.

③ The button is activated when the data in the "Hardware data" setting area is configured and all entered values are valid.

Figure 10-6 Calling advanced setup function views

Further configuration options are displayed by clicking on the tool icon .

Finish commissioning

When commissioning is completed successfully, the settings are stored in the converter in a non-volatile manner. The option to perform an optimization of the motor data is displayed. The option can be deselected.

10.5.1.5 Testing the converter configuration

Overview

After commissioning, the web server allows you to test the converter configuration set up in jog mode or continuous motion via the control panel.

Description

To test the configuration, the control panel must be open and the speed setpoint entered.

There are 2 ways of opening the control panel:

- Button "Finish quick setup" > Dialog query with selection option "Open control panel"
- Action bar > "Control panel"

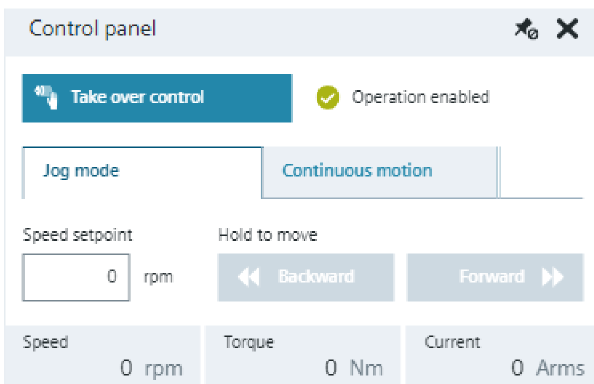


Figure 10-7 Testing the converter configuration via the control panel

More information

You can find more information in Chapter "Control panel (Page 271)".

10.5.1.6 Safety Integrated commissioning

Overview

Commissioning the Safety Integrated Functions of the converter includes the following:

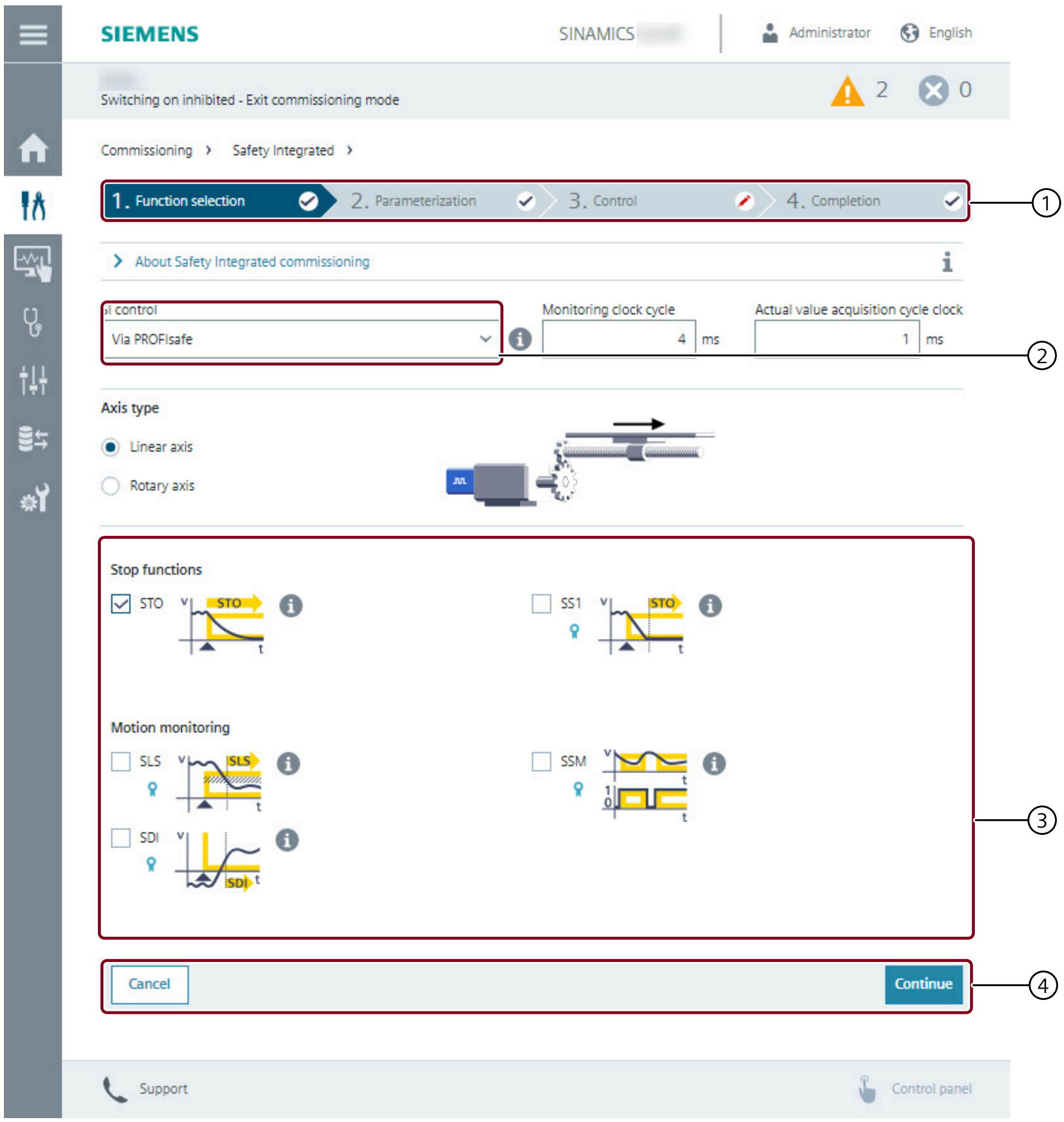
- Selecting the functions
- Parameterizing the functions as required for the application
- Control of the functions

Requirement

- The drive system has been configured. The components are wired.
- Web server access is active.
  Commissioning using the web server is only possible if access to the web server via interfaces X127 and/or X150 was selected in the security settings.
- The appropriate license is available for Safety Integrated Functions requiring a license.
- With UMAC activated, the necessary rights have been assigned, e.g. via the "Drive Safety Engineer" role.

Description of function

Depending on the product being used, the display of the Safety Integrated Functions can differ.



① Step display of the Safety Integrated commissioning Wizards

② Control type

③ Function selection

④ Navigation

Figure 10-8 Safety Integrated commissioning using the web server (example)

Changes to Safety Integrated settings are only possible in the "Safety Integrated commissioning" mode. The drive is in the safe state as soon as the commissioning mode is active. Safe Torque Off (STO) is active.

Commissioning of Safety Integrated must be completely run through. No settings are applied if an interruption occurs during commissioning.

The activated user management protects against unauthorized changes to Safety Integrated settings. Login takes place when the web server starts. After this, only authorized users have the necessary rights to change Safety Integrated settings. The "Edit Safety Integrated application" right is a component of the "Drive Safety Engineer" role.

When starting Safety Integrated commissioning, the converter creates a restore point. The converter saves the changes after every commissioning step. If Safety Integrated commissioning is canceled, the converter is reset to the restore point.

For fast navigation through Safety Integrated commissioning, for example to check the settings, the web server has a read-only mode.

Safety Integrated commissioning involves the following steps:

1. Function selection
   - Selecting the Safety Integrated control type
   - Monitoring cycle: Value is preset to 4 ms at the factory and can be adjusted to values in the range 1 ... 12 ms.
   - Actual value acquisition cycle: Value is preset to 1 ms at the factory and can be adjusted to values in the range 1 ... 8 ms.
   - Selecting the axis type
     When switching over the axis type, the units are also changed.
   - Selecting the available Safety Integrated Functions depending on the control type
   - License symbol
     The license symbol shows the Safety Integrated Functions that require a Safety Extended license. Safety Integrated can be used in the Trial License mode for test purposes.
2. Parameter assignment
   Configuration of the activated Safety Integrated Functions
   - Function-dependent display of the converter parameters
     The function view shows a graphic of the function. The parameters of the function are listed in the context-sensitive table.
     The parameter values can be changed. When required, additional parameters are displayed.
   - Actual value acquisition/mechanical system
     The actual value acquisition/mechanical system screen appears if Safety Integrated motion monitoring functions were activated.
     The parameter values can be changed.
3. Control
   Parameterizing the control type
4. Completion
   The configurations are completed and applied by clicking on "Finish":
   - The subsequent parameter assignments are made
   - Checksums are calculated

More information

You can find more information in chapter "Safety Integrated (Page 657)".

10.5.2 Operator control and monitoring

10.5.2.1 Drive status

Overview

Function view "Drive status" shows the current status of the converter.

Description of function

Product-specific information and settings are covered over in the diagram.

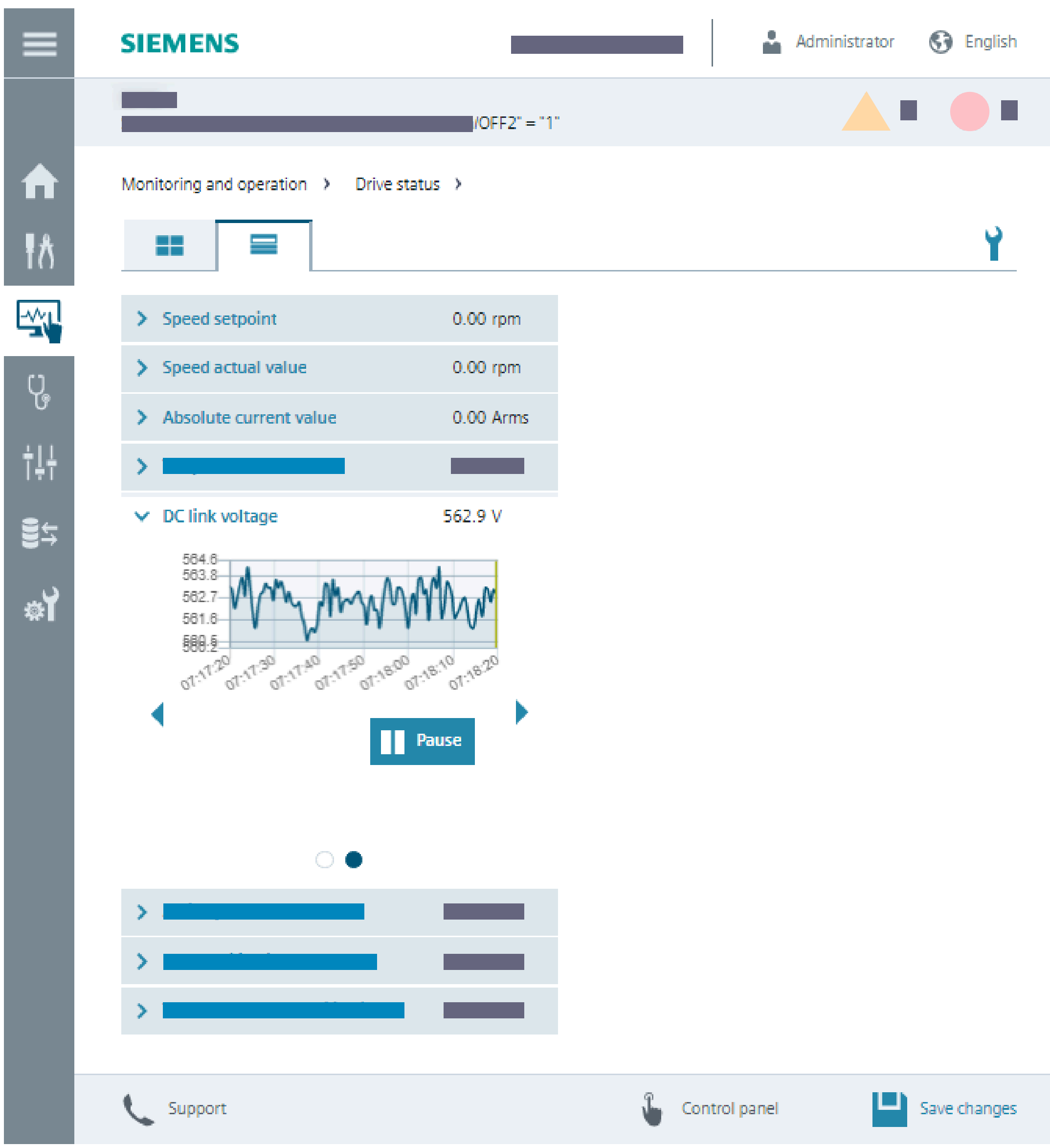


Figure 10-9 Drive status

The drive information displayed is preset in the factory setting, and when required, can be adapted using symbol . If user management is active, the "Edit web server configuration" right is required in order to make changes.

Values are indicated as follows:

- Factory setting: 8 values are displayed
- It is possible to display all values completely

The drive status is displayed as follows:

- : Individual values are continuously displayed
- : Individual values and trend diagrams are continuously displayed

10.5.2.2 Inputs/outputs

Overview

The function view "Inputs/outputs" shows the status of all inputs and outputs.

Description of function

Product-specific information and settings are covered over in the diagram.

Depending on the product being used, the number of inputs and outputs can differ.

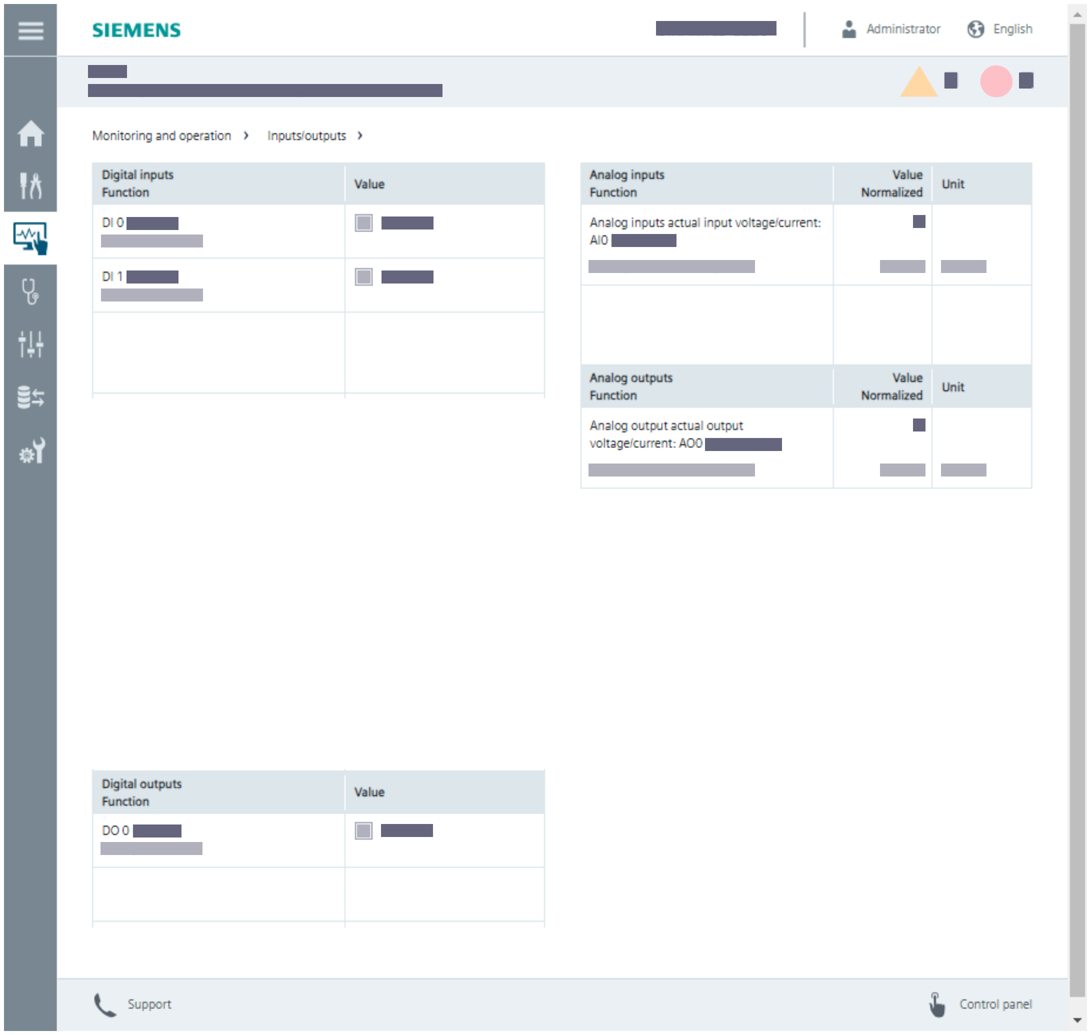


Figure 10-10 Inputs/outputs

The function view "Inputs/outputs" shows the following information:

- Name and terminal marking of the input and output
- Function of the input and output
- Actual value, e.g. "high" or "low" for a digital input

10.5.3 Diagnostics

10.5.3.1 Messages

Overview

Function view "Messages" shows active and historical messages.

Description of function

Product-specific information and settings are covered over in the diagram.

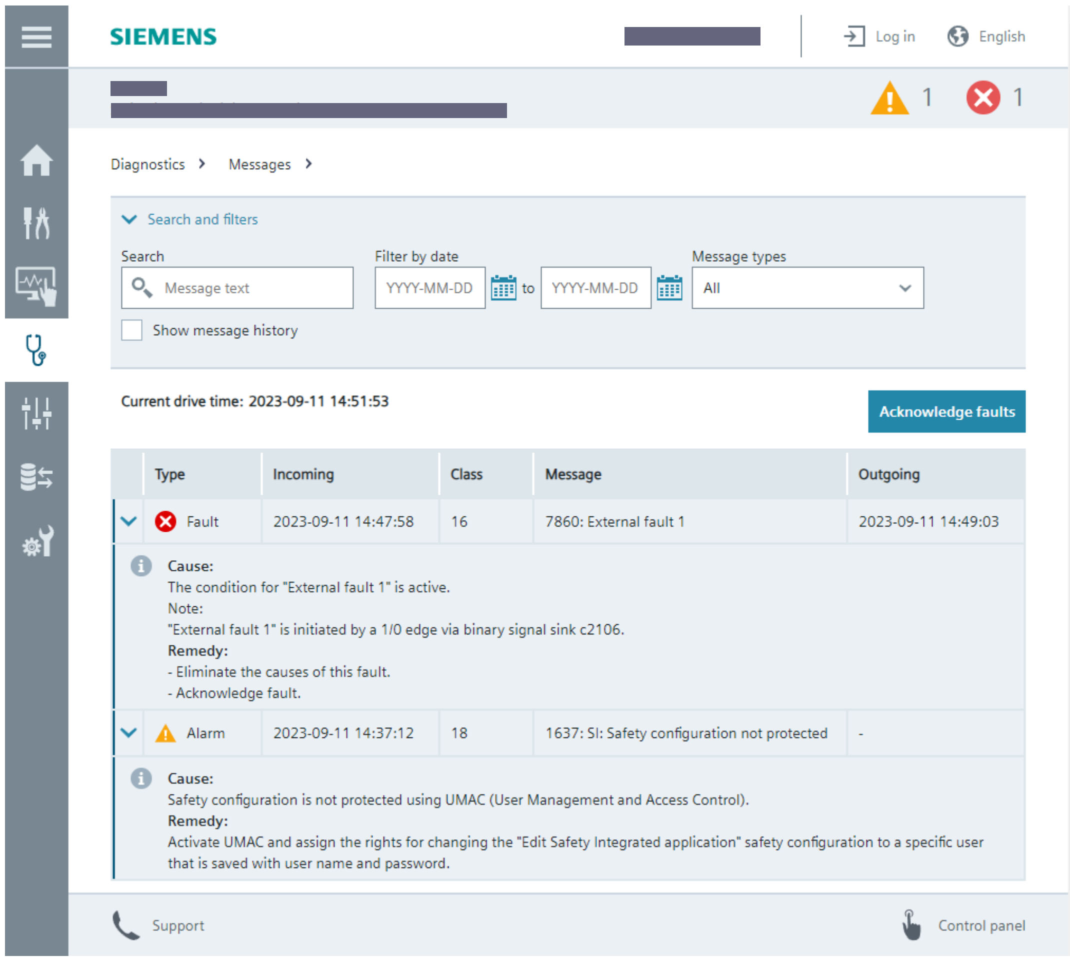


Figure 10-11 Messages

Using search and filter options, the number of alarms and faults can be restricted.

The message history can optionally be viewed.

Selecting messages

Search	Enter a keyword
Filter by date	Select a date or time interval
Message types	Select the message type that should be displayed: • All • Faults • Alarms

Displaying messages

Type	Displaying the message type: • Alarm • Fault
Incoming	Time that the message was received
Class	Assign the message to a message class according to PROFIdrive The message number is output on all operating units, e.g. PC or SIMATIC HMI.
Message	Specification of the message number with message text
Gone	Time when the message went • Faults are given the status "Outgoing" if the following are true: – The causes have been eliminated. – The message has been acknowledged.
›	Selection for more information: • Description of the message with cause and remedy

10.5.3.2 Diagnostics buffer

Overview

Function view "Diagnostic buffer" provides information about all system-relevant operations, e.g. commissioning, new ramp-up, generation of a certificate.

Description of function

Product-specific information and settings are covered over in the diagram.

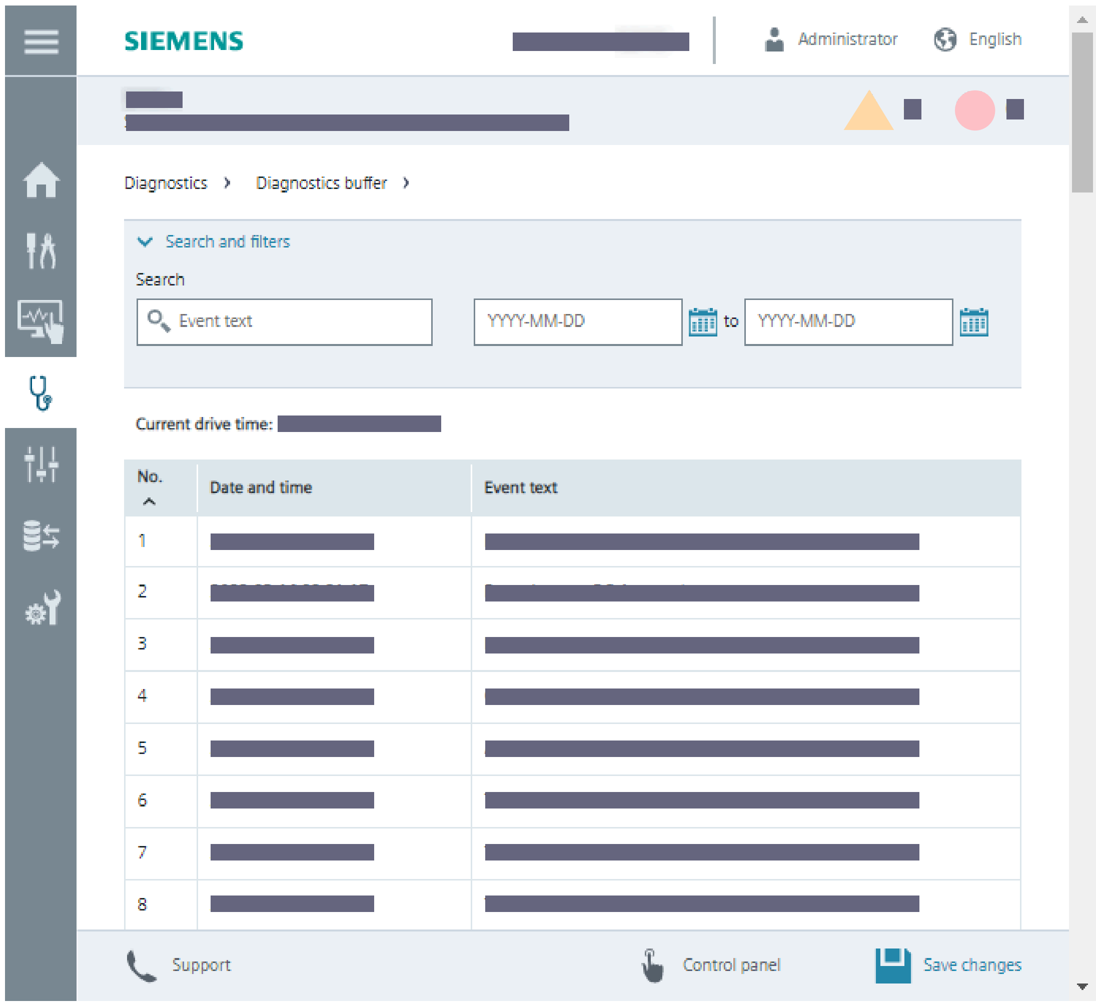


Figure 10-12 Diagnostic buffer

Reading out the diagnostic buffer facilitates converter diagnostics and supports fault analysis.

The search can be limited by searching for keywords and using the filter function according to date.

The diagnostic buffer can only be cleared by performing a manual reset to factory settings with a memory card. For more information, refer to the Chapter "Restore factory settings (Page 766)".

The diagnostic buffer is kept when restoring factory settings via menu "Backup and restore".

10.5.3.3 Safety Integrated

Overview

The "Safety Integrated" function status provides information about the Safety Integrated Functions that have been enabled.

Description of function

Product-specific information and settings are covered over in the diagram.

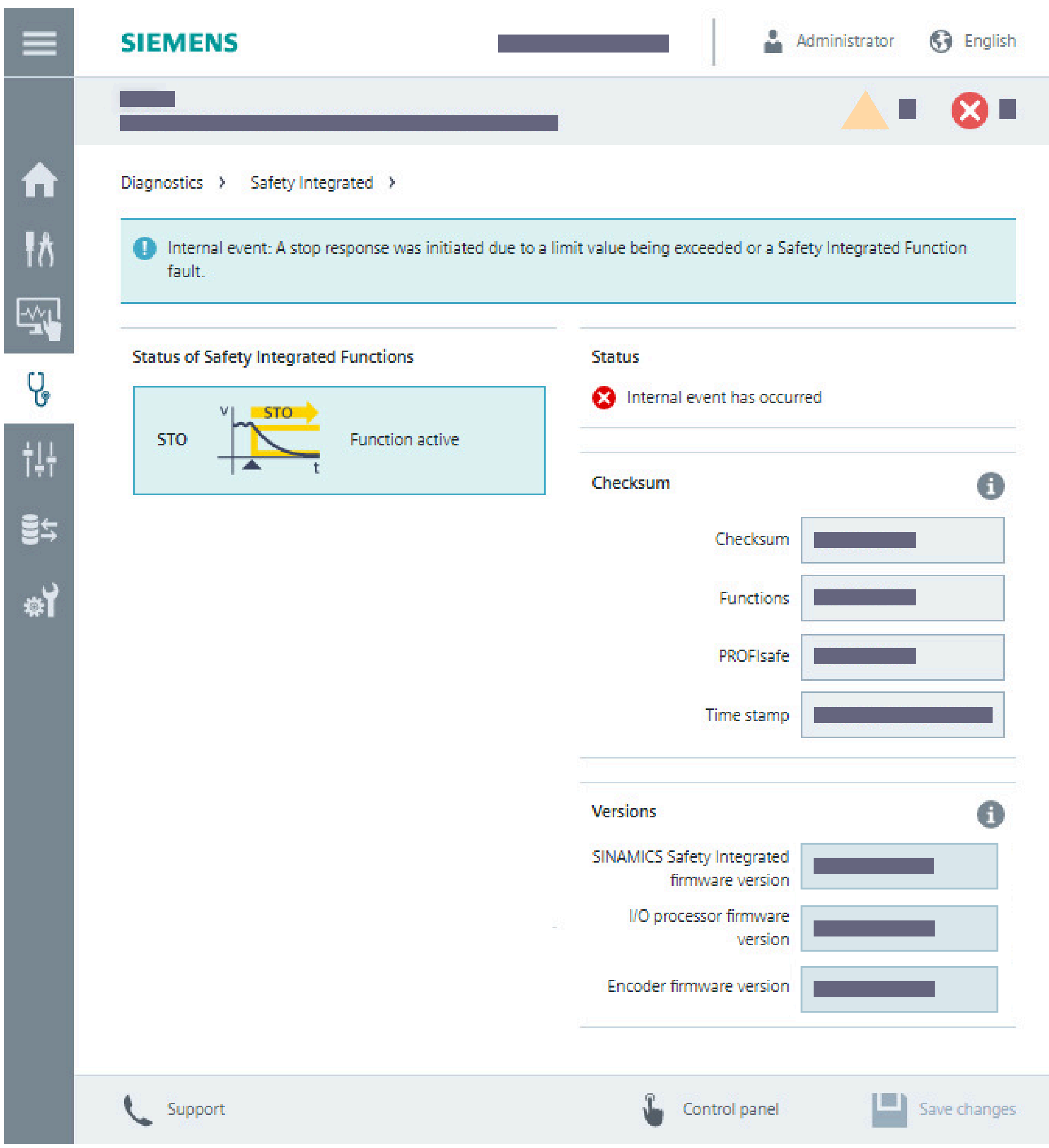


Figure 10-13 Safety Integrated

The following content is displayed:

- "Status of Safety Integrated Functions"
  The status of the enabled Safety Integrated Functions is displayed.
- "Status"
  Displays the internal events (limit violations, system errors)
- "Checksums"
  - "Checksum"
    Displays the functional checksum of the converter to track changes (safety logbook)
  - "Functions"
    Displays the checksum over the checksum-checked parameters to configure the converter
  - "PROFIsafe"
    Displays the checksum of the PROFIsafe parameterization
  - "Time stamp"
    The time stamp indicates when the update was made.
- "Versions"
  Displays the safety-relevant software versions of the corresponding components

10.5.3.4 Connection overview

Overview

Function view "Connection overview" provides information about the connections in the drive system.

Description of function

Product-specific information and settings are covered over in the diagram.

Figure 10-14 Connection overview

The individual components with IP address and additional details are graphically displayed in the connection overview.

10.5.3.5 Communication

Overview

The "Communication" function view provides information about the activated fieldbus protocol.

Description of function

Product-specific information and settings are covered over in the diagram.

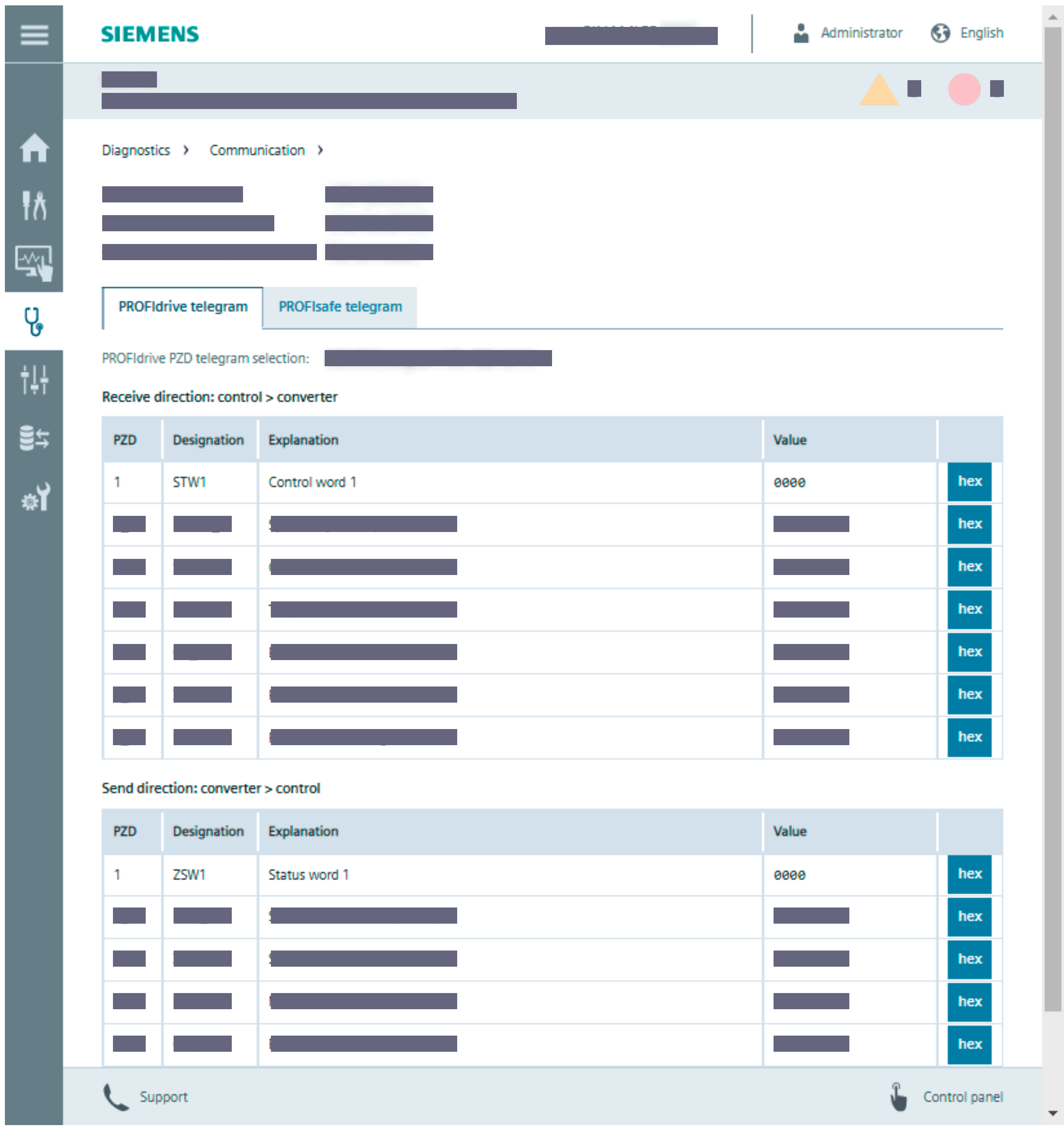


Figure 10-15 Communication

The following content is displayed:

- PROFIdrive telegram: Process data of the set telegram in the send and receive directions PROFIdrive telegrams are selected by users with corresponding function rights during converter commissioning via extended commissioning.
- PROFIsafe telegram: Process data of the set telegram in the send and receive directions. PROFIsafe telegrams are selected by users with corresponding function rights during Safety Integrated commissioning.

The telegrams are displayed in hex format. The display of individual values is switched between binary, decimal and hex format by clicking on the button to the right of the value.

10.5.3.6 Status word and control word

Overview

The function view "Control/status word" provides information about the current status of the sequence control system.

Description of function

Product-specific information and settings are covered over in the diagram.

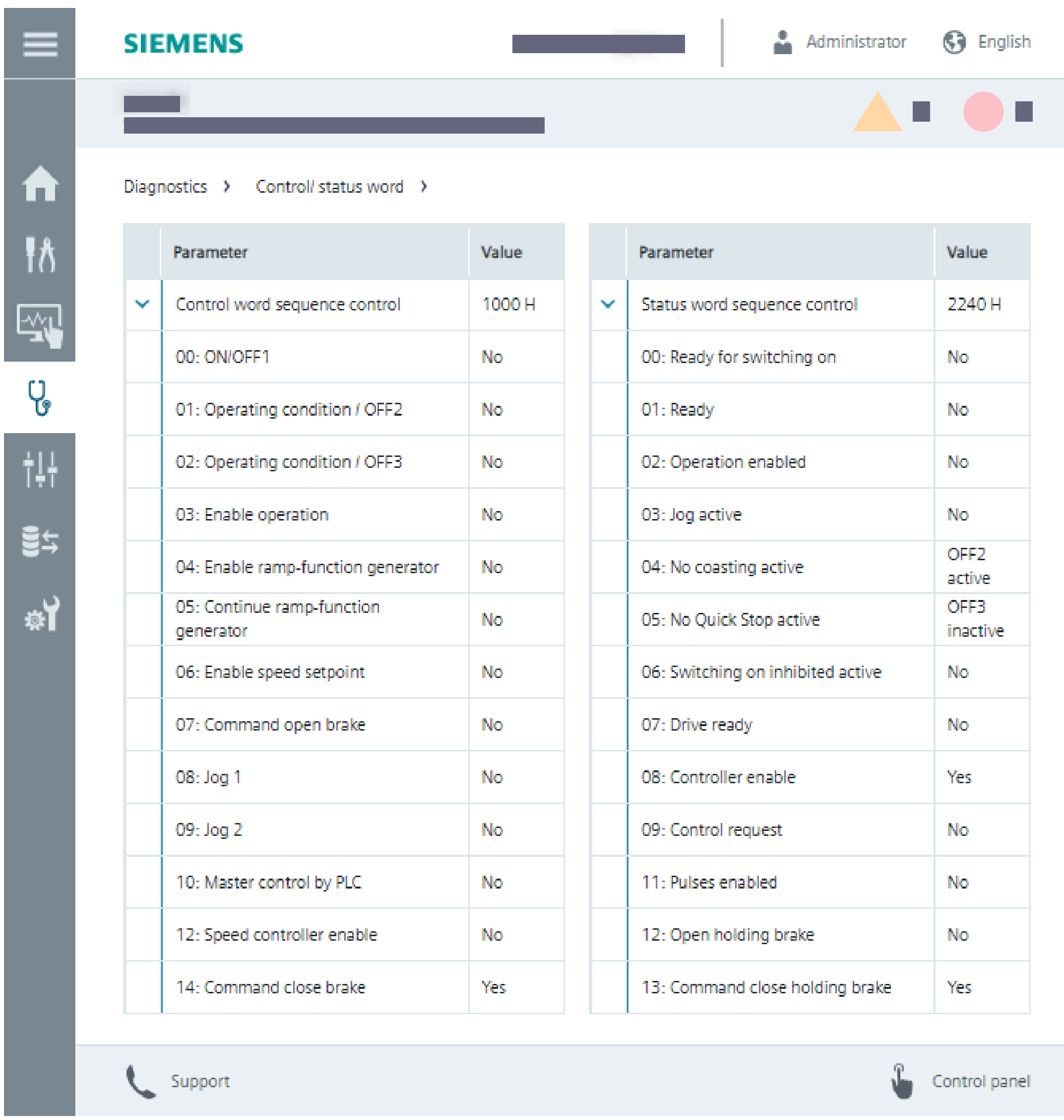


Figure 10-16 Control and status word

The control and status word is indicated by all sequence control states. This also includes states that are not available, which prevent the motor from being switched on and switched off. Diagnostics supports fault analysis.

10.5.4 Parameters

10.5.4.1 Parameter list

Overview

The "Parameter list" function view contains the converter parameters and enables the targeted modification of specific parameter values.

Description of function

Product-specific information and settings are covered over in the diagram.

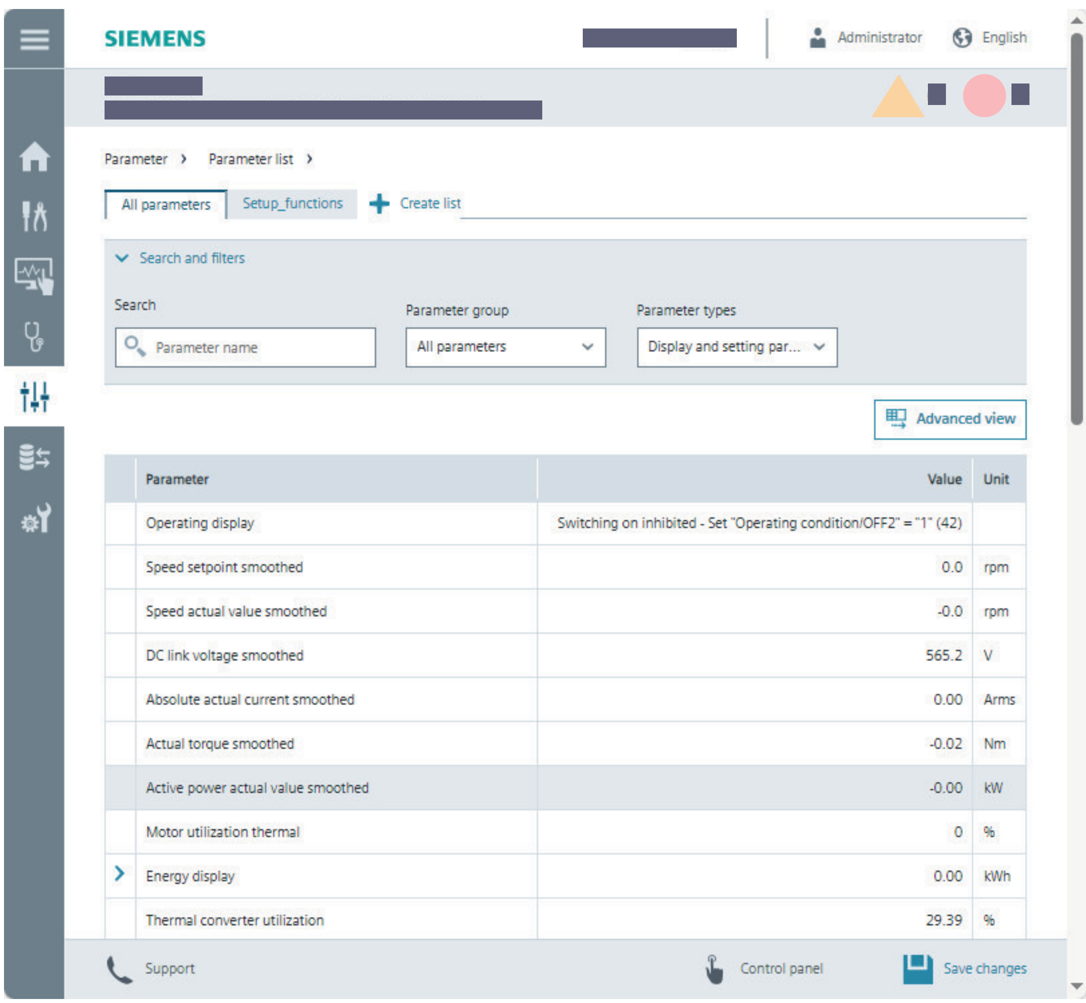


Figure 10-17 Parameter list in the extended view

The function view shows the following:

- Parameter list
  Depending on the setting in the "System" menu > Settings, the parameter list shows either all parameters or just the standard parameters.
- User-defined parameter list (optional)
  - The user-defined parameter list contains selected parameters and is created using the "+ Create list" tab.
  - "Setup_functions" parameter list
    The "Setup_functions" parameter list is intended for parameters that can only be configured with the converter in commissioning mode. It is not currently possible to access these parameters from the advanced setup menu. Suggestions are contained in the factory setting.
    Additional parameters can be added to the parameter list. This allows uniform access to the parameters of a drive function, for example.
    Starting the advanced setup automatically activates commissioning mode.
    So that the user-defined parameter list can be used during advanced setup, it is created and managed with the name "Setup_functions".

  You can find more information in chapter "User-defined parameter list (Page 249)".

The parameter list offers the following options:

- Toggling between two list views
  - Show as "Simple view" and "Advanced view" with parameter numbers
- Searching parameters
  - Search by parameter number or text search within parameter names
- Filtering the parameter list
  - Parameter groups: Only show the parameters that are assigned to a particular function.
  - Parameter types: display and/or adjustable parameters
- Changing parameter values directly in a parameter list
  - Exception: blocked parameters

p	Adjustable parameters	Are read/write.
		The adjustable parameter can only be parameterized in the active commissioning mode. Depending on the parameter, changes are possible in the quick setup or Safety Integrated commissioning.
		The adjustable parameter can only be parameterized when the user has the appropriate function rights.
r	Display parameters	Can only be read and cannot be edited.
c	Display parameters	Can only be read and cannot be edited.

10.5.4.2 User-defined parameter list

Overview

A user-defined parameter list is a combination of specific parameters from the standard parameter list of the converter. These can be used to configure frequently used user functions, for example.

Description of function

With the user-defined parameter lists, the web server provides the following functions:

- Creating up to 20 user-defined parameter lists
- Configuring list properties
  - Name
  - Position or sequence of the tabs
  - Comment
  - Delete list
- Exporting and importing user-defined parameter lists
  Export:
  - Export one or several user-defined parameter lists.
  - The web server exports the lists exclusively as a json file.
  - Export files generated by the web server can be imported into a Startdrive project.

  Import:
  - The list import function in the web server exclusively imports json files.
  - User-defined parameter lists exported via the web server or Startdrive as a json file can be imported into another drive of the same type via the web server.
    Requirement: same drive type and same firmware version

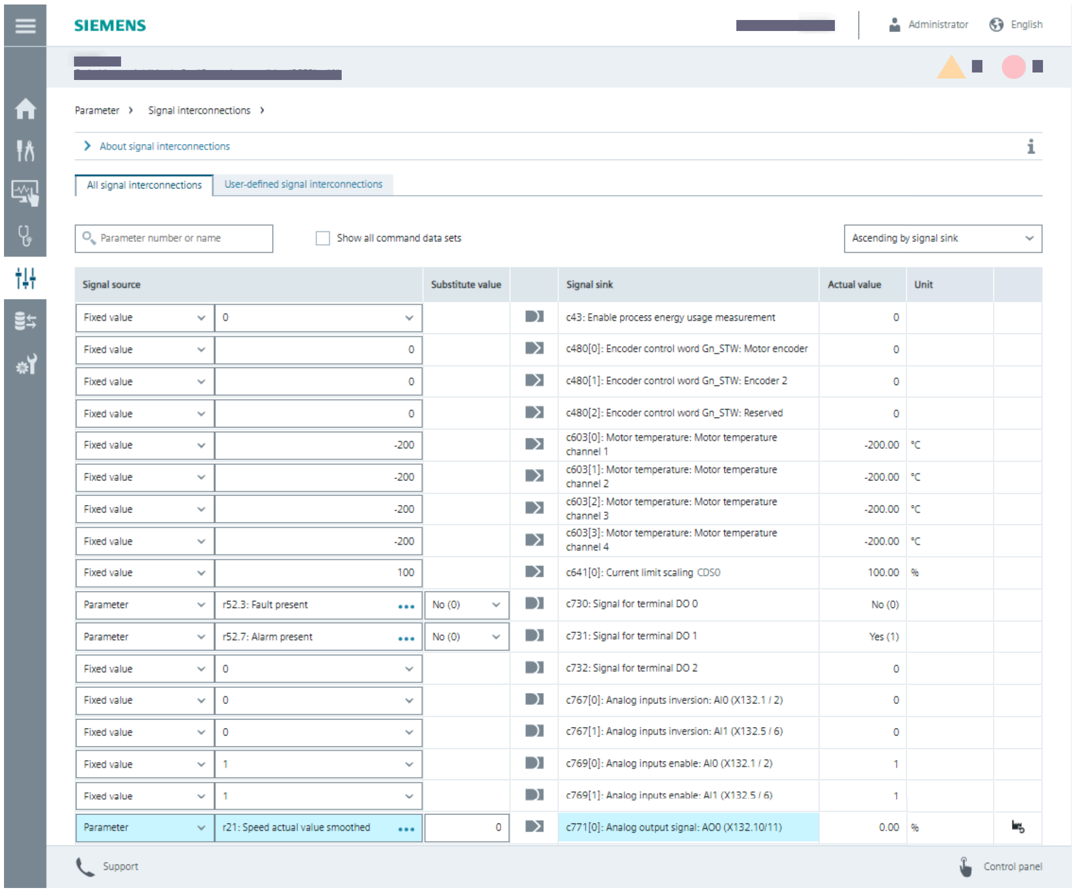
10.5.4.3 Signal interconnections

Overview

The "Signal interconnections" function view provides an overview of the converter signal interconnections (signal source and signal sink).

Signal interconnections can be added, modified and/or reset to factory settings.

Description of function



	Binary signal interconnection
	Numerical signal interconnection
	Reset signal interconnection to factory setting
Blue marks	Signal interconnections with changes to the factory setting

Figure 10-18 Signal interconnections

All signal interconnections

All the existing converter signal interconnections

The following possibilities are available:

- Search signal interconnections by parameters
- Show all command data sets
- Sort signal sources/sinks in ascending or descending order

User-defined signal interconnections

Signal interconnections defined by the user according to the application. These can include signal interconnections in the I/O configuration that were created during the commissioning of the converter, for example.

The following possibilities are available:

- Add and adjust new signal interconnections
- Modify user-defined signal interconnections:
  - Change the interconnection of the signal source parameter or fixed value with the signal sink parameter
  - Select a substitute value in case of interruption of the signal interconnection
- Show all command data sets
- Sort signal sources/sinks in ascending or descending order

More information

You can find more information in chapter: "Signal interconnection (Page 317)".

10.5.5 Backup and restore

10.5.5.1 Backup and restore

Overview

In the "Backup and restore" function view, you can back up parameters and other settings and restore the settings again if necessary.

Description of function

Product-specific information and settings are covered over in the diagram.

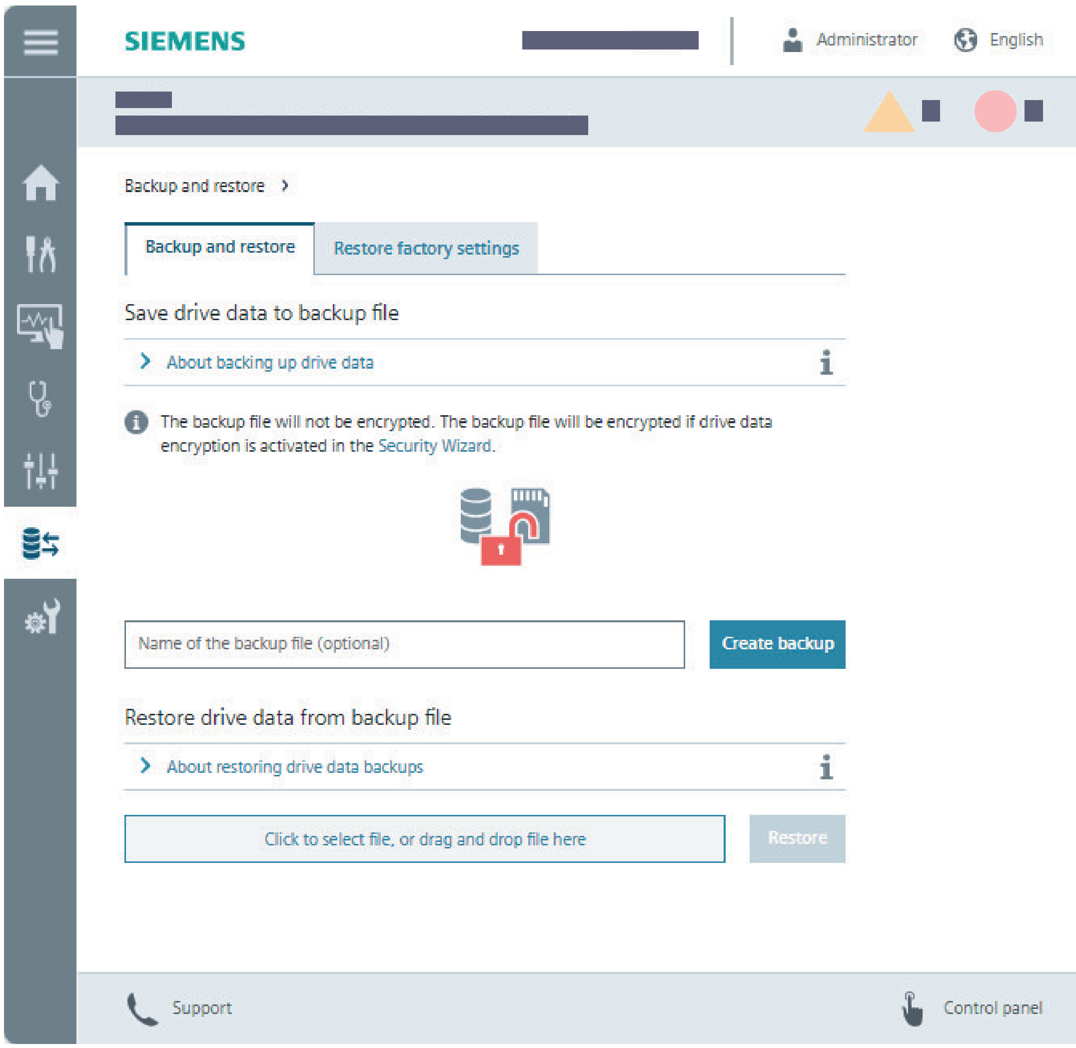


Figure 10-19 Backup and restore

The following functions are available:

Backup and restore

- Save drive data to backup file
  You back up the settings to a file after commissioning.
  The drive data are encrypted in the backup file if function "Drive data encryption" is activated in the Security Wizard.
- Restore drive data from backup file
  When replacing a device or for series commissioning, you load the backed-up settings to the converter.

Restore factory settings

- Restore factory settings
  The user-specific parameterization of the converter is deleted.
- Restore Safety Integrated to factory settings
  You only restore the settings of the Safety Integrated Functions to factory settings. All other settings remain unchanged.

More information

If you want to restore the converter to factory settings with the memory card, see the information in chapter "Full reset of all device settings (Page 768)".

10.5.5.2 Save drive data to backup file

Overview

Run the "Save drive data to backup file" function in the following situations:

- After commissioning
- Before drive data is reset using function "Restore factory settings" in the web server
  You can find more information in Chapter "Scope of the backup (Page 254)".
- Before drive data is completely reset
  You can find more information in Chapter "Full reset of all device settings (Page 768)".
- Before a firmware upgrade/downgrade

Requirement

There are no active converter faults.

Procedure

To save the drive data to a backup file, proceed as follows:

1. Call the "Backup and restore" menu.
2. Press the "Save drive data to backup file" button.
   Optional: Assign a name for the backup file.

Result

The drive data is saved to the backup file. The backup file is saved in the download folder of your operating unit.

Drive data encryption:

- The drive data is not encrypted in the backup file if you deactivated function "Drive data encryption" in the Security Wizard.
- The drive data is encrypted in the backup file if function "Drive data encryption" is activated in the Security Wizard and you have configured a drive password.

Description

The "Backup and restore" function is used to restore the drive data for the converter from an encrypted or unencrypted backup file.

The following restrictions apply if the drive password is lost:

- Drive data encryption cannot be deactivated.
- The drive data cannot be restored from an encrypted backup file.

We recommend storing the drive password in a secure location, for example in a password manager.

See also

Series commissioning using the web server (Page 292)

Replacing the converter without memory card (Page 761)

10.5.5.3 Scope of the backup

Overview

The "Save drive data to backup file" function backs up all converter settings to one file.

Description

The converter backs up the following data and settings:

- Communication interface settings
- Parameters (including safety parameters)
- Security settings

- UMAC data
- Web server settings:
  - Modified settings in window "Drive status" on the home page
  - User-defined parameter lists
  - Support settings
  - Save changes manually / automatically
  - Displayed parameters
    (Standard parameters/Show all parameters):
  - SINAMICS SDI standard settings
    (Display brightness, display time, start screen configuration)

The converter firmware files are not backed up.

10.5.5.4 Restoring drive data from an unencrypted backup file

Requirement

Requirements:

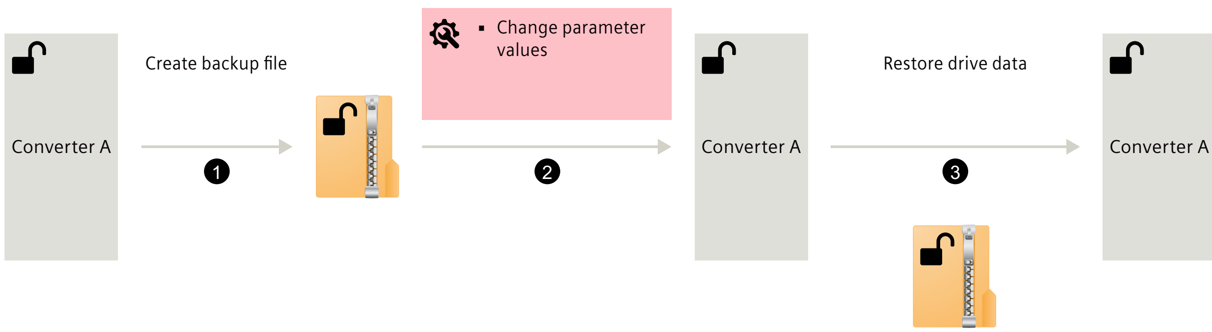
- An unencrypted backup file of the converter is available on the operating unit.
- You have the rights required for active user management (UMAC):
  - "Create backup or load drive data to Startdrive"
  - If Safety Integrated is contained in the backup file, the "Edit Safety Integrated application" right is required.

Procedure

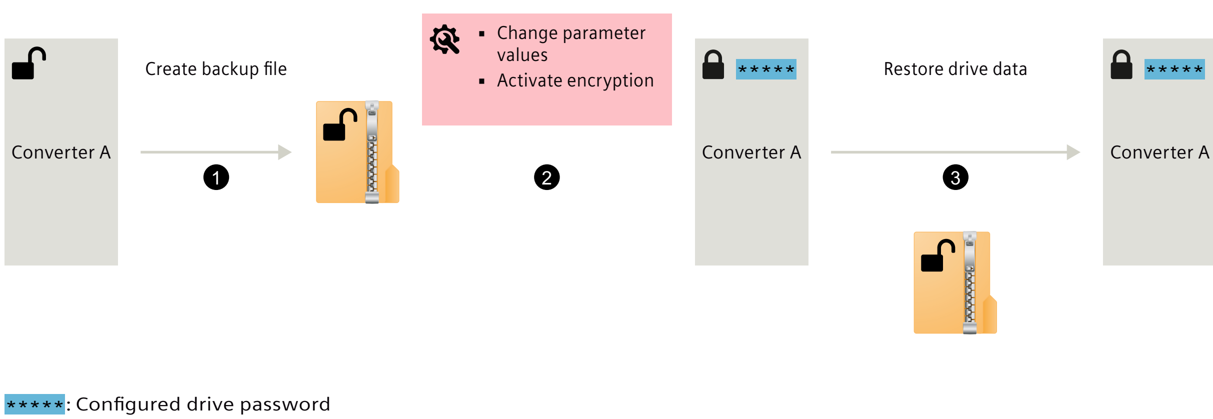
To restore the drive data for the converter, proceed as follows:

1. Call the "Backup and restore" menu.
2. Navigate to the "Restore drive data from backup file" area.
3. Use the "Click to select file, or drag and drop file here" button to select the backup file.
4. The next steps depend on the use case:

- **Use case 1:** A drive password has not been configured as function "Drive data encryption" has not been activated.



  - Press the "Restore" button.
  - The converter takes the drive data from the backup file.
    The settings at the time of the backup are restored.
- **Use case 2:** A drive password is configured after the backup file has been created.



  - Press the "Restore" button.
  - Enter the drive password.
  - The converter takes the drive data from the backup file.
    The settings at the time of the backup are restored.
    Function "Drive data encryption" is activated.
    The drive password is still effective in the converter after data has been restored.

10.5.5.5 Restoring drive data from an encrypted backup file

Requirement

Requirements:

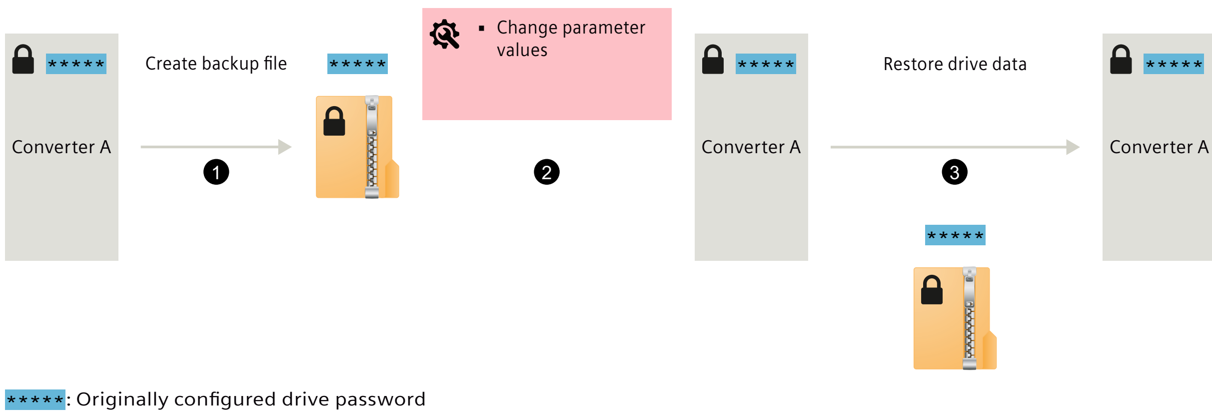
- An unencrypted backup file of the converter is available on the operating unit.
- Configured drive password:
  - You know the originally configured drive password with which the drive data in the backup file was encrypted.
  - You know the currently configured drive password.
    Is only applicable if the currently configured drive password deviates from the originally configured drive password, with which the drive data in the backup file was encrypted.
- You have the rights required for active user management (UMAC):
  - "Create backup or load drive data to Startdrive"
  - If Safety Integrated is contained in the backup file, the "Edit Safety Integrated application" right is required.

Procedure

To restore the drive data for the converter, proceed as follows:

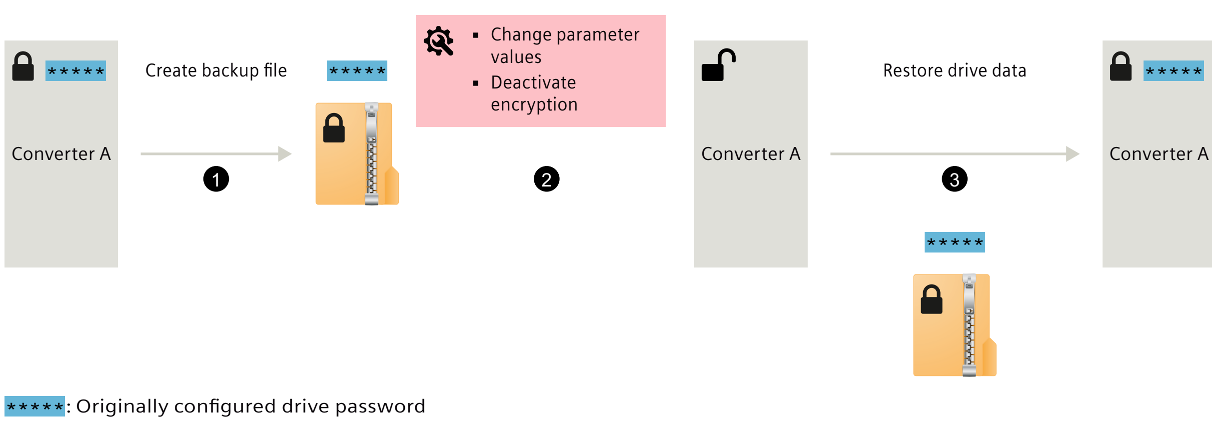
1. Call the "Backup and restore" menu.
2. Navigate to the "Restore drive data from backup file" area.
3. Use the "Click to select file, or drag and drop file here" button to select the backup file.
4. The next steps depend on the use case:

- **Use case 1:** A drive password is configured. The drive data in the backup file is encrypted with this password.



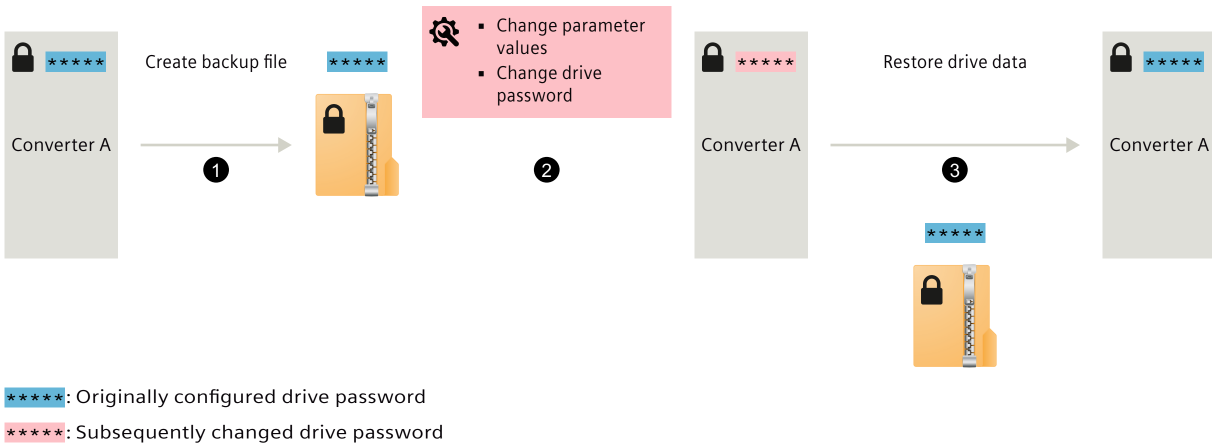
  - Press the "Restore" button.
  - Enter the drive password originally configured.
  - The converter takes the drive data from the backup file.
    The settings at the time of the backup are restored.
    Function "Drive data encryption" is activated.
    The originally configured drive password is applied.

- **Use case 2:** A drive password is configured. The drive data in the backup file is encrypted with this password. Function "Drive data encryption" is deactivated after creating the backup file.

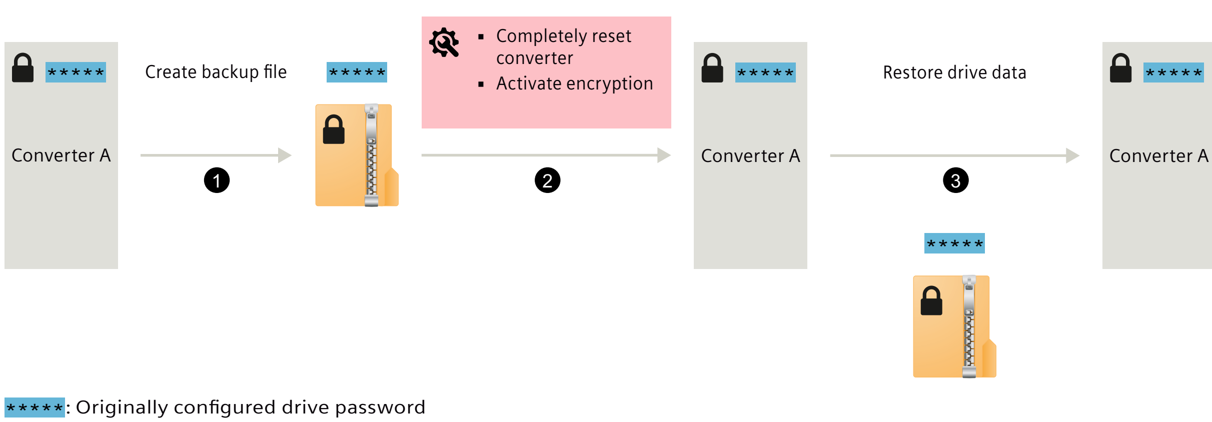


  - Press the "Restore" button.
  - Enter the drive password originally configured.
  - The converter takes the drive data from the backup file.
    The settings at the time of the backup are restored.
    Function "Drive data encryption" is activated.
    The originally configured drive password is applied.

- **Scenario 3:** The originally configured drive password is modified.



  – Press the "Restore" button.
  – Enter the drive password configured in step 2.
    The drive password configured in this step differs from the drive password with which the drive data in the backup file was encrypted.
  – Enter the drive password that was used to encrypt the drive data in the backup file.
  – The converter takes the drive data from the backup file.
    The settings at the time of the backup are restored.
    Function "Drive data encryption" is activated.
    The originally configured drive password is applied.
    The drive password configured in step 2 is then overwritten.
- **Scenario 4:** Before restoring, all user-defined settings for the converter are reset to the factory settings and a drive password is configured.



  – Press the "Restore" button.
  – Enter the drive password configured in step 2.
    The drive password configured in this step corresponds to the drive password with which the drive data in the backup file was encrypted.

- Enter the drive password that was used to encrypt the drive data in the backup file.
- The converter takes the drive data from the backup file.
  The settings at the time of the backup are restored.
  Function "Drive data encryption" is activated.
  The originally configured drive password is applied.

10.5.6 System

10.5.6.1 Settings

Overview

The function view "Settings" offers basic settings for the web server and the converter.

Requirement

- To edit the web server settings you will need the "Edit web server configuration" right.
- To edit the drive settings you will need the "Edit device configuration or drive applications" right.

Description of function

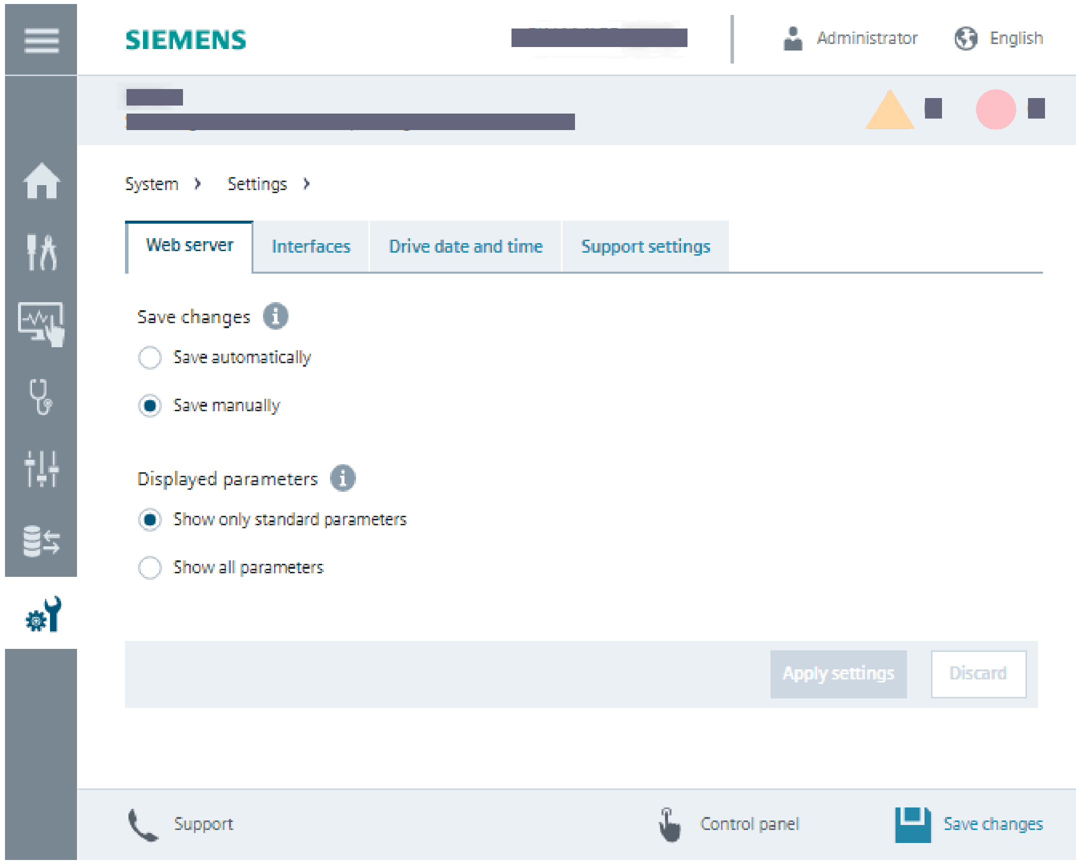


Figure 10-20 Settings

Web server

Under "Web server", the web server offers options for saving changes and displaying parameters.

Interfaces

Under "Interfaces", the web server provides information about the status and the settings of the interfaces of the converter:

- The IP address of the X-127 service interface is configurable.
- The interface settings for the X150 fieldbus interface are displayed. Changes can only be made in advanced setup.

Drive date and time

Under "Drive date and time", the web server provides options for setting the date format and for obtaining the date, time and time zone of the converter.

Maintenance

The web server calculates the wear limit of the converter fan.

After the fan is replaced, the wear calculation is reset manually. The calculation then starts from the beginning.

Support settings

Under "Support settings", the web server provides the option to store additional support and hotline data. The web server displays these data in the function view "Support".

10.5.6.2 Configuring the OM-IIoT option module

Overview

When configuring Option Module OM-IIoT, you define the communication between the OM-IIoT and the edge device.

Requirement

"Display all parameters" is selected under "System > Settings".

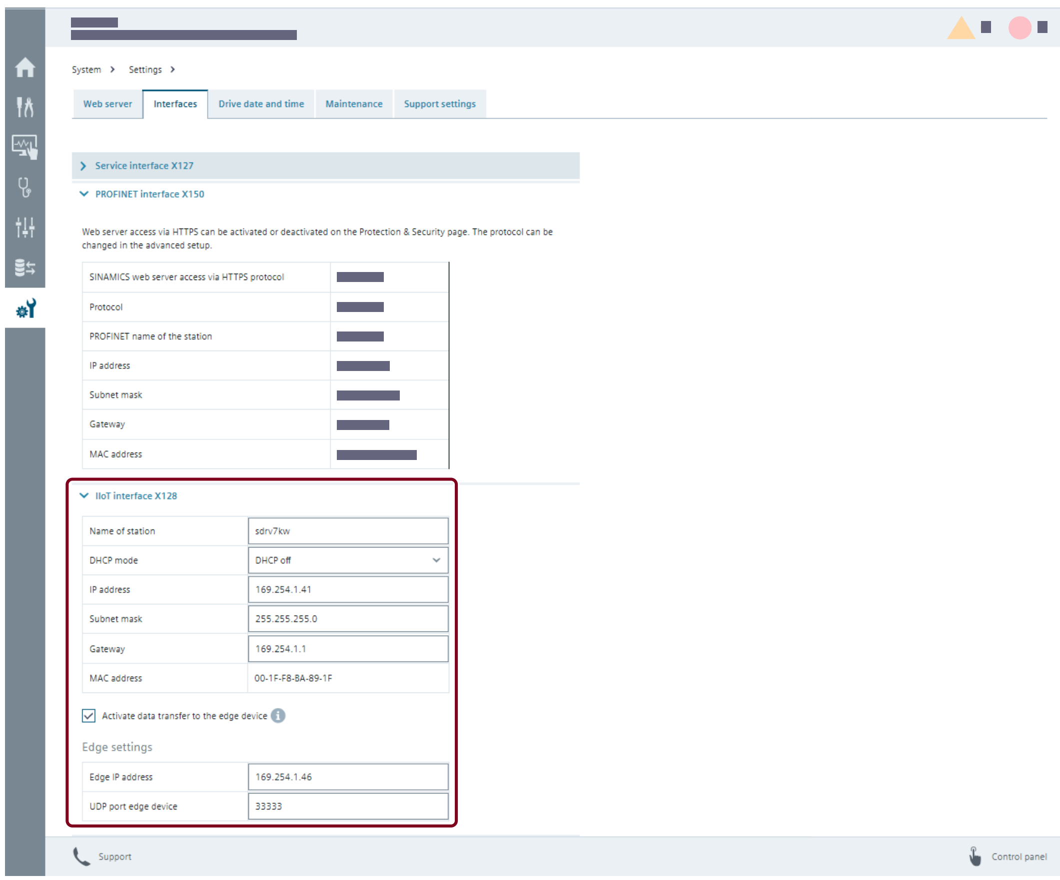
The procedure includes as example the "Drive System Framework" app that runs in the edge device.

Procedure

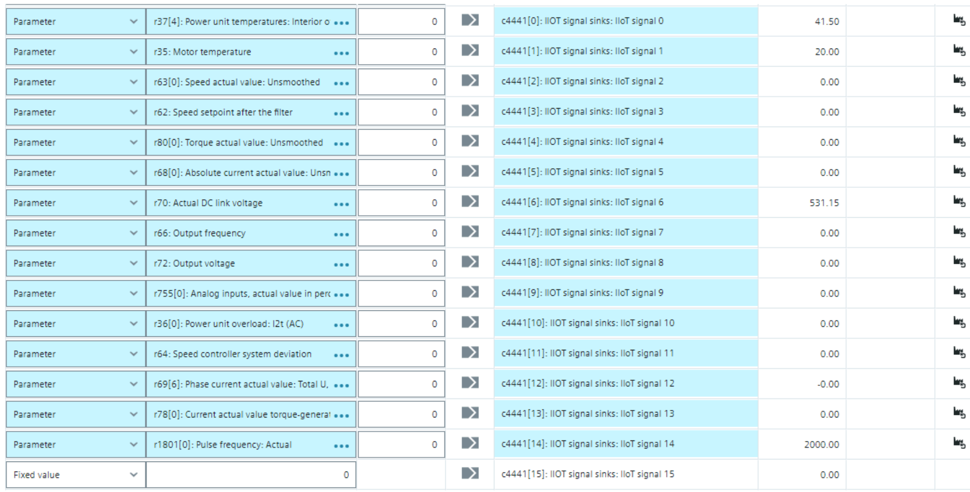
Proceed as follows to define the communication between the OM-IIoT and the edge device:

1. Set the following:
   - "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

   Product-specific information and settings are covered over in the diagram.



2. Interconnect the converter signals that you wish to transfer to the edge device with the OM-IIoT.



10.5.6.3 User management

Overview

In the "User management" function view, you manage users and configure their roles and rights for accessing the converter.

Requirement

- You activated user management (UMAC) in "Configure security settings".
- You are logged into the web server and have the necessary rights to manage users.

Description of function

Product-specific information and settings are covered over in the diagram.

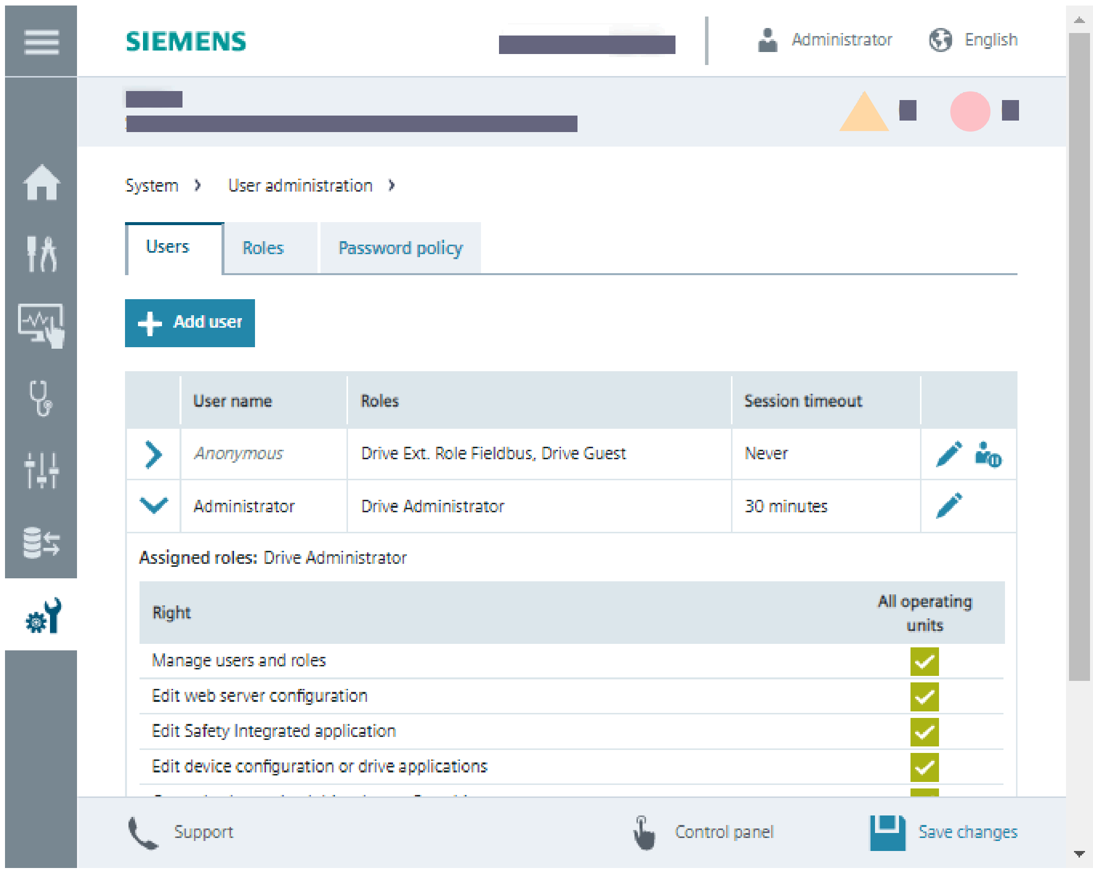


Figure 10-21 User management

Users

Under "Users", the web server provides a summary of the created users and offers the following functions:

- Create new user accounts
- Change existing user accounts
- Activate or deactivate user accounts

Roles are assigned to give users read or write access to certain functions.

Roles

Under "Roles", the web server provides a summary of the existing roles and the assigned rights.

Password policy

Under "Password policy", you specify the requirements a password must meet. You define the password complexity and the time to password expiry (if any).

More information

More information about user management and the settings can be found on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.5.6.4 Protection & Security

Overview

In the "Protection & Security" function view, you configure basic security settings using the Security Wizard.

Requirement

- You are logged into the web server.
- If you have activated UMAC, then you have the rights to edit drive data.

Description of function

Product-specific information and settings are covered over in the diagram.

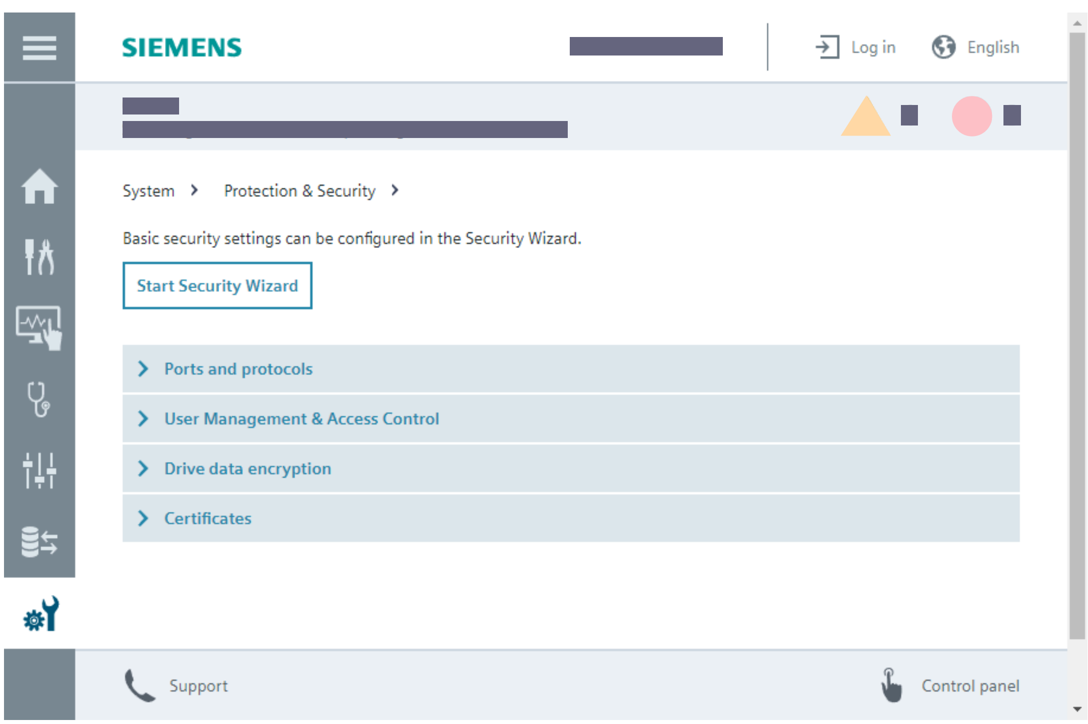


Figure 10-22 Protection & Security

Start Security Wizard

The Security Wizard guides you through the converter security settings. They include User Management & Access Control and web server activation.

Ports and protocols

The web server provides an overview of the available ports and protocols and their status.

User Management & Access Control

The web server provides an overview of the settings in user management.

Drive data encryption

The web server displays whether the converter encrypts sensitive drive data.

Certificates

The web server provides an overview of the issued certificates. The certificates are required for secure communications via HTTPS.

More information

More information on configuring secure communications can be found in the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

10.5.6.5 Licenses

Overview

You must purchase licenses for supplementary functions and options.

Use the function view "Licenses" to manage the licenses for drive functions and options.

Requirement

- You are logged into the web server and have the necessary rights to edit drive data.
- The operating panel is connected online with the drive.

Description of function

Product-specific information and settings are covered over in the diagram.

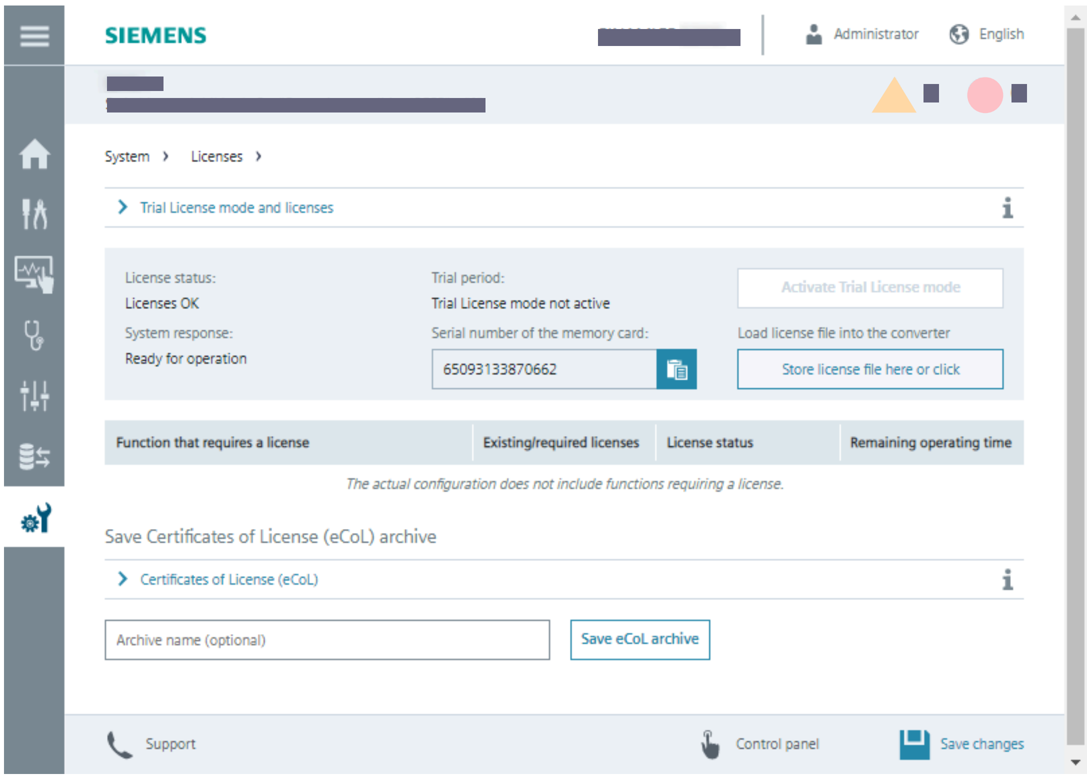


Figure 10-23 Licenses

The function view "Licenses" offers the following functions:

- Display the installed functions requiring licenses
- Read and copy the serial number of the SD card inserted into the converter
- Load and activate purchased licenses

Load and activate licenses

Under "Trial License mode and licenses", you upload license files created with the Web License Manager.

In Trial License mode, you can try out functions for a specified period.

Using functions/options requiring a license

The web server provides an overview of the options that require licensing and their license status.

Certificates of License (eCoL)

Under "Certificates of License (eCoL)", you transfer a license from the memory card into the file system of the operating unit.

More information

- You can find more information about creating and managing license files in Chapter "Functions that require licensing (Page 732)".
- More information about the licensing process or on the Trial License mode is provided in the TIA Portal information system. There, search for the key term "Managing supplementary functions that require a license".

10.5.6.6 Firmware update

Overview

You can perform a firmware update in the web server:

- For an upgrade, the converter settings are retained.
- For a downgrade, the converter is restored to factory settings.

Requirement

You have saved the ZIP file with the firmware to a drive, which you can access using the operating panel.

Description of function

This function view "Firmware update" displays the current version of the firmware and of the web server.

To copy a different firmware version to the converter, load the ZIP file containing the firmware from the file system of the operating panel.

10.5.6.7 About web server

Overview

The "About web server" function view contains information about the web server and links to more information.

Description of function

Under "Versions" you can see the revision levels of the web server and the loaded firmware.

Under "Third-party software" there is a link to information about any third-party software used. The license conditions are loaded to the operating panel in the file "READ_OSS.ZIP". You can display the HTML file included in the ZIP file using your browser.

There are more links to information about:

- Cookie policies
- Industrial Cybersecurity
- Privacy policy

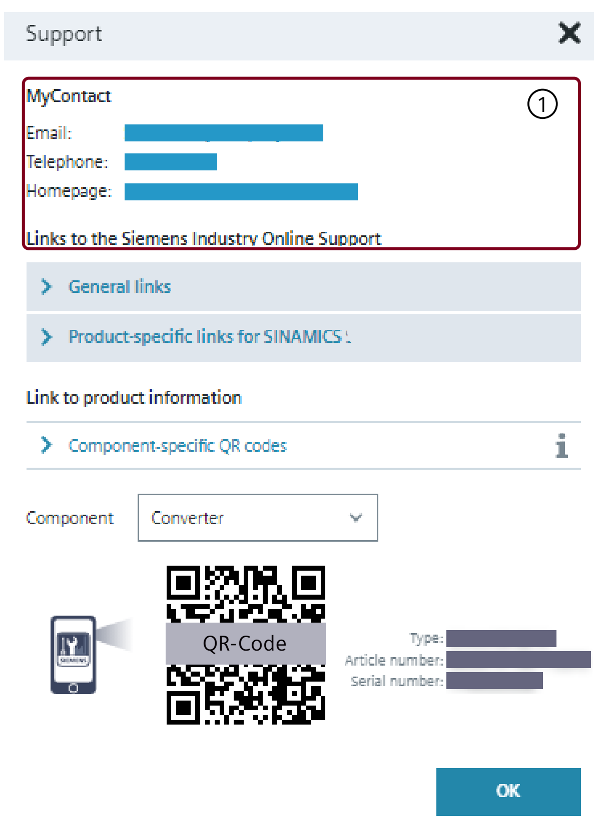
10.5.7 Support

Overview

The action bar of the web server contains a support dialog

Description of function

The support dialog contains links to additional information for the converter.



① Display of additional support and hotline data
For more information about configuration, see Chapter "Settings (Page 260)".

Figure 10-24 Support information

10.5.8 Control panel

Overview

The control panel moves the motor using the operating unit, bypassing the higher-level controller, for example to test the converter settings after commissioning.

Requirement

⚠ WARNING

Unexpected motor movement through incorrect operation

If the control panel is active, the safety shutdowns of the higher-level controller have no effect. The "Stop with space bar" function is not guaranteed in all operating states. Incorrect operation by untrained personnel may result in unexpected motor movement which can cause death or serious injuries.

- Only use the control panel for commissioning, diagnostics and service purposes.
- Only use the control panel if you are trained and authorized accordingly.
- Install an EMERGENCY STOP for the drive which is independent of the higher-level controller.

Description of function

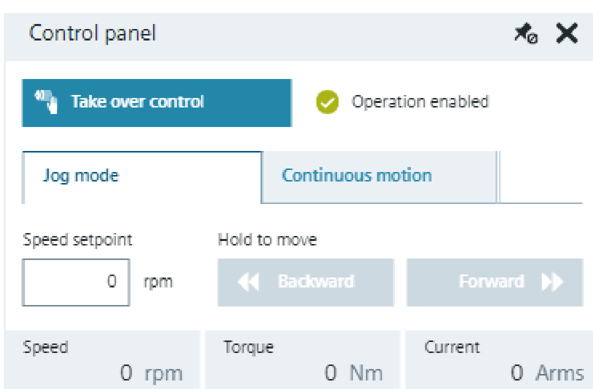


Figure 10-25 Control panel

The "Take over control" dialog deactivates the signals of the higher-level controller and switches the source for enables and the setpoint value to the control panel.

Note

Drive responds immediately

Although all enable signals are removed before returning the master control, the setpoints and commands still come from the original parameterized sources after the master control is returned.

The control panel offers the following operating modes to move the motor:

- Jog mode moves the motor while the direction buttons are pressed.
- Continuous operation starts the motor when a direction button is pressed.

11 Commissioning (Startdrive)

11.1 Introduction

Description

You configure devices and commission your converter in the Startdrive commissioning tool.

Further information about the Startdrive commissioning tool can be found in the information system of the TIA Portal.

11.2 Basics

11.2.1 Communication interfaces

Description

The following interfaces are available for accessing the converter:

Interface	Information
Service interface X127	Default access to Startdrive and the web server is via service interface X127.
	Ethernet interface X127 is intended for commissioning and diagnostics, which means that it must always be accessible.
	Defaults: • IP address: 169.254.11.22 • Subnet mask: 255.255.0.0 • Data transfer via HTTPS is activated in the factory setting.
	Restrictions: • Only local access is allowed. • Only local networking in a closed and locked electrical cabinet is permissible. • For remote access to the electrical cabinet, you must apply additional Industrial Cybersecurity measures to prevent misuse through sabotage, data manipulation by unqualified persons and interception of confidential data.
PROFINET interface X150	• Converters are connected to several components, such as an operating unit or a higher-level control system, via PROFINET interface X150. • The network at PROFINET interface X150 must be located in a secure protection zone. Access to cables and open connections must be implemented in a protected fashion, such as in a control cabinet. • The IP addresses of the service interface X127 and the PROFINET interface X150 must not be in the same subnet. • Configured IP addresses are stored in SINAMICS SDI Standard: "Support" menu > "Scan IP Address".

More information

More information about the supported protocols is available on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

11.2.2 Protected communication

Description

If the Startdrive project and the converter are unprotected, access is possible via both interfaces. This enables unrestricted access from the project or a higher-level controller to the drive data.

Non-authorized users can manipulate the drive data. To avoid the risk of data manipulation, we recommend protecting access to the project and the converter.

Detailed information about security settings is provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578).

11.2.3 Loading data from the drive into the project

Overview

If you change the configuration of a converter in the online mode, then the configuration deviates from the data in the Startdrive project. To update project data, load the drive data from the converter into the project.

Requirement

- A project with a matching drive is created and is open in Startdrive.
- The converter and SIMATIC S7 controller are in offline mode.
- For activated user management (UMAC) in Startdrive:
  The function rights for editing drive data and the hardware configuration are activated for your user account.
  You also need the function right "Edit Safety Integrated application of the drive" for editing Safety Integrated data.
- For activated user management (UMAC) in the converter:
  The "Create backup or load drive data to Startdrive" function right is activated for your user account.

Details on this topic are provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578) in section "Security settings in Startdrive".

Procedure

1. Click on icon  (Upload from device) in the toolbar.
   The "Upload preview" dialog opens. Startdrive checks whether all requirements for loading have been met. In the event of any obstructions, these are displayed as messages in the dialog.
2. Check the messages. If necessary, activate the actions in column "Action".
   As soon as uploading becomes possible, the "Upload from device" button is enabled.
3. Click the "Upload from device" button.
   The data, except for the UMAC configuration, is loaded from the converter into the project. The drive data is saved with the project.

11.2.4 Loading project data into the drive

Overview

Load the data from your Startdrive project into a drive.

Requirement

- A project has been created.
- A drive has been created and completely configured in the project.
- Optional: There is an active online connection between the drive and operating unit.
- For activated user management (UMAC) in Startdrive:
  The following function rights are activated for your user account:
  - "Download to drives"
  - "Manage users and roles" (the UMAC configuration must be loaded to the drive)
- For activated user management (UMAC) in the converter:
  Depending on which data is loaded to the converter, you require the corresponding function rights for your user account.

Details on this topic are provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578) in section "Security settings in Startdrive".

Procedure

1. Select a drive in the project tree.
2. Click on icon (Load to device) in the toolbar.
   - If you have already established an online connection, then the "Load preview" dialog opens.
     This dialog displays alarms and proposes actions necessary for loading.
   - If you have still not established an online connection, then the "Extended loading" dialog opens.
     Using this dialog, establish an online connection to the required drive.
3. Check the messages in the "Load preview" dialog.
   The "Save parameterization retentively" action is enabled by default.
4. Click "Load".
   The project data is downloaded into the drive.

11.2.5 Saving changes in the project

Overview

Project data that are not saved are lost when closing the project. The entire project must be saved in order for the settings to take effect permanently.

Requirement

- Project protection is active
  The following function rights for editing drive data are activated for your user account:
  - "Open and edit the project"
  - "Edit hardware configuration"
  - "Edit drive applications"
  - "Edit drive Safety Integrated application"
  - "Manage users and roles"

  Details on this topic are provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578) in Chapter "Security settings in Startdrive".

Procedure

In the toolbar, click on the icon .

OR

Select the "Project > Save" or "Project > Save as" menu.

11.2.6 Retentively saving changes

Overview

You have created and fully configured a drive in the project and you wish to save your settings in the converter.

Parameter assignments of your drive are always volatile and are lost when the drive is switched off. Information is subsequently provided as to how you can retentively save online data or offline data.

Requirement

- A project has been created.
- For activated user management (UMAC):
  The function rights for editing drive data are activated for your user account.
  Details on this topic are provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578) in Chapter "Security settings in Startdrive".

Retentively saving online data

You are connected online with the drive; save your configuration as follows:

1. In the function view of the active Startdrive project, click on icon (retentively save data of the complete device).
   OR
2. In the project tree of your drive device, double-click on "Online & Diagnostics".
   - In the secondary navigation select menu "Functions > Backup/Restore".
   - In the "Retentively save RAM data" area, click "Save".

The system checks whether a memory card is available. If an appropriate memory card is detected, then the parameter values are retentively saved to the memory card.

Retentively saving offline data

When retentively saving data, it is important that the settings made are not only saved on your operating unit in the Startdrive project, but also permanently saved on the drive memory card (also known as "save retentively" or "RAM to ROM"). An online connection must be established to the drive for this purpose.

1. Establish an online connection to your drive.
2. Load the project data into your drive.
3. Click the icon in the function view of the active Startdrive project.
   The current project settings are stored retentively on the memory card of the drive.

11.2.7 Using parameter lists and user-defined lists

Overview

Users configure a drive in Startdrive as standard using specific configuration views. For the configuration, experienced users preferably take the parameter lists or user-defined lists.

Requirement

- For activated user management (UMAC):
  The function rights for editing drive data are activated for your user account.
  Details on this topic are provided in the Configuration Manual SINAMICS Industrial Security (https://support.industry.siemens.com/cs/ww/en/view/109810578) in Chapter "Security settings in Startdrive".

Parameter list

The following functions are available:

- Monitoring parameter values
- Editing parameter values directly from the parameter view
  Only parameters with a light grey background can be directly edited in the parameter list. Other parameters are locked in the parameter list and cannot be edited.
- Exporting parameters as CSV
- Comparing parameter settings:
  - Offline - Factory setting
  - Online - Offline
  - Online - Factory setting

User-defined list

You compile the selected parameters in a user-defined list. This involves an excerpt with specific parameters, from an underlying parameter list.

User-defined lists are only created and edited in the project tree.

You use user-defined lists for the following purposes:

- Compiling the most important parameters
- Assigning parameters to parameter groups with comments for users
- Carrying out series commissioning based on saved parameter values
- Documentation of the drive with listed parameters and setting values

Opening and reading parameter lists in the web server

Parameter lists are exported in the json format. You can import and open lists and view parameter values if you access the converter using the web server.

Example

In the following application, you create a user-defined list with the objective of accepting parameter values for an additional drive.

1. You create a user-defined list with parameter values for a configured drive.
2. You open the list in another drive with the same hardware configuration.
3. You compare the parameter values of the drive with the saved values.
4. You apply the required parameter values for the drive.

More information

Detailed information about handling parameter lists and user-defined lists is provided in the TIA Portal information system.

11.3 Device configuration and basic parameterization

11.3.1 Overview

Note

Only in the offline mode

The drive components can only be combined and specified in the offline mode. In the online mode, all corresponding setting ranges are marked in the device view and in the inspector window.

Note

User management and security

SINAMICS drives of the latest generation generally have extended protection. This usually has the effect that, as a user, you have to log in to view or edit the drive data offline as well as online. The most important protective measures in brief:

- Project protection can be activated for Startdrive projects in the TIA Portal (offline). If project protection is activated, corresponding rights are required for access. Once project protection has been activated, it cannot be deactivated.
- A "Security Wizard" usually appears when creating new drives in the project. The Security Wizard helps you to make the most important security settings for this drive in the project when creating the drive. After loading the project data into the drive, the protection settings become effective in the drive.
- To access a protected drive online, you need the corresponding access rights. This also applies if no project protection is activated for the Startdrive project.

Detailed information on this topic can be found under "User management and security (Page 287)".

Note

Editing mode required for online commissioning

If you want to make important settings online, activation of the editing mode is mandatory. Restore points that are required as a return point following a cancellation of the current online parameterization are automatically created by the editing mode in the "guided quick startup" (and in the "Parameterization" area) during configuration.

No separate editing mode is necessary in the "Rotate & optimize" area.

Note

Telegram configuration offline

In the guided quick startup, telegram settings can in principle only be made offline.

11.3.2 Simple basic parameterization (offline)

Procedure

The following steps are required for simple basic parameterization:

1. Create or open project with Startdrive.
2. Create the device configuration in Startdrive offline
   – Insert the SINAMICS drive into the project and specify it
   – Create and specify SINAMICS components
   – Make detailed settings for drive and components
   – Optional: Configure user administration and make protection settings for the drive
3. Make basic settings offline via the guided quick startup
4. Load project data into the target device.
5. Establish an online connection between Startdrive and the target device
6. Perform optimization

Result:

The motor rotates.

More information

Detailed information can be found in the information system of the TIA Portal in Chapter "Configuring SINAMICS G220 drives".

11.3.3 Simple basic parameterization (online)

Procedure

The basic parameterization can also be carried out in online mode as an alternative to offline mode. The results in the following process sequence:

The following steps are required:

1. Create or open project with Startdrive.
2. Create the device configuration in Startdrive offline
   – Insert the SINAMICS drive into the project and specify it
   – Create and specify SINAMICS components
   – Make detailed settings for drive and components
   – Optional: Configure user administration and make protection settings for the drive
3. Download project data to the target device
4. Establish an online connection between Startdrive and the target device
5. Make basic settings online via the guided quick startup in editing mode
   – Make basic settings in quick startup screen forms
   – Perform optimization

Result:

The motor rotates.

More information

Detailed information can be found in the information system of the TIA Portal in Chapter "Configuring SINAMICS G220 drives".

11.3.4 Basic parameterization together with a SIMATIC controller

Procedure

If you want to commission the SINAMICS drive together with a SIMATIC control system, the optimum sequence for basic parameterization is as follows:

1. Create or open the project with Startdrive
2. Create the device configuration in Startdrive offline
   – Insert the SINAMICS drive into the project and specify it
   – Create and specify SINAMICS components and make detailed settings
   – Insert the SIMATIC controller into the project and specify it
   – Network the SIMATIC controller and drive
   – Optional: Configure user administration and make protection settings for the drive and control
   – Insert a technology object into the SIMATIC controller
   – Interconnect the technology object with the drive
3. Download project data to the target devices
4. Establish an online connection between Startdrive and the target device
5. Make basic settings online via the guided quick startup in editing mode
   – Make basic settings in quick startup screen forms
   – Perform optimization

Result:

The motor rotates.

More information

Detailed information can be found in the information system of the TIA Portal in Chapter "Configuring SINAMICS G220 drives".

11.3.5 Configuring the OM-IIoT option module

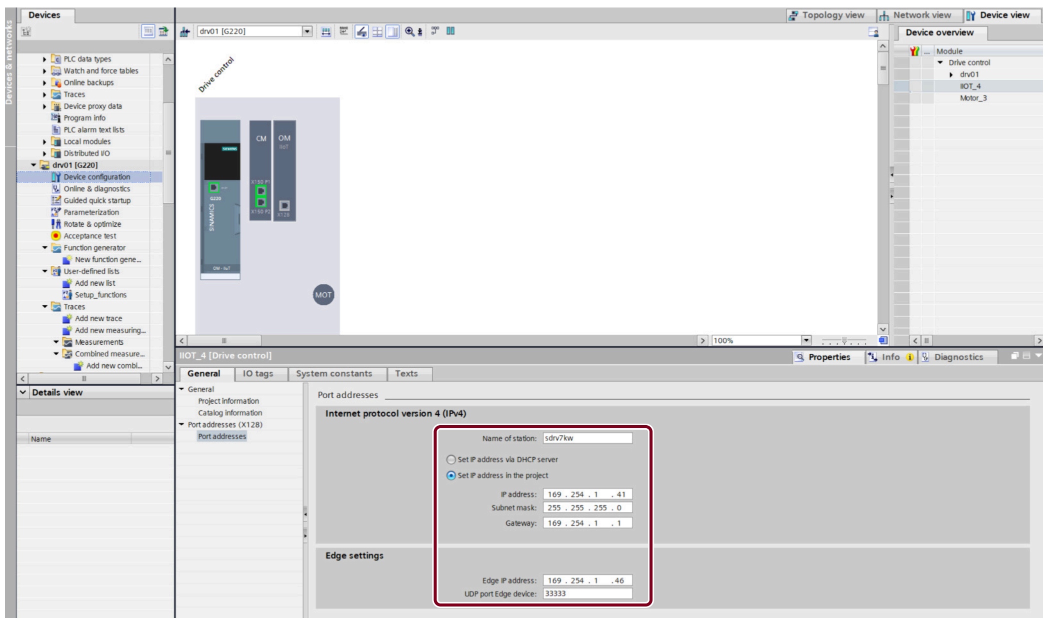
Overview

When configuring option module OM-IIoT, you define the communication between the OM-IIoT and the edge device.

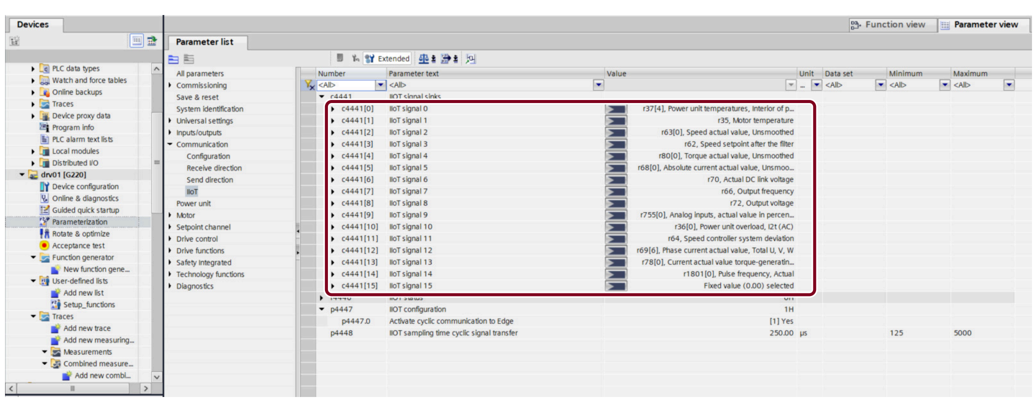
Procedure

Proceed as follows to define the communication between the OM-IIoT and the edge device:

1. Set the following:
   - "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. Interconnect the converter signals that you wish to transfer to the edge device with the OM-IIoT.



11.4 Overview of the guided quick startup

Overview

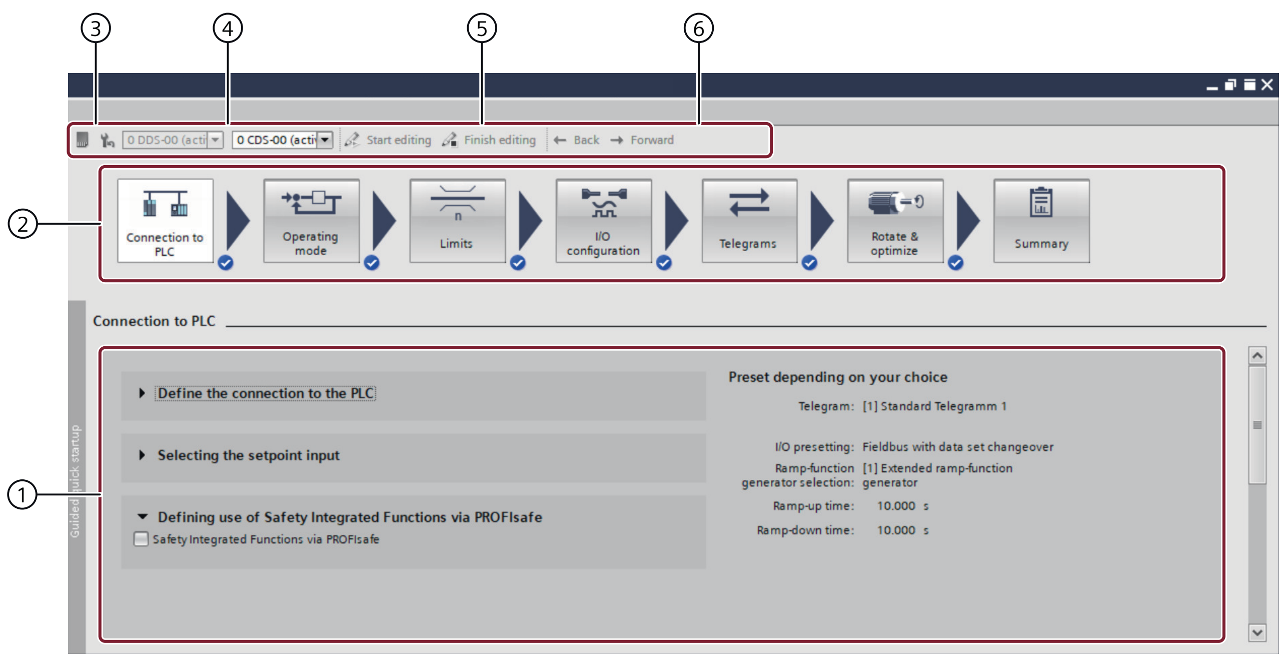
The guided quick startup is a drive commissioning wizard. You can use the wizard to make the basic settings for the drive. It preassigns drive settings for the intended application.

Requirement

You need the following Engineering rights to run the guided quick startup if project protection is activated:

- Edit hardware configuration
- Edit drive applications

Description of function



①	Make detailed settings for the active quick startup area
②	Active quick startup area (highlighted)
③	Icons: store data in a power-independent manner, restore factory setting (each in online mode)
④	Select active data sets (CDS, DDS)
⑤	Icons: Start editing/Finish editing
⑥	Icons: one step forward or back

Figure 11-1 Example: Guided quick startup in offline mode

Settings changed in the quick startup might also apply to other setting areas in the quick startup.

Table 11-1 Status indicators after changes

Icon	Meaning
	The defaults in this setting area are valid.
	The settings in this setting area are valid. The settings were configured in this setting area or in another setting area.
	The program changed the settings in this setting area. Possible causes are: • Settings that are not automatically valid were configured in other setting areas. • The device configuration was changed. The settings in this setting area must be checked and adjusted.

Settings in the quick startup areas might also apply to previously configured settings. Check and adjust the relevant settings.

Table 11-2 Status indicators for deviating settings

Icon[1)]	Meaning
	Shows deviating settings.
	Inputs possible.
	Input required.

1) A note appears when you mouse over.

11.5 Guided quick startup

Requirement

- The drive has been completely created and specified in the device configuration.
  If the drive does not have a complete specification, the guided quick startup cannot be used. A corresponding message appears.
- Access if project protection is activated:
  If project protection is activated, authentication is required.
  The rights required in order to use the guided quick startup are assigned to your user account and activated.
- Use of a controller:
  If a controller is used, it must be connected to the drive in the topology view and network view. The connection between the devices must be configured.
- Optional: The operating unit is physically connected to the drive via a LAN cable.

Description of function

You can define the following basic settings in the setting areas with the same name:

- "Conn. to PLC":
  This setting area determines whether the drive is used with a controller. This also defines the control authority.
- "Operating mode":
  This setting area determines the required control mode of the drive.
- "Limits":
  This setting area determines the minimum and maximum values of the motor used, for example current, speed, run times.
- "I/O configuration":
  Setting area for configuration of the analog or digital inputs and outputs.
- "Telegrams":
  Telegrams are suggested depending on the selected defaults. Telegrams and detailed settings can be specified independently of the suggested telegrams. Settings are only possible offline.
- "Rotate & optimize":
  This setting area determines the basic settings for the motor data identification.
  The basic setting take effect the first time the motor is switched on. Optional: Test the settings in operation.
- "Summary":
  This display area is an overview of all configured settings.
  Optional: If no changes are necessary, transfer the settings directly to the device.

More information

Detailed information about the guided quick startup can be found in the information system of the TIA Portal.

11.6 Security settings

Description

Multi-level security functionality is available for SINAMICS drives in the TIA Portal application "Startdrive".

- Security default settings for the projects
  With the TIA Portal, you make overarching default security settings across the complete project.
- Security settings for the drive
  You make specific protection settings for the selected drive in the Inspector window.
- Security Wizard
  With the help of the wizard, you make the fundamental settings for the drive as soon as it is created in the Startdrive project. The wizard uses important basic settings from the user management system (e.g. roles and rights) for this purpose.

- User Management and Access Control (UMAC):
  With user management, you can activate project protection for Startdrive projects. Further, as an "Administrator" you specify the general roles and rights in user management and manage the individual user accounts. Users can then only access the project in Startdrive by logging in. The drive can also be provided with protection. If the drive is protected, a login is also always required for online access to it. The drive protection (runtime) can also only be deactivated by a complete reset to factory settings using an SD card.
- Secure communication with Trusted Devices
  Connections between the operating unit and drives must be secure. By accepting certificates in secure connections, you classify drives as "Trusted Devices".

More information

You can find more information on the Internet:

Industrial Cybersecurity Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/109810578)

11.7 Differences between offline and online parameterization

Overview

All offline settings and therefore all data relating to parameterization, device configuration and quick startup must be loaded to the converter in order to take effect.

To parameterize commissioning parameters in online mode, the editing mode must be activated. Restore points are created during parameterization. If the online connection to the converter is lost and a new connection is established, editing can continue from the most recently backed-up parameterization status.

Safety Integrated Functions

In the offline and online modes, Safety Integrated Functions can only be configured if the edit mode is activated.

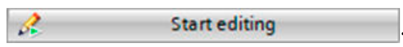
After completion of offline editing, the configuration can be loaded into the converter and executed without any further postprocessing.

Requirement

- The drive has been completely created and specified in the device configuration.
- For the online parameterization:
  There is an active online connection between the converter and the operating unit.

- Activate editing:
  Only possible if access is exclusively via the currently connected operating unit.
  Editing cannot be activated if the converter is being simultaneously accessed by multiple operating units via Startdrive or the web server. The converter indicates that other accesses are active and refuses to activate editing.
- Access if project protection is activated:
  If project protection is activated, authentication is required.
  The rights required for editing are assigned to your user account and activated.

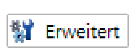
Activate/finish editing

Display	Description
	Editing mode is not activated. Start editing with .
	Editing mode is activated. Finish editing with . **Note** When editing finishes, a new restore point is created automatically. The current configuration is stored in a power-independent manner.

11.8 Extended parameterization

Description

In the function and parameter view, the scope of the displayed functions can be toggled between "Standard" and "Extended".

- Clicking  displays the extended functions.
- Clicking  reduces the scope of the functions to the standard functions.

Certain defaults, such as operating mode and motor, affect the display of extended functions.

Functions displayed in both the "Standard" and the "Extended" view may differ in terms of the scope of parameterization options.

Toggling between "Standard" and "Extended" has an effect within the setting areas of the "Parameterization" function view.

Note

Call functions from the Inspector window

Functions can also be called from the individual setting or display areas in the Inspector window. If the function is an extended function, such as encoder evaluation, the function is displayed in the function view. The secondary navigation in the function is extended automatically.

Series commissioning 12

12.1 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

12.2 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 an empty SD card with a maximum capacity of 32 GB (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. Switch off the supply voltage of converter 2.
12. Remove the memory card from converter 2.

Repeat steps 8 to 12 for all additional converters to which you wish to transfer these settings.

12.3 Series commissioning using the web server

Overview

For "Series commissioning using the web server" transfer the settings of converter 1 using the web server to converter 2 or to additional converters.

Procedure

Proceed as follows to perform series commissioning using the web server:

1. Switch on the supply voltage of converter 1.
2. Commission the converter using your operating unit, e.g. a PC.
   You can find more information in Chapter "Commissioning (web server) (Page 211)".
3. Save the settings retentively once commissioning has been completed via .
4. Call the "Backup and restore" menu.
5. Click the "Create backup" button in the "Save drive data to backup file" area.
   Optional: Assign a name for the backup file.
   The drive data are backed up in the backup file in the download folder of your operating unit.
6. Switch on the supply voltage of converter 2.

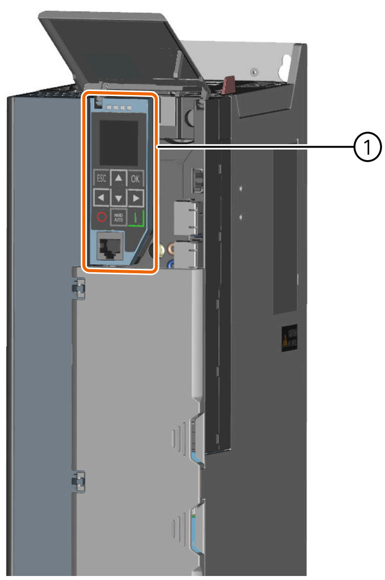
7. In the web browser, enter the IP address of the converter 2, e.g. https://169.254.11.22.
   You determine the IP address of the converter 2, e.g. using the integrated SINAMICS SDI Standard. You can find more information in Chapter "Scanning the IP address (Page 311)".
   The web server of converter 2 displays page "Basic settings".
8. Make the basic settings for converter 2.
   You can find more information in Chapter "Basic settings (Page 215)".
9. In the Security Wizard, select option "Exit the Security Wizard and continue with low security settings".
10. Call the "Backup and restore" menu.
11. Click the "Click to select file, or drag and drop file here" button to select the backup file.
12. Click on "Restore".
    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 6 to 12 for all additional converters to which you wish to transfer the settings of converter 1.

Operation and monitoring with SINAMICS SDI Standard 13

13.1 SINAMICS SDI Standard, converter in degree of protection IP20

Description



① SINAMICS SDI Standard

Figure 13-1 SINAMICS SDI Standard

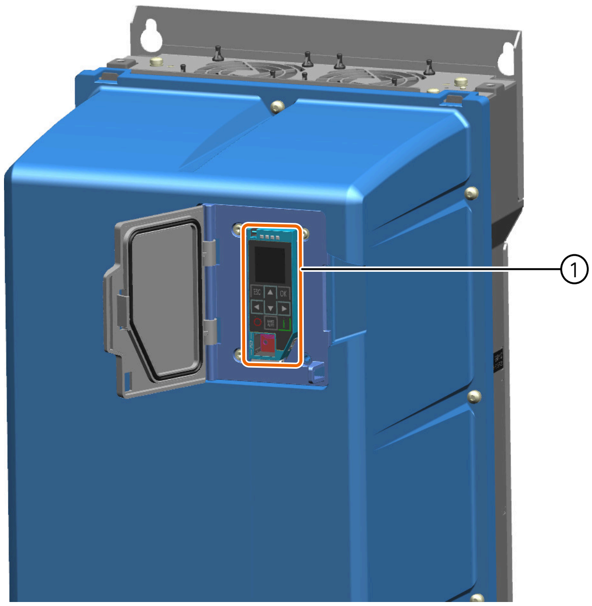
The SINAMICS SDI operator panel (Smart Drive Interface) Standard is located behind the front flap of the converter.

13.2 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 13-2 SINAMICS SDI Standard

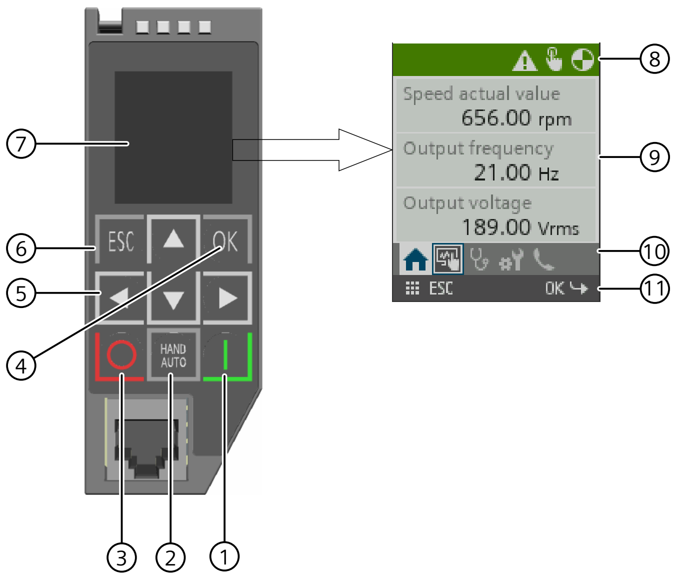
The SINAMICS SDI operator panel (Smart Drive Interface) Standard is located behind the front door of the converter.

13.3 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		Home page	
①	ON	⑧	Status bar
②	MANUAL/AUTO	⑨	Content area
③	OFF	⑩	Navigation bar
④	OK	⑪	Footer
⑤	Arrow keys		
⑥	ESC		
⑦	Display		

Figure 13-3 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.

13.4 Icons

13.4.1 Navigation bar

Description

The following table shows the navigation bar icons.

Table 13-1 Navigation bar icons

Icons	Description
	Start screen
	Operator control and monitoring
	Diagnostics
	System
	Support

13.4.2 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 13-2 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 13-3 Examples of actions

Icons	Description
ESC	Briefly press ESC key → focus change to navigation bar
ESC 2s	• 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
OK	Press "OK" key → confirm selection
OK	Press "OK" key → edit selection
OK	Press "OK" key → navigate to next level down

The icons in the footer are shown with different background colors.

Table 13-4 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

13.4.3 Status bar

Description

The following table shows selected status bar icons.

Table 13-5 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 13-6 Status bar background color

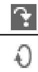
Color	Description	
Green	Converter is ready for operation.	Motor is running or ready for operation.
gray	Converter is not ready for operation. Cause: Missing control signals in the converter sequential control are preventing the motor from starting.	The motor is not running or cannot be started.
Red	Converter is not ready for operation. Cause: Fault present	The motor is not running or cannot be started. Exception: ESM is active and fault occurs. In this case, the motor is running.

13.4.4 Content area

Description

The following table shows selected content area icons.

Table 13-7 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 13-8 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.

13.5 Functions

13.5.1 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

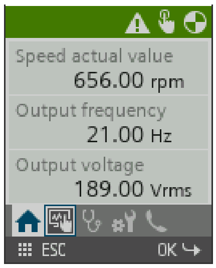


Figure 13-4 Start screen

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.

13.5.2 "Diagnostics" menu

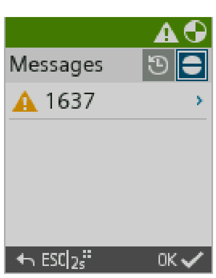
13.5.2.1 Displaying faults and alarms

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 13-5 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.

13.5.3 "Operation and monitoring" menu

13.5.3.1 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

13.5.3.2 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 13-6 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.

13.5.3.3 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

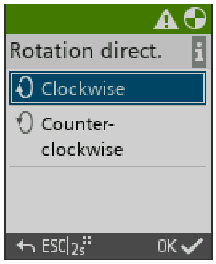


Figure 13-7 Changing the direction of rotation of the motor

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

13.5.4 "System" menu

13.5.4.1 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:

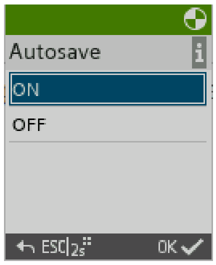


Figure 13-8 Saving changes

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.

13.5.4.2 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 "Communication interfaces (Page 213)".

Procedure

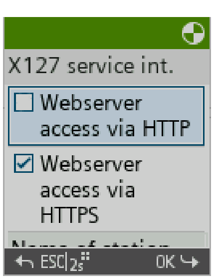


Figure 13-9 Interface information about service interface X127

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.

13.5.4.3 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

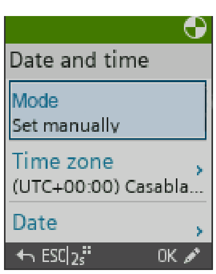


Figure 13-10 Changing the date and time

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.

13.5.4.4 Setting the display

Overview

You change the following settings in the "System" menu > "Settings" menu item > "Display":

- Lighting dur.
- Brightness

Procedure

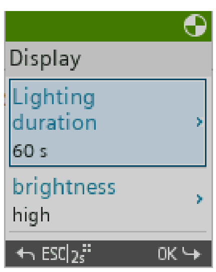


Figure 13-11 Changing the display settings

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.

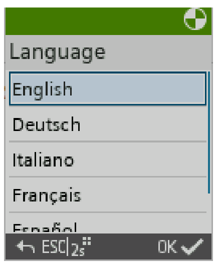
13.5.4.5 Change language

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.

13.5.5 "Support" menu

13.5.5.1 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 13-12 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.

13.5.5.2 Retrieving component information with a code scanner app

Overview

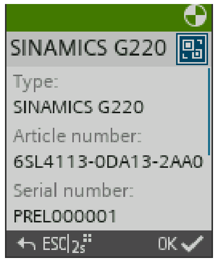
A component-specific QR code is provided in menu "Support" > "Component".

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.

Functions

14

14.1 Overview of converter functions

Overview

The converter has the following range of functions:

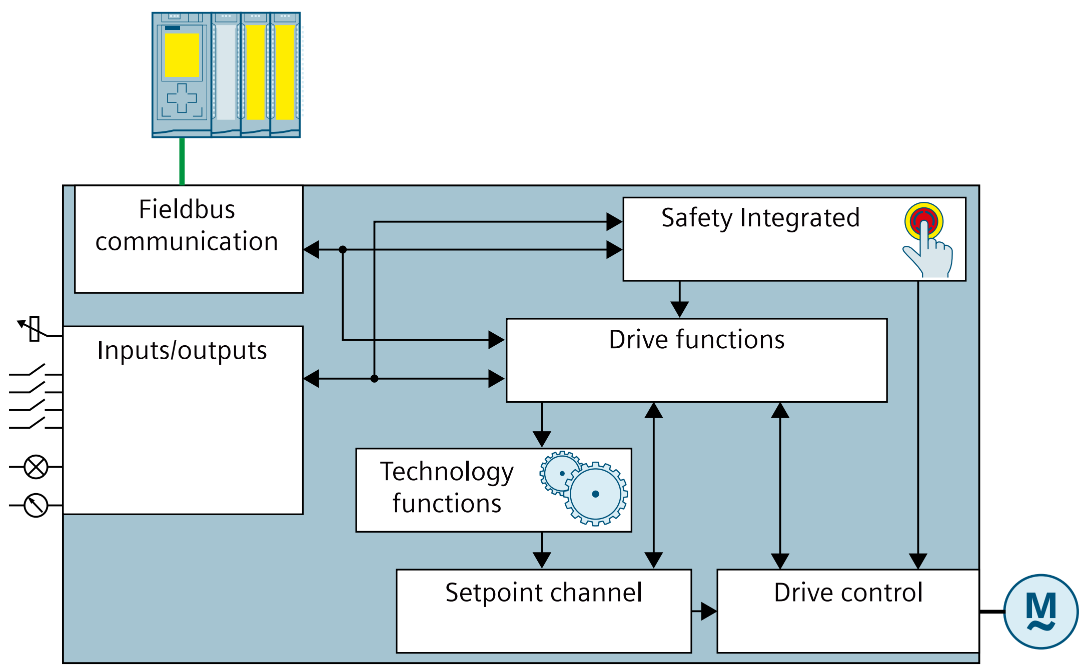


Figure 14-1 Converter functions

Description of function

Inputs/outputs

- Adapt terminal strip signals
- Interconnect terminal strip signals with drive functions

Fieldbus communication

- Telegram configuration
- Acyclic communication
- PROFIenergy

Setpoint channel

- Setpoints
- Jog
- Motorized potentiometer
- Speed limitation
- Acceleration limitation

Drive control

- Select the operating mode or motor control
- Optimize the motor efficiency

Drive functions

- Sequence control when switching the motor on and off
- Controlling clockwise and counter-clockwise rotation via digital inputs
- Line contactor
- Motor holding brake
- Messages and monitoring

Safety Integrated

- Monitor the motor speed
- Stop the motor

Technology functions

- PID technology controller
- Bypass

14.2 Brief description of the parameters

Overview

The brief parameter description provides the most important information for all of the parameters that are assigned to a certain converter function.

Description of function

The parameters are classified as follows:

- Adjustable parameters p
- Display parameters r
- Interconnection parameters c

The parameter number is made up of a "p", "r" or "c", followed by the four-digit parameter number, and optionally the specification of an index or bit.

p/r/cxxxx**[x...x]**	Parameters with indices
p/r/cxxx.**x...x**	Parameters with bit array
p/r/cxxxx**[x].x**	Parameter with index and bit

Table 14-1 Examples of parameter descriptions

Parameters	**Description**
p - adjustable parameters (read and write)	
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)
p1070[1]	Adjustable parameter 1070, index 1
p0795.4	Adjustable parameter 795, bit 4
r- display parameters (read only)	
r0020	Display parameter 20
r0052.0...15	Display parameter 52 with bit array from bit 0 (lowest bit) to bit 15 (highest bit)
p2089[1].3	Display parameter 2089, index 1, bit 3
c - interconnection parameters	
c0840[0]	Interconnection parameter 840, index 0

14.3 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.

Description of function

A converter function comprises one or several subfunctions that are interconnected with one another.

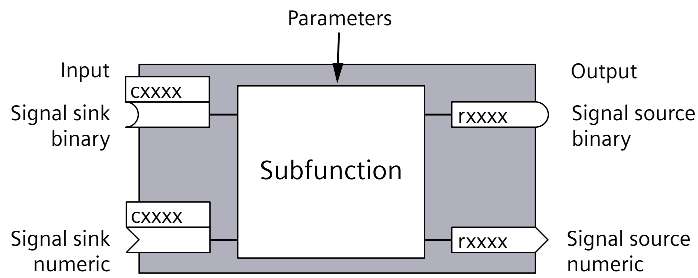


Figure 14-2 An interconnectable subfunction

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 14-2 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 analog signal	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.

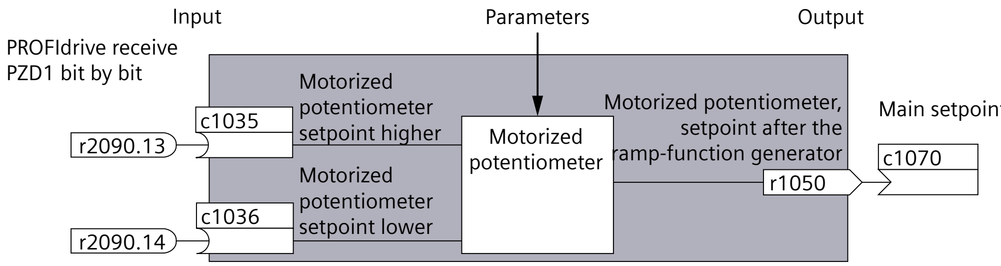


Figure 14-3 Example: Signal interconnection of the "Motorized potentiometer" converter function

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.

14.4 PROFINET communication

14.4.1 PROFINET IO fieldbus

Overview

You can integrate the converter into a PROFINET network.

Requirement

Requirements:

- Converter with Ethernet interface X150
- To integrate the converter into a PROFINET network you require the TIA Portal with the current Startdrive version or for third-party control systems, the GSDML file of the converter.
- The PN topology is configured in the controller to replace the device without removable data storage medium.

Description of function

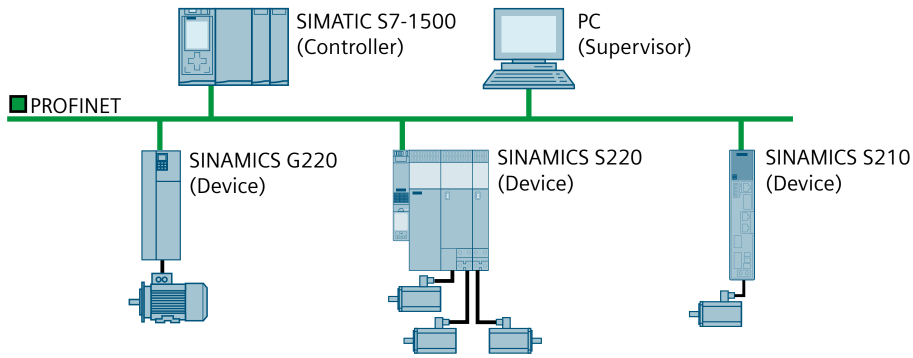


Figure 14-4 The converter in PROFINET IO operation (examples)

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 Planned Duplication): Media redundancy, bumpless.
- Shared device: Two different control systems access the converter in parallel 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 IO 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)

14.4.2 PROFINET protocols

14.4.2.1 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 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 14-3 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 0x8892 (PROFINET)	**Accessible stations, PROFINET Discovery and Configuration** DCP detects PROFINET devices and enables basic settings. DCP uses the special multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
LLDP: Link Layer Discovery Protocol	not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x88CC (PROFINET)	**PROFINET Link Layer Discovery Protocol** 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 0x88E3 (PROFINET)	**PROFINET media redundancy** 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 0x8892 (PROFINET)	**PROFINET send clock and time synchronization, based on IEEE 1588** PTCP enables the send clock synchronization and time synchronization between RJ45 ports required for IRT operation. PTCP uses the special Multicast MAC address: xx-xx-xx-01-0E-CF, xx-xx-xx = Organizationally Unique Identifier
PROFINET IO data	not relevant	(2) Ethernet II and IEEE 802.1Q and Ethertype 0x8892 (PROFINET)	**PROFINET cyclic IO data transfer** The PROFINET IO telegrams transfer process data cyclically between the PROFINET IO controller and IO devices via Ethernet.
PROFINET Context Manager	34964	(4) UDP	**PROFINET connection less RPC** The PROFINET Context Manager provides an endpoint mapper in order to establish an application relationship (PROFINET AR).

14.4.2.2 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.

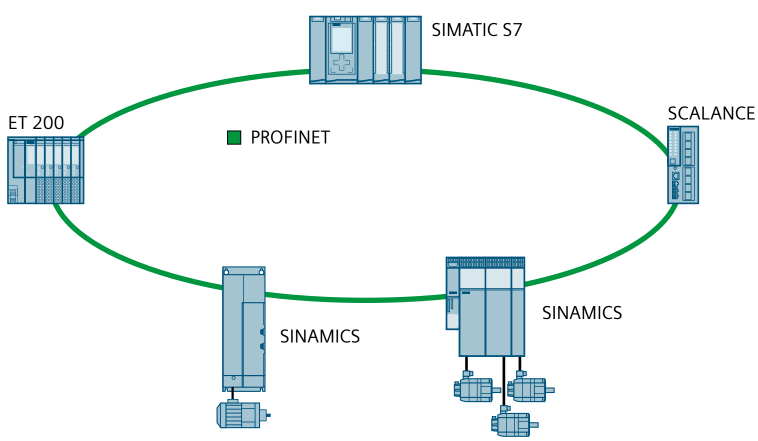
MRP can be expanded to MRPD (Media Redundancy with Planned Duplication of frames).

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.

Description of function



SIMATIC S7	PROFINET controller
ET 200	Distributed I/O
SINAMICS	Converter
SCALANCE	Redundancy manager

Figure 14-5 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) as the system switches over to the redundant data path.

2 alternatives are available if a brief interruption is not permitted:

- The watchdog timer in the hardware configuration is > 200 ms.
- IRT High Performance data transfer is set.

14.4.2.3 Connection-oriented communication protocols

Overview

The converter supports connection-oriented communication protocols.

Connection-oriented communication ensures that data arrives in the correct order.

Description of function

Table 14-4 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. Is closed when delivered, and is opened when selecting the DHCP mode.
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 devices of other suppliers. Communication with engineering system, human machine interface, etc. Is activated 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 open in the as-supplied state 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.

14.4.3 Shared device

Overview

The converter supports the PROFINET Shared Device.

PROFINET Shared Device improves network performance or allows the project to be distributed, e.g. into one standard project and one safety project.

Requirement

PROFINET Shared Device is only possible when using a safety control (F-CPU).

Description of function

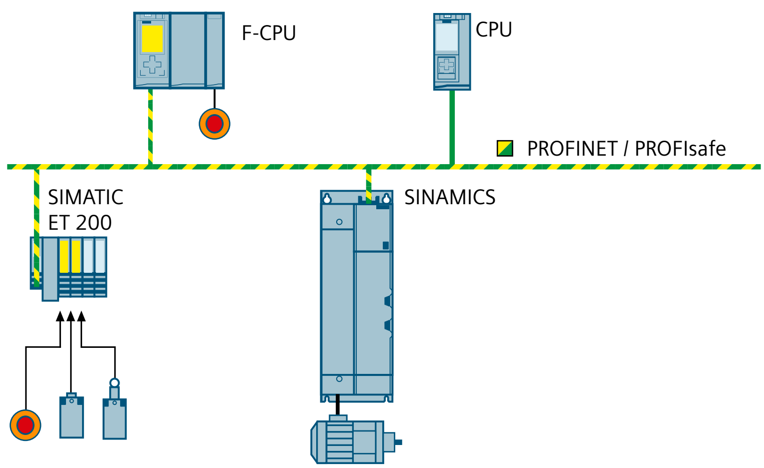


Figure 14-6 Shared device

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.

14.4.4 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.

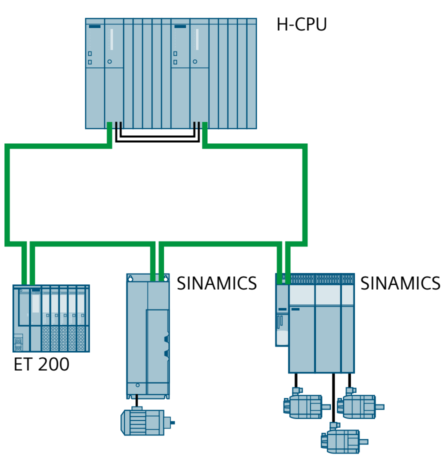
Requirement

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
- For the configuration in the TIA Portal, the data length information for the variables is as follows:
  Maximum input data length according to the device master data for variable MaxInputLength = 100 bytes.
  Maximum output data length according to the device master data for variable MaxOutputLength = 100 bytes.
  Maximum total data length according to the device master data for variable MaxDataLength = 200 bytes.
- System redundancy can only be configured with GSD.

Description of function



H-CPU	A high-availability (fault-tolerant) control system comprising two synchronized controllers
ET 200	Distributed I/O
SINAMICS	Converter

Figure 14-7 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 has only one PROFINET interface to connect with a single network.
- 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.

14.4.5 Diagnostics with PROFINET

Overview

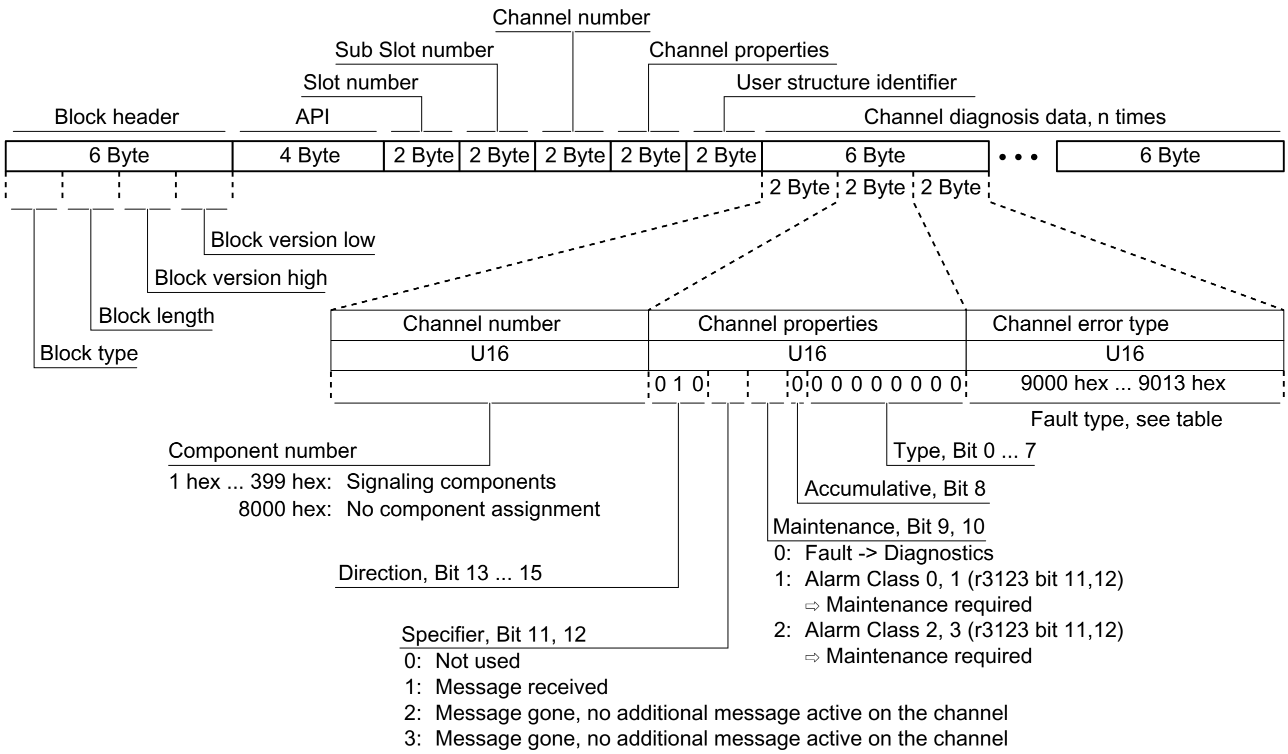
The converter provides the diagnostics standardized for PROFINET. This means that faults and alarms with a component assignment can be output directly to an HMI via the PROFINET controller.

Description of function

The fault and alarm messages are saved in the converter in parameters.

The converter transfers the messages in the sequence in which they occurred. The control generates the time stamp when the messages are received.

PROFINET uses channel diagnostics to transfer the PROFIdrive message classes.



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 module 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 14-8 Structure of the channel diagnostics

To read out the diagnostics data, the control requests the diagnostics data from the converter via "Read data set", e.g. using a read record with index 800C hex.

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	

14.4.6 PROFIenergy

14.4.6.1 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.

14.4.6.2 Energy-saving mode 2

Overview

The converter supports hibernation mode 2.

Description of function

The converter exhibits the following behavior when hibernation 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 hibernation mode 2.
- When transitioning into hibernation mode 2, the converter can control or switch-off other devices. 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.
- The bus connection to the higher-level control is interrupted.

Parameters

The following list contains the parameters of the "Energy-saving mode" function.

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	

14.4.6.3 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 14-5 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).
	p5611.1 = 0	You use p5614 to interconnect a signal source that you use to switch off the converter and place it in switching on inhibited state (S1).

14.4.6.4 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 14-6 Control commands energy-saving mode

Command	Explanation
Start_Pause	Switches to energy-saving mode depending on the pause duration
Start_Pause_with_time_re-sponse	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

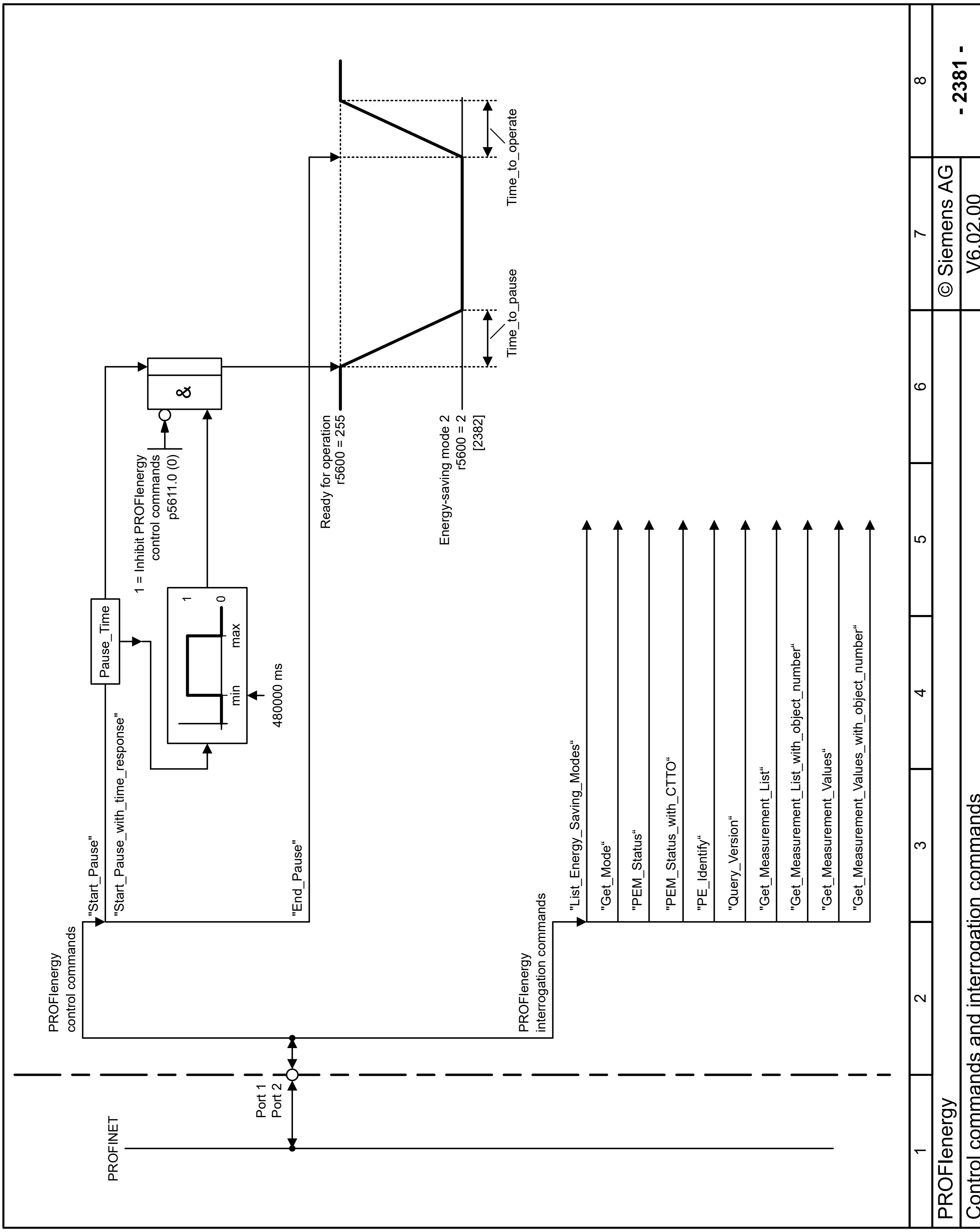


Figure 14-9 2381 - Control commands and interrogation commands

14.4.6.5 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 14-7 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_Measurement_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_Values_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 14-8 Measured values

<table>
<tr><th colspan="4">PROFIenergy</th><th rowspan="3">Unit</th><th colspan="2" rowspan="2">SINAMICS source parameters</th><th rowspan="3">Value range</th></tr>
<tr><th colspan="2">Measured value</th><th colspan="2">Accuracy</th></tr>
<tr><th>ID</th><th>Name</th><th>Domain</th><th>Class</th><th>Number</th><th>Name</th></tr>
<tr><td>34</td><td>Active power</td><td>1</td><td>12</td><td>W</td><td>r0032</td><td>Active power smoothed</td><td>r2004</td></tr>
<tr><td>166</td><td>Power factor</td><td>1</td><td>12</td><td>1</td><td>r0038</td><td>Smoothed power factor</td><td>0 ... 1</td></tr>
<tr><td>200</td><td>Active energy import</td><td>2</td><td>11</td><td>Wh</td><td>r0039[1]</td><td>Energy accepted</td><td>-</td></tr>
</table>

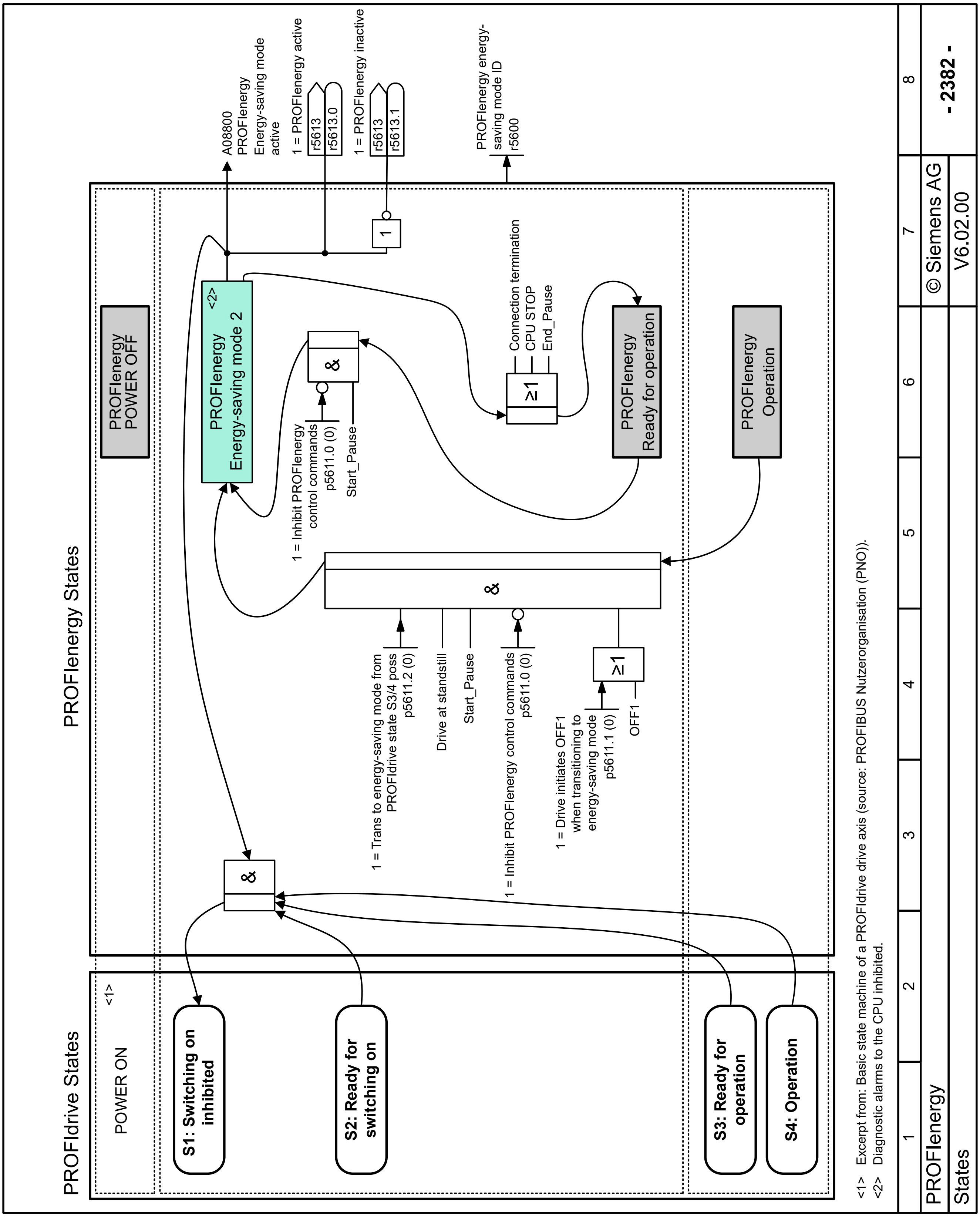


Figure 14-10 2382 - States

14.4.6.6 Error values

Overview

The converter responds to invalid PROFIenergy commands with an error value.

Description of function

Table 14-9 Error value in the parameter response

Error value 1	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

14.4.7 PROFIdrive telegrams

14.4.7.1 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.

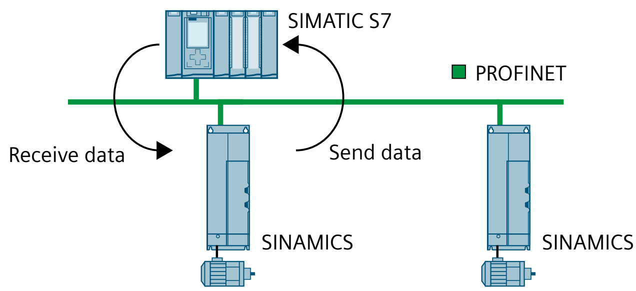


Figure 14-11 Cyclic data exchange

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.

14.4.7.2 Telegram 1

Overview

The telegram is suitable for closed-loop speed control of a drive.

Description of function

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

14.4.7.3 Telegram 2

Overview

The telegram is suitable for closed-loop speed control of a drive.

Description of function

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

14.4.7.4 Telegram 3

Overview

The telegram is suitable for closed-loop speed control of a drive and the control of 1 position encoder.

Description of function

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	---			

14.4.7.5 Telegram 4

Overview

The telegram is suitable for closed-loop speed control of a drive and the control of 2 position encoders.

Description of function

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
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	---			

14.4.7.6 Telegram 20

Overview

The telegram is suitable for closed-loop speed control of a drive according to the specification of the process industry (VIK-NAMUR).

Description of function

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

14.4.7.7 Telegram 102

Overview

The telegram is suitable for closed-loop speed control of a drive and the control of 1 position encoder.

Description of function

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
PZD07	---	Not assigned	G1_XIST1	Position actual value 1 from encoder 1
PZD08	---			
PZD09	---		G1_XIST2	Position actual value 2 from encoder 1
PZD10	---			

14.4.7.8 Telegram 103

Overview

The telegram is suitable for closed-loop speed control of a drive and the control of 2 position encoders.

Description of function

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

Process data	Telegram 103			
	Control → Converter		Converter → Control	
	Signal	Explanation	Signal	Explanation
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	---			

14.4.7.9 Telegram 352

Overview

The telegram can be used to communicate with a PCS7 process control system.

Description of function

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

14.4.7.10 Telegram 700

Overview

Supplementary telegram 700 transfers the status of Safety Integrated Functions to the higher-level control, independently of PROFIsafe.

Description of function

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	---			

The Safety Info Channel enables the higher-level control to react promptly to the selection of a Safety Integrated Function.

Transfer of telegram 700 is not failsafe. A PROFIsafe telegram is required for failsafe transfer.

14.4.7.11 Telegram 750

Overview

Supplementary telegram 750 is suitable for controlling the drive torque, e.g. for the electronic counterweight of a vertical axis.

Function description

Process data	Telegram 750			
	Control system → Converter		Converter → Control system	
	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	---	

14.4.7.12 Telegram 999

Overview

The telegram length and the assignment can be freely configured.

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 system → Converter		Converter → Control system	
	Signal	Explanation	Signal	Explanation
PZD01	STW1	Control word 1	ZSW1	Status word 1
PZD02	...	Freely assignable	...	Freely assignable
PZD03	...		...	
. . .				
PZD31	...		...	
PZD32	...		...	

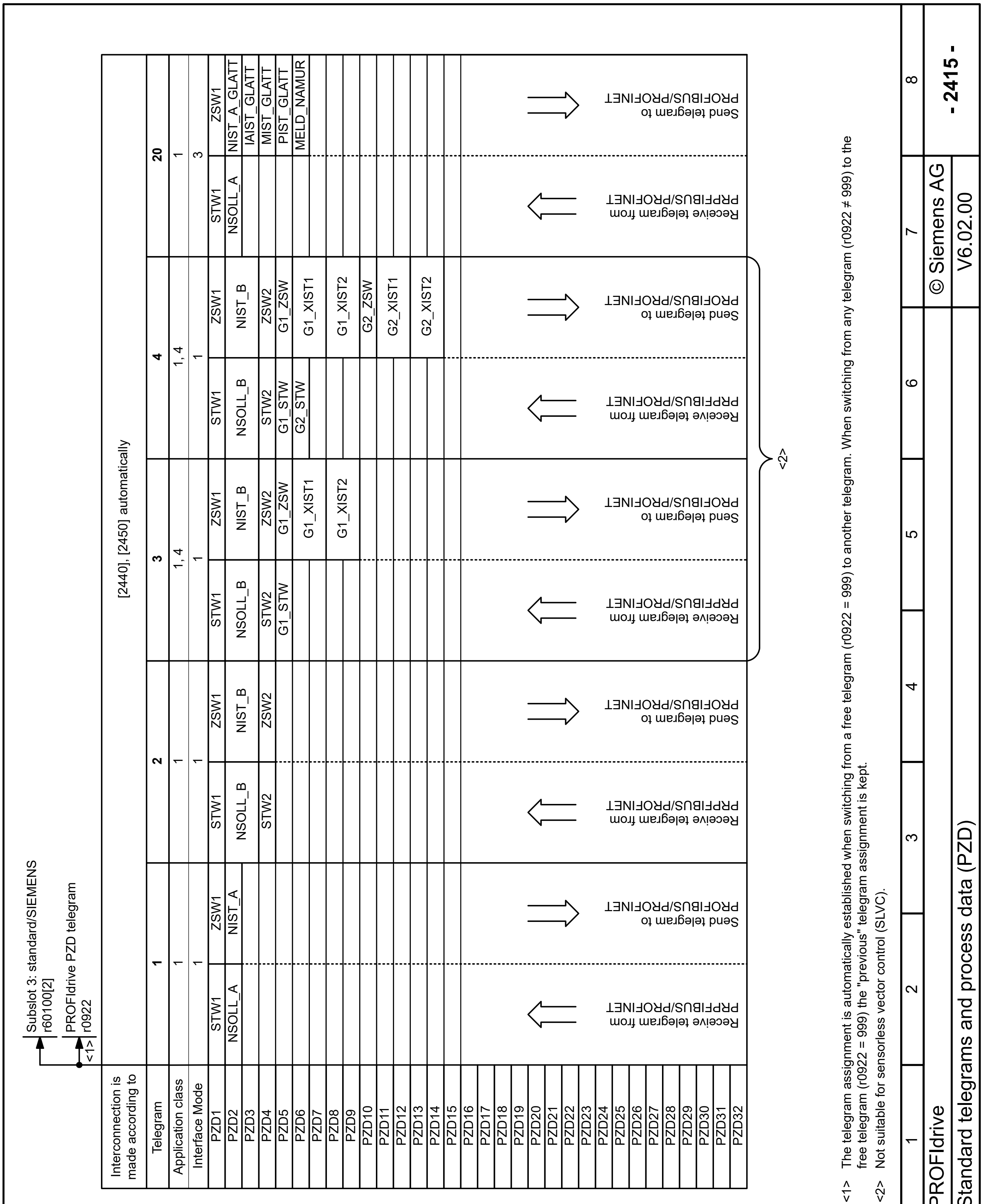
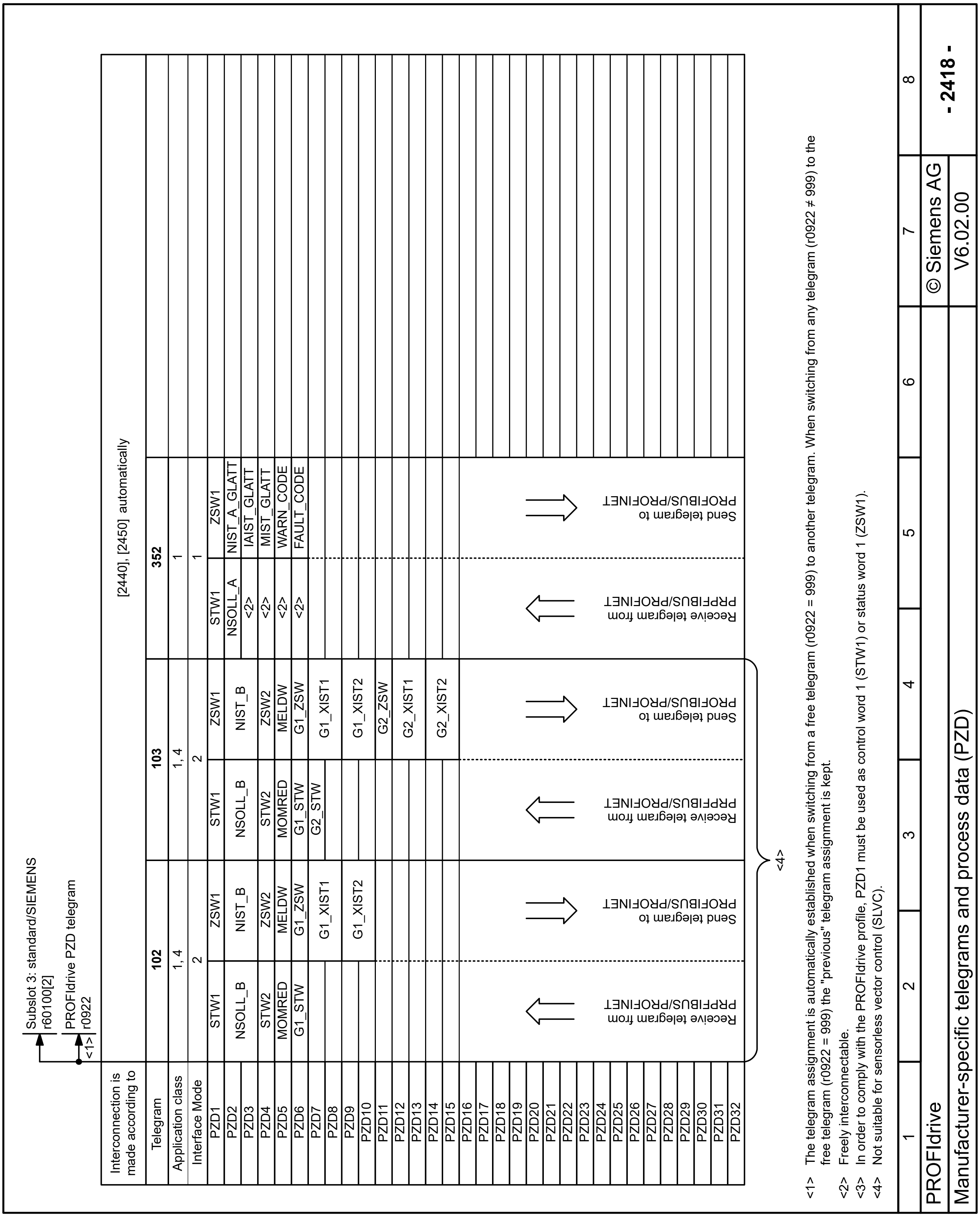


Figure 14-12 2415 - Standard telegrams and process data (PZD)



Interconnection is made according to	[2440], [2450] automatically					
Telegram	**102**		**103**		**352**	
Application class	1, 4		1, 4		1	
Interface Mode	2		2		1	
PZD1	STW1	ZSW1	STW1	ZSW1	STW1	ZSW1
PZD2	NSOLL_B	NIST_B	NSOLL_B	NIST_B	NSOLL_A	NIST_A_GLATT
PZD3					<2>	IAIST_GLATT
PZD4	STW2	ZSW2	STW2	ZSW2	<2>	MIST_GLATT
PZD5	MOMRED	MELDW	MOMRED	MELDW	<2>	WARN_CODE
PZD6	G1_STW	G1_ZSW	G1_STW	G1_ZSW	<2>	FAULT_CODE
PZD7		G1_XIST1	G2_STW	G1_XIST1		
PZD8						
PZD9		G1_XIST2		G1_XIST2		
PZD10						
PZD11				G2_ZSW		
PZD12				G2_XIST1		
PZD13						
PZD14				G2_XIST2		
PZD15						
PZD16						
PZD17						
PZD18						
PZD19						
PZD20						
PZD21						
PZD22						
PZD23						
PZD24						
PZD25						
PZD26						
PZD27						
PZD28						
PZD29						
PZD30						
PZD31						
PZD32						

<1> The telegram assignment is automatically established when switching from a free telegram (r0922 = 999) to another telegram. When switching from any telegram (r0922 ≠ 999) to the free telegram (r0922 = 999) the "previous" telegram assignment is kept.

<2> Freely interconnectable.

<3> In order to comply with the PROFIdrive profile, PZD1 must be used as control word 1 (STW1) or status word 1 (ZSW1).

<4> Not suitable for sensorless vector control (SLVC).

Figure 14-13 2418 – Manufacturer-specific telegrams and process data (PZD)

14.4.7.13 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.

Description of function

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 "Ready" state. If, in addition, bit 3 = 1, the converter switches on the motor.
01	0 = OFF2	Switch off motor immediately, the motor then coasts down.
	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 (suppress 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.
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 "closing lockout" state.

<table>
<tr><th colspan="5">Control word 1 (STW1)</th></tr>
<tr><th colspan="5">Control → Converter</th></tr>
<tr><th>Bit</th><th colspan="3">Drive function</th><th>Explanation</th></tr>
<tr><td>08</td><td colspan="4">Reserved</td></tr>
<tr><td>09</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">10</td><td colspan="3">0 = No control by PLC</td><td>Converter ignores the process data from the fieldbus.</td></tr>
<tr><td colspan="3">1 = Control by PLC</td><td>Control via fieldbus, converter accepts the process data from the fieldbus.</td></tr>
<tr><td>11</td><td colspan="3">1 = Direction reversal</td><td>Invert setpoint in the converter.</td></tr>
<tr><td rowspan="2">12</td><td>Telegrams 102, 103</td><td colspan="2">All other telegrams</td><td rowspan="2"></td></tr>
<tr><td>1 = Unconditionally release holding brake</td><td colspan="2">Reserved</td></tr>
<tr><td rowspan="2">13</td><td colspan="2">Telegrams 20, 102, 103</td><td>All other telegrams</td><td rowspan="2">Increase the setpoint saved in the motorized potentiometer.</td></tr>
<tr><td colspan="2">Reserved</td><td>1 = MOP raise</td></tr>
<tr><td rowspan="2">14</td><td>Telegrams 102, 103</td><td>Telegram 20</td><td>All other telegrams</td><td rowspan="2">Reduce the setpoint saved in the motorized potentiometer.</td></tr>
<tr><td>1 = Torque control active
0 = Closed-loop speed control active</td><td>---</td><td>1 = MOP lower</td></tr>
<tr><td>15</td><td>Reserved</td><td>CDS bit 0</td><td>Reserved</td><td>Changeover between settings for different operation interfaces (command data sets).</td></tr>
</table>

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.
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 acknowledgement is necessary.

<table>
<tr><th colspan="5">Status word 1 (ZSW1)</th></tr>
<tr><th colspan="5">Converter → Control</th></tr>
<tr><th>Bit</th><th colspan="3">Status</th><th>Explanation</th></tr>
<tr><td>08</td><td colspan="3">1 = Speed deviation within the tolerance range</td><td>Setpoint/actual value deviation within the tolerance range.</td></tr>
<tr><td>09</td><td colspan="3">1 = Control request</td><td>The automation system has been reques-ted to take over control of the converter.</td></tr>
<tr><td>10</td><td colspan="3">1 = Comparison speed reached or exceeded</td><td>Speed is greater than or equal to the cor-responding maximum speed.</td></tr>
<tr><td rowspan="2">11</td><td>Telegrams 102, 103</td><td>Telegram 20</td><td>All other tele-grams</td><td rowspan="2">Comparison value for current or torque has been reached or exceeded.</td></tr>
<tr><td>1 = Alarm class bit 0</td><td>1 = Current or torque limit reached</td><td>1 = Torque limit reached</td></tr>
<tr><td>12</td><td>1 = Alarm class bit 1</td><td>---</td><td>1 = Holding brake open</td><td>Signal for opening and closing a motor holding brake.</td></tr>
<tr><td rowspan="2">13</td><td>Telegrams 102, 103</td><td colspan="2">All other telegrams</td><td rowspan="2">--</td></tr>
<tr><td>Reserved</td><td colspan="2">0 = Alarm motor overtemperature</td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">1 = Torque con-trol active</td><td colspan="2">1 = Motor rotates clockwise</td><td>Converter-internal actual value > 0.</td></tr>
<tr><td colspan="2">0 = Motor rotates counter-clockwise</td><td>Converter-internal actual value < 0</td></tr>
<tr><td rowspan="2">15</td><td>Telegrams 102, 103</td><td>Telegram 20</td><td>All other tele-grams</td><td rowspan="2"></td></tr>
<tr><td>Reserved</td><td>1 = CDS display</td><td>0 = Alarm con-verter thermal overload</td></tr>
</table>

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 setpoint raise	
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

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STW1 control word interconnection in Interface Mode 3 (VIK/NAMUR) — V6.02.00

Figure 14-14 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, 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

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STW1 control word interconnection in Interface Mode 1 — V6.02.00

Figure 14-15 2442 - control word interconnection via Interface Mode 1

Signal sources for ZSW1 in Interface Mode 3 (VIK-NAMUR) <1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control 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	c2053[0].11 = r0052.11	[2510.7]	-
ZSW1.12	Reserved	-	-	-
ZSW1.13	1 = No motor overtemperature alarm	c2053[0].13 = r2135.6	[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 = Display CDS	c2053[0].15 = r0836.0 <4>	-	-

<1> Used in telegram 20.
<2> The ZSW1 is generated using c2053[0].0...15.
<3> The drive is ready to accept data.
<4> Interconnection is not disabled.

1	2	3	4	5	6	7	8
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ZSW1 status word interconnection in Interface Mode 3 (VIK-NAMUR)						V6.02.00	

Figure 14-16 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 control 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	c2053[0].11 = r0052.11	[2510.7]	-
ZSW1.12	1 = Open holding brake	c2053[0].12 = r0899.12	[2503.7]	[2701]
ZSW1.13	1 = No motor overtemperature alarm	c2053[0].13 = r2135.6	[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	c2053[0].15 = r2135.7	[2549.7]	[8021]

<1> Used in telegram 1, 2, 3, 4, 352.
<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

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ZSW1 status word interconnection in Interface Mode 1 — V6.02.00 — - 2452 -

Figure 14-17 2452 – ZSW1 status word interconnection in Interface Mode 1

14.4.7.14 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.

Description of function

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 and 4	Telegrams 102 and 103
	1 = Drive data set selection DDS bit 3	Reserved
04, 05	Reserved	
06	Telegrams 2, 3 and 4	Telegrams 102 and 103
	Reserved	1 = Integrator disable speed controller
07	1 = Parking axis selection	
08	1 = Travel to fixed stop	
09	Telegrams 2, 3 and 4	Telegrams 102 and 103
	Reserved	1 = Drive data set selection DDS bit 3
10	Reserved	
11	Positive edge = motor changeover feedback	
12 … 15	Reserved	

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 and 4	Telegrams 110 and 111
	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
07	1 = Parking axis active	
08	1 = Travel to fixed stop active	

Status word 2 (ZSW2)		
Converter → Control		
Bit	**Status**	
09	Telegrams 2, 3 and 4	Telegrams 110 and 111
	Reserved	1 = Drive data set DDS effective bit 3
10	1 = Pulses enabled	Reserved
11	1 = Motor changeover active	
12 ... 15	Reserved	

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	PB/PN clock synchronous 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

<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	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	Master sign-of-life, bit 0	c2045 = r2050[3]	-	-
STW2.13	Master sign-of-life, bit 1			
STW2.14	Master sign-of-life, bit 2			
STW2.15	Master sign-of-life, bit 3			

<1> Used in telegram 1, 2, 3, 4, 352.

1	2	3	4	5	6	7	8

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STW2 control word interconnection in Interface Mode 1 | V6.02.00

Figure 14-18 2444 – STW2 control word interconnection in Interface Mode 1

Signal sources for ZSW2 in Interface Mode 1

<1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control 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 1, 2, 3, 4, 352.
<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

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ZSW2 status word interconnection in Interface Mode 1	V6.02.00	

Figure 14-19 2454 – ZSW2 status word interconnection in Interface Mode 1

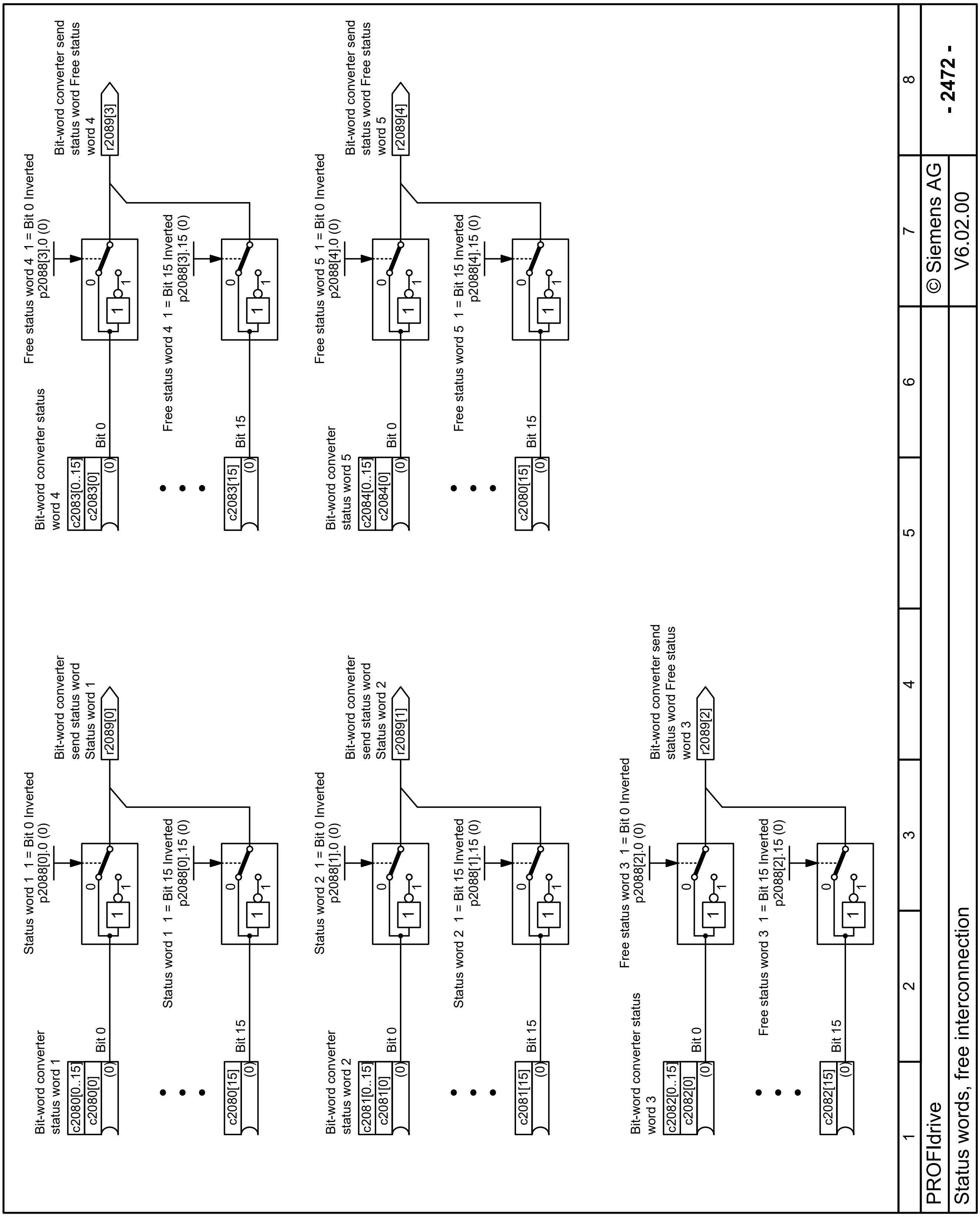

Figure 14-20 2472 - Status words free interconnection

14.4.7.15 Message word

Overview

The message word (MELDW) signals the converter status to the higher-level control system.

Description of function

<table>
<tr><th colspan="3">Message word (MELDW)</th></tr>
<tr><th colspan="3">Converter → Control</th></tr>
<tr><th>Bit</th><th>Status</th><th>Explanation</th></tr>
<tr><td rowspan="2">00</td><td>0 = Ramp-function generator active</td><td>The motor is presently accelerating or braking.</td></tr>
<tr><td>1 = Ramp-up/ramp-down completed</td><td>Speed setpoint and actual speed are the same.</td></tr>
<tr><td>01</td><td>1 = Torque utilization [%] < torque threshold value 2 (p2194)</td><td>---</td></tr>
<tr><td>02</td><td>1 = |n_actt| < speed threshold value 3 (p2161)</td><td>---</td></tr>
<tr><td>03</td><td>1 = |n_act| speed threshold value 2 (p2155)</td><td>---</td></tr>
<tr><td>04</td><td>1 = Vdc_min controller active</td><td>---</td></tr>
<tr><td>05</td><td>Variable signaling function 1 output signal</td><td>---</td></tr>
<tr><td>06</td><td>1 = No motor overtemperature alarm</td><td>The motor temperature is within the permissible range.</td></tr>
<tr><td>07</td><td>1 = No alarm power unit thermal overload</td><td>The converter temperature is within the permissible range.</td></tr>
<tr><td>08</td><td>1 = Speed setpoint - actual value deviation within tolerance t_on</td><td>Speed setpoint and actual speed are within the permissible tolerance p2163.</td></tr>
<tr><td>09, 10</td><td colspan="2">Reserved</td></tr>
<tr><td>11</td><td>1 = Controller enable</td><td>The speed controller is enabled.</td></tr>
<tr><td>12</td><td>1 = Drive ready</td><td>The converter is ready to start.</td></tr>
<tr><td>13</td><td>1 = pulses enabled</td><td>The motor is switched on.</td></tr>
<tr><td>14</td><td>Variable signaling function 2 output signal</td><td>---</td></tr>
<tr><td>15</td><td>Variable signaling function 3 output signal</td><td>---</td></tr>
</table>

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	
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...2	Variable signaling function output signal	

Signal sources for MELDW

<1> <2>

Signal	Meaning	Interconnection parameter	[Function diagram] internal control word	[Function diagram] signal target
MELDW.0	1 = Ramp-up/ramp-down completed	c2053[4].0 = r2199.5	[2537.7]	[8011]
MELDW.1	1 = Torque utilization < torque threshold value 2 (p2194)	c2053[4].1 = r2199.11	[2537.7]	[8012]
MELDW.2	1 = |n_act| < speed threshold value 3 (p2161)	c2053[4].2 = r2199.0	[2537.7]	[8010]
MELDW.3	1 = |n_act| > speed threshold value 2 (p2155)	c2053[4].3 = r2197.1	[2534.7]	[8010]
MELDW.4	1 = Vdc_min controller active	c2053[4].4 = r0056.15	[2526.7]	[6220], [6320]
MELDW.5	Variable signaling function 1 output signal	c2053[4].5 = r3294.0	-	[8024]
MELDW.6	1 = No motor overtemperature alarm	c2053[4].6 = r2135.6	[2549.7]	[8016]
MELDW.7	1 = No alarm, thermal overload, power unit	c2053[4].7 = r2135.7	[2549.7]	[8021]
MELDW.8	1 = Speed setpoint - actual value deviation within tolerance t_on	c2053[4].8 = r2199.4	[2537.7]	[8011]
MELDW.9	Reserved	-	-	-
MELDW.10	Reserved	-	-	-
MELDW.11	1 = Controller enable	c2053[4].11 = r0899.8	[2503.7]	[2610]
MELDW.12	1 = Drive ready	c2053[4].12 = r0899.7	[2503.7]	[2610]
MELDW.13	1 = Pulses enabled	c2053[4].13 = r0899.11	[2503.7]	[2610]
MELDW.14	Variable signaling function 2 output signal	c2053[4].14 = r3294.1	-	[8024]
MELDW.15	Variable signaling function 3 output signal	c2053[4].15 = r3294.2	-	[8024]

<1> Used in telegram 102, 103.
<2> The MELDW is generated using c2053[4].0...15.

1	2	3	4	5	6	7	8

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MELDW status word interconnection
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Figure 14-21 2460 - MELDW status word interconnection

14.4.7.16 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	Reserved
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	

14.4.7.17 Control and status word encoder

Overview

The encoder control word (G1_STW and G2_STW) and the encoder status word (G1_ZSW and G2_ZSW) 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.

Description of function

Control word encoder (G1_STW and G2_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 G1_XIST2 or G2_XIST2	
14	Park	1 = Request to park the encoder	
15	Acknowledge	0 → 1 = Acknowledge encoder fault	

Status word encoder (G1_ZSW and G2_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
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

Status word encoder (G1_ZSW and G2_ZSW)			
Converter → Control			
Bit	**Status**	**Explanation**	
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 G1_XIST2 or G2_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	

14.4.7.18 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).

Description of function

Safety Info Channel status word 1B (S_ZSW1B)	
Converter → Control	
Bit	**Safety status**
00	STO active
01	SS1 active
02	Reserved
03	Reserved
04	SLS active
05	Reserved
06	SLS selected
07	Internal event
08	Reserved
09	Select SLS Bit 0
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" function.

Number	Name	Unit
r9734.0...15	SI Safety Information Channel status word S_ZSW1B	

14.4.7.19 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.

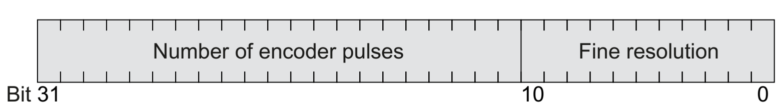
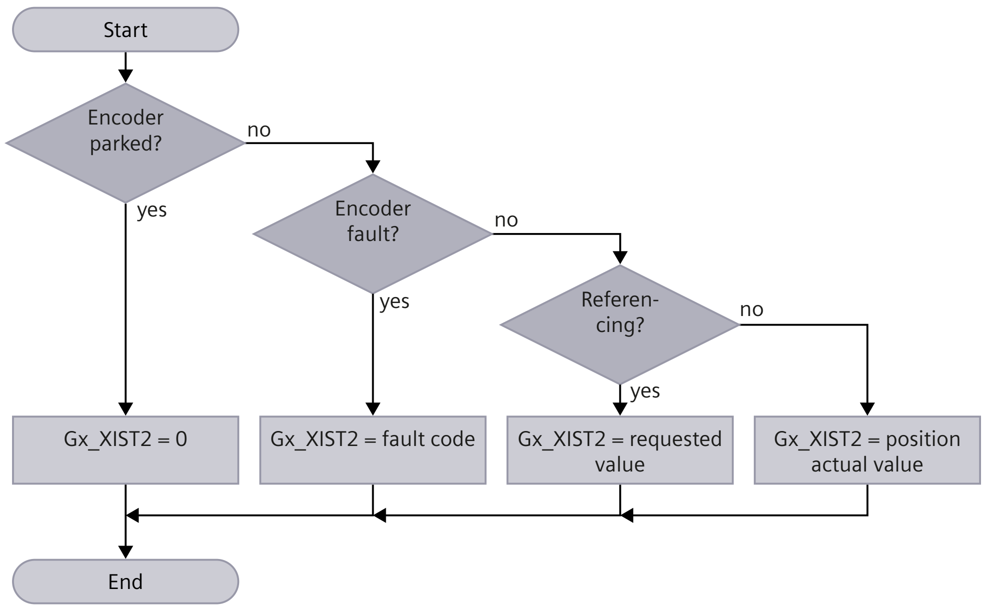


Figure 14-22 Encoder resolution

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 14-23 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 14-10 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
5	Fetch reference value canceled	• More than four values were requested. • No value requested. • Requested value is not available.

No.	Explanation	Possible cause
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	---

14.4.7.20 Receive data

Overview

The converter writes the receive data of the set telegram to signal sources designated for that purpose.

Requirement

You have activated communication via fieldbus and set a telegram.

Description of function

The converter stores the receive data as follows:

- "Word" format in r2050
- "Double word" format in r2060

The converter automatically interconnects parameters r2050 and r2060 with the signals corresponding to the telegram.

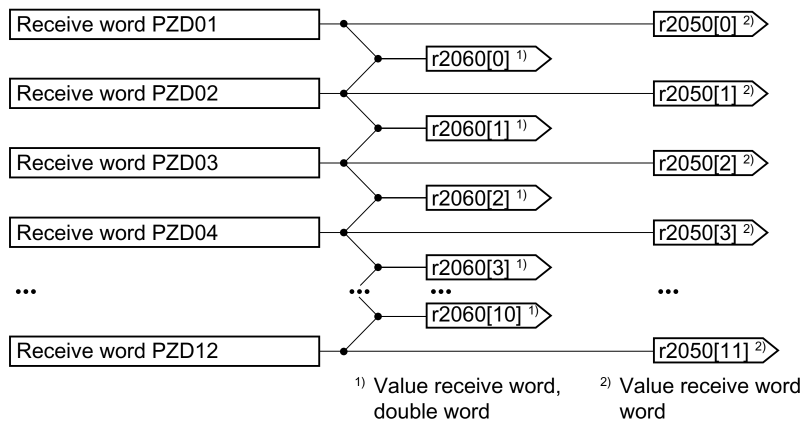
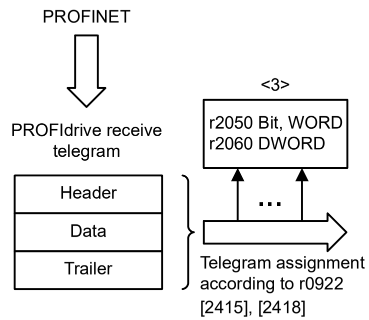


Figure 14-24 Interconnection of receive data

Parameters

The following list contains the parameters of the "Receive data" function.

Number	Name	Unit
r0922	PROFIdrive PZD telegram	
r2050[0...31].0...15	PROFIdrive PZD receive word	
r2060[0...30]	PROFIdrive PZD receive double word	



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]	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	-
MOMRED	Torque reduction	101	c1542	-	I16	4000 hex ≙ p1544

<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 according to to the PROFIdrive profile: I16 = Integer16, I32 = Integer32, U16 = Unsigned16.
<3> Display parameters for receive data according to [2468].

1	2	3	4	5	6	7	8

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PZD receive signals interconnection	V6.02.00	

Figure 14-25 2440 - PZD receive signals interconnection

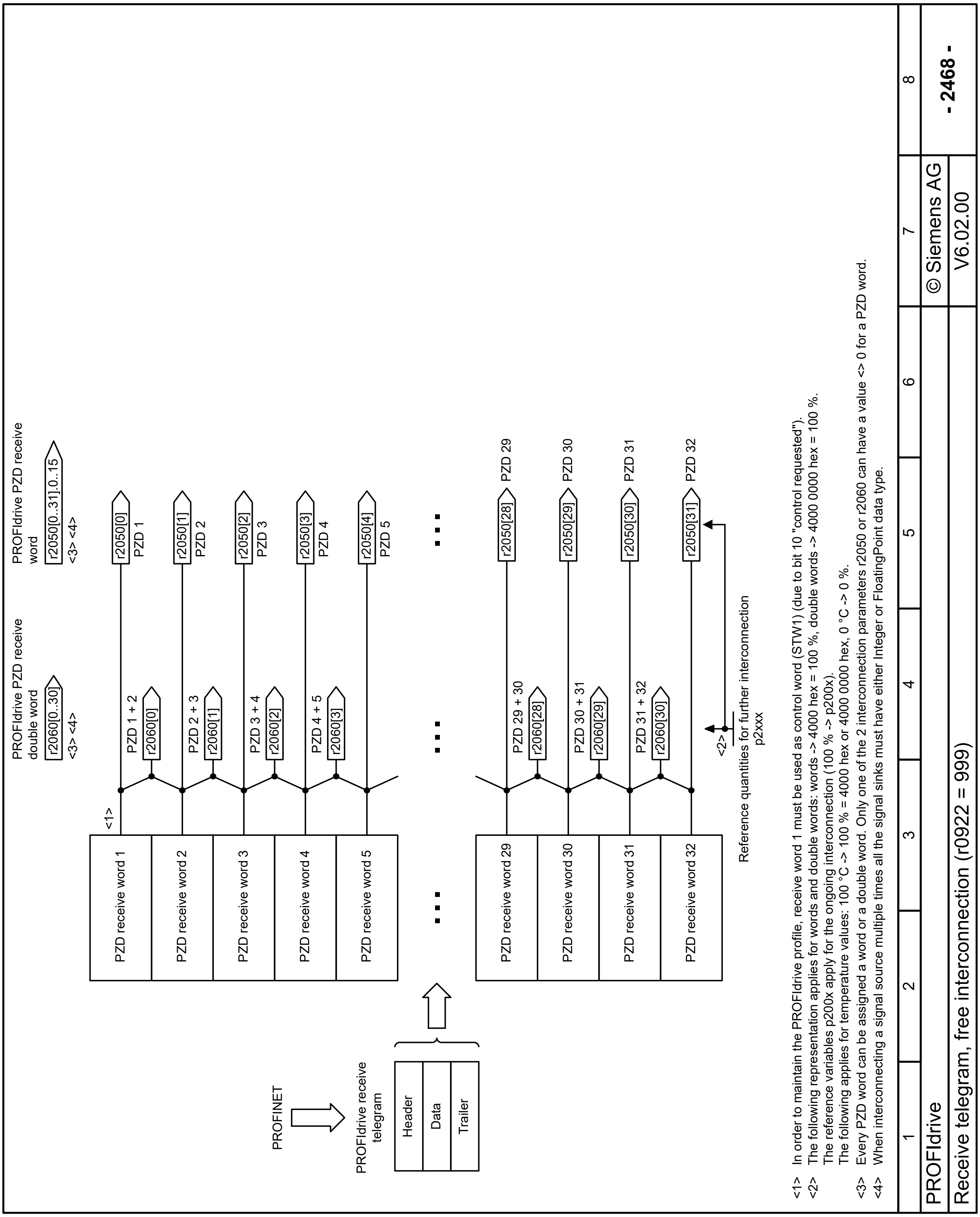


Figure 14-26 2468 - Receive telegram free interconnection

14.4.7.21 Send data

Overview

The converter receives the send data of the set telegram from signal sinks designated for that purpose.

Requirement

You have activated communication via fieldbus and set a telegram.

Function description

The send data is available in the converter in the "Word" format (p2053) and "Double word" format (p2063). The converter automatically interconnects parameters p2053 and p2063 with the appropriate signals.

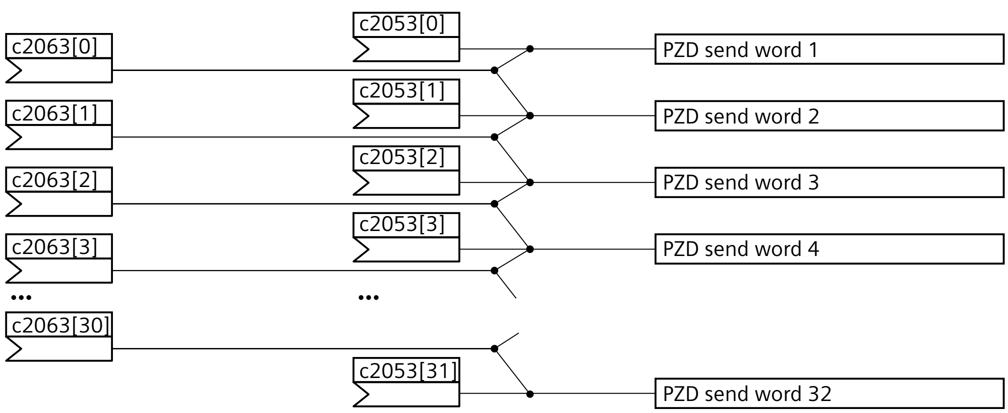


Figure 14-27 Interconnection of send data

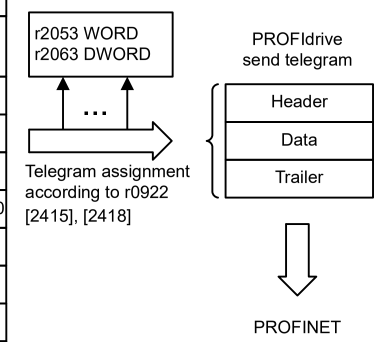
Parameters

The following list contains the parameters of the "Send data" function.

Number	Name	Unit
r0922	PROFIdrive PZD telegram	
c2053[0...31]	PROFIdrive PZD send word	
c2063[0...30]	PROFIdrive PZD send double word	

Signal sources for PZD send signals

Signal	Meaning	PROFIdrive Signal-No.	Interconnection parameter	Function diagramm	Data type <1>	Scaling
ZSW1	Status word 1	2	r2053[0]	[2451], [2452]	U16	-
ZSW2	Status word 2	4	r2053[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	-
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
NIST_A_GLATT	Actual speed, smoothed	57	r0063[1]	[6799]	I16	4000 hex ≙ p2000
MELDW	VIK-NAMUR message bit bar	58	r3113	-	U16	-
FAULT_CODE	Fault code	301	r2131	[8060]	U16	-
WARN_CODE	Alarm code	303	r2132	[8065]	U16	-



<1> Data type according to to the PROFIdrive profile: I16 = Integer16, I32 = Integer32, U16 = Unsigned16.

1	2	3	4	5	6	7	8

PROFIdrive
PZD send signals interconnection
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V6.02.00
- 2450 -

Figure 14-28 2450 - PZD send signals interconnection

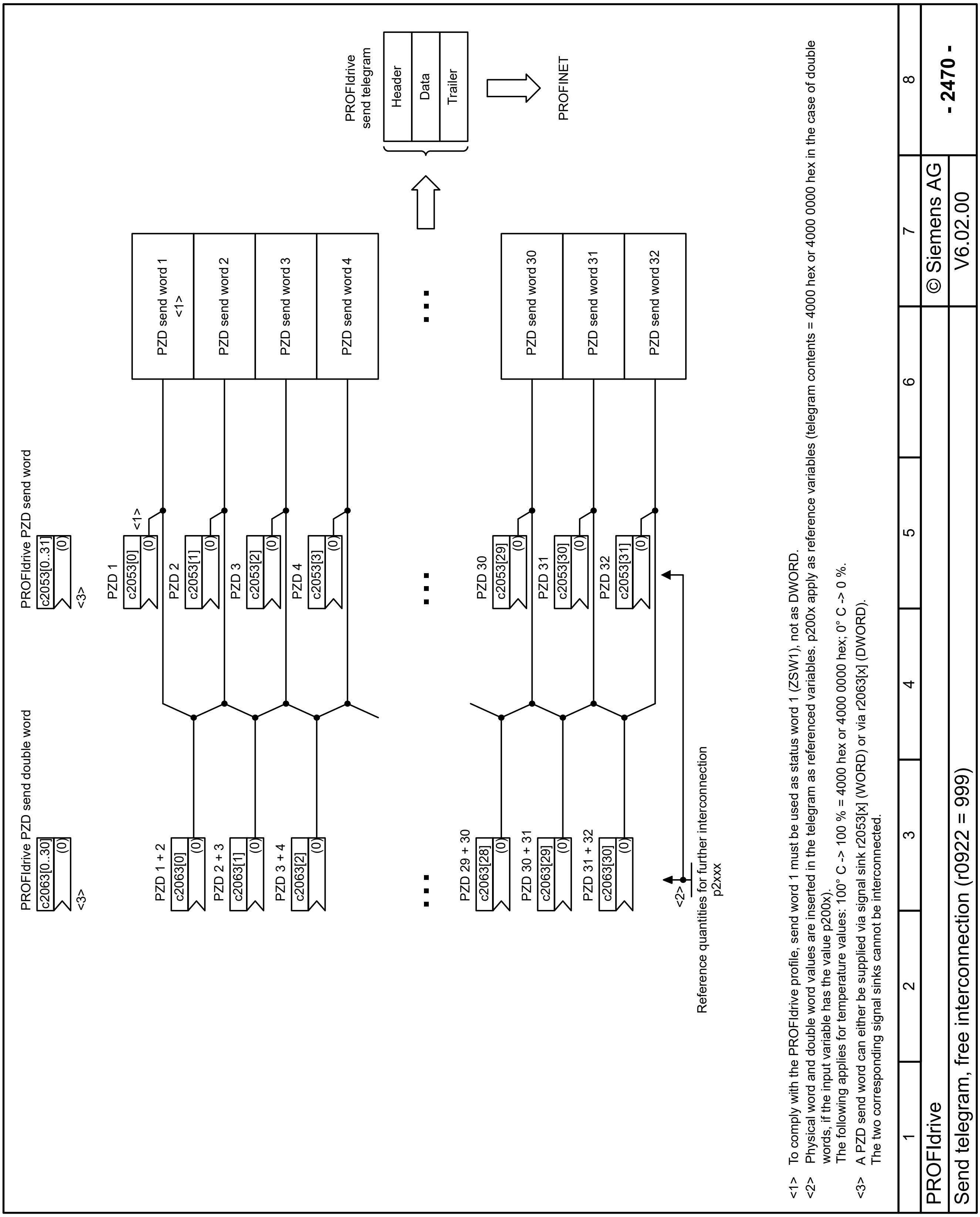


Figure 14-29 2470 - Send telegram free interconnection

14.4.8 Acyclic PROFIdrive communication

14.4.8.1 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.

14.4.8.2 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 14-11 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 14-12 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	...		

14.4.8.3 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.

Description of function

Values in italics in the following tables mean that these values must be adapted to the specific request.

Table 14-13 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	01 hex (drive object)	**Number of parameters (m)** *01 hex ... 27 hex*	2
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	...		

Data block	Byte n	Bytes n + 1	n
...	...		...
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 14-14 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
	01 hex (ID of drive objects, for G120 always = 01 hex)	**Number of parameters** (identical to a change request)	2

Table 14-15 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
	01 hex (ID of drive objects, for G120 always = 01 hex)	**Number of parameters** (identical to a change request)	2
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	...		

Data block	Byte n	Bytes n + 1	n
...	...		...
Values, parameter m	...		

14.4.8.4 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.

Description of function

Table 14-16 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)
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.)

Error value 1	Meaning
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 ready.
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 (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)

14.4.9 Identification & Maintenance (I&M) data

Overview

I&M data are identification and maintenance data that are stored in a device. The higher-level controller has access to the I&M data of all devices on the fieldbus.

Using the I&M data, the plant operator can identify and label devices and define maintenance measures.

The converter supports the identification and maintenance (I&M) data listed in the table.

Description of function

Table 14-17 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 14-18 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

14.5 Modbus TCP communication

14.5.1 Modbus TCP fieldbus

Overview

Modbus TCP is a fieldbus standard used by the converter to communicate with a higher-level control system.

Requirement

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 controller-device architecture, transfers data as TCP/IP packets.

The converter supports connection to a maximum of three controllers.

TCP port 502 is reserved for Modbus TCP.

The controller accesses converter process data and parameters via registers:

- Process data: Registers 40100 - 40119
- Drive data: Registers 40300 - 40522
- Parameters via DS47: Registers 40601 - 40722

Modbus TCP provides a basic Ethernet functionality:

- Commissioning access
- DCP, for example for setting the IP address
- SNMP for identification

14.5.2 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.

Description of function

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 14-19 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 14-20 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 14-21 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 14-22 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	-	-	-	r0474.1, 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 14-23 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[2)]	R	RPM	1	-32768 ... 32767		r0020
40341	Speed actual value[2)]	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 14-24 Faults and alarms

Register	Description	Access[1)]	Unit	Scaling	Value range	Parameters
40400	Failure number, index 0	R	-	1	0 ... 65535	r0947 [0]
40401	Failure number, index 1	R	-	1	0 ... 65535	r0947 [1]
40402	Failure 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 14-25 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

2) "R" stands for read (with FC 03), "W" for write (with FC 06 or FC 16) and "R/W" for read/write

Table 14-26 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

14.5.3 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 14-30 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.

14.5.4 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 14-27 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 14-28 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 14-29 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

14.5.5 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 14-30 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 14-31 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 14-32 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

14.5.6 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 14-33 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 14-34 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 14-35 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

14.5.7 Communication via DS 47

Overview

Communication via DS 47 is possible using registers 40601 ... 40722.

Description of function

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 14-36 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 14-37 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 14-38 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 (14 bytes are returned)
	0002 h	9, 10	40601: DS47 Control = 2 (the request was executed)
	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 14-39 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: Check value 1 = request being processed
	2F00 h	11, 12	40602: Function code 2F h (47), response length 0 (error)
	0004 h	13, 14	40603: Error code 0004 (response has still not been issued)

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 14-40 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 14-41 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 14-42 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 request was executed)
	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 14-43 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: Check value 1 = request being processed
	2F00 h	11, 12	40602: Function code 2F h (47), response length 0 (error)
	0004 h	13, 14	40603: Response has still not been issued

14.5.8 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 14-44 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

14.6 Ethernet/IP communication

14.6.1 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

14.6.2 Supported objects

Overview

The higher-level control system accesses converter process data and parameters via Ethernet/IP objects.

Description of function

Table 14-45 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	-
F5 hex	245	TCP/IP interfacing object [2]	x	-
F6 hex	246	Ethernet link object [2]	x	-
32C hex	812	Siemens drive object	-	x
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

14.6.3 Cyclic communication

14.6.3.1 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.

14.6.3.2 "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 14-46 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 14-47 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

14.6.4 Acyclic communication

14.6.4.1 "Identity object" class

Overview

The "identity object" enables the controller to access selected converter data.

Description of function

The "identity object" has object class 01 h.

Table 14-48 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 14-49 Instance attributes

Attribute ID	Service[1]	Type	Name	Value/explanation
1	get	UINT16	Vendor ID	1251
2	get	UINT16	Device: Siemens device	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 14-50 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

14.6.4.2 "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 14-51 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 14-52 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
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

14.6.4.3 "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 14-53 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 14-54 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

14.6.4.4 "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 14-55 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 14-56 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
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

Attribute ID	Service[1)]	Type	Name	Value/explanation
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	-
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

14.6.4.5 "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 14-57 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 14-58 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

Attribute ID	Service[1)]	Type	Name	Value/explanation
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
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

Attribute ID	Service[1)]	Type	Name	Value/explanation
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

14.6.4.6 "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 14-59 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 14-60 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

Attribute ID	Service	Type	Name	Value/explanation
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

14.6.4.7 "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 14-61 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)

14.7 Communication with edge device

14.7.1 Communication with the edge device

Overview

The converter transmits freely configurable signals with an adjustable transfer rate to the edge device.

Requirement

The option module OM-IIoT is mounted and configured in the converter.

Description of function

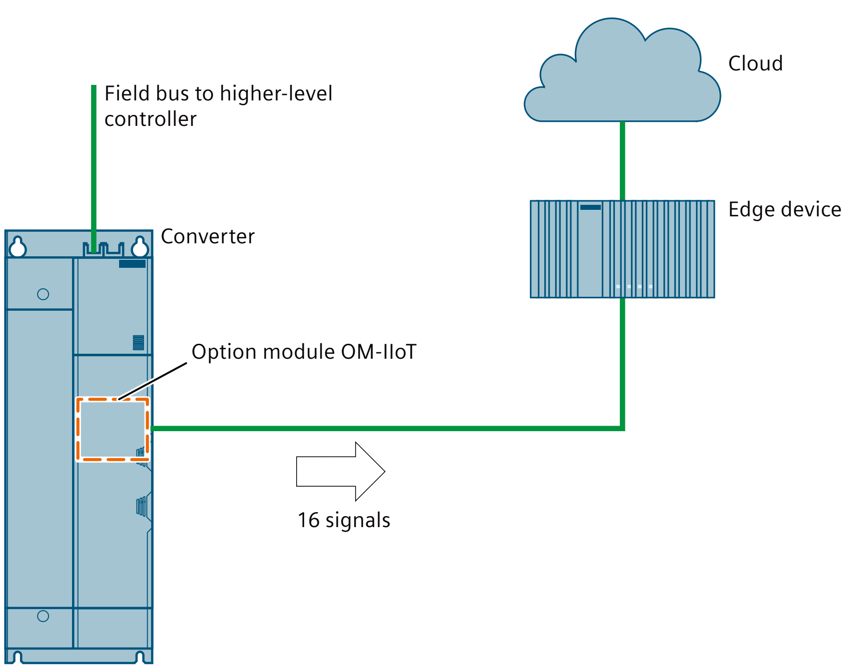


Figure 14-31 Signal transmission from the converter to the edge device

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 14-62 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]

14.7.2 Configure communication with the converter in the edge device

Overview

You must configure communication with the option module OM-IIoT in the edge device.

Requirement

You have configured communication with the edge device in the converter using a commissioning tool.

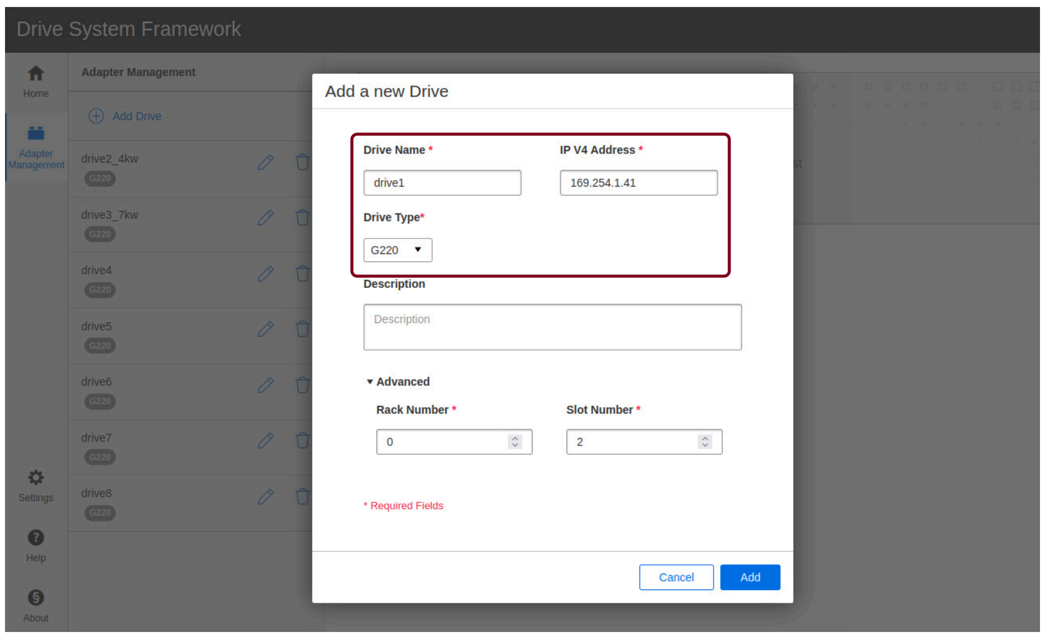
The procedure includes as example the "Drive System Framework" app that runs in the edge device.

Procedure

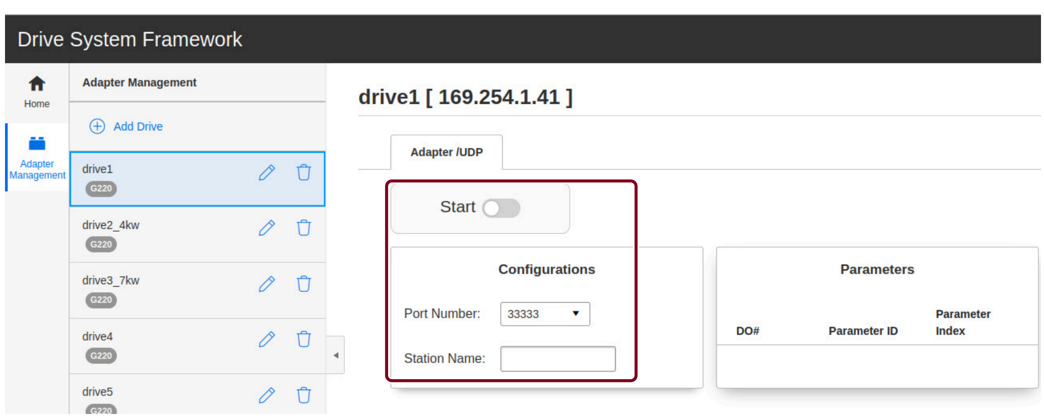
Proceed as follows to configure communication with the OM-IIoT in the edge device:

1. Create a new drive in the Drive System Framework.
2. Set the following:
   – Name of the drive
   – IP address of the OM-IIoT
   – Product name

   The settings must match the corresponding settings in the web server.



3. Set the port number and the station name.
   The settings must match the corresponding settings in the web server.
   If several OM-IIoTs are connected to the same edge device, then each OM-IIot must have a unique port number.



4. Activate the "Start" button to start communications.

14.8 Inputs/outputs

14.8.1 Default settings for inputs/outputs

14.8.1.1 I/O presetting "Conveyor systems 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.

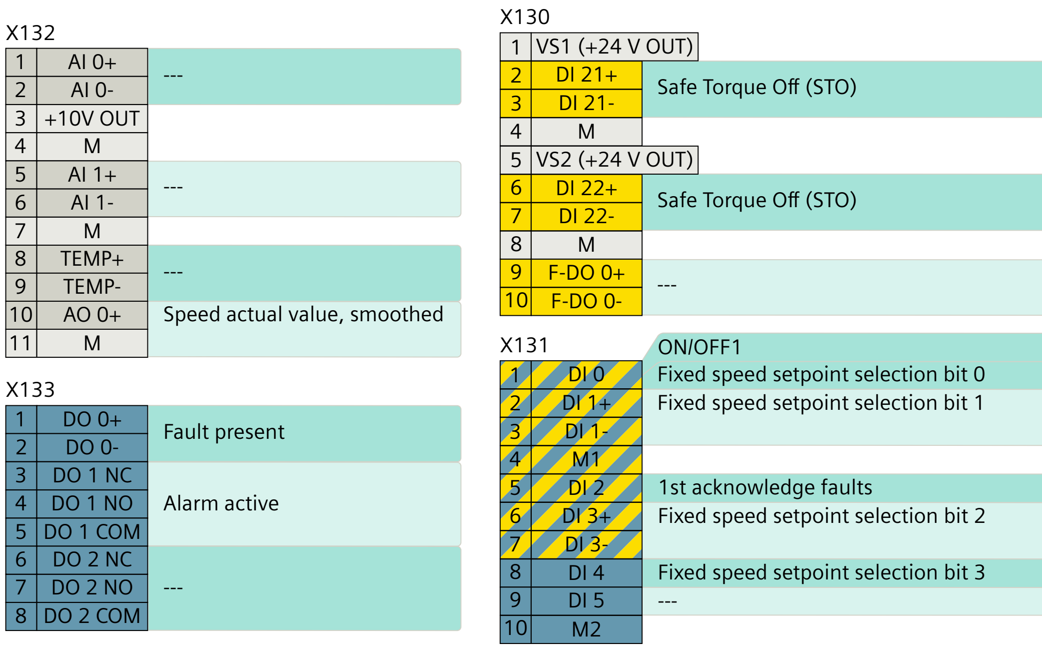


Figure 14-32 I/O preset "Conveyor systems with 4 fixed setpoints"

Table 14-63 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 = r0052.3 c0731 = r0052.2
DI 1 DI 2 DI 3 DI 4	c1021[0] = r0722.1 c2103[0] = r0722.2 c1022[0] = r0722.3 c1023[0] = r0722.4	AO 0	c0771[0] = r0021

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	

14.8.1.2 I/O presetting "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.

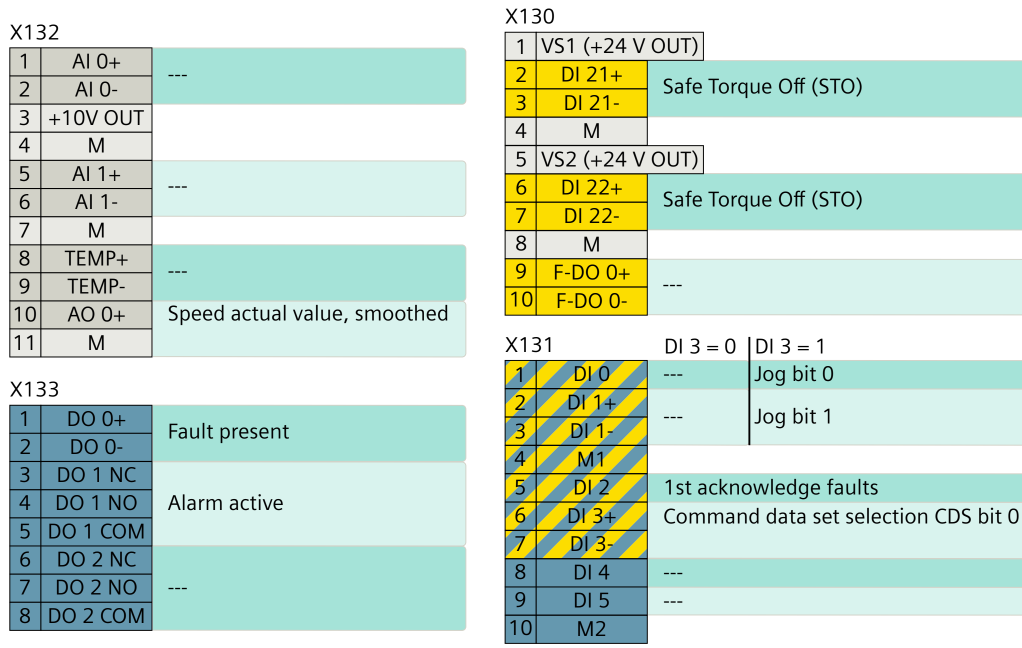


Figure 14-33 I/O preset "Fieldbus with data set switchover"

Table 14-64 Signal interconnection of the inputs and outputs

Input	Signal interconnection	Output	Signal interconnection
DI 0 DI 1 DI 2 DI 3	c1055[1] = r0722.0 c1056[1] = r0722.1 c2103[1] = r0722.2 c0810[0] = r0722.3	DO 0 DO 1	c0730 = r0052.3 c0731 = r0052.2
		AO 0	c0771[0] = r0021

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 bit 0	
c1056[0...n]	Jog bit 1	
c2103[0...n]	1st acknowledge faults	

14.8.1.3 I/O presetting "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.

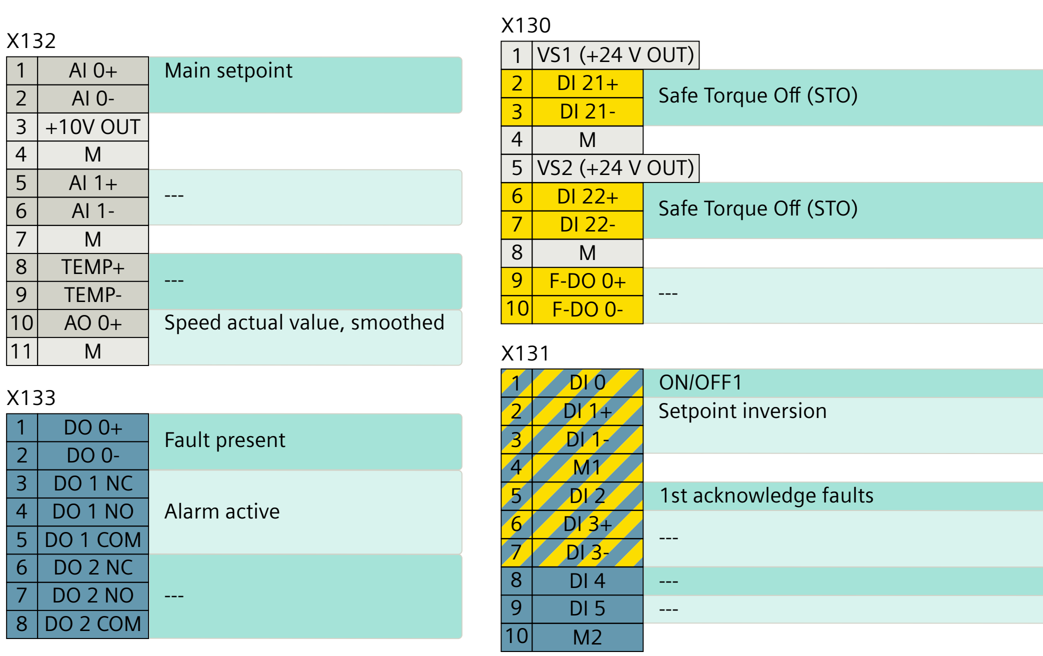


Figure 14-34 I/O preset "Standard I/O with analog setpoint"

Table 14-65 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 = r0052.3 c0731 = r0052.2
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	

14.8.2 Analog inputs

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.

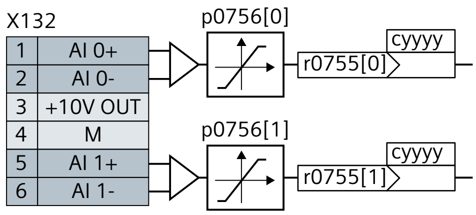


Figure 14-35 Type and function of an analog input

Description of function

Analog inputs have the following properties:

- Type can be selected
  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
No sensor connected	---		8
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
No sensor connected	---		8

- Scaling
  Scaling is used to adapt the analog input to the machine or the existing components. For example, if the entire input range of the voltage or the current is not utilized, the input value can still be scaled to 100%.
  The converter converts the current or voltage that the analog input reads in to 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 linear scaling characteristic is defined by two points (p0757, p0758) and (p0759, p0760). Parameters p0757 ... p0760 are assigned to an analog input by their index, e.g. parameters p0757[0] ... p0760[0] belong to analog input 0.

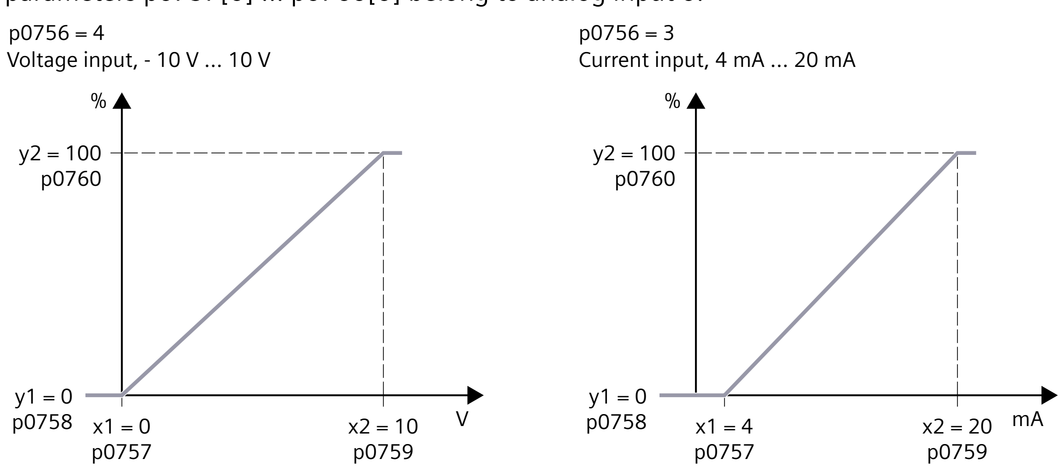


Figure 14-36 Scaling for analog input

- Function can be set
  The function of the analog input is defined by the interconnection of the numeric signal sink with parameter r0755.
  Multiple interconnections are possible.
  Parameter r0755 is assigned to the respective analog input by its index, e.g. parameter r0755[0] is assigned to analog input 0.
  Frequently used numeric signal sinks:

Parameter	Description
r1070	Main setpoint
r1075	Supplementary setp
r2253	Technology controller setpoint 1
r2264	Technology controller actual value

- Offset can be set
  Parameter p0763 determines the offset for the analog input.
- Smoothing can be set
  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 can be set
  Analog values are always subject to noise. Parameter p0768 determines the value of the noise suppression for the input signal.
- Wire-break monitoring can be set
  Parameters p0761 and p0762 define the behavior of wire break monitoring.
- Absolute-value generation can be set
  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 dead zone	
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	

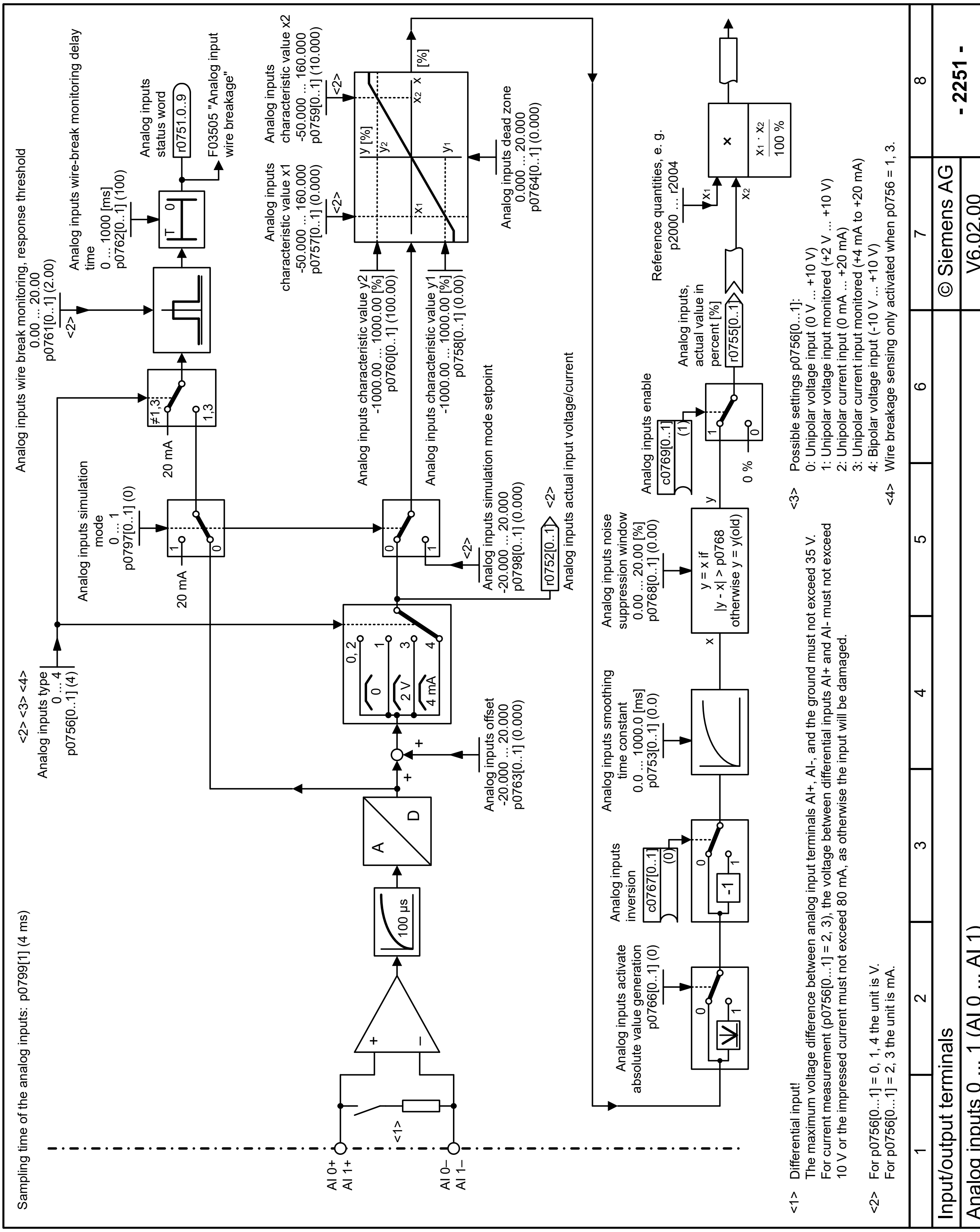


Figure 14-37 2251 - Analog inputs 0 ... 1 (AI 0 ... AI 1)

14.8.3 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.

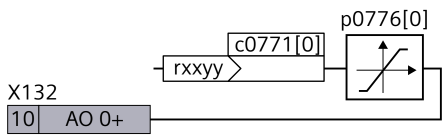


Figure 14-38 Function of an analog output

Description of function

The analog output has the following properties:

- Type can be selected
  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 can be set
  The interconnection of a numeric signal source of the converter with parameter p0771 defines the function of an analog output.
  Frequently used numeric signal sources of the converter:

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 can be set
  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 can be set
  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 can be set
  Parameter p0783 determines the offset for the analog output.
- Scaling can be set
  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.

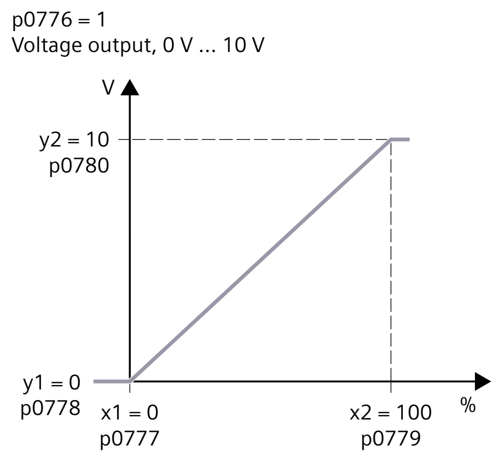


Figure 14-39 Scaling of the analog output

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	

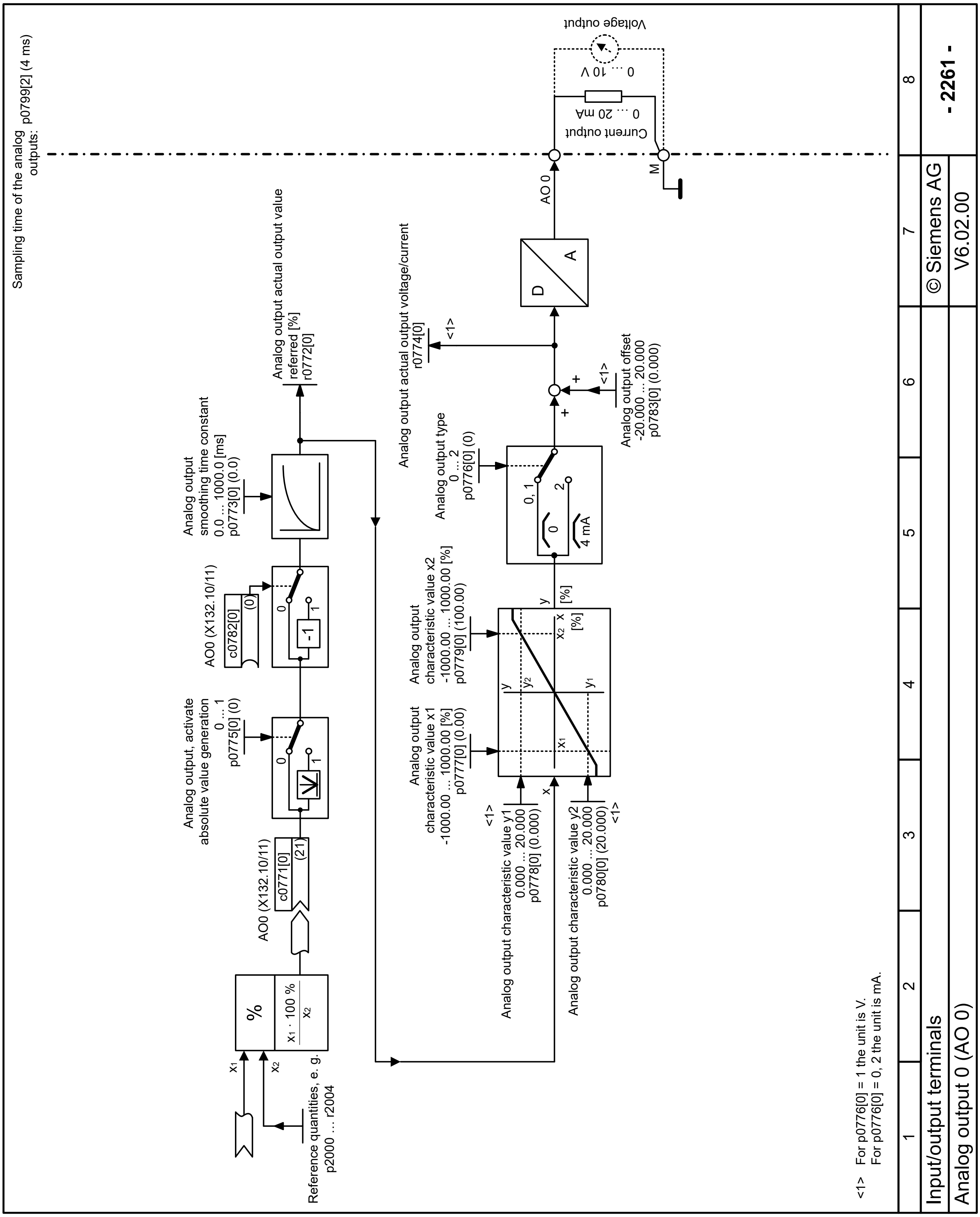


Figure 14-40 2261 - Analog output 0 (AO 0)

14.8.4 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

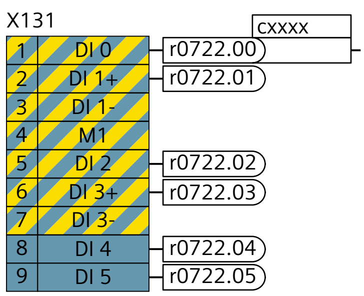


Figure 14-41 Binary signal sources of the digital inputs

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.

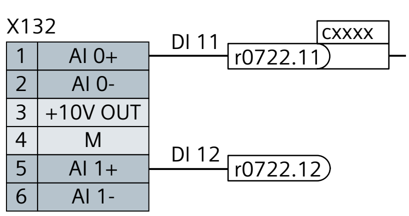


Figure 14-42 Analog inputs as digital inputs

Parameters

The following list contains the parameters of the "Functions of digital inputs" function.

Number	Name	Unit
r0722.0...22	Digital inputs status	
r0723.0...22	Digital inputs status inverted	
p0724	Digital inputs debounce time	[ms]

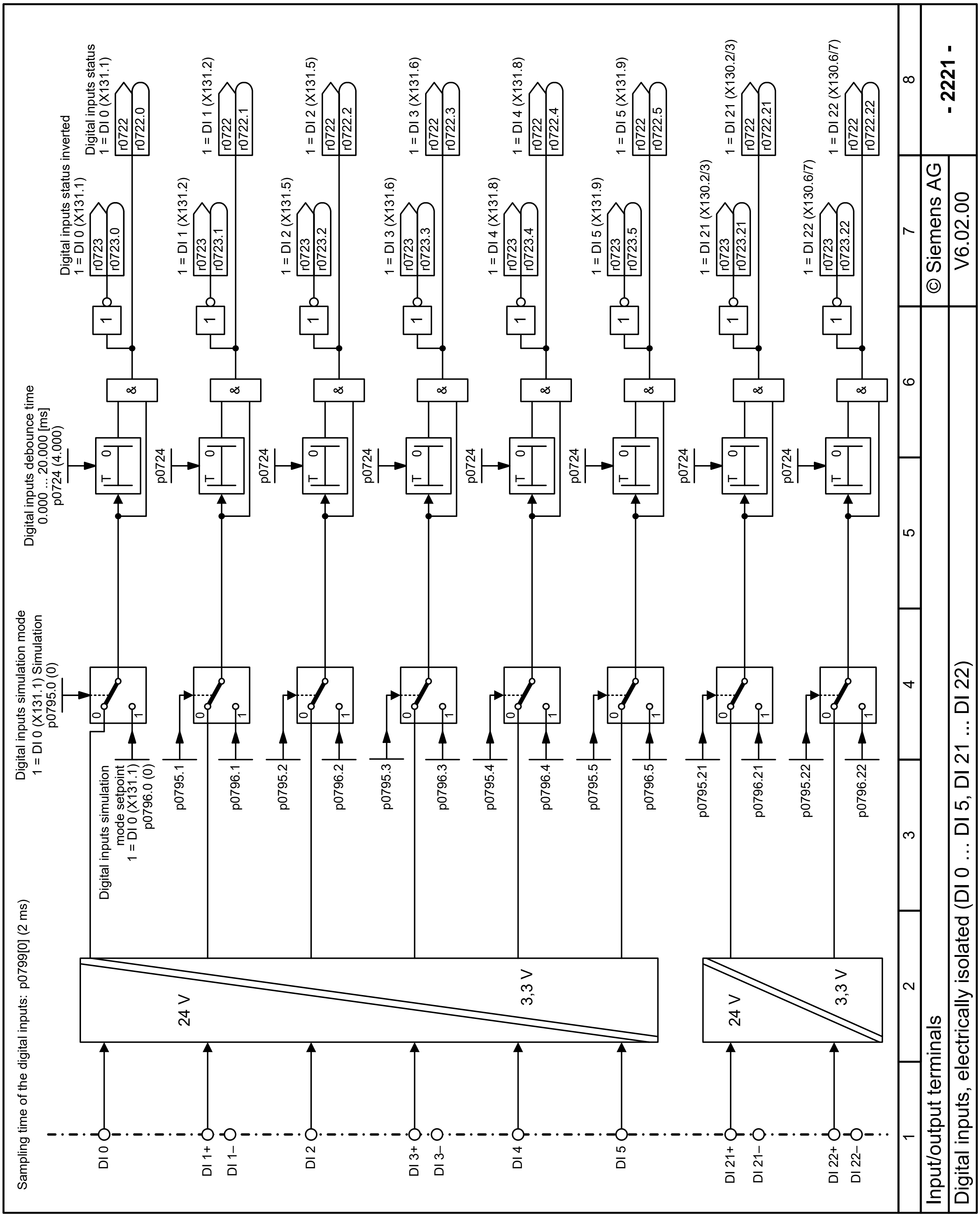


Figure 14-43 2221 – Digital inputs isolated (DI 0 ... DI 5, DI 21 ... DI 22)

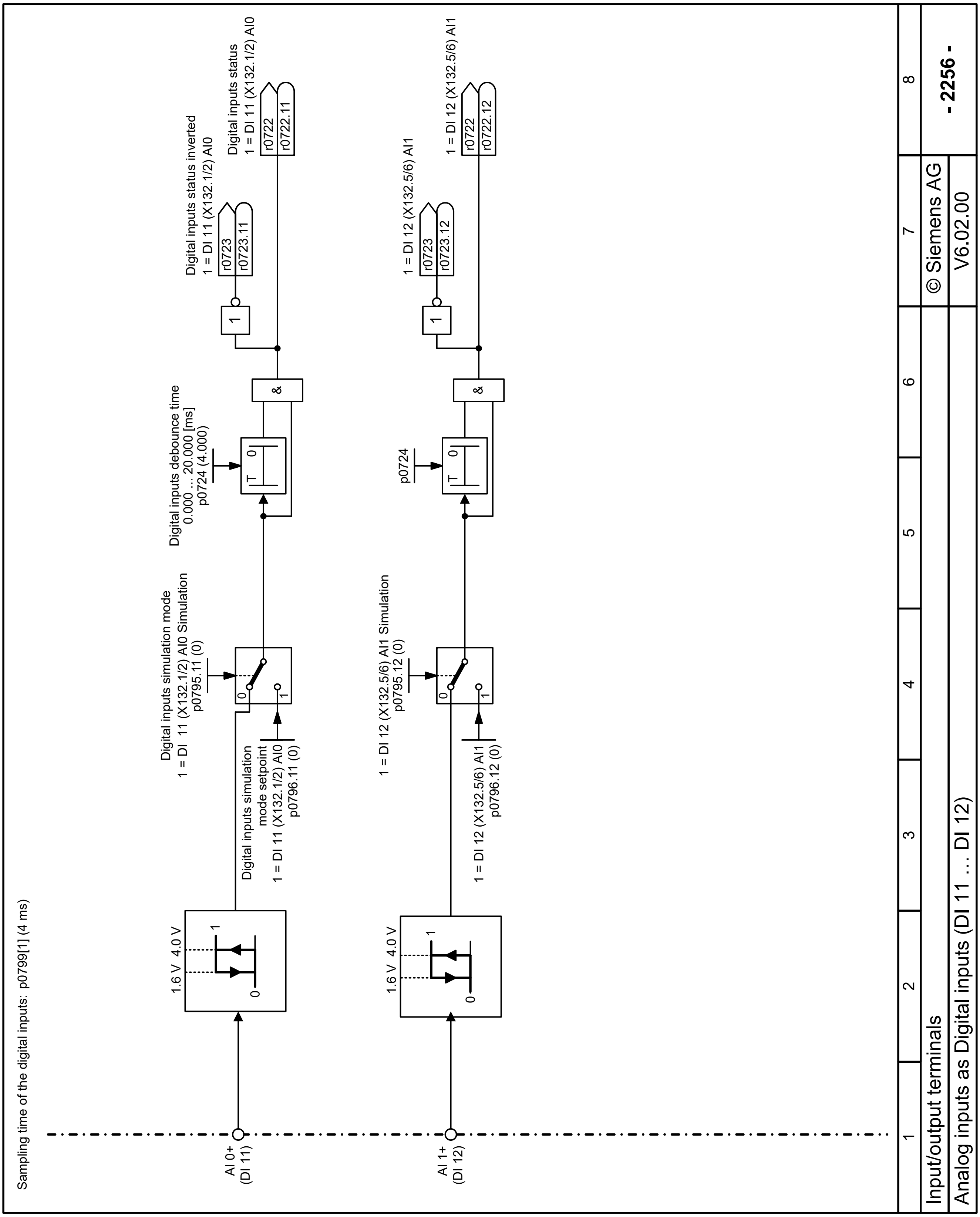


Figure 14-44 2256 - Analog inputs as digital inputs (DI 11 ... DI 12)

14.8.5 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

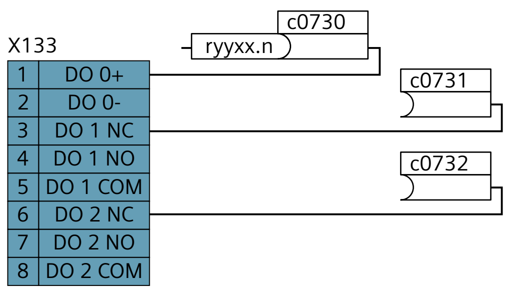


Figure 14-45 Binary signal sinks of the digital outputs

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 the "Functions of digital outputs" function.

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	

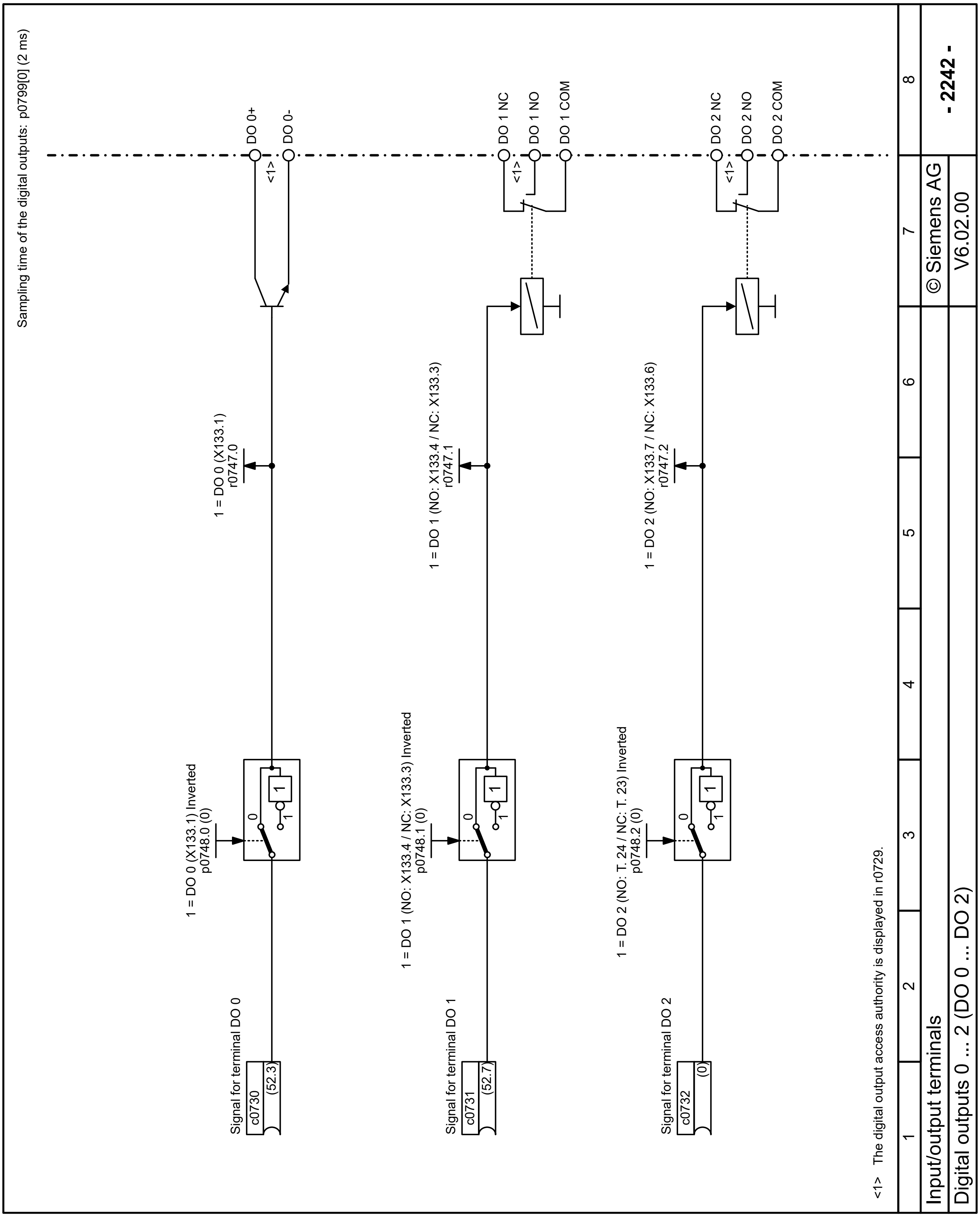


Figure 14-46 2242 - Digital outputs (DO0 ... DO2)

14.9 Setpoint channel

14.9.1 Main setpoint

Overview

The main setpoint specifies the speed of the motor.

Description of function

The converter receives its main setpoint via one of the following setpoint sources:

- Fieldbus interface of the converter
- Analog input of the converter
- 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.

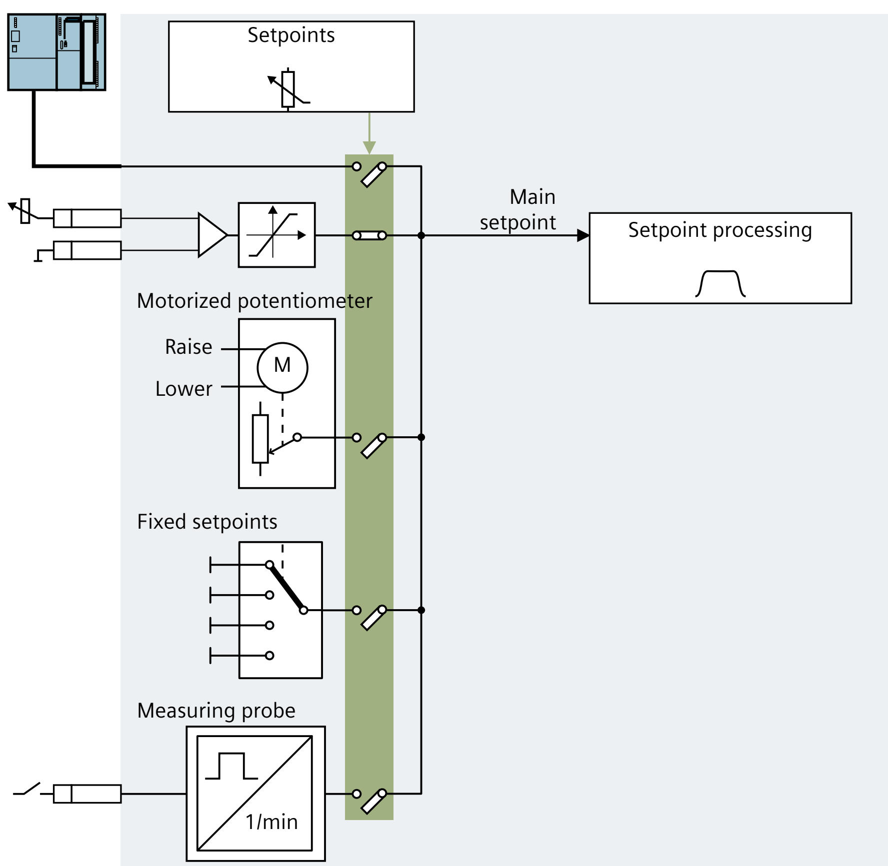


Figure 14-47 Setpoint sources of the converter

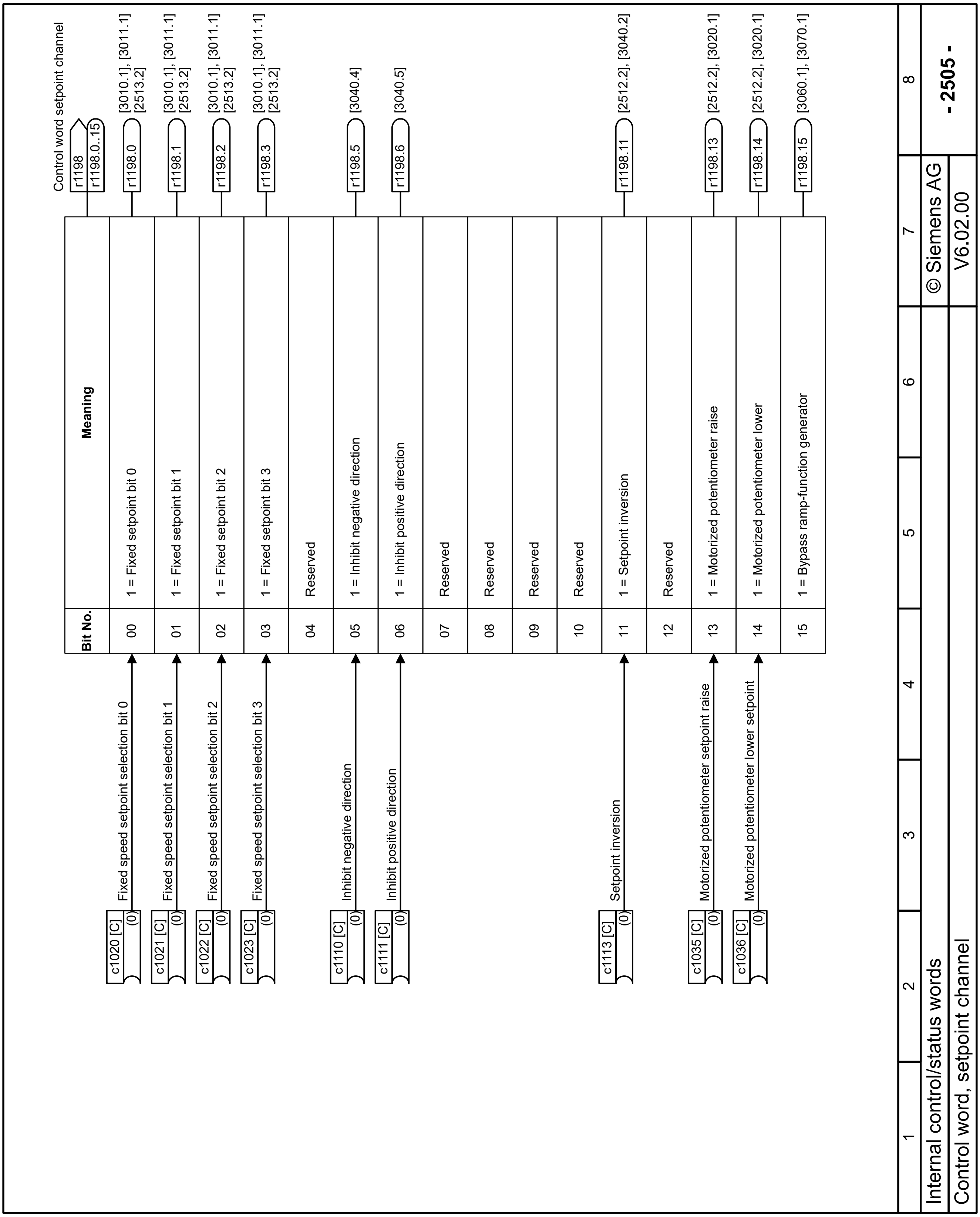


Figure 14-48 2505 - Control word setpoint channel

14.9.2 Motorized potentiometer as setpoint source for the main setpoint

Overview

The "Motorized potentiometer" function emulates an electromechanical potentiometer. You can interconnect the output of the motorized potentiometer with the main setpoint.

Description of function

The "Motorized potentiometer" function emulates an electromechanical potentiometer.

The output value of the motorized potentiometer can be set using the "raise" and "lower" control signals.

Setting with the motorized potentiometer as setpoint source:

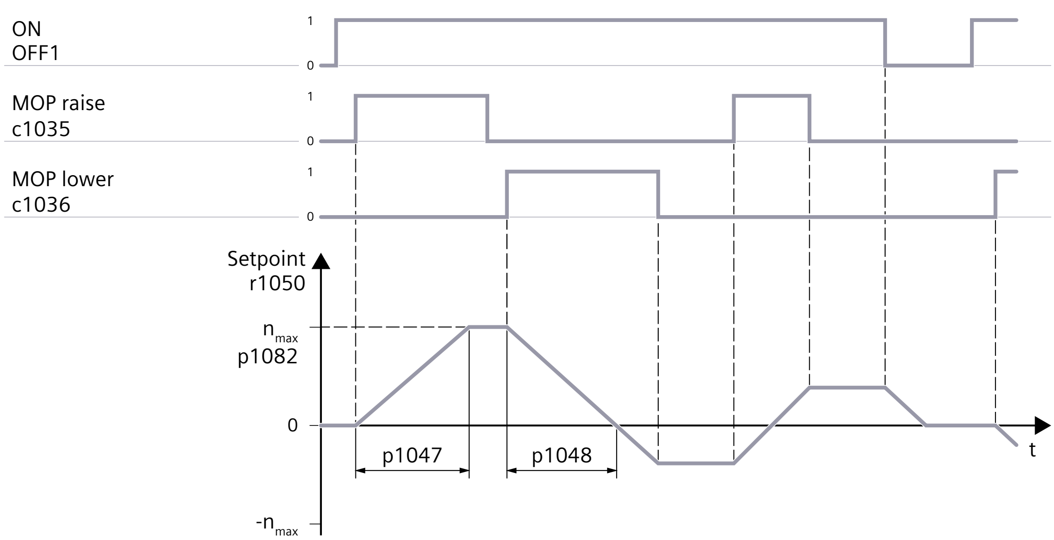


Figure 14-49 Function diagram of the motorized potentiometer

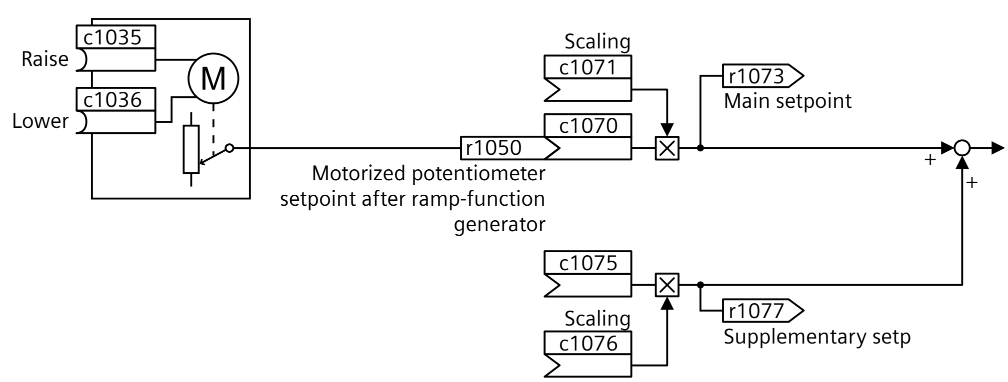


Figure 14-50 Motorized potentiometer as setpoint source

Parameters

The following list contains the parameters of the "Motorized potentiometer as setpoint source for the main setpoint" function.

Number	Name	Unit
p1030[0...n].0...4	Motorized potentiometer configuration	
c1035[0...n]	Motorized potentiometer setpoint raise	
c1036[0...n]	Motorized potentiometer lower setpoint	
p1037[0...n]	Motorized potentiometer maximum speed	[rpm]
p1038[0...n]	Motorized potentiometer minimum speed	[rpm]
p1040[0...n]	Motorized potentiometer starting value	[rpm]
c1043[0...n]	Motorized potentiometer accept setting value	
c1044[0...n]	Motorized potentiometer setting value	[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]
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	[%]

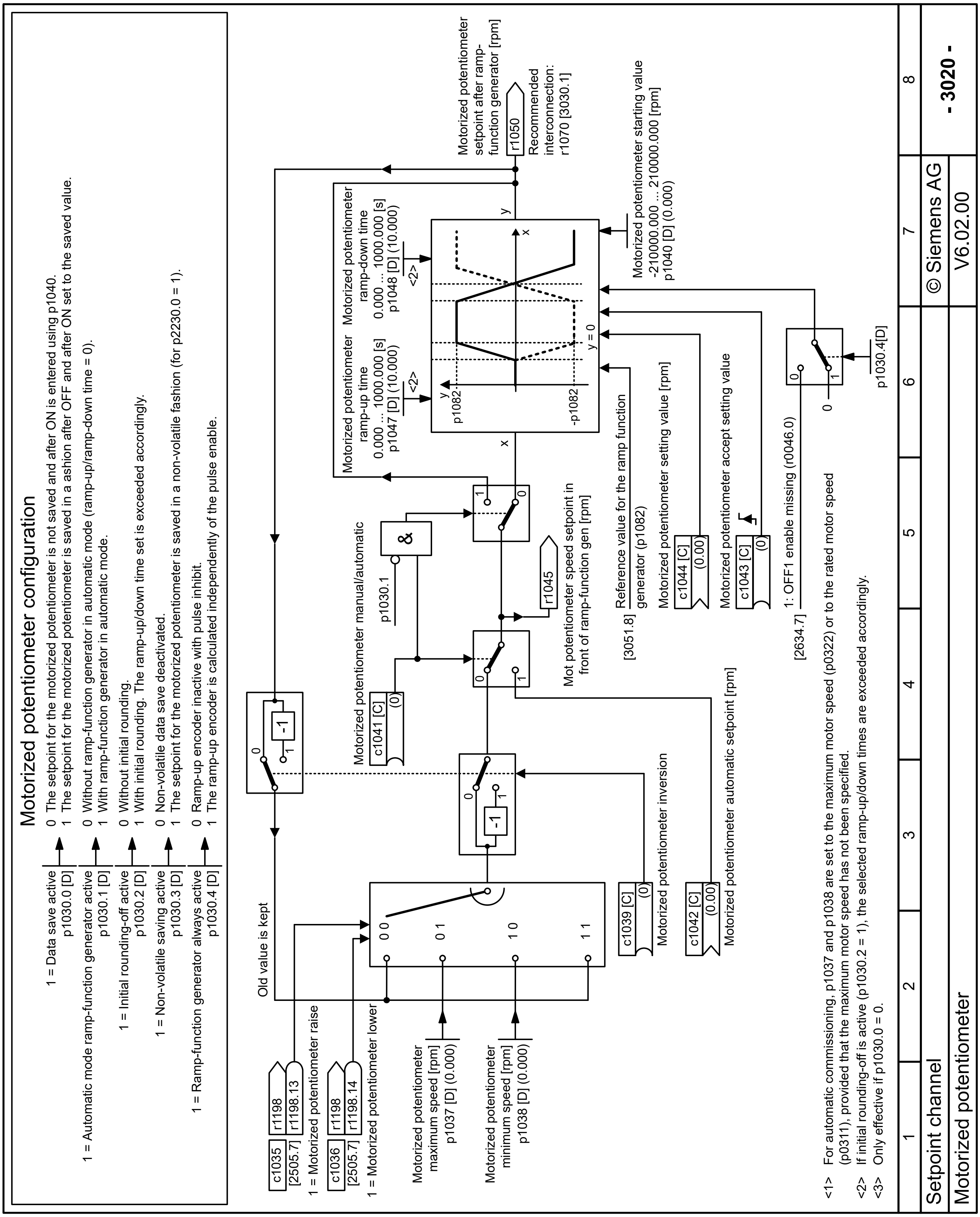


Figure 14-51 3020 - Motorized potentiometer

14.9.3 Fixed speed setpoint as setpoint source for the main 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.

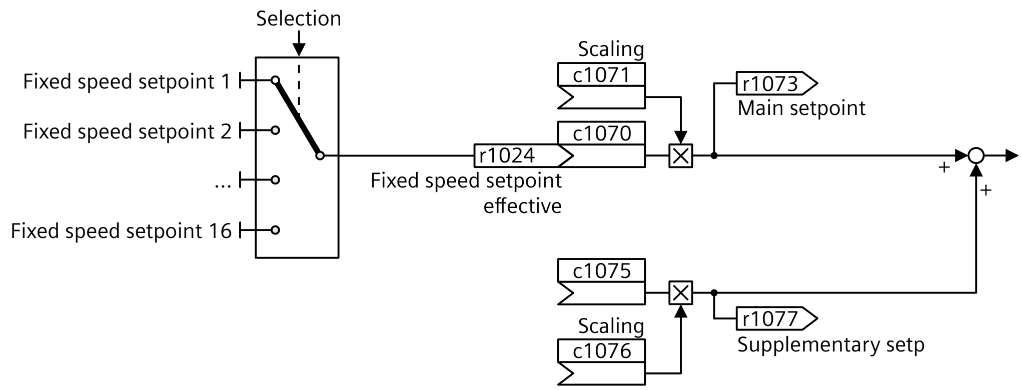


Figure 14-52 Fixed speed setpoint as setpoint source

Description of function

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.

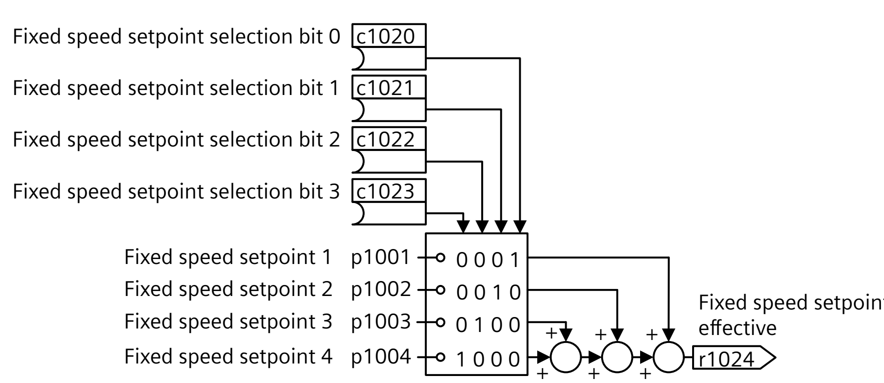


Figure 14-53 Direct selection of fixed speed setpoints

Table 14-66 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 16 different fixed speed setpoints p1001 ... p1015 are defined. A certain combination of selection bits is assigned to each of the 16 fixed speed setpoints.

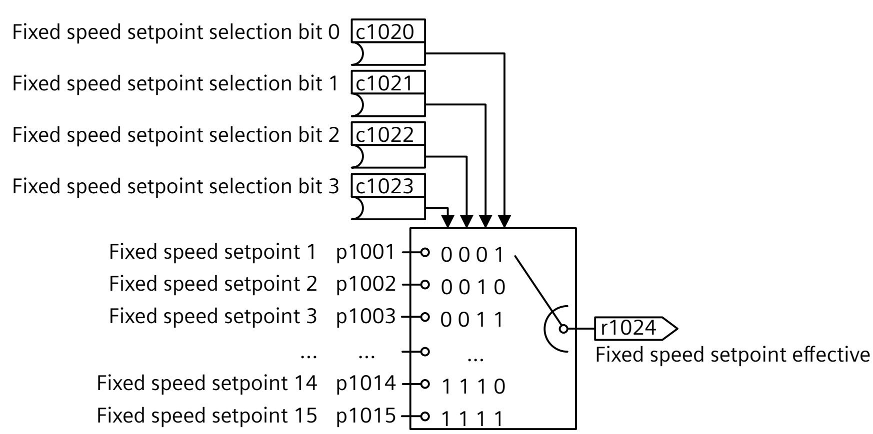


Figure 14-54 Binary selection of fixed speed setpoints

Table 14-67 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

Parameters

The following list contains the parameters of the "Fixed speed setpoint as setpoint source for the main setpoint" function.

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]

14.9.4 Example for setting fixed speed setpoint

Overview

The example shows how to select two fixed speed setpoints directly.

The motor should run at different speeds as follows:

- The signal at digital input 0 switches on the motor and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.
- With the signals at both digital inputs, the motor accelerates to 2300 rpm.

Settings

Table 14-68 Setting a fixed speed

Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1**
p1002 = 2000.000	**Fixed speed setpoint 2**
r0840 = 722.0	**ON/OFF1:** Switch on motor with digital input 0
r1070 = 1024	**Main setpoint:** Interconnect main setpoint with fixed speed setpoint.
r1020 = 722.0	**Fixed speed setpoint selection bit 0:** Interconnect fixed speed setpoint 1 with digital input 0 (DI 0).
r1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnect fixed speed setpoint 2 with digital input 1 (DI 1).
p1016 = 1	**Fixed speed setpoint mode:** Choose direct selection of fixed speed set-points.

Result

Table 14-69 Resulting fixed speed setpoints for the application example

Fixed speed setpoint selected via	Resulting setpoint
DI 0 = 0	Motor stops
DI 0 = 1 and DI 1 = 0	300 rpm
DI 0 = 1 and DI 1 = 1	2300 rpm

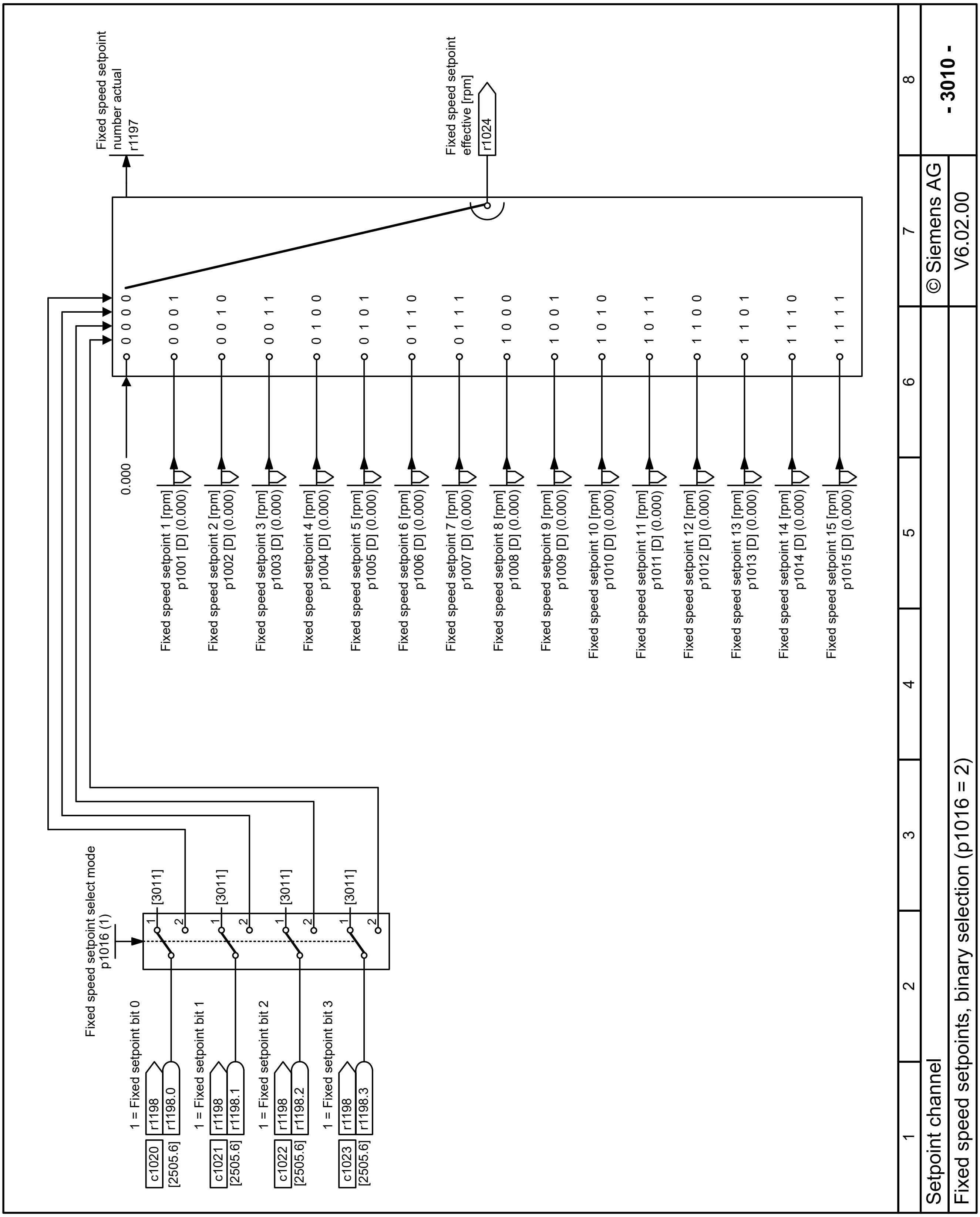


Figure 14-55 3010 - Fixed speed setpoints, binary selection

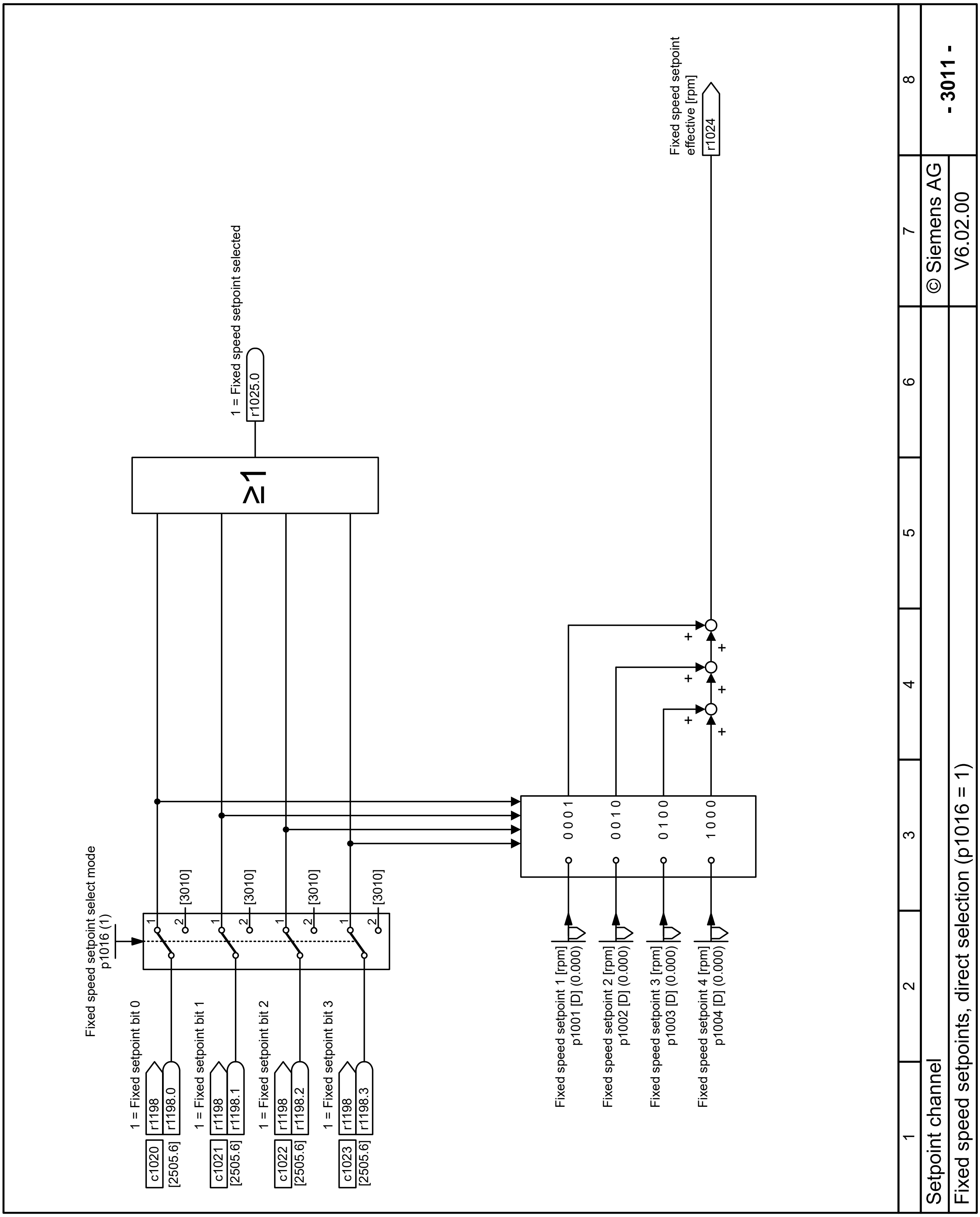


Figure 14-56 3011 - Fixed speed setpoints, direct selection

14.9.5 Setpoint inversion

Overview

The "Invert" function changes the setpoint polarity.

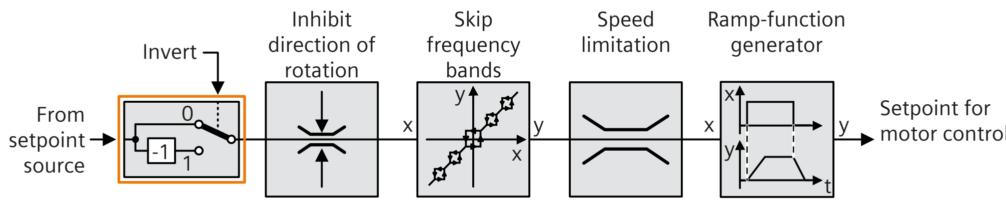


Figure 14-57 Setpoint processing in the converter

Description of function

The function inverts the sign of the setpoint using a binary signal.

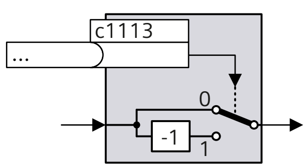


Figure 14-58 Setpoint inversion in the extended setpoint channel

Parameters

The following list contains the parameters of the "Setpoint inversion" function.

Number	Name	Unit
c1113[0...n]	Setpoint inversion	

14.9.6 Direction reversal without changing the setpoint

Overview

Parameters p1820 and p1821 make it possible to reverse the direction of the motor.

Requirement

The direction of the motor can be reversed when the motor is switched off.

Parameter p1821 can only be adjusted during commissioning.

NOTICE
Damage to the motor caused by unregulated acceleration
When using an external actual speed value for the speed controller via p1440, positive feedback can occur in the closed-loop speed control when the direction is reversed, which can cause the motor to accelerate up to its limit speed and suffer damage as a result. • When reversing the direction of the motor, also change the polarity of the external actual speed value.

Description of function

Parameters p1820 and p1821 change the direction of rotation of the motor without the motor power connections having to be swapped.

Parameter p1820 changes the output phase sequence in the converter. This reverses the rotating field of the motor. When using an encoderless motor, it is sufficient to change p1820. When operating a motor with an encoder, the encoder signal must also be inverted, for example using p0410.

Parameter p1821 also changes the direction of rotation of the motor, in its case by changing the output phase sequence of the converter. p1821 inverts the encoder signal like p1820.

The direction reversal can be detected with reference to the motor direction of rotation and via the phase-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	

14.9.7 Direction limiting

Overview

The "Direction limiting" function prevents the motor from rotating in the incorrect direction. This can make sense for conveyor belts, extruders, pumps and fans, for example.

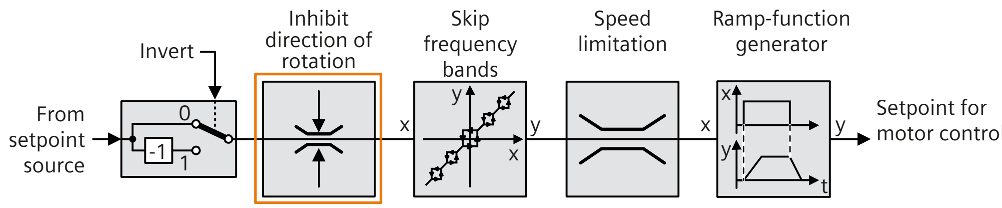


Figure 14-59 Setpoint processing in the converter

Description of function

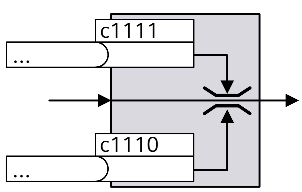


Figure 14-60 Direction limiting in the extended setpoint channel

Both directions of rotation of the motor are enabled in the factory setting of the converter.

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	

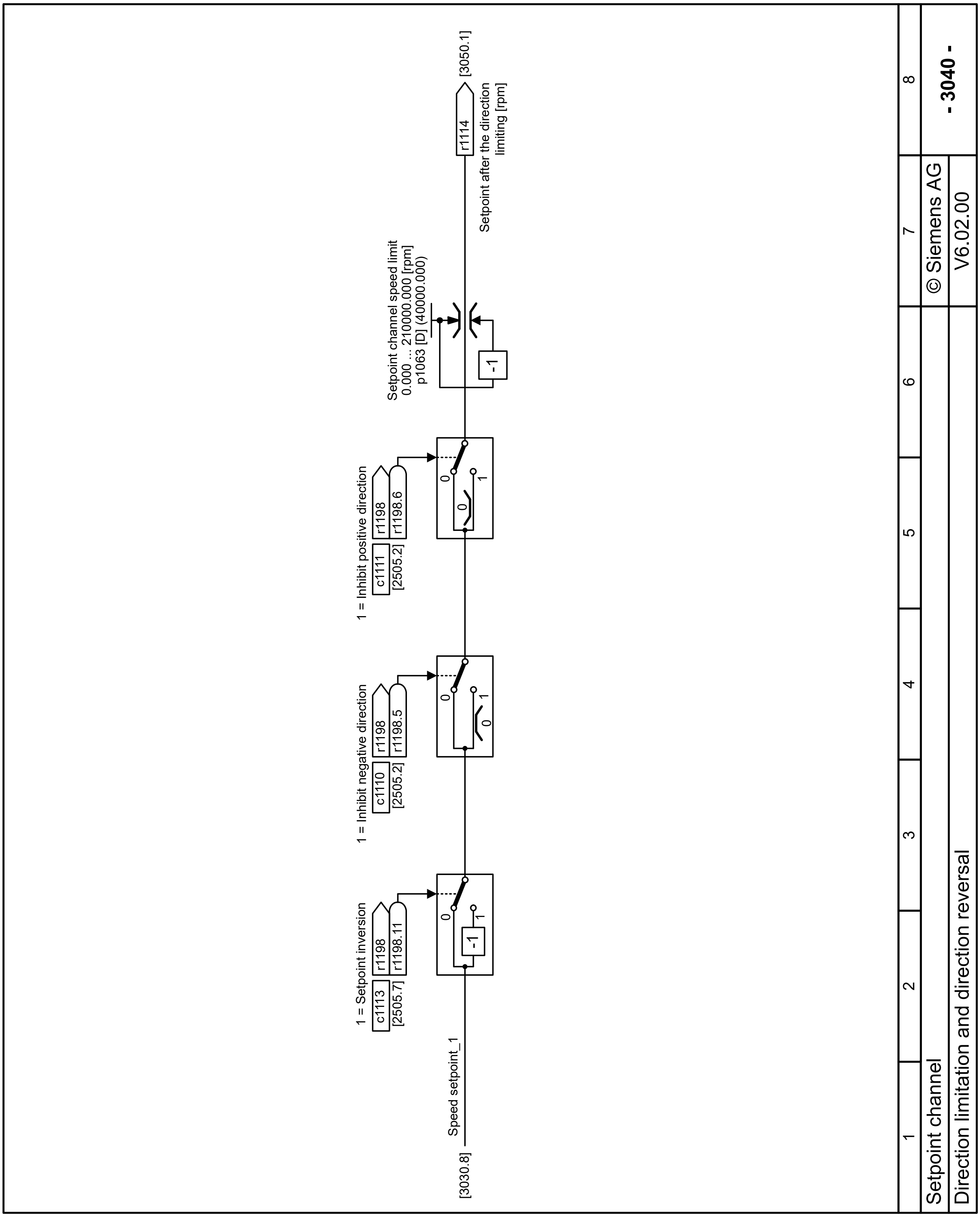


Figure 14-61 3040 - Direction limitation and direction reversal

14.9.8 Minimum speed

Overview

An example of this is a conventional pump application in which a specific delivery rate must be maintained. Accordingly, the motor speed must not fall below the minimum speed.

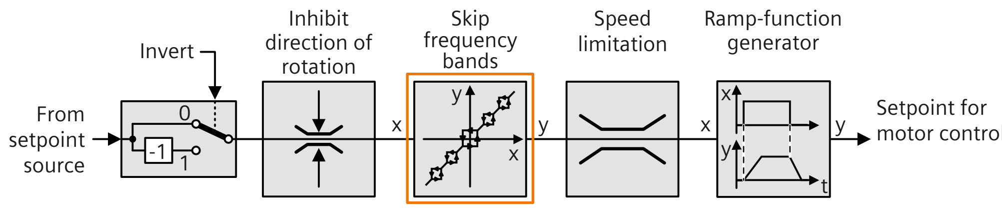


Figure 14-62 Setpoint processing in the converter

Description of function

The minimum speed prevents the continuous operation of the motor at speeds less than the minimum speed.

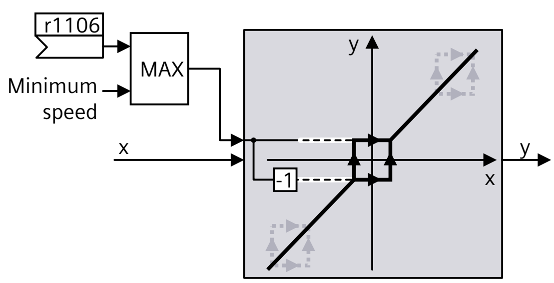


Figure 14-63 Minimum speed in the extended setpoint channel

Speeds whose absolute value is less than the minimum speed are only possible when the motor is accelerating or braking.

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]

14.9.9 Skip frequency bands

Overview

This function prevents mechanical resonance effects by only permitting the motor to operate temporarily at specific speeds.

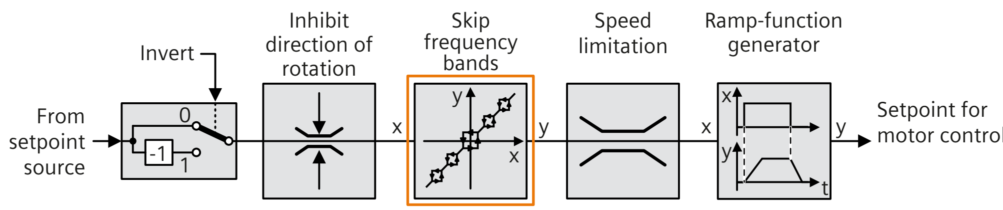


Figure 14-64 Setpoint processing in the converter

Description of function

The converter has 4 skip frequency bands.

Each skip frequency band prevents continuous operation of the motor within a specific speed range.

This function prevents mechanical resonance effects by only permitting the motor to operate temporarily at specific speeds.

Parameters

The following list contains the parameters of the "Skip frequency bands" function.

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]

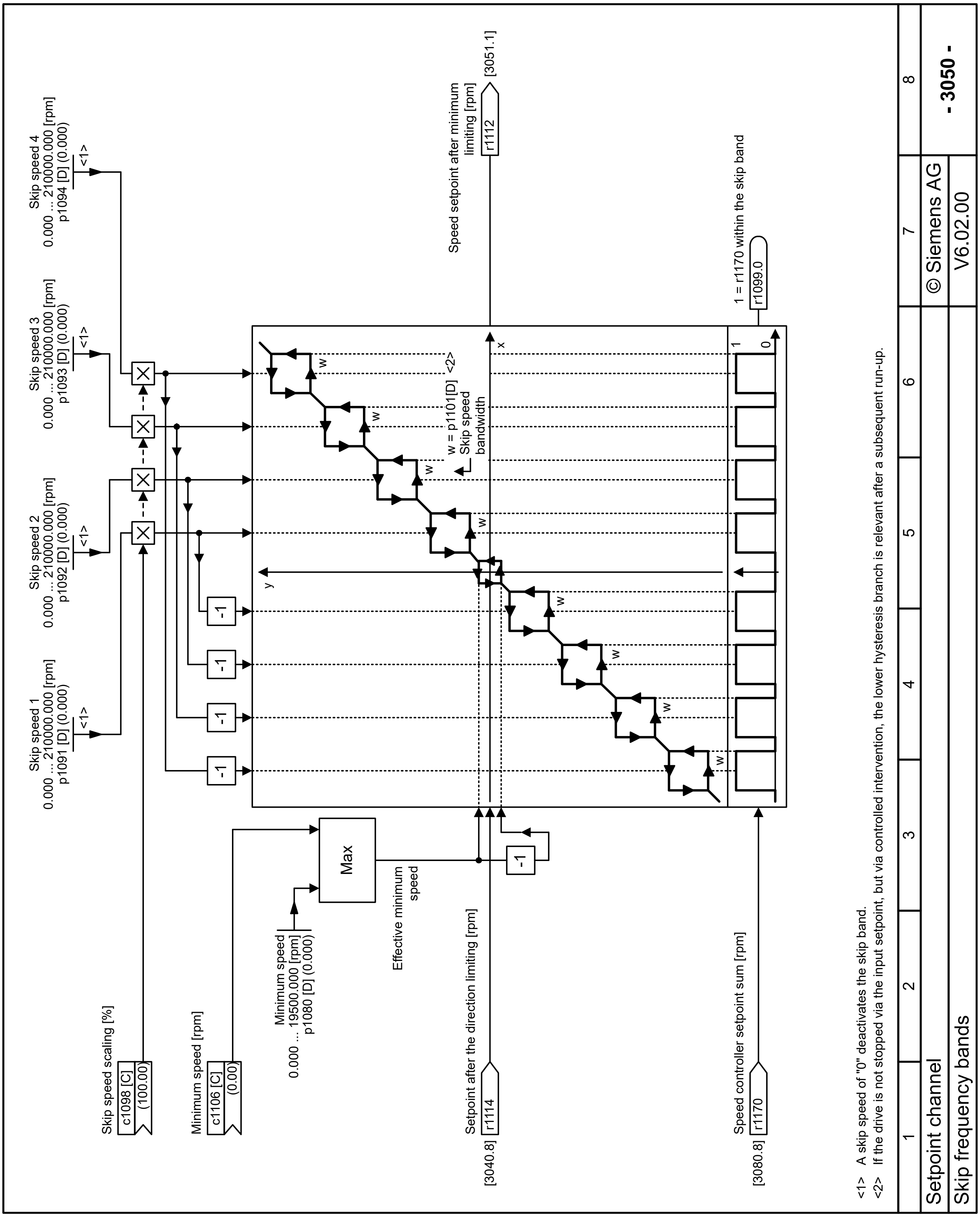


Figure 14-65 3050 - Skip frequency bands

14.9.10 Speed limitation

Overview

The speed limitation protects the motor and the driven load against excessively high speeds.

Description of function

The maximum speed limits the speed setpoint range in both directions.

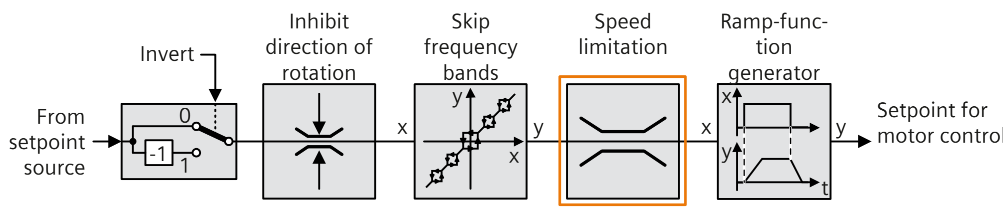


Figure 14-66 Setpoint processing in the converter

The converter generates a message (fault or alarm) when the maximum speed is exceeded.

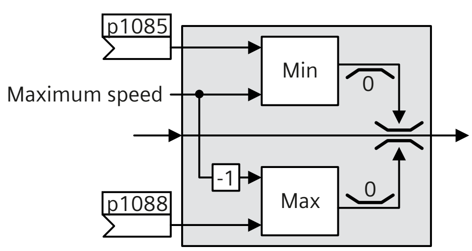


Figure 14-67 Speed limitation in the extended setpoint channel

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]

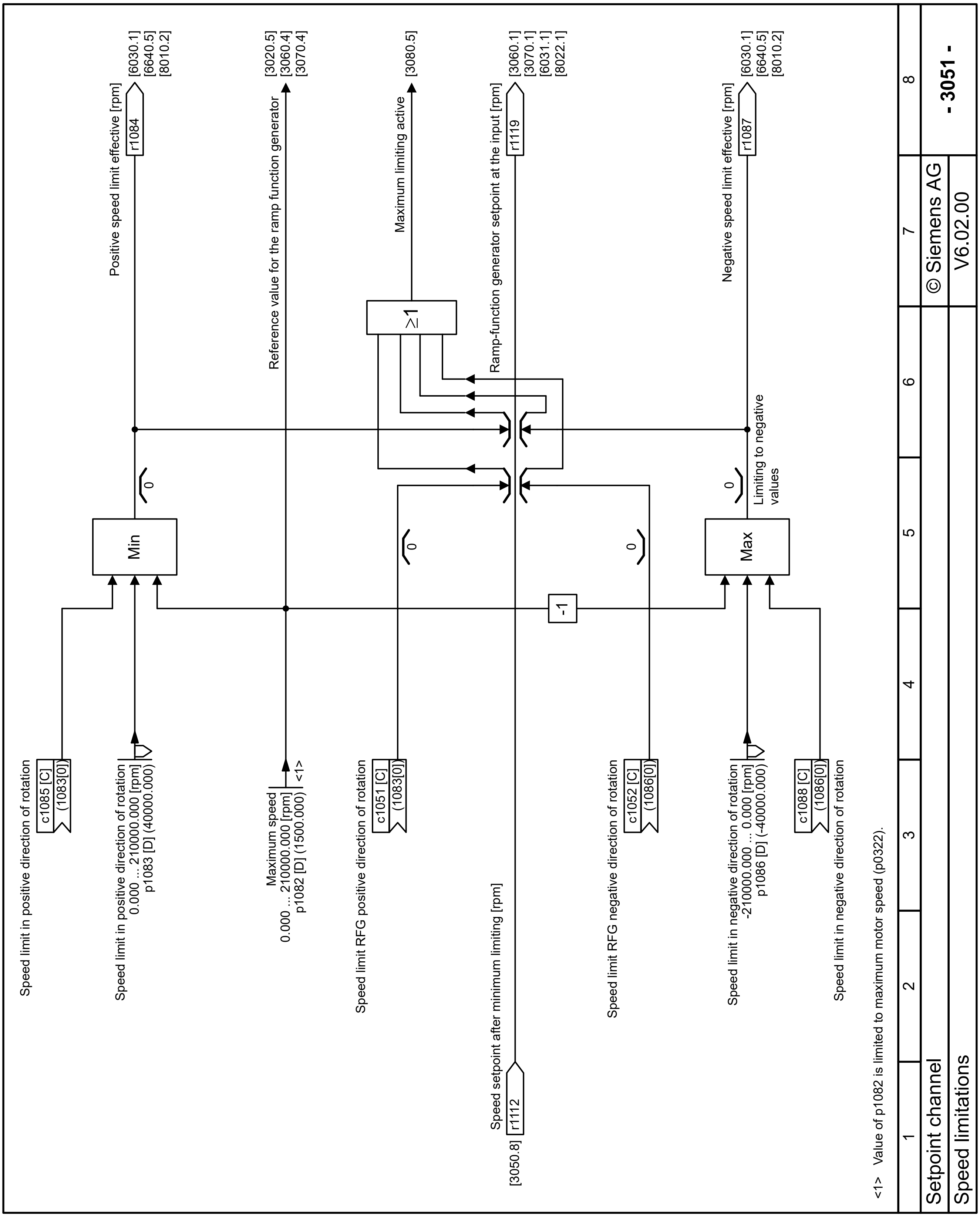


Figure 14-68 3051 - Speed limitations

14.9.11 Ramp-function generator

14.9.11.1 Extended ramp-function generator

Overview

The ramp-function generator reduces the load on the mechanical system of the driven machine.

With the extended ramp-function generator, acceleration and deceleration are not linear. Rounding at the start and end areas using a selected rounding type can be parameterized to make the transitions smoother.

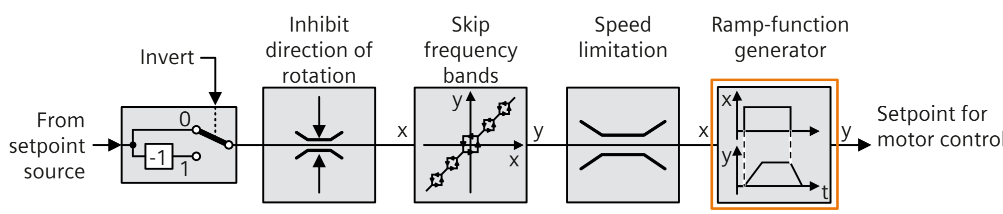


Figure 14-69 Setpoint processing in the converter

Description of function

The extended ramp-function generator limits the change of acceleration (jerk) by rounding the setpoint. As a result, the torque does not build up suddenly in the motor.

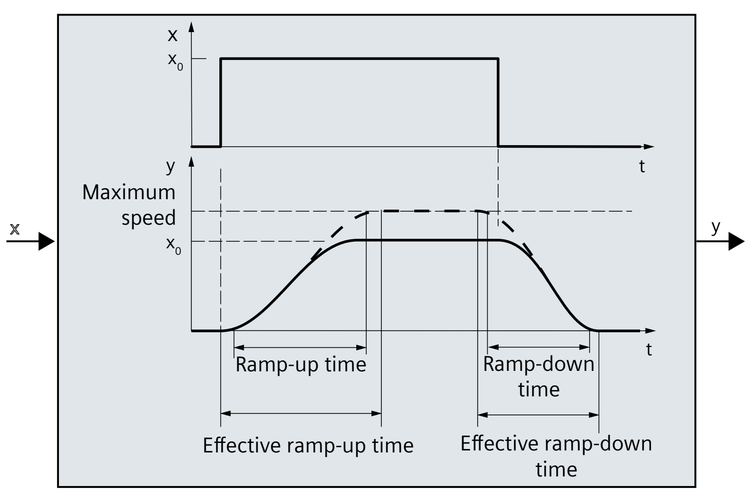


Figure 14-70 The extended ramp-function generator in the extended setpoint channel

The ramp-up and ramp-down times of the extended ramp-function generator can be set independent of each other.

The optimal times depend on your application, and can lie in the range from a few 100 ms to several minutes.

Initial and final rounding allow jerk-free acceleration and braking.

The ramp-up and ramp-down times of the motor are increased by the roundings:

- Effective ramp-up time = p1120 + 0.5 · (p1130 + p1131).
- Effective ramp-down time = p1121 + 0.5 · (p1130 + p1131).

Parameters

The following list contains the parameters of the "Extended ramp-function generator" function.

Number	Name	Unit
p1115	Ramp-function generator selection	
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	[%]

14.9.11.2 Basic ramp-function generator

Overview

The ramp-function generator reduces the load on the mechanical system of the driven machine.

The basic ramp-function generator limits the acceleration and deceleration of the motor using linear ramps.

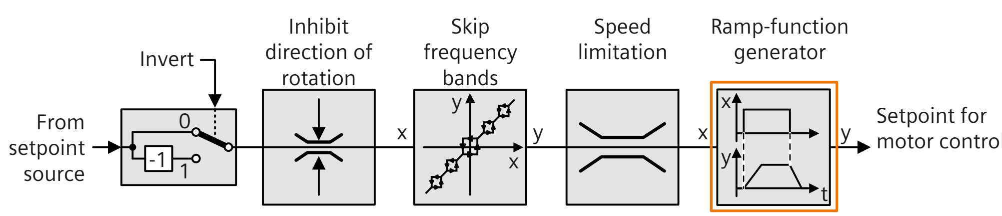


Figure 14-71 Setpoint processing in the converter

Description of function

Unlike the extended ramp-function generator, the basic ramp-function generator does not use rounding times.

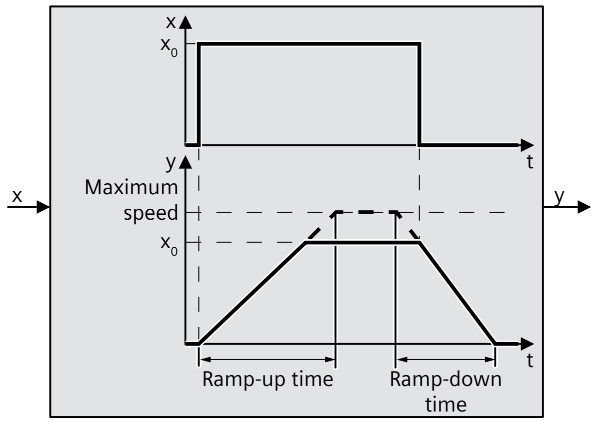


Figure 14-72 Basic ramp-function generator in the extended setpoint channel

Parameters

The following list contains the parameters of the "Basic ramp-function generator" function.

Number	Name	Unit
p1082[0...n]	Maximum speed	[rpm]
p1115	Ramp-function generator selection	
p1120[0...n]	Ramp-function generator ramp-up time	[s]
p1121[0...n]	Ramp-function generator ramp-down time	[s]
p1135[0...n]	OFF3 ramp-down time	[s]

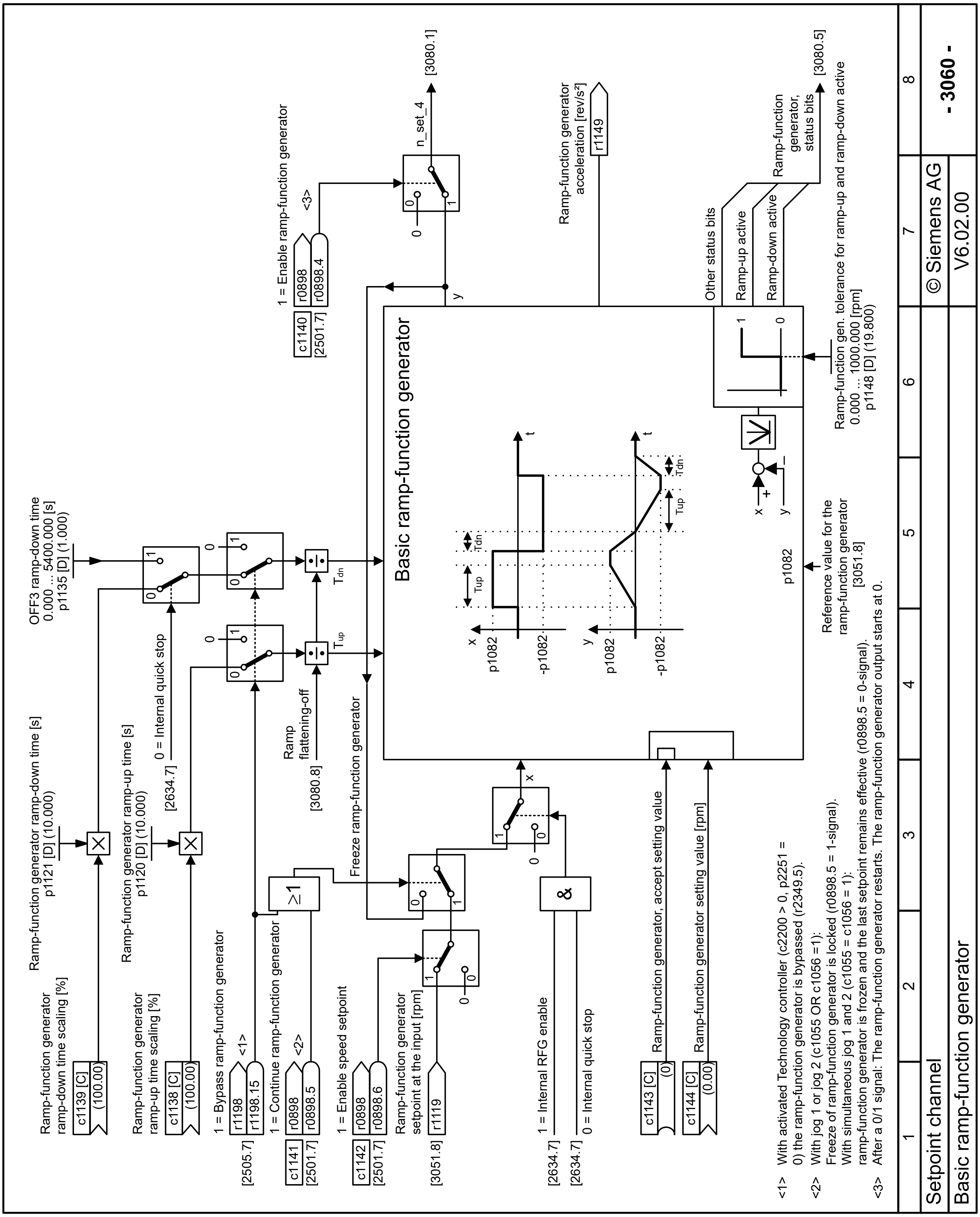


Figure 14-73 3060 - Basic ramp-function generator

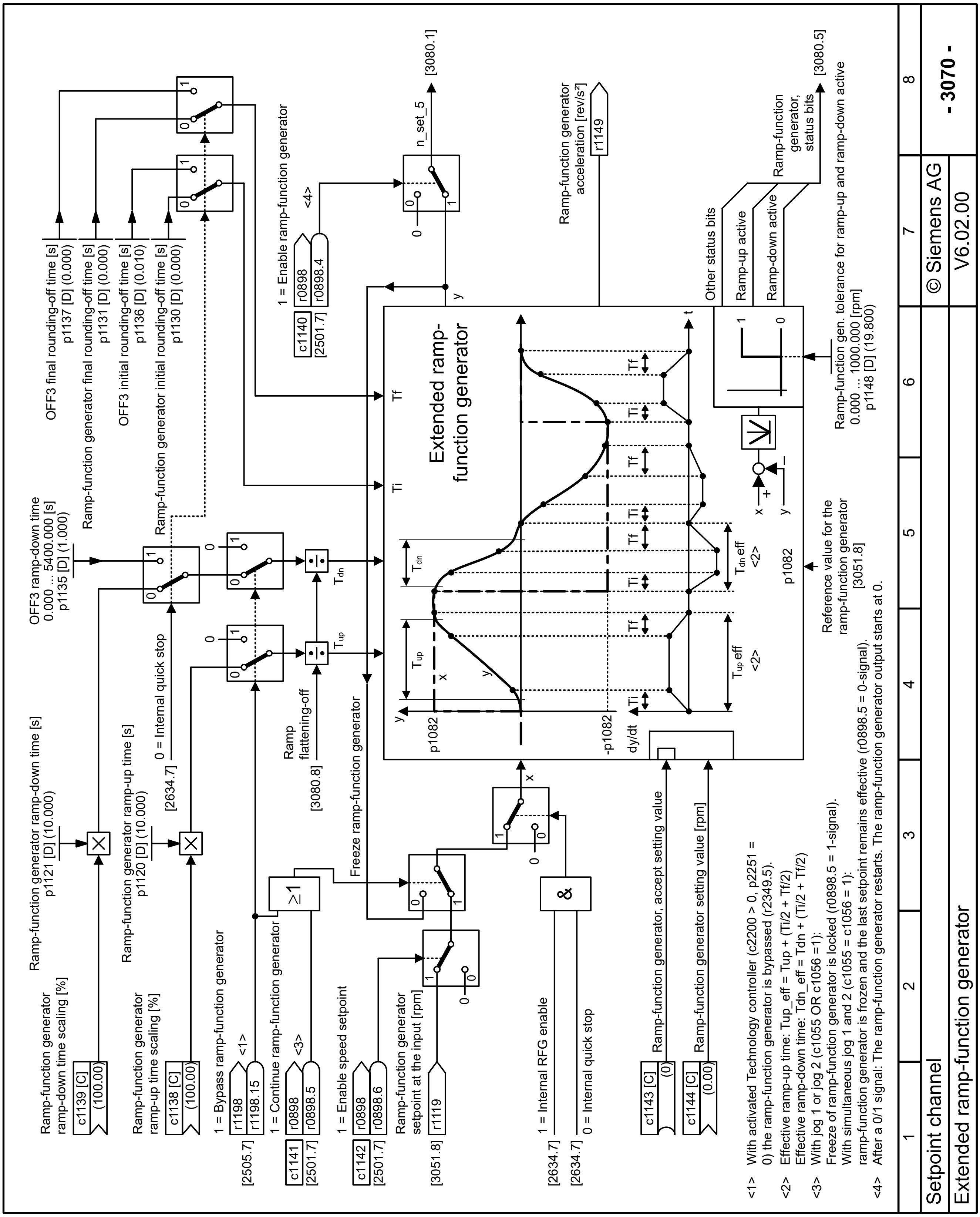


Figure 14-74 3070 - Extended ramp-function generator

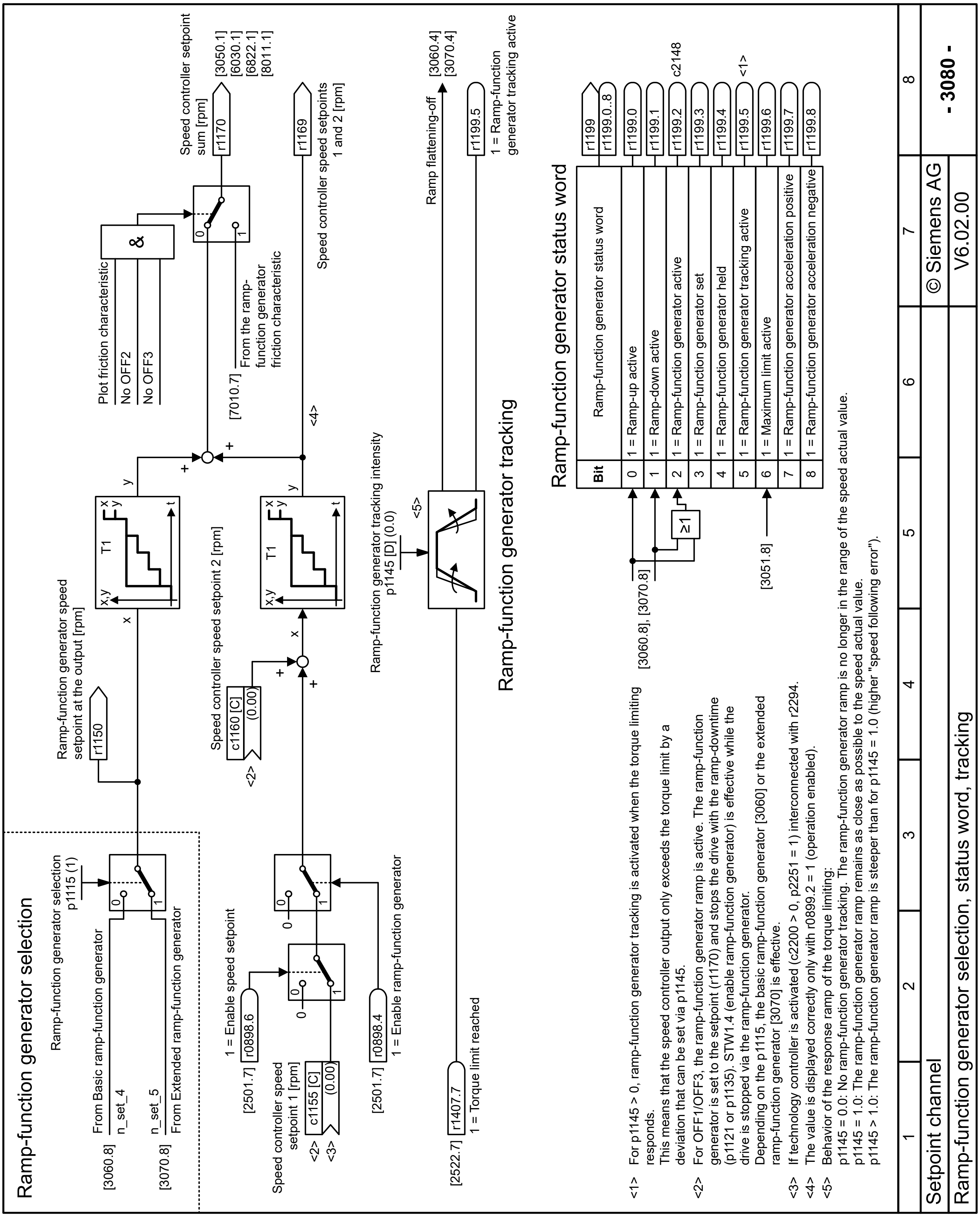


Figure 14-75 3080 - Ramp-function generator selection, status word, tracking

14.9.12 Jog

Overview

The Jog function is typically used to temporarily move a motor using local control commands.

Description of function

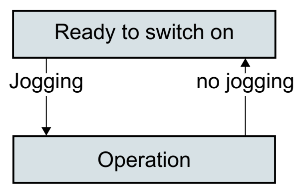


Figure 14-76 Jog

Commands "Jog 1" and "Jog 2" switch the motor on and off.

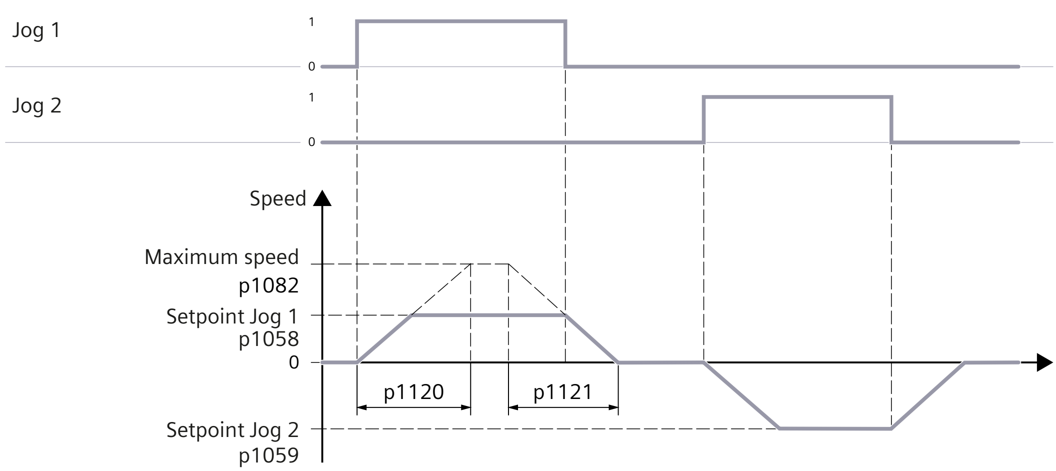


Figure 14-77 Behavior of the motor when jogging

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 bit 0	
c1056[0...n]	Jog bit 1	
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]

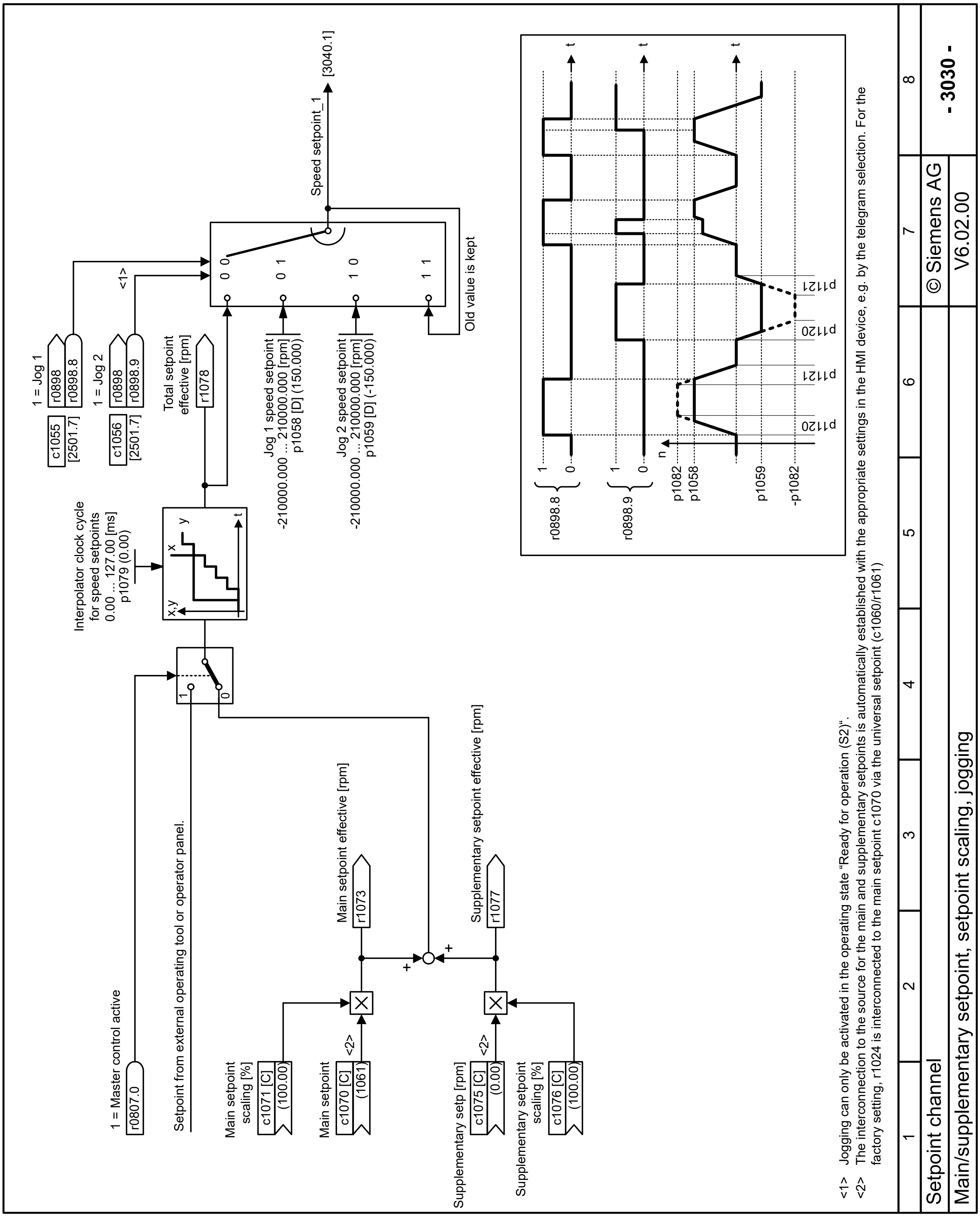


Figure 14-78 3030 - Main/supplementary setpoint, setpoint scaling, jogging

14.10 Closed-loop drive control

14.10.1 Motor reactor, sine-wave filter, and cable resistance

Overview

The following components between the converter and the motor influence the closed-loop control quality of the converter:

- Motor reactors or sine-wave filters
- Motor cable with unusually high cable resistance

Description

In the factory setting, for the motor data identification, the converter assumes that neither a motor reactor nor a sine-wave filter are connected at the converter output.

For the motor data identification, the converter assumes a cable resistance = 20% of the stator resistance of the cold motor.

Correct parameter setting of the components between the converter and the motor improves the closed-loop control quality of the motor.

Motor data identification is necessary after changing a parameter.

Parameters

The following list contains the parameters of the "Motor control" function.

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]

14.10.2 Standard Drive Control operating mode

14.10.2.1 Standard Drive Control

Overview

Standard Drive Control is open-loop speed control, and is more robust and has a higher speed accuracy than U/f control when starting the motor as well as when accelerating and braking the driven load.

Requirement

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.

Description of function

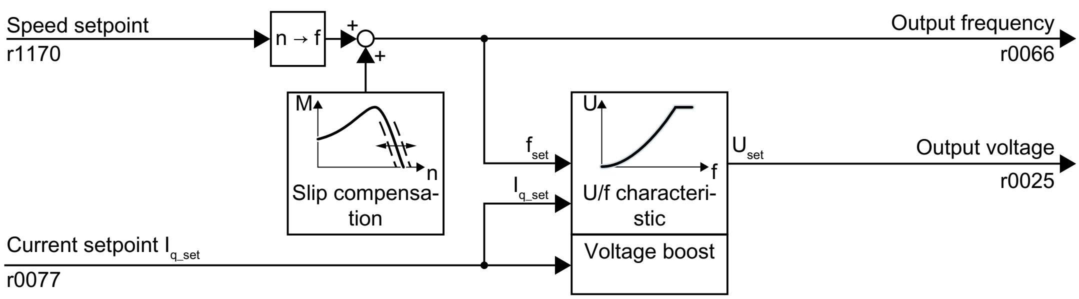
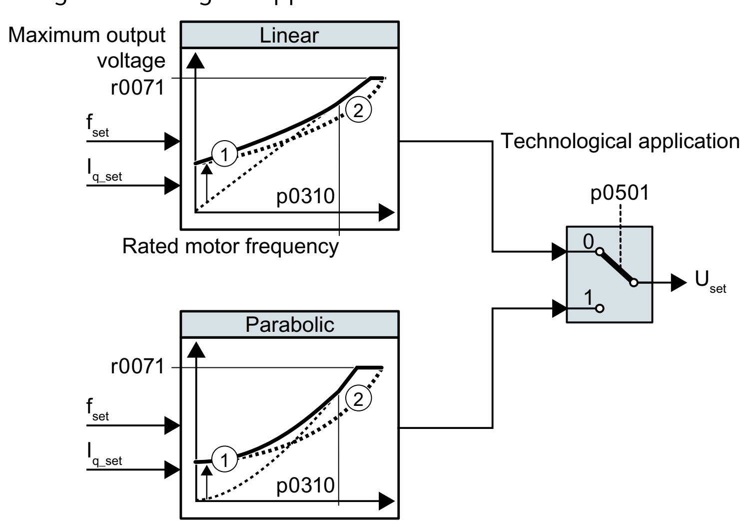


Figure 14-79 Default setting of the U/f control after selecting Standard Drive Control

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 U/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 14-80 Characteristics after selecting Standard Drive Control

- Slip compensation is activated.
- Soft starting is possible.
- Fewer setting options compared to U/f control

Parameters

The following list contains the parameters of the "U/f control with Standard Drive 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)	

14.10.2.2 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 14-70 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.

14.10.2.3 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.

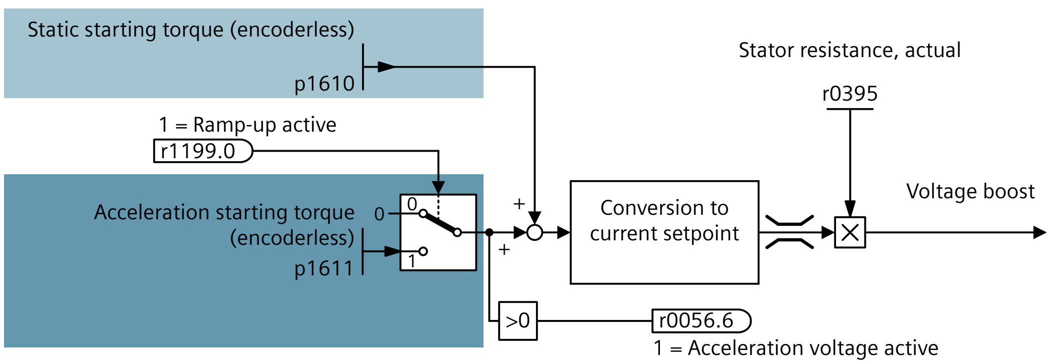


Figure 14-81 Simplified function diagram of the voltage boost

The following example shows the voltage boost for the U/f characteristic.

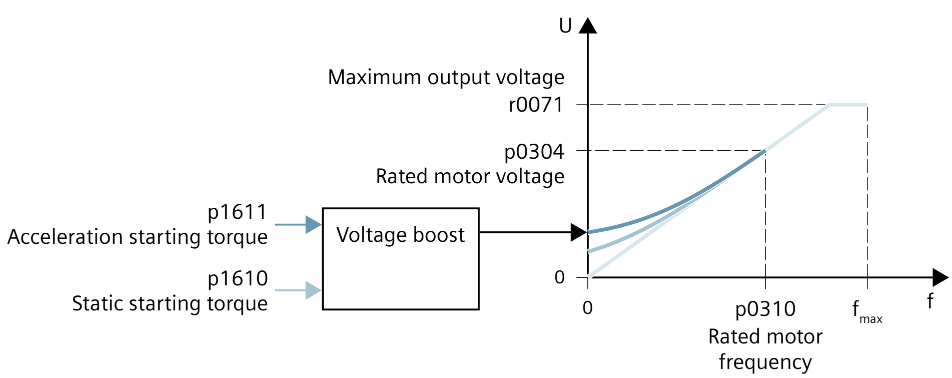


Figure 14-82 Voltage boost example for a linear U/f characteristic

Parameters

The following list contains the parameters of the "Optimize motor startup for Standard Drive Control operating mode" function.

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]

p1401[0...n].0...30	Flux control configuration	
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	

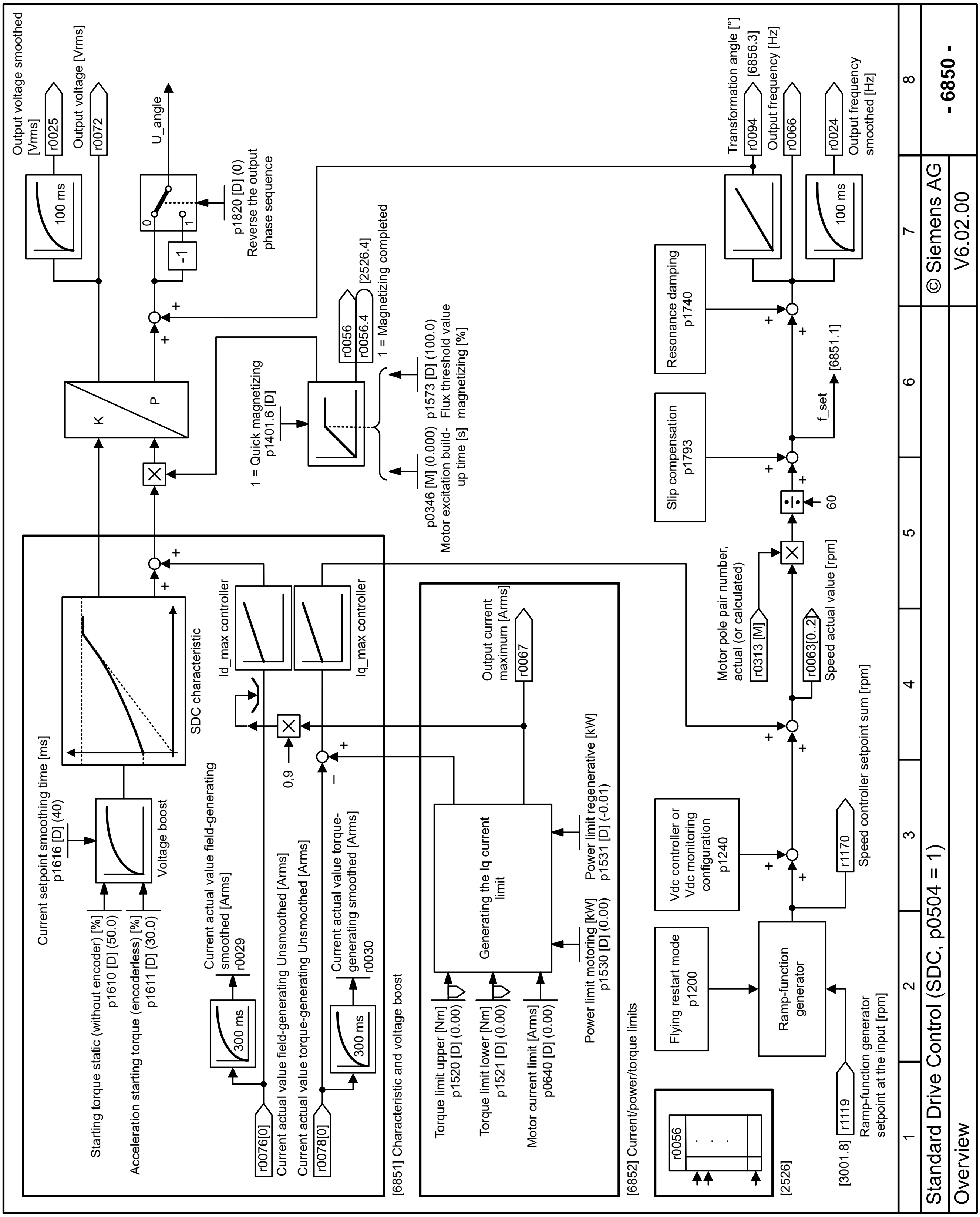


Figure 14-83 6850 - Overview

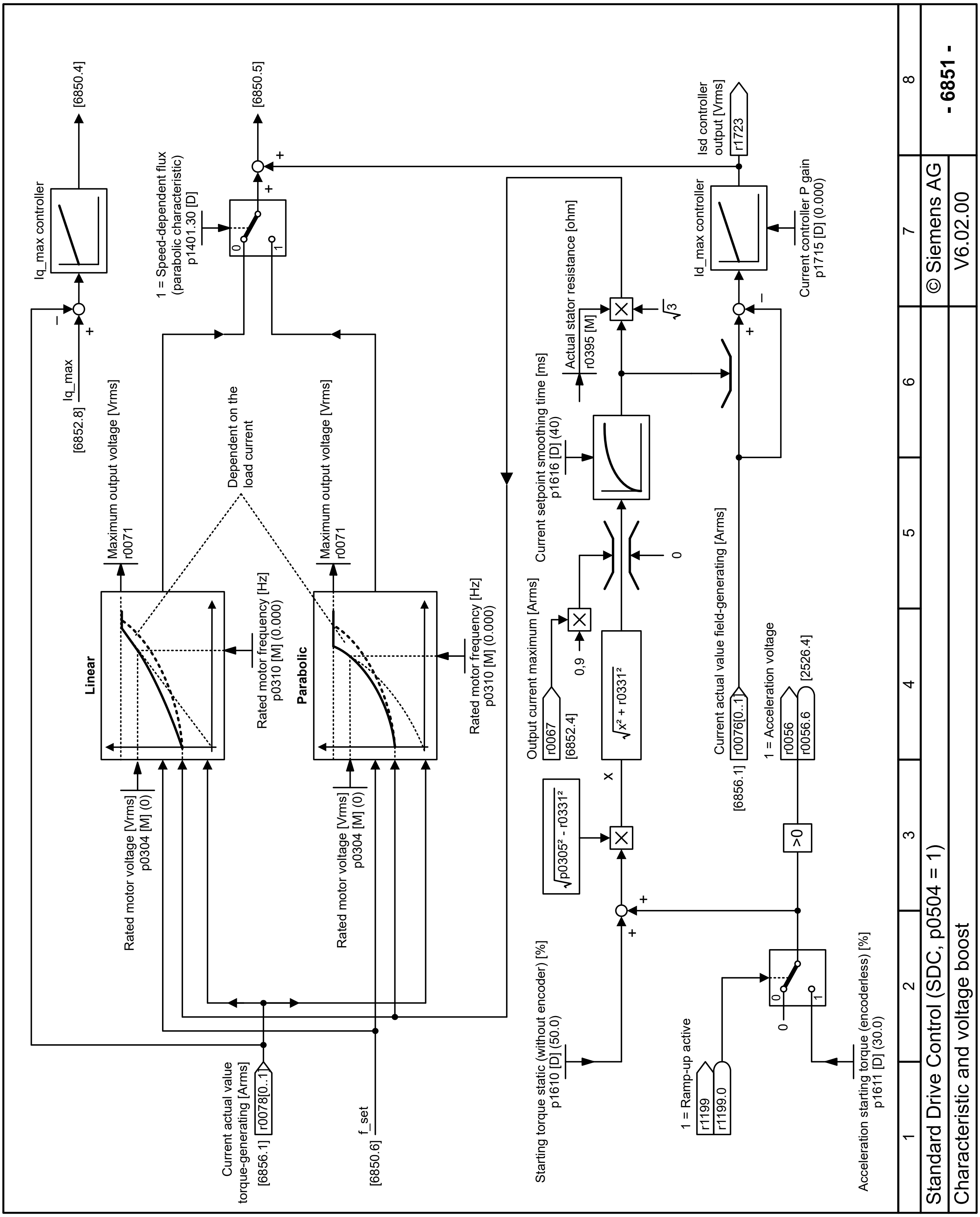


Figure 14-84 6851 - Characteristic and voltage boost

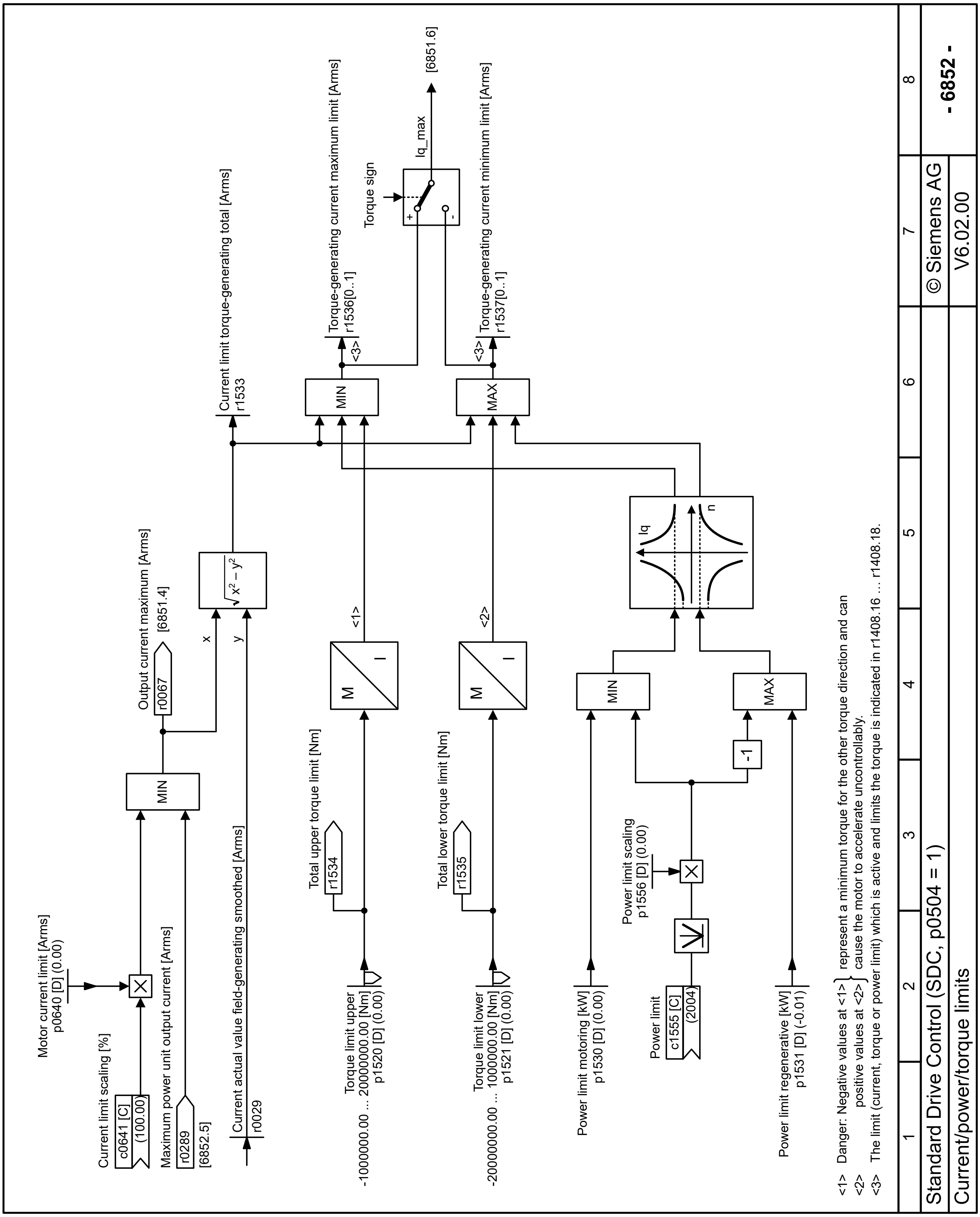


Figure 14-85 6852 - Current/power/torque limits

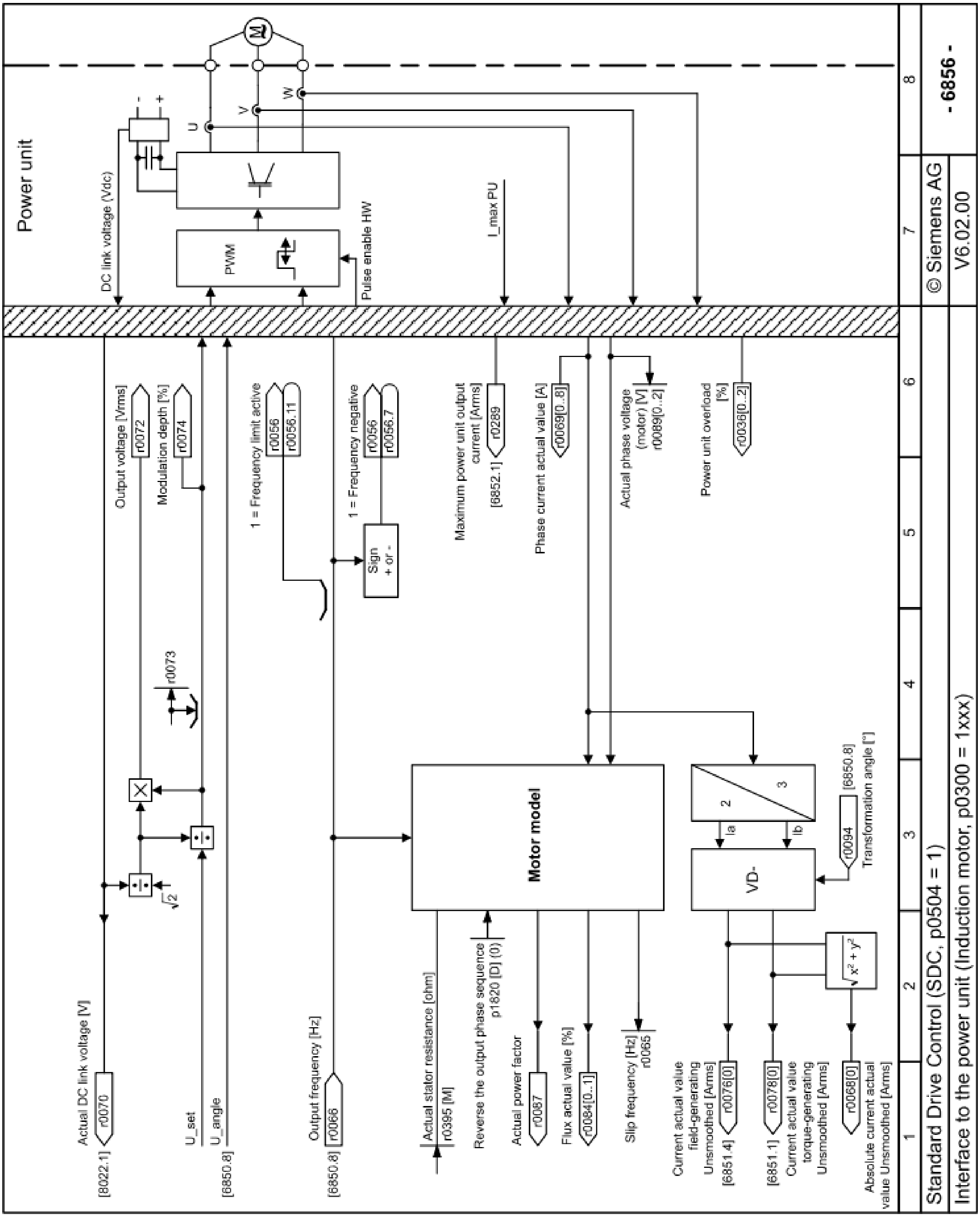


Figure 14-86 6856 - Interface to power unit (induction motor)

14.10.3 Dynamic Drive Control operating mode

14.10.3.1 Differences between speed control and Dynamic Drive Control

Overview

The Dynamic Drive Control operating mode has a higher speed accuracy and is more rugged with respect to load fluctuations when compared to the standard drive control operating mode. When compared to the "Closed-loop speed control" control mode, Dynamic Drive Control has a simplified structure and therefore less setting options.

Requirement

Dynamic Drive Control works with the following motors:

- Induction motor
- Synchronous motor without starting cage
- Reluctance motor without starting cage

Description of function

The Dynamic Drive Control operating mode is field-oriented vector control with speed control loop.

Setting options with and without selection of the Dynamic Drive Control operating modes:

	Speed control after selection of the Dynamic Drive Control operating mode	Speed control without selecting an operating mode
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

14.10.3.2 Setting of technological application in 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.

Description of function

The following settings are available to select for motor control with parameter p0502.

Table 14-71 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 control down to f = 0 (passive loads)	• Setting for encoderless control of induction motors, reluctance motors and permanent-magnet synchronous motors Innomotics PM 1FZ • Speed-controlled operation of induction motors at low speeds • Speed-controlled operation at low speeds using the pulse technique (a license is required) – for reluctance motors – for permanent-magnet synchronous motors Innomotics PM 1FZ • A passive load cannot accelerate the current-free motor. Examples are pumps, fans, extruders, but not hoisting gear

5	Starting with high break loose torque	• Setting for all motor types without 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 drives with high power and a total moment of inertia at least 5 times greater than the motor moment of inertia • Increased default setting of speed actual value smoothing • Optimized default setting of the speed controller

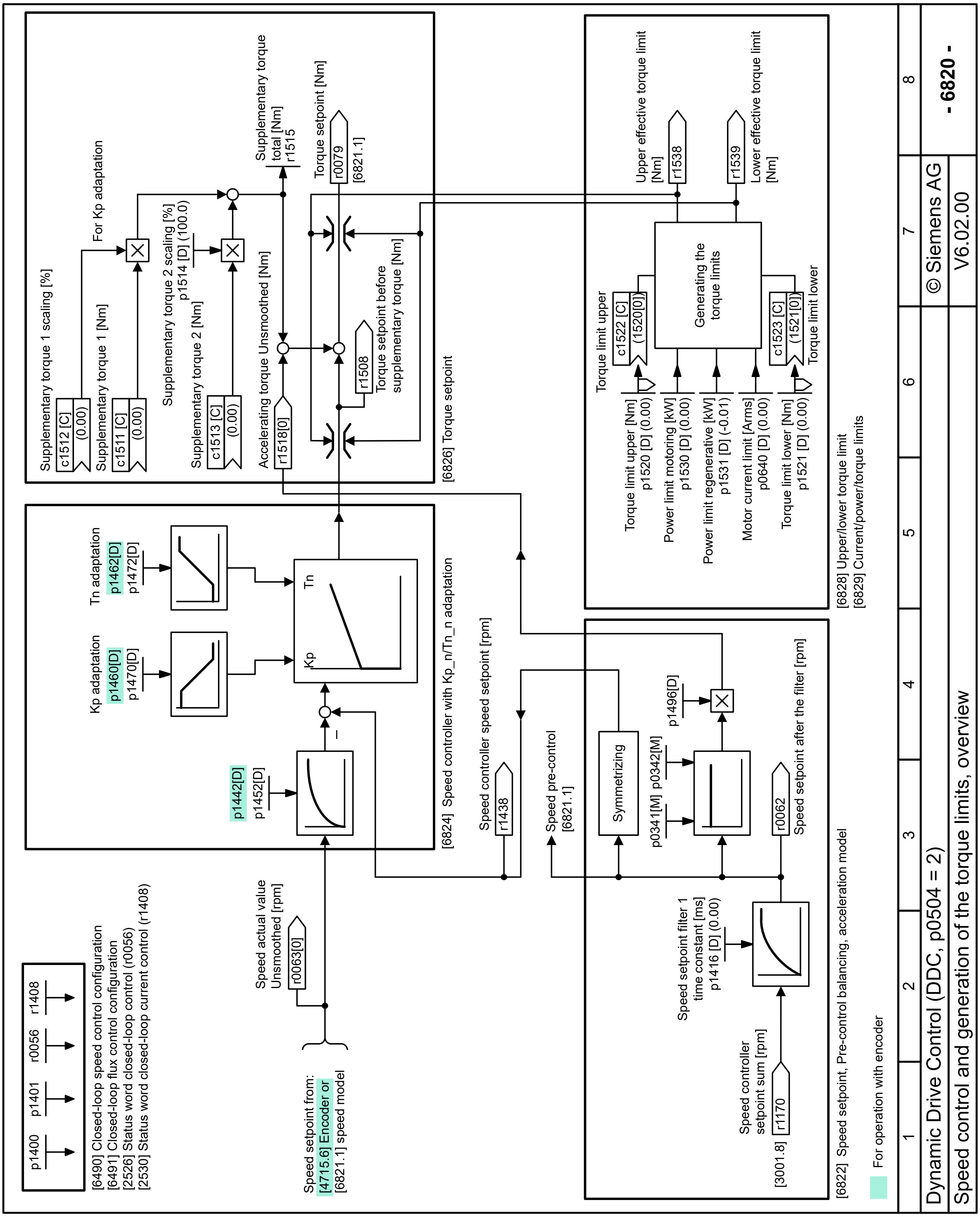


Figure 14-87 6820 - Speed control and generation of the torque limits, overview

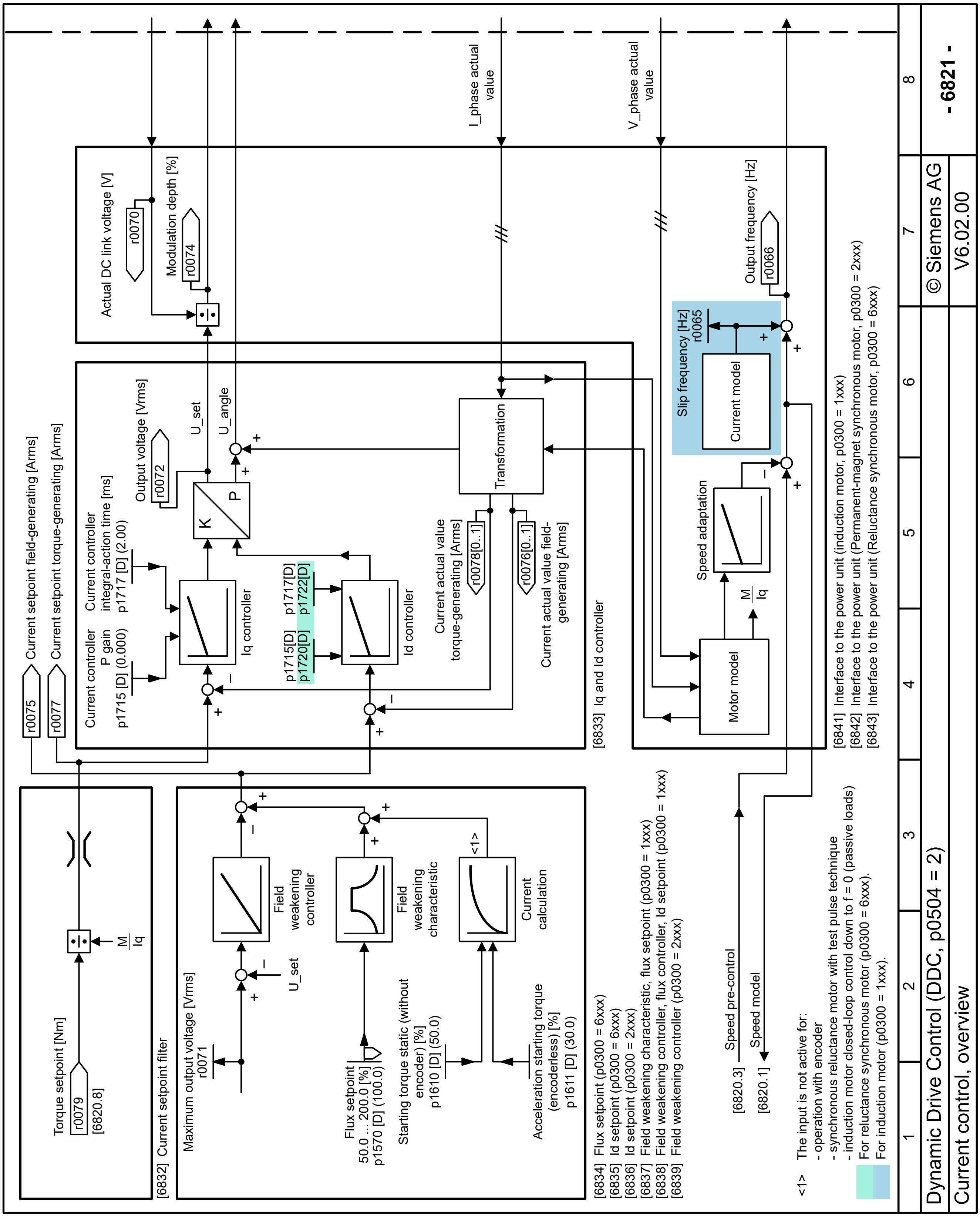


Figure 14-88 6821 - Current control, overview

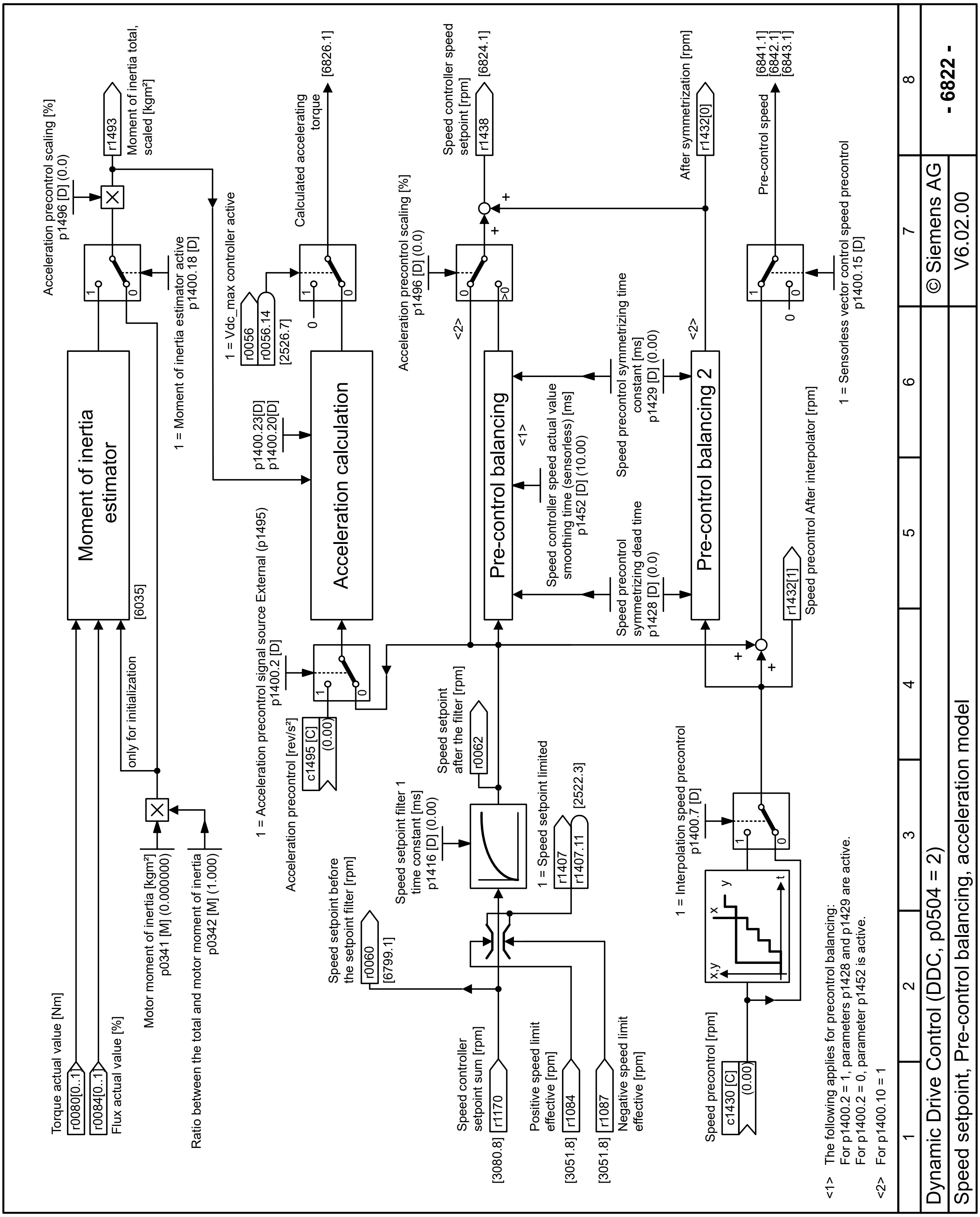


Figure 14-89 6822 - Speed setpoint, pre-control balancing, acceleration model

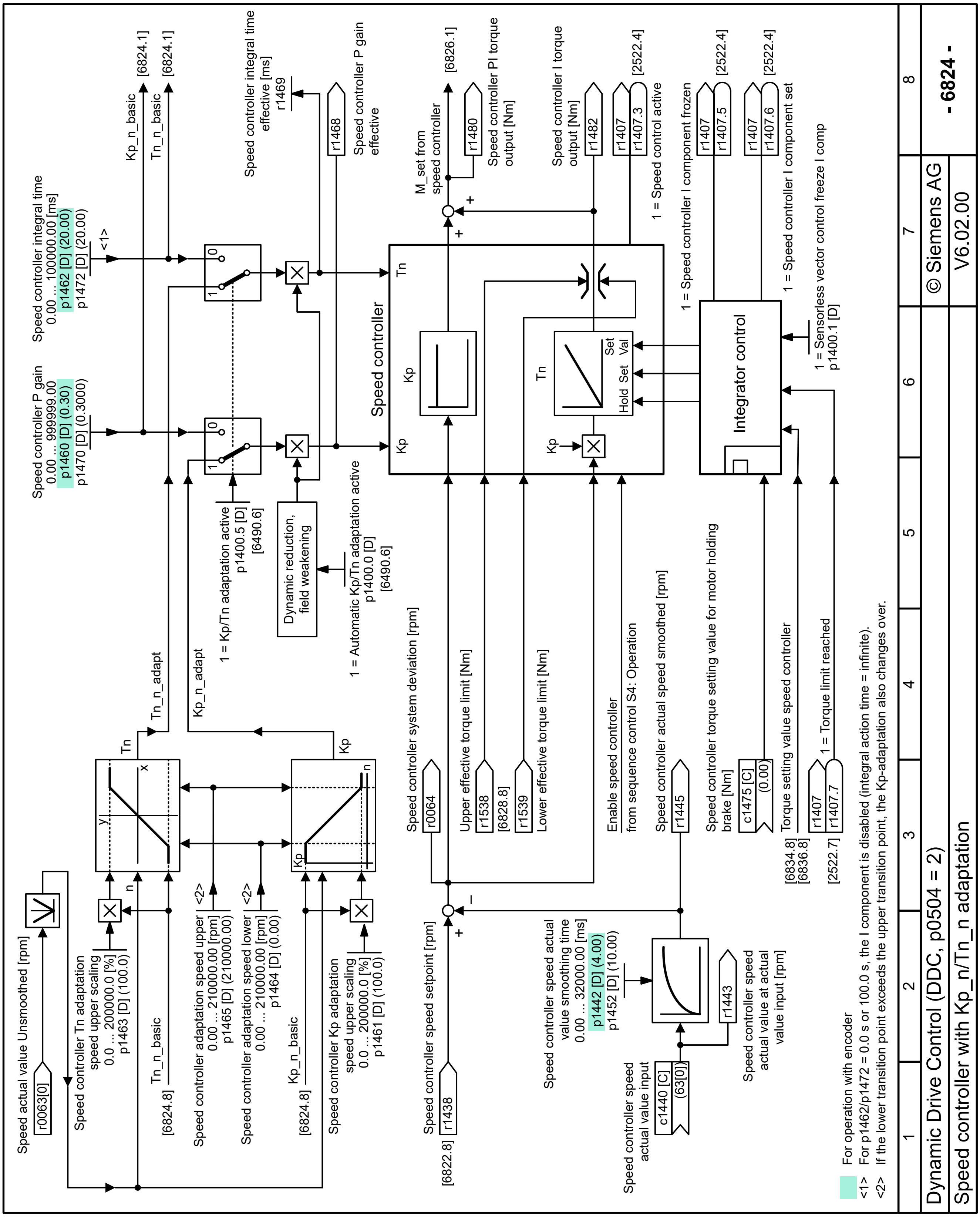


Figure 14-90 6824 - Speed controller with Kp_n-/Tn_n adaptation

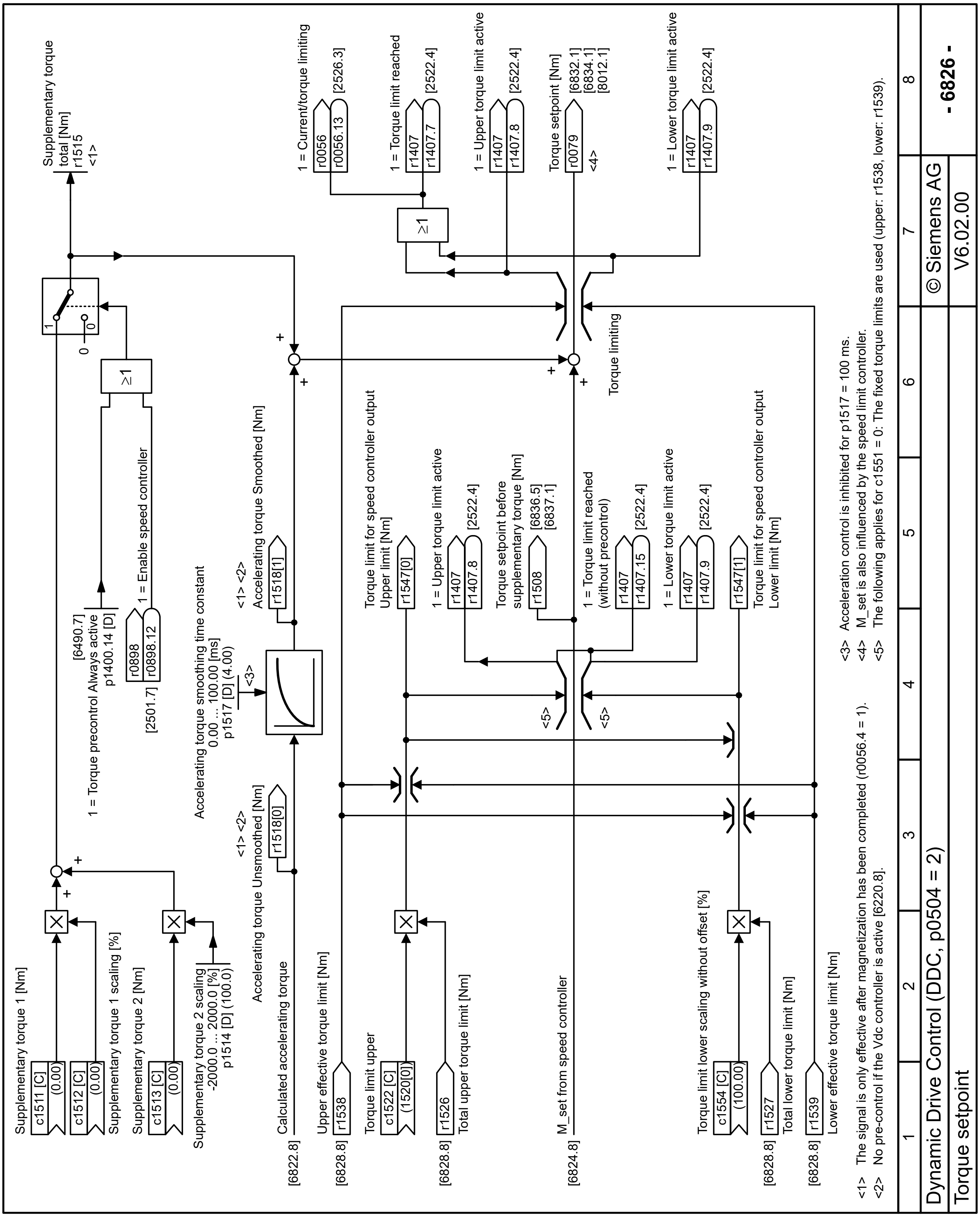


Figure 14-91 6826 - Torque setpoint

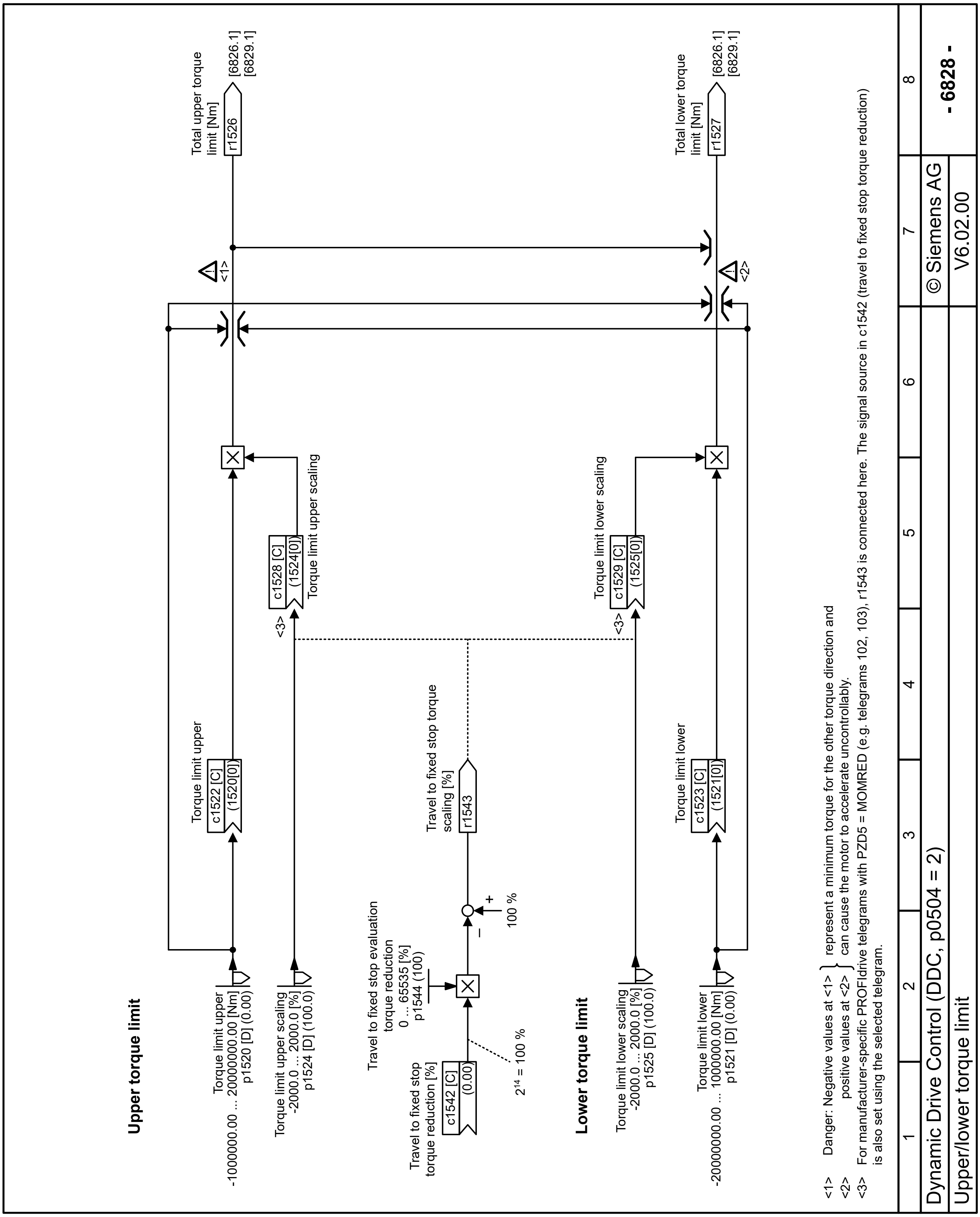


Figure 14-92 6828 - Upper/lower torque limit

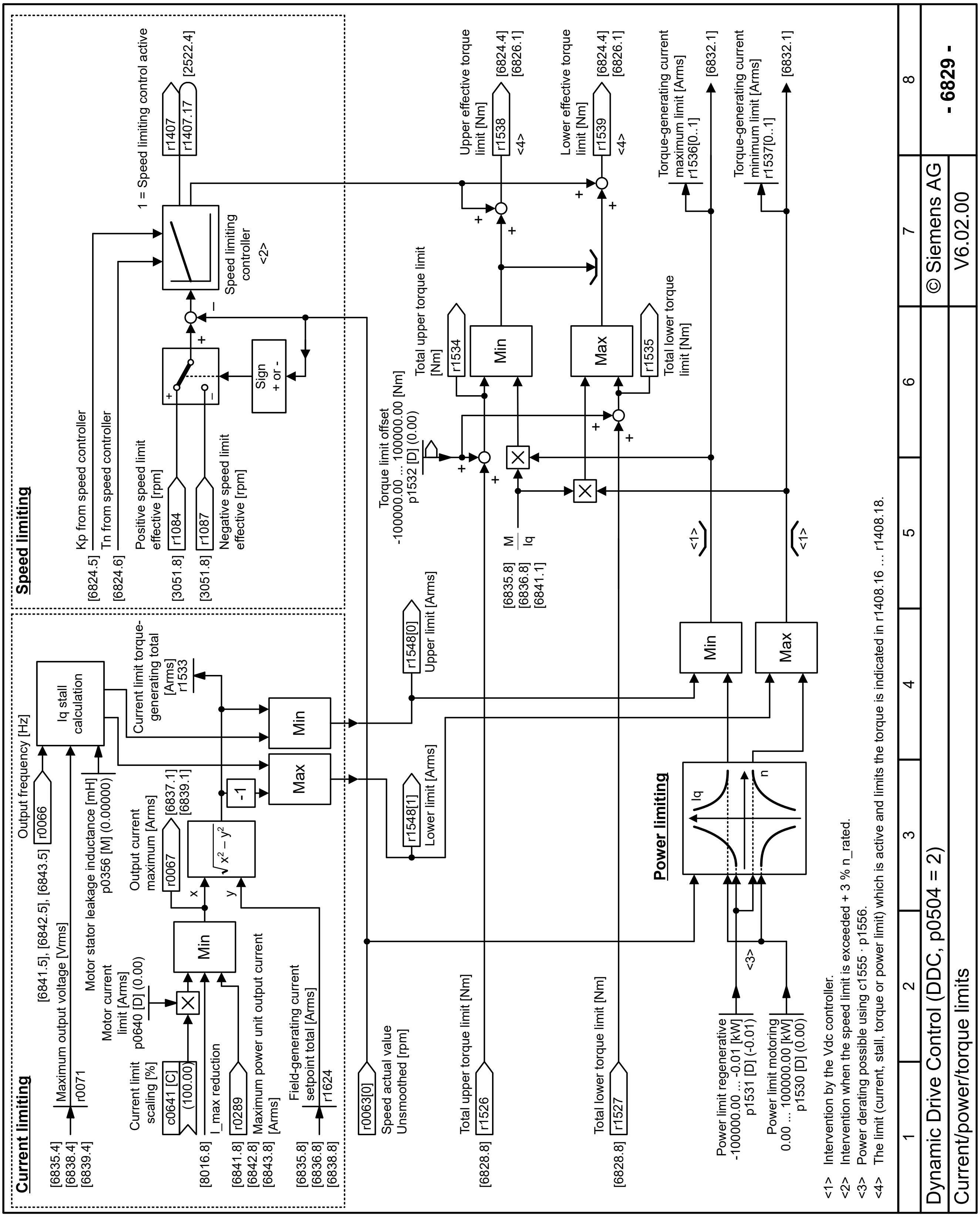


Figure 14-93 6829 - Current/power/torque limits

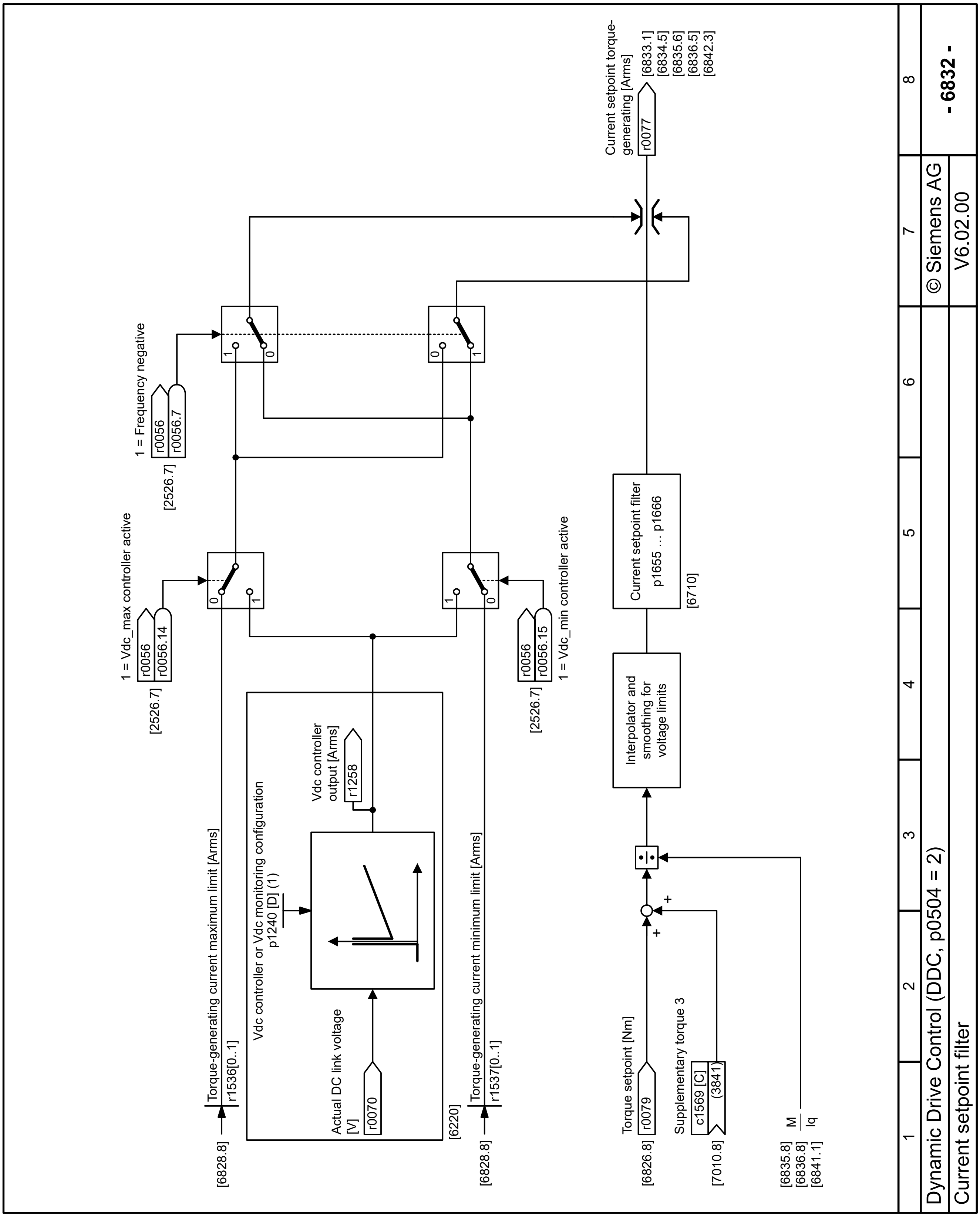


Figure 14-94 6832 - Current setpoint filter

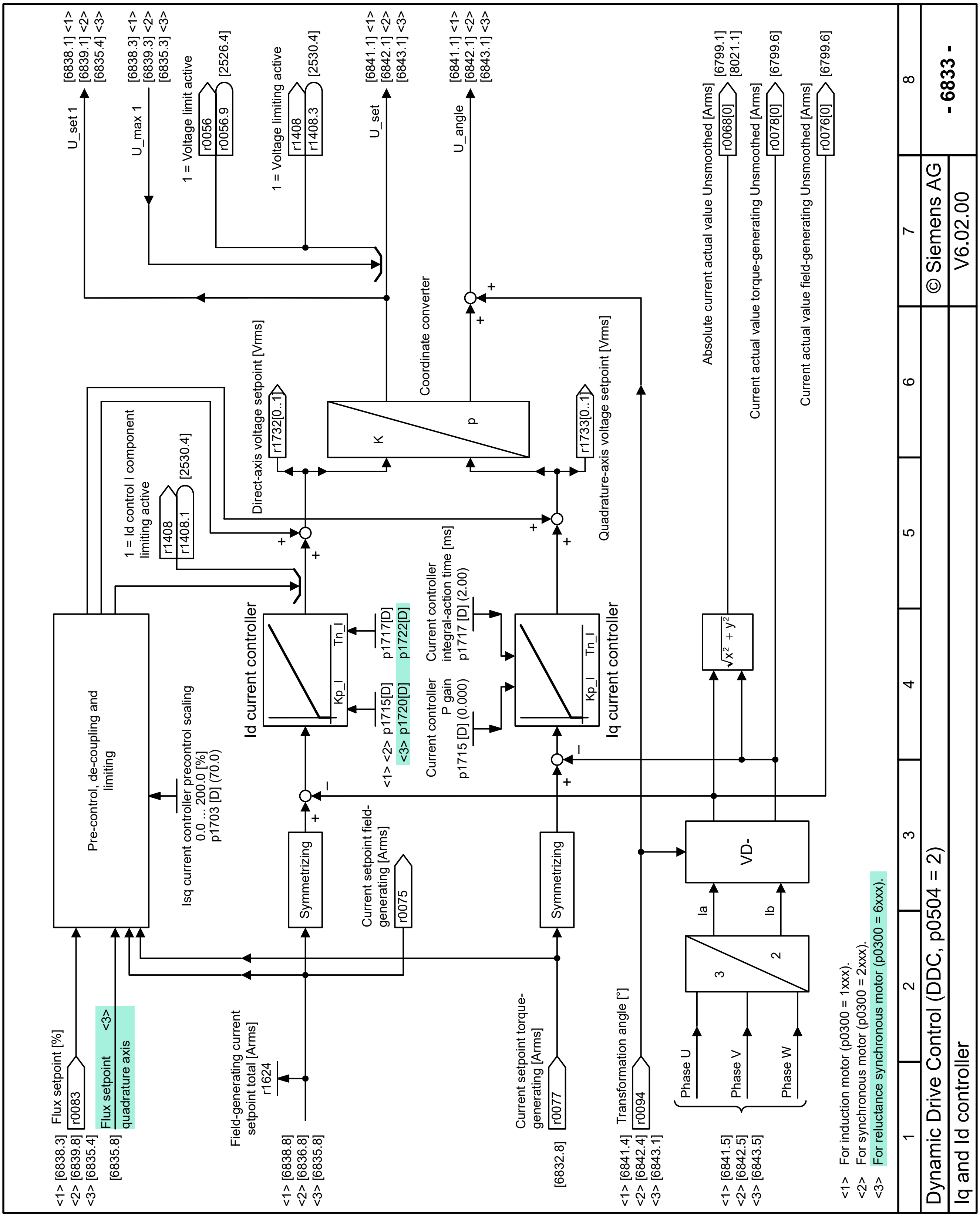


Figure 14-95 6833 - Iq and Id controllers

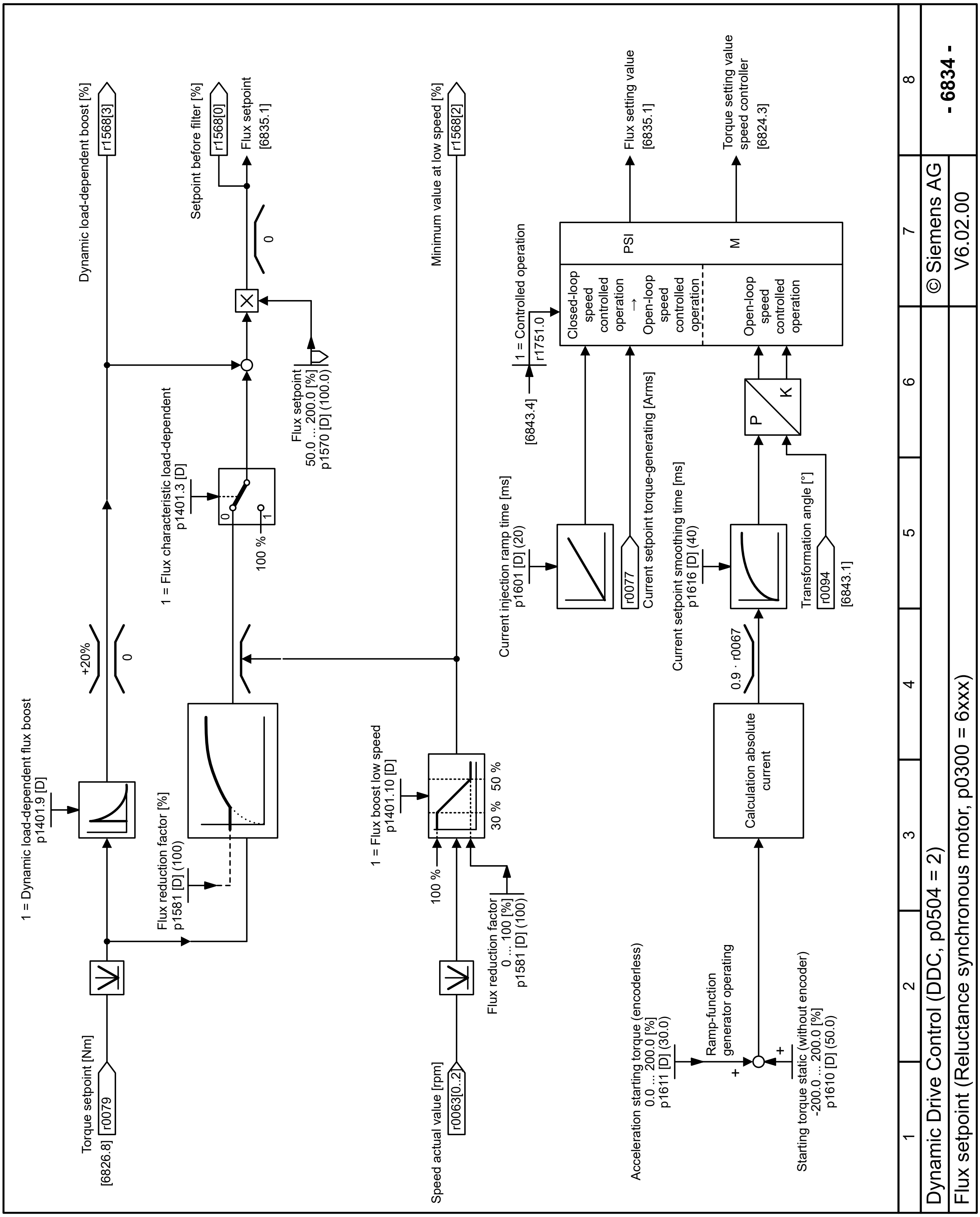


Figure 14-96 6834 - Flux setpoint (synchronous reluctance motor)

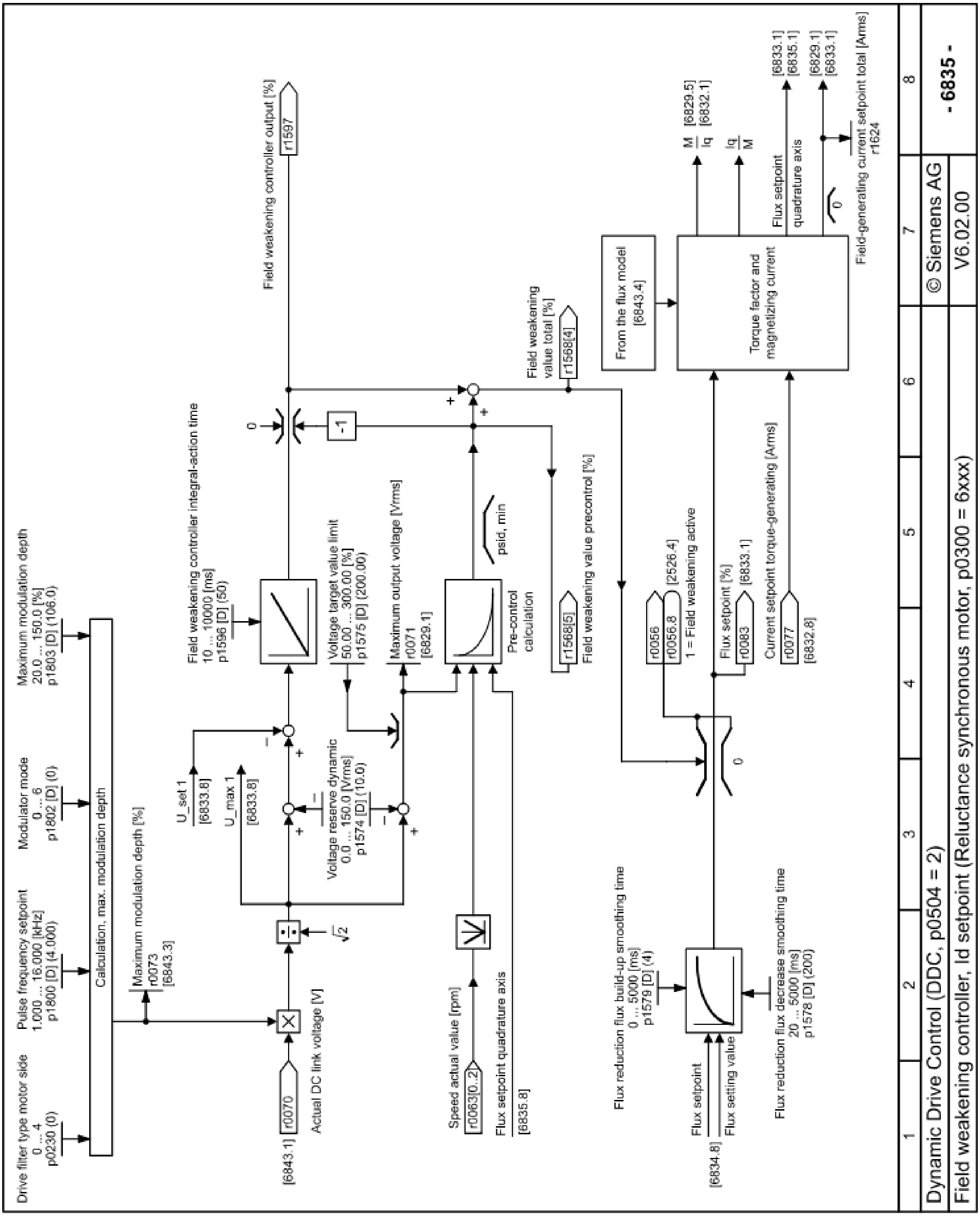


Figure 14-97 6835 – Field weakening controller, Id setpoint (synchronous reluctance motor)

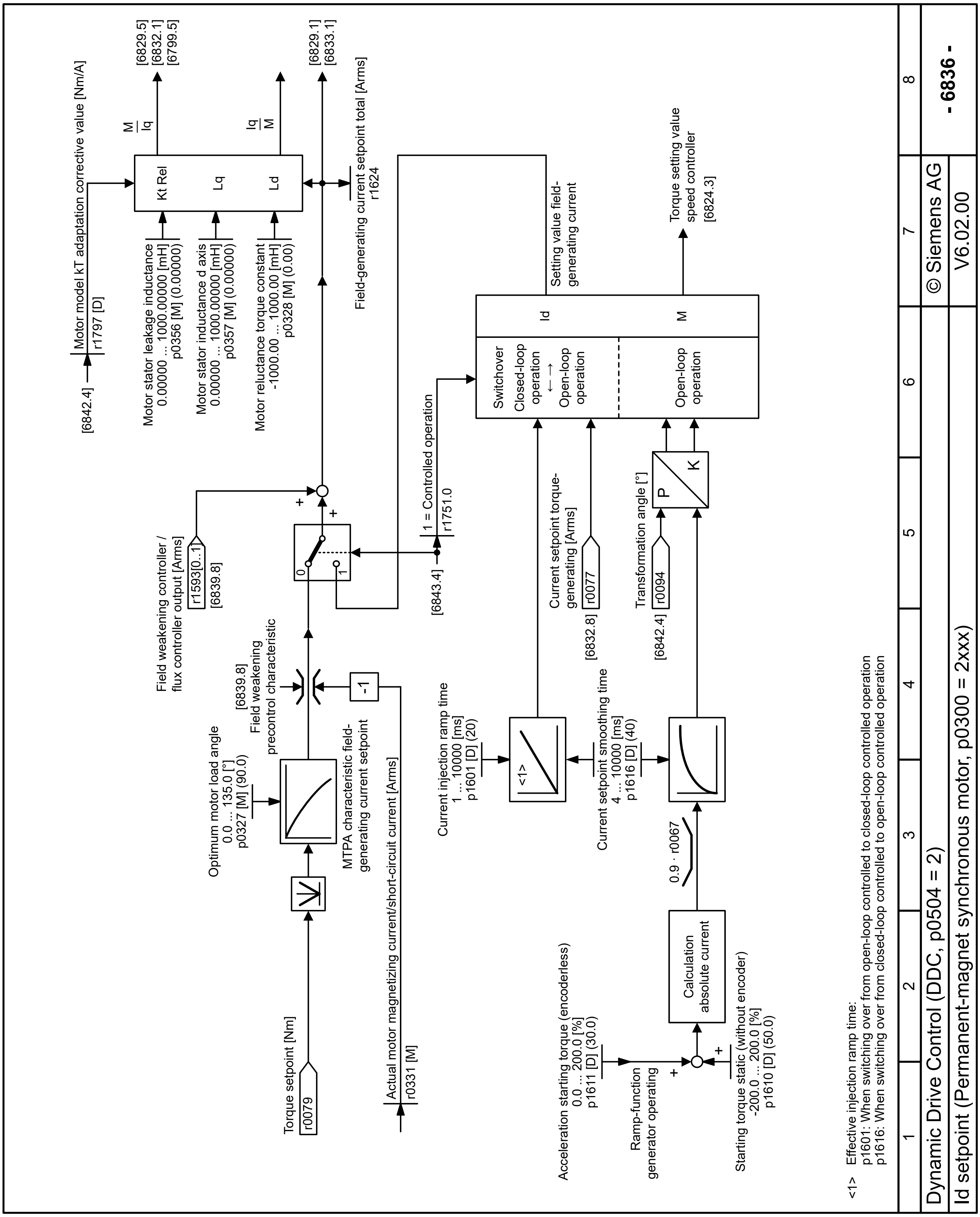


Figure 14-98 6836 - Id setpoint (permanent-magnet synchronous motor)

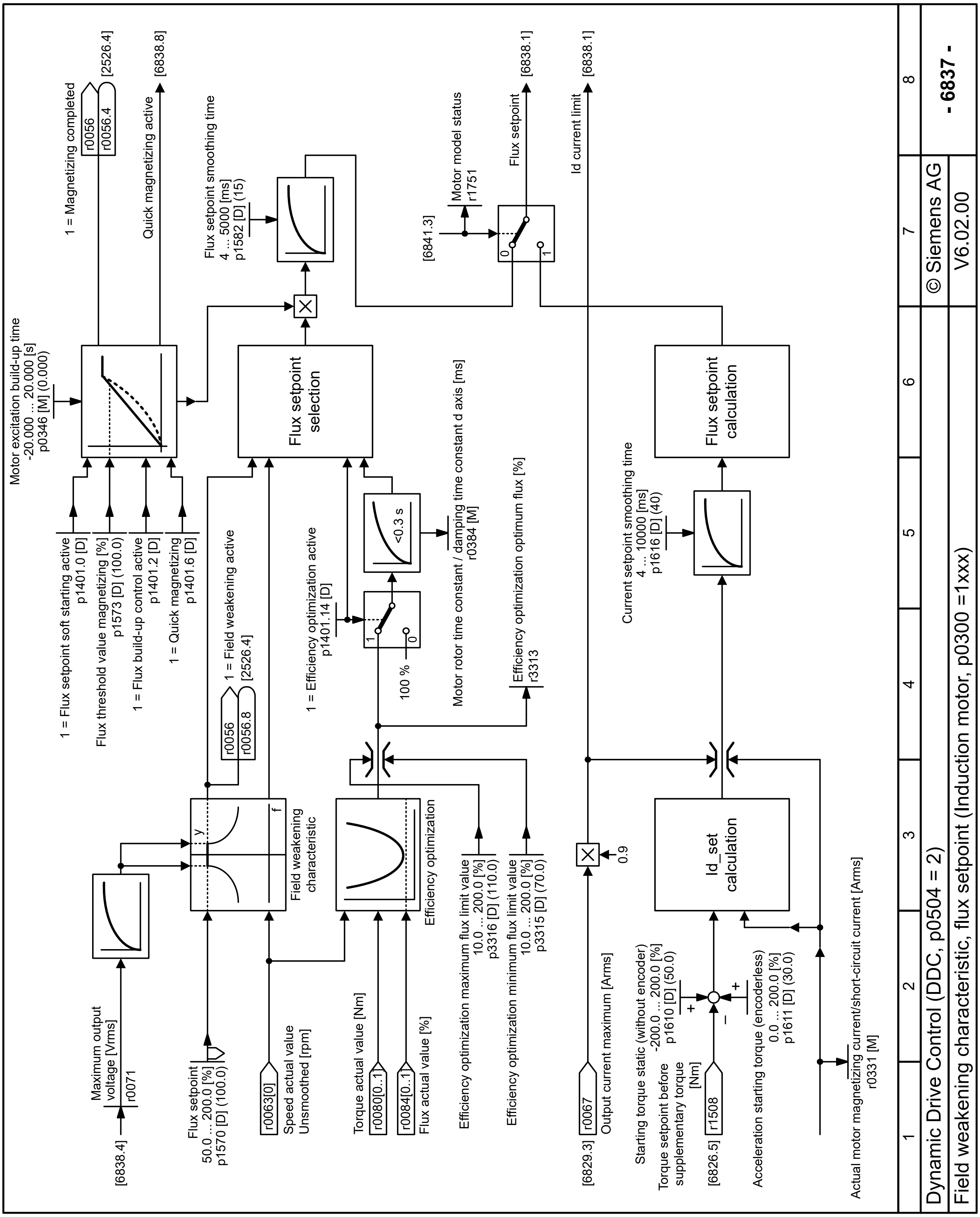


Figure 14-99 6837 – Field weakening characteristic, flux setpoint (induction motor)

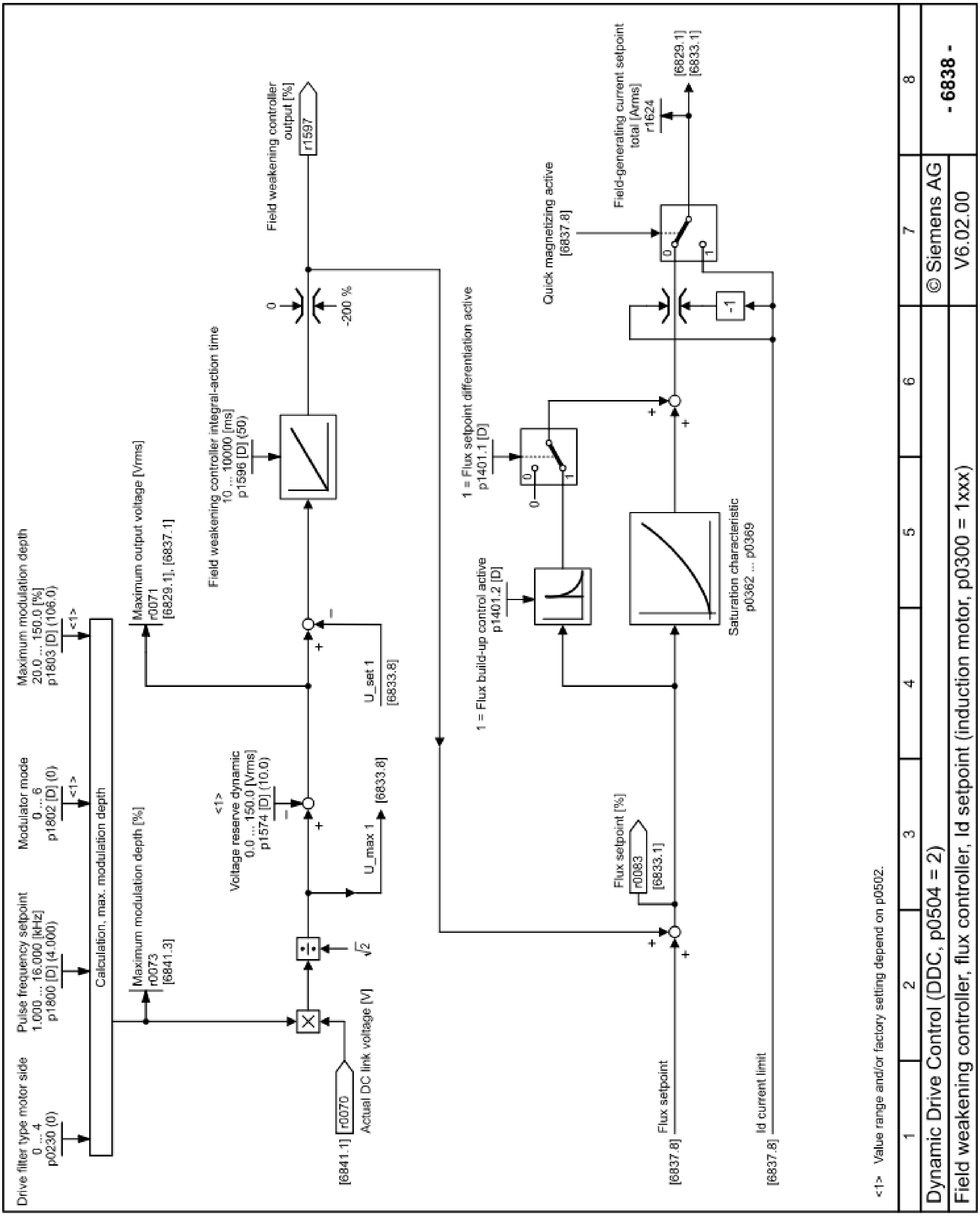


Figure 14-100 6838 – Field weakening controller, flux controller, Id setpoint (induction motor)

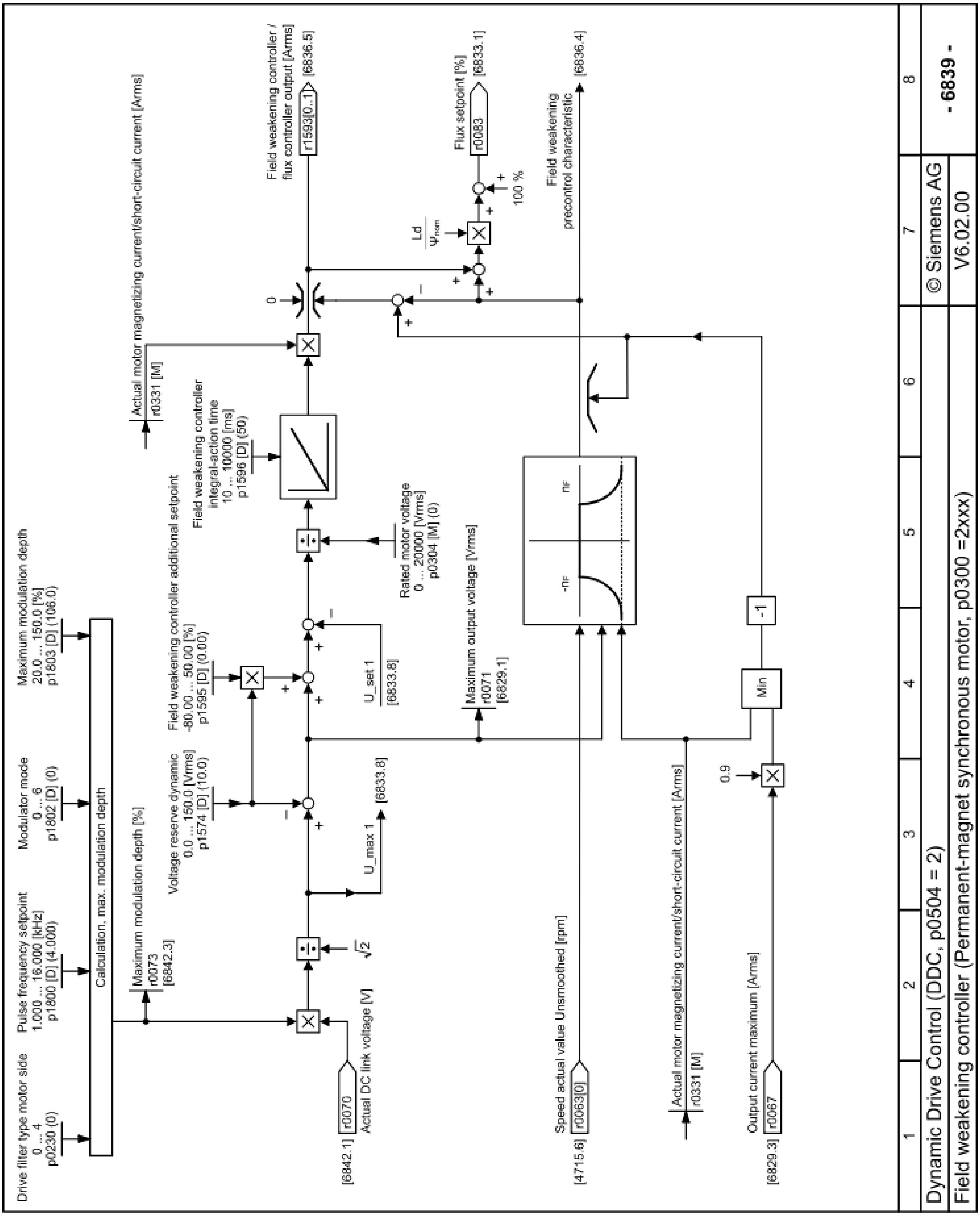


Figure 14-101 6839 - Field weakening controller (permanent-magnet synchronous motor)

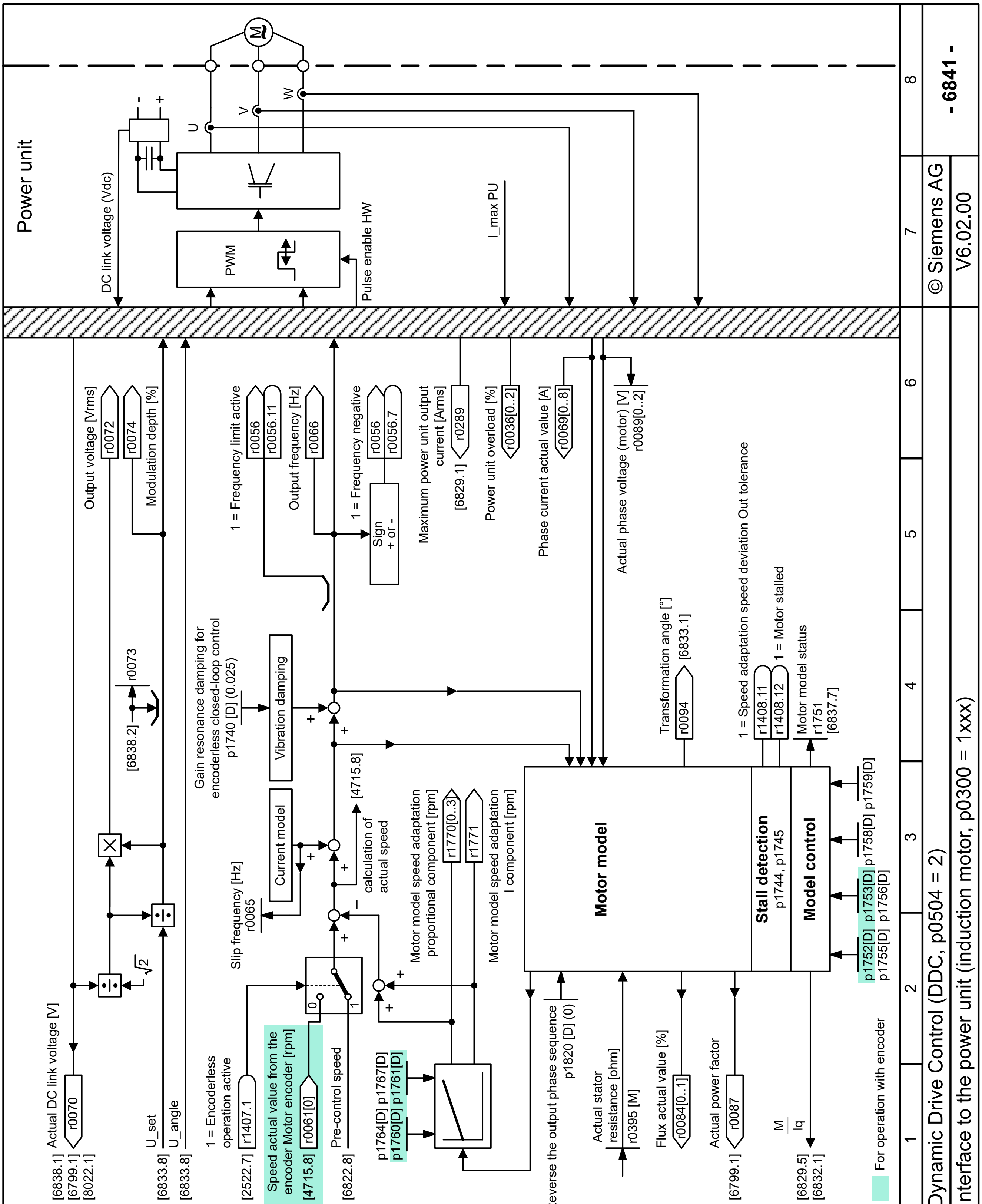


Figure 14-102 6841 - Interface to power unit (induction motor)

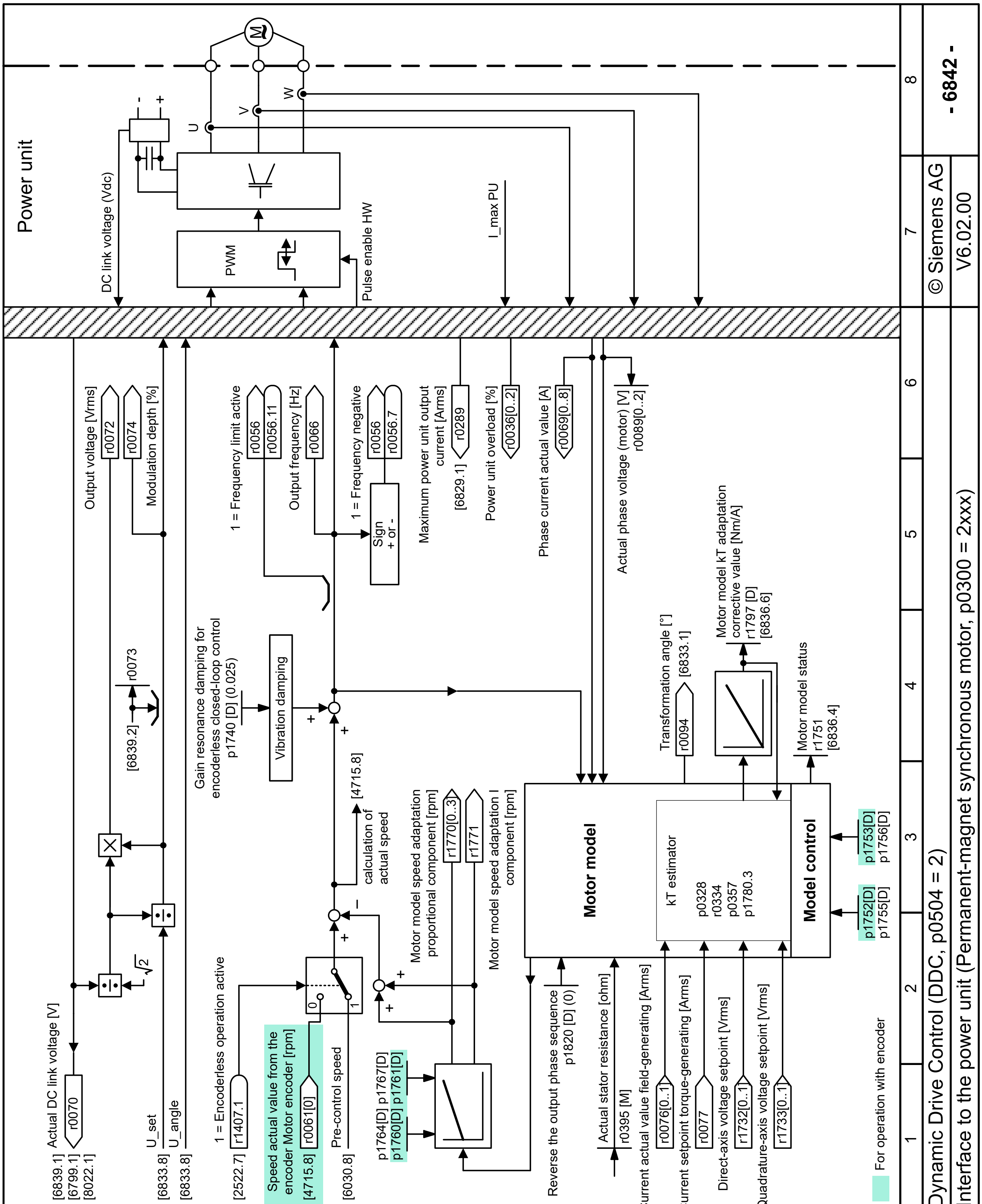


Figure 14-103 6842 - Interface to the power unit (permanent-magnet synchronous motor)

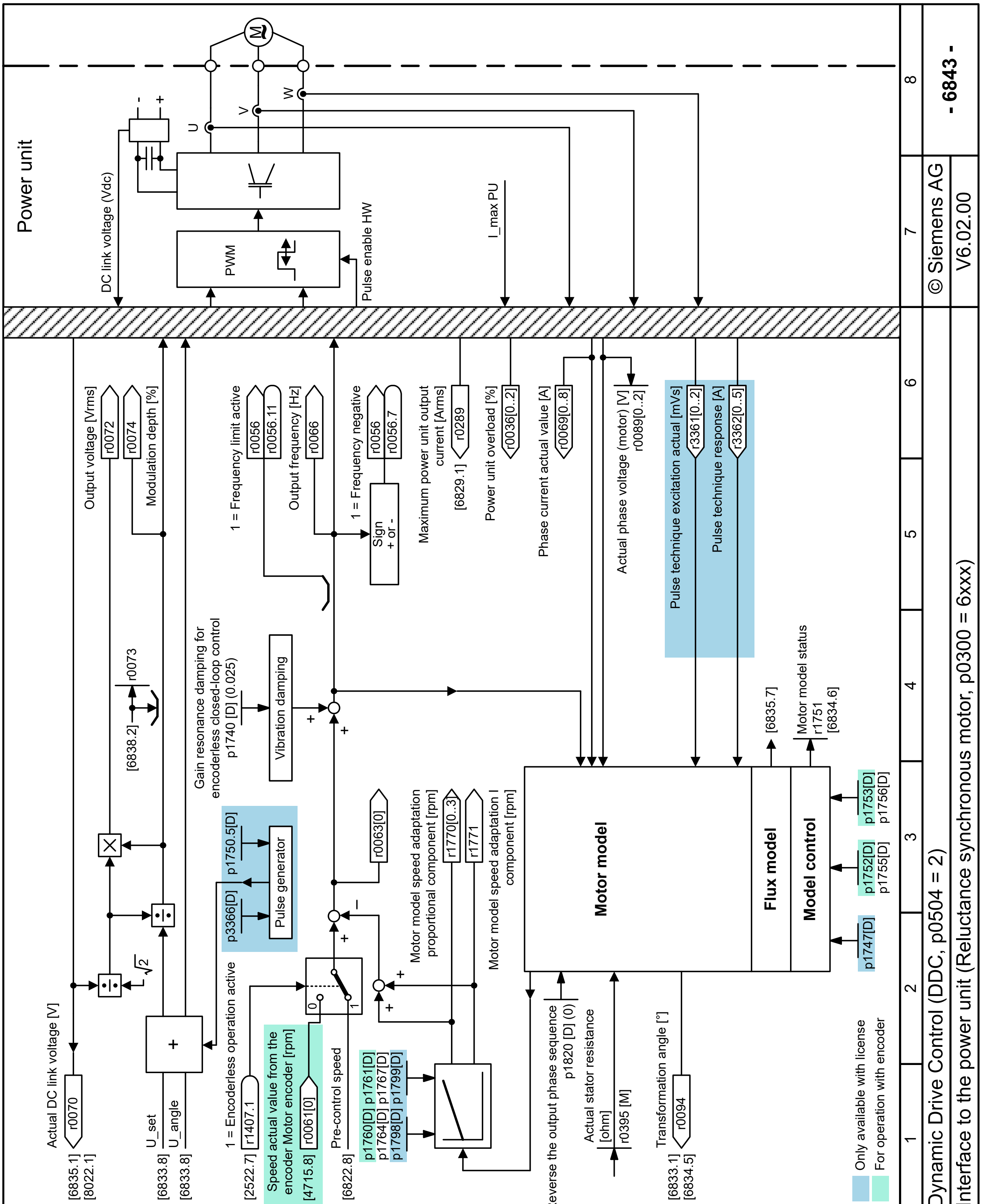


Figure 14-104 6843 - Interface to the power unit (synchronous reluctance motor)

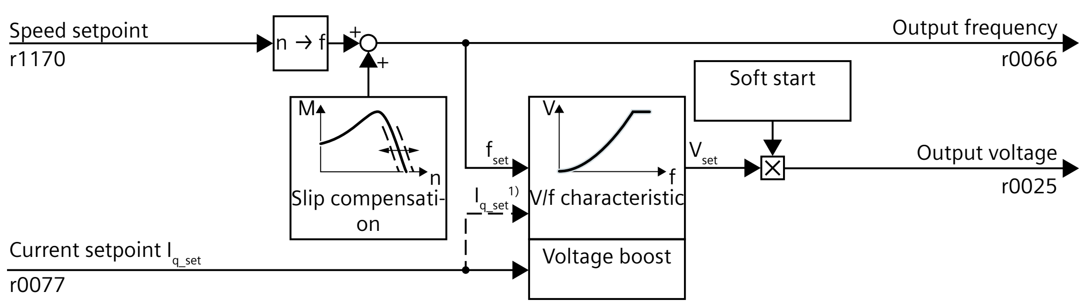
14.10.4 U/f control

14.10.4.1 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.

Description of function



1) In the "Flux current control (FCC)" variant of V/f control, the converter controls the motor current (starting current) at low speeds.

Figure 14-105 Simplified representation of 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.

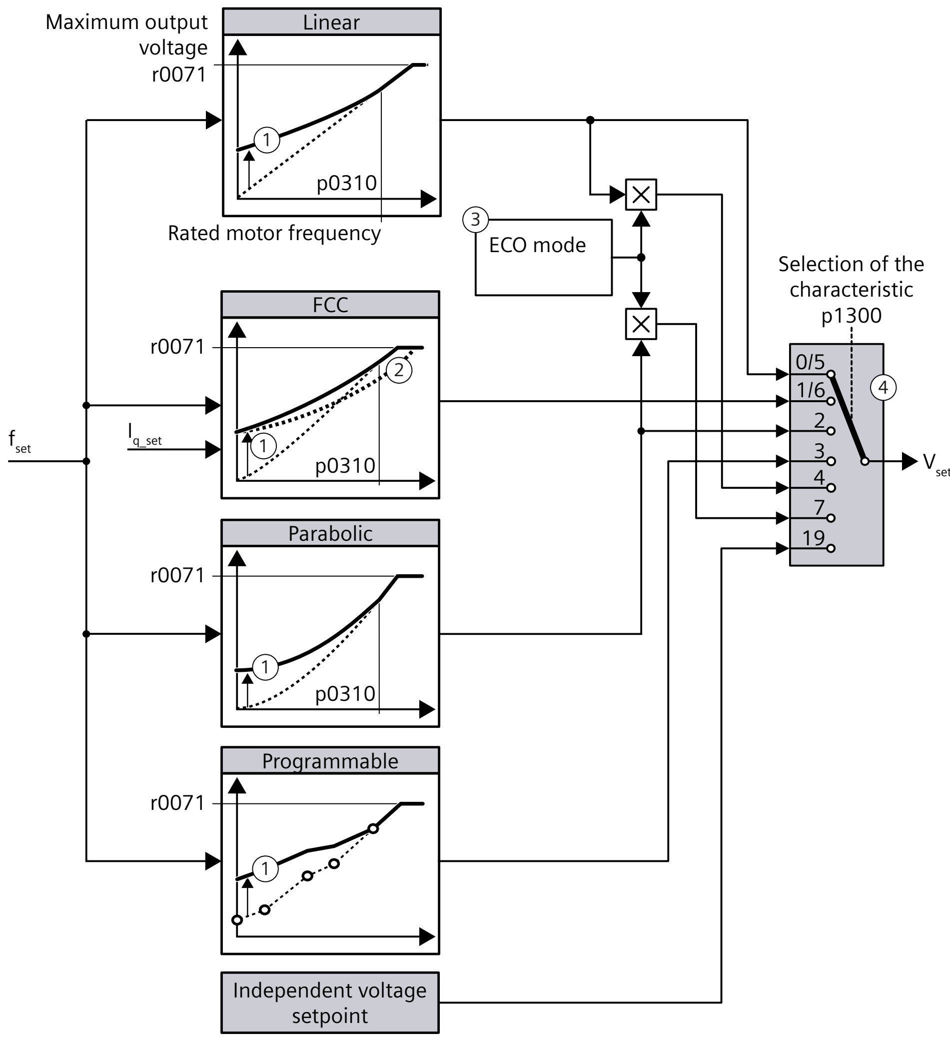
The converter can increase the output frequency even at the maximum output voltage. The motor is then operated with field weakening.

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 control 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 14-106 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 type	
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	

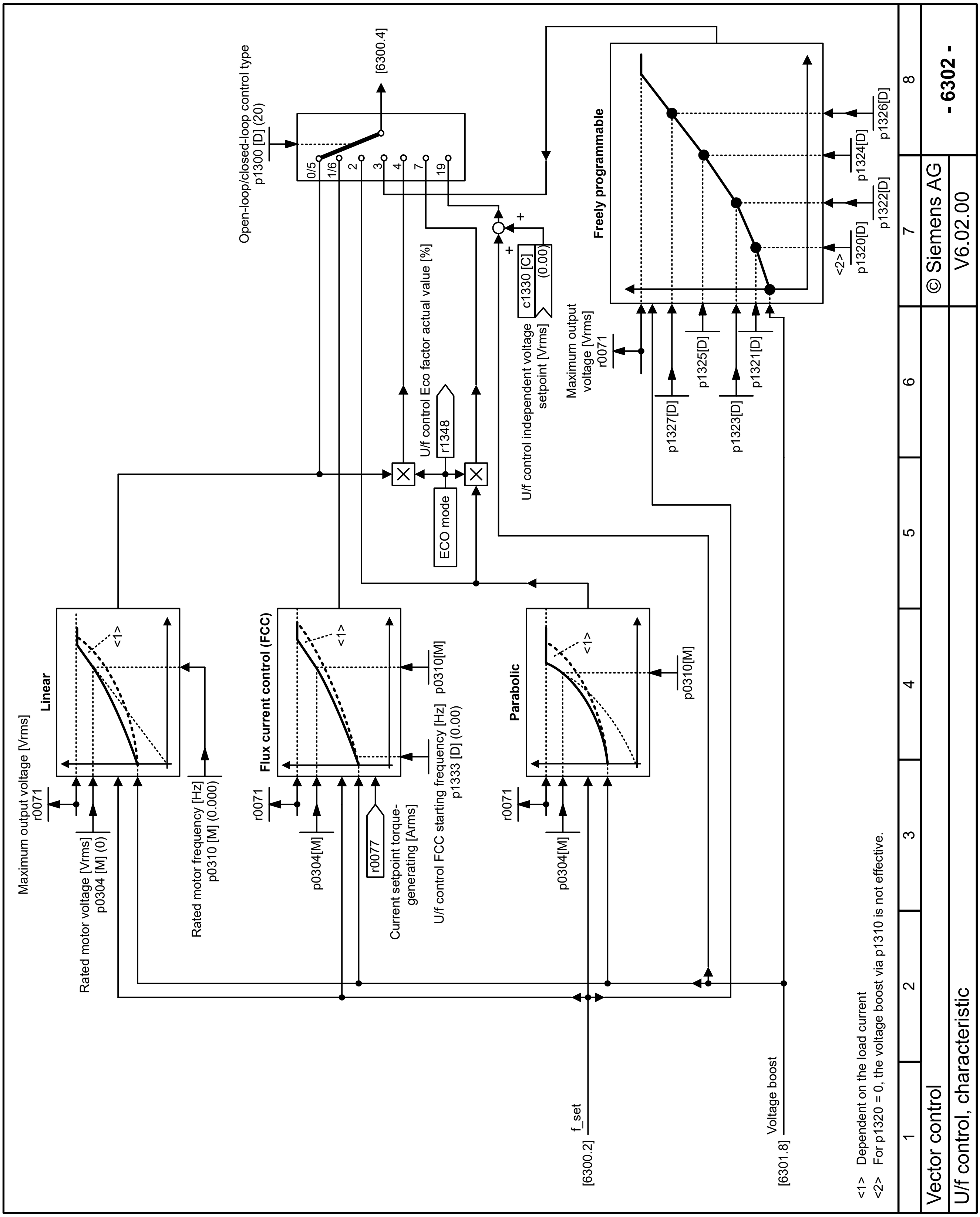


Figure 14-107 6302 - U/f characteristic

14.10.4.2 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.

Description of function

The U/f characteristic supplies an output voltage of 0 V at an output frequency of 0 Hz. The motor does not generate any torque at 0 V.

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

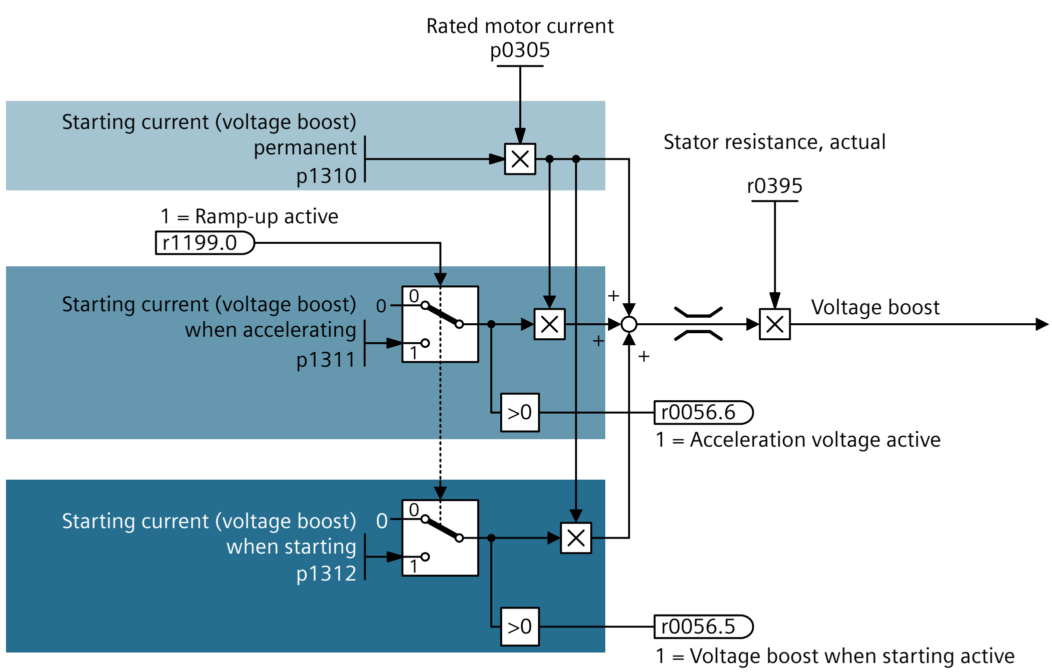


Figure 14-108 Simplified function diagram of the voltage boost

The resulting voltage boost combines the three elements for the U/f characteristic as shown in the following example.

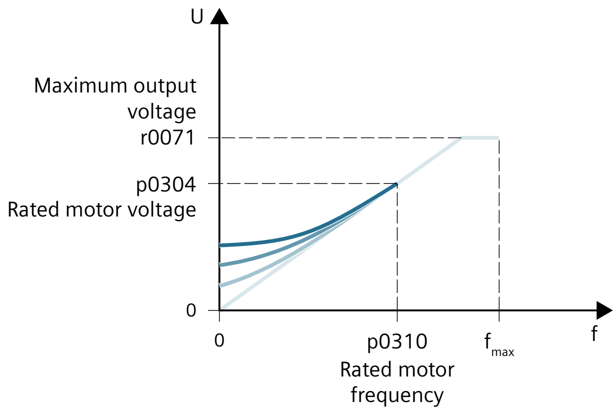


Figure 14-109 Resulting voltage boost example for a linear U/f characteristic

Parameters

The following list contains the parameters of the "Optimize motor startup" function.

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	[%]

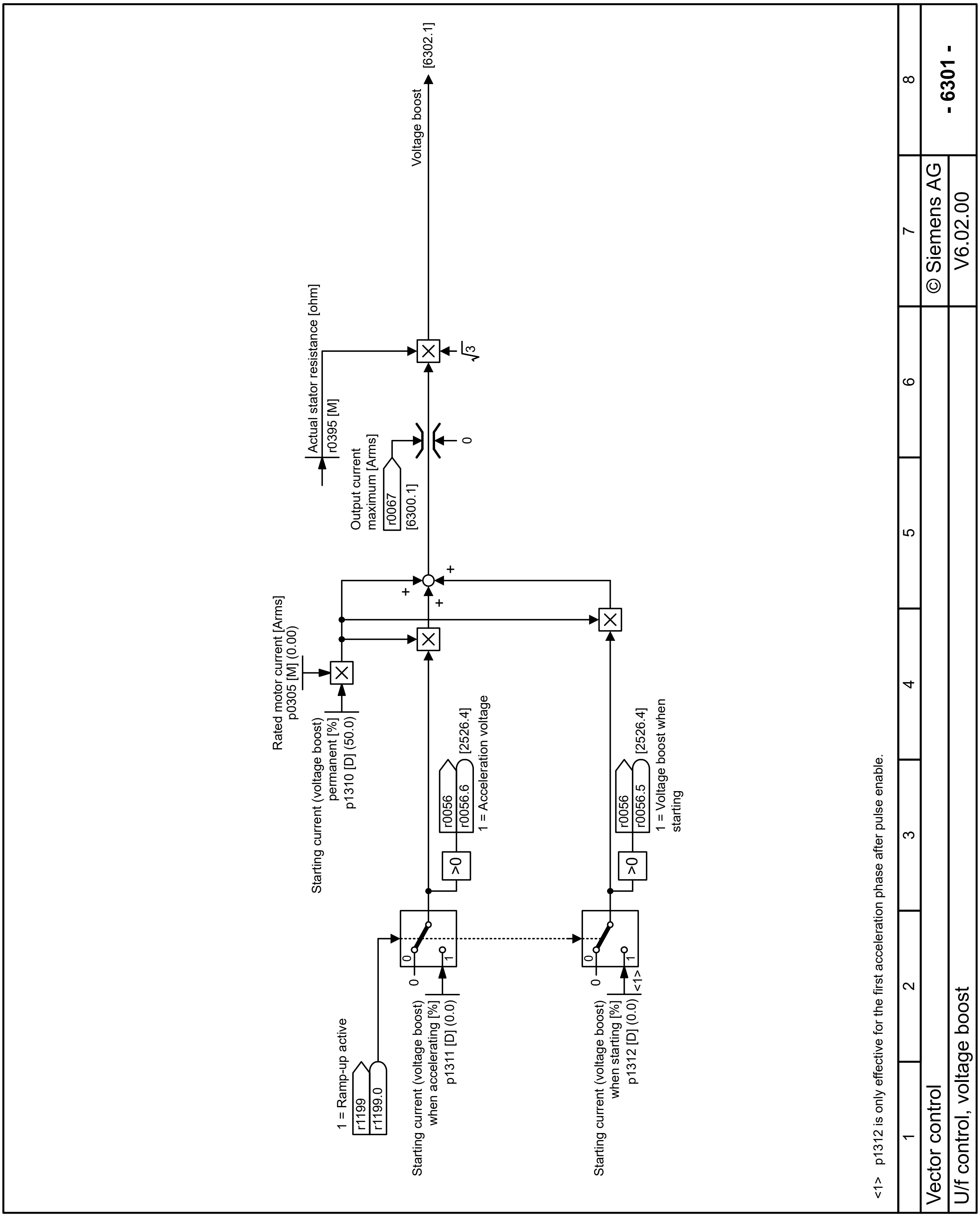


Figure 14-110 6301 - Voltage boost

14.10.4.3 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.

Description of function

When the power dips or fails, the DC link voltage in the converter decreases. 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.

The Vdc_min controller can typically accommodate power failures of up to 1 second.

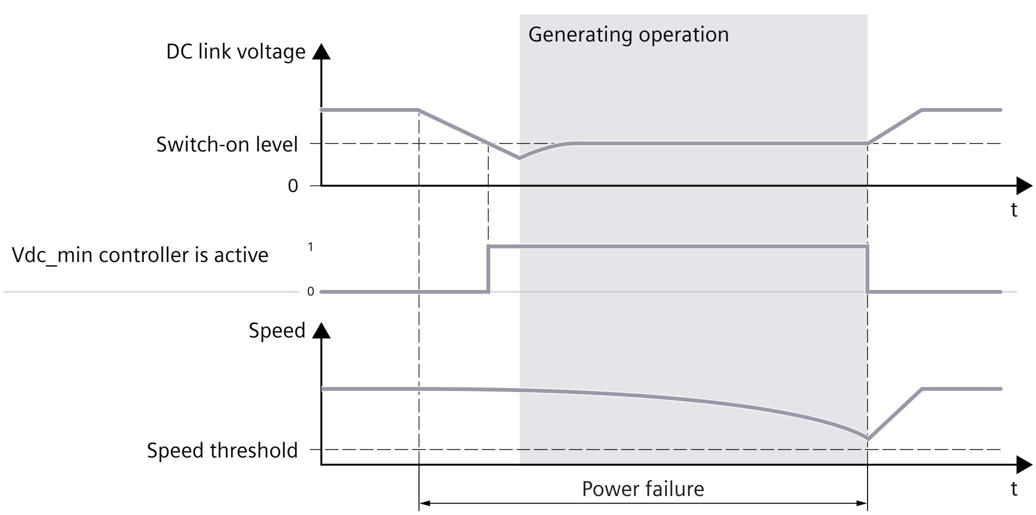


Figure 14-111 Principal mode of operation of the Vdc_min controller

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]

14.10.4.4 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.

Requirement

The Vdc_max control is suitable for applications with short-time generator operation of the motor, e.g. pumps or fans.

Excluding applications with continuous generator operation of the motor, e.g. hoists or centrifuges.

Description of function

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.

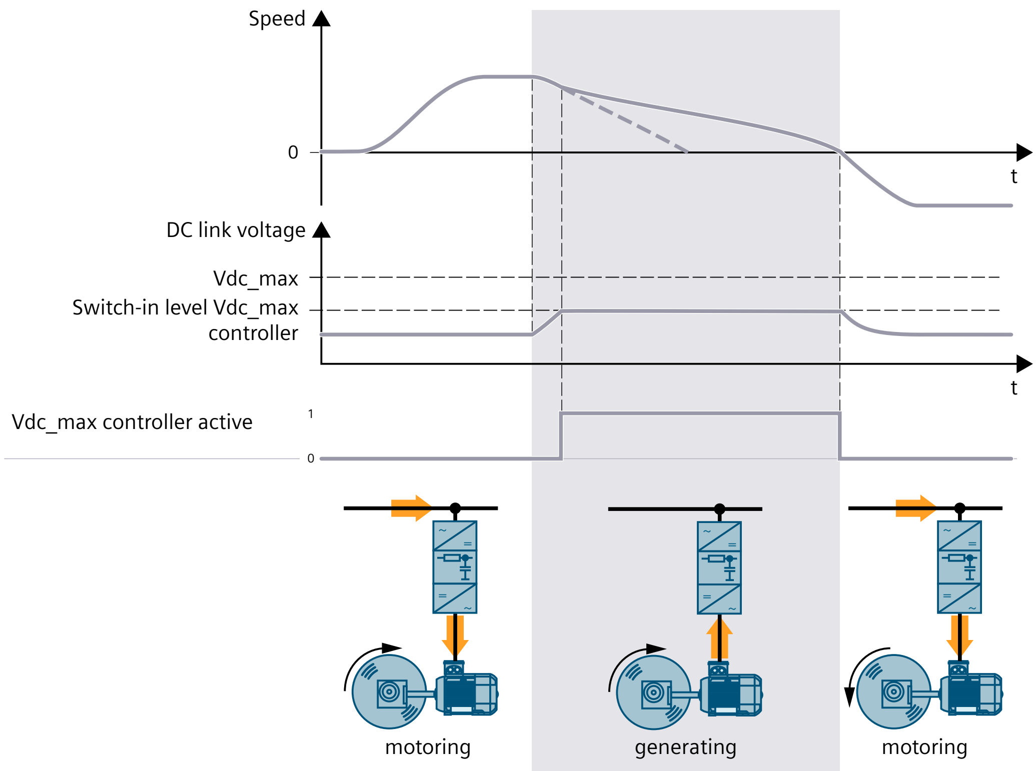


Figure 14-112 Simplified representation of the Vdc_max control

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	
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 detection ON signal level (U/f)	
r1298	Vdc controller output (U/f)	[rpm]

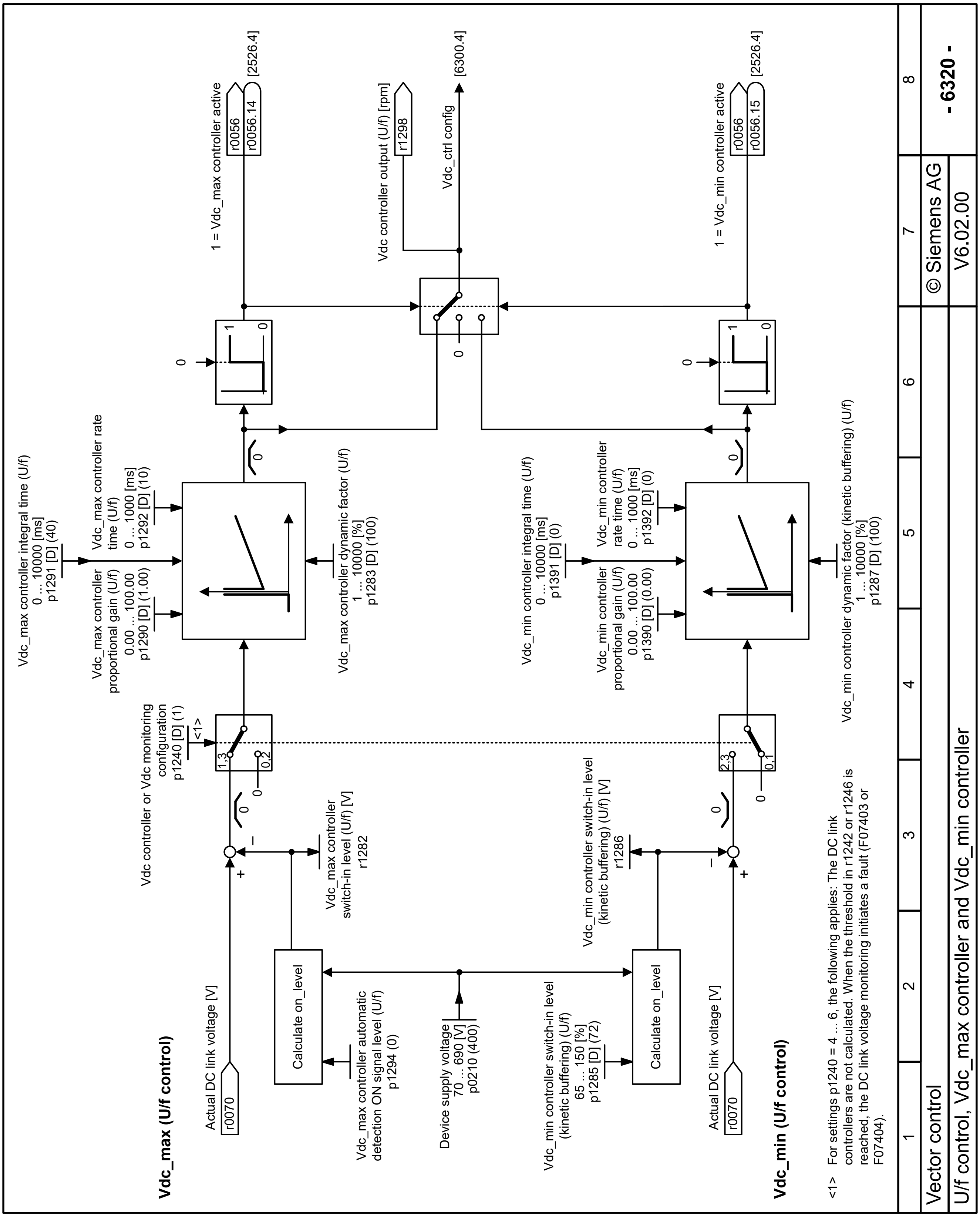


Figure 14-113 6320 - Vdc_max controller and Vdc_min controller (U/f)

14.10.4.5 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%.

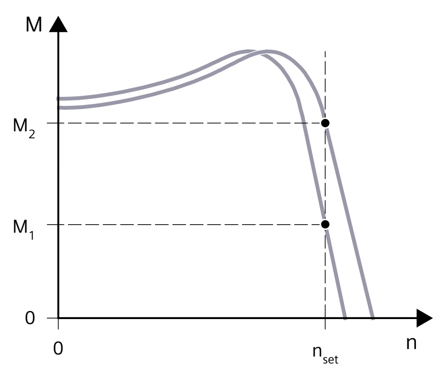


Figure 14-114 Slip compensation

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	[%]

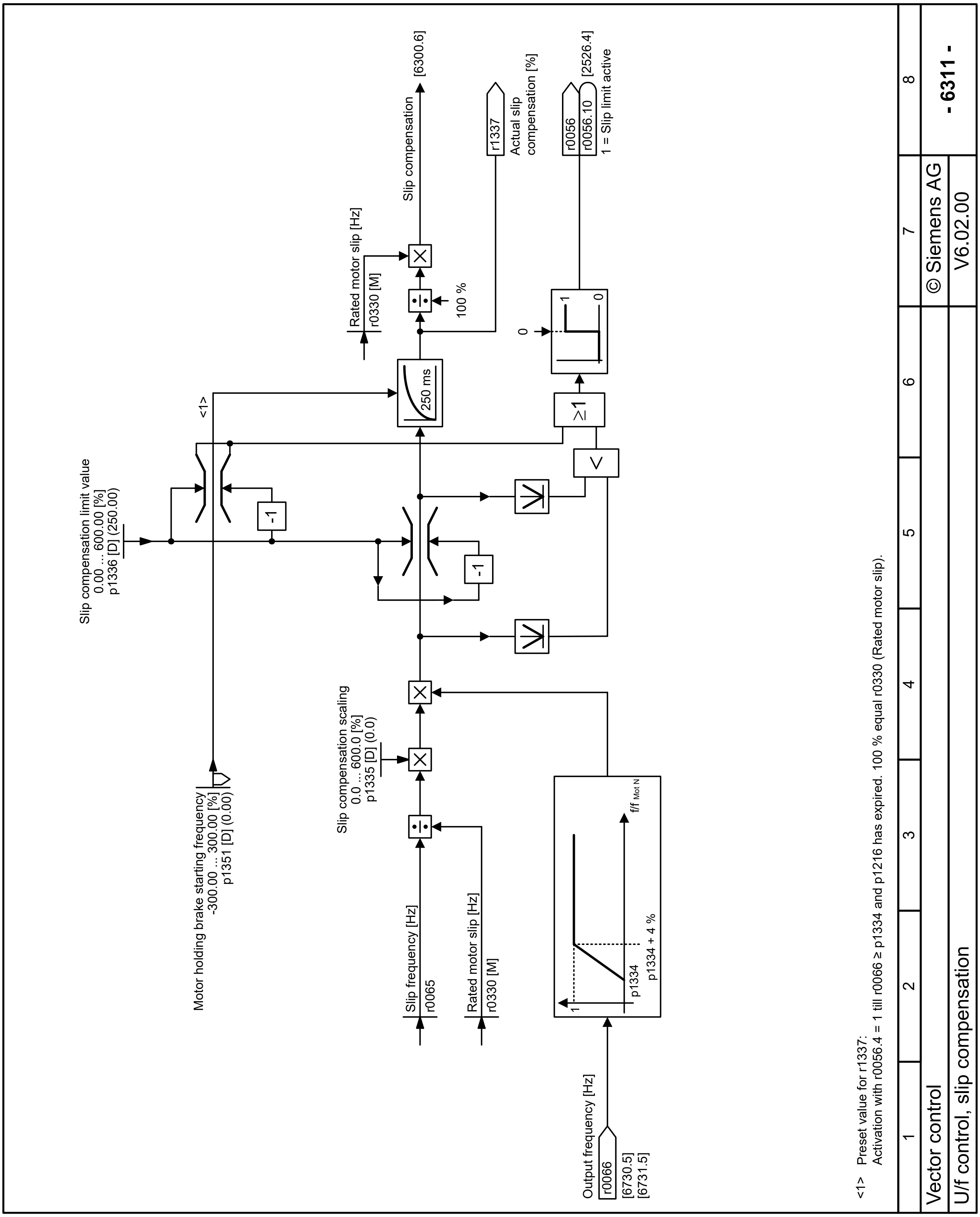


Figure 14-115 6311 - Slip compensation (U/f)

14.10.4.6 Resonance damping

Overview

Resonance damping reduces speed oscillations for a motor without load or for sudden load changes.

Description of function

With p1349 > 0, resonance damping is active for the following output frequencies:

- Between 6% and 90% of the motor rated frequency f_{MotN}
- Maximum 45 Hz

With p1349 = 0, resonance damping is active for the following output frequencies:

- 95 % of the motor rated frequency f_{MotN}
- Maximum 45 Hz

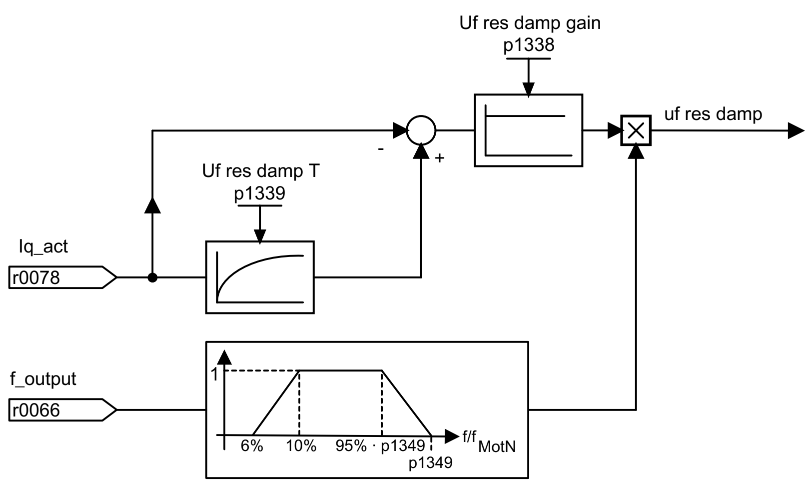


Figure 14-116 Resonance damping

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]

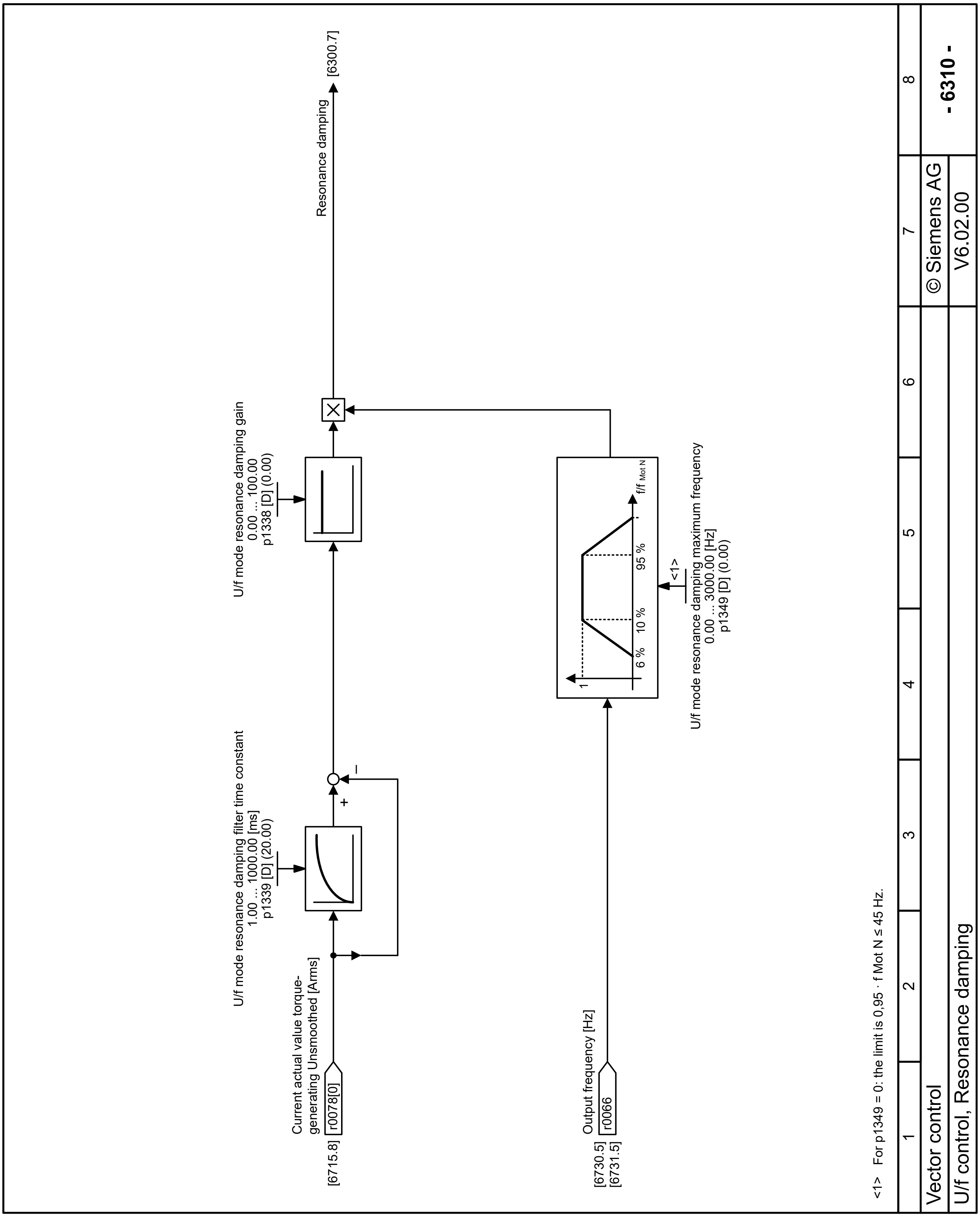


Figure 14-117 6310 - Resonance damping

14.10.4.7 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 U/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 "U/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 U/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]

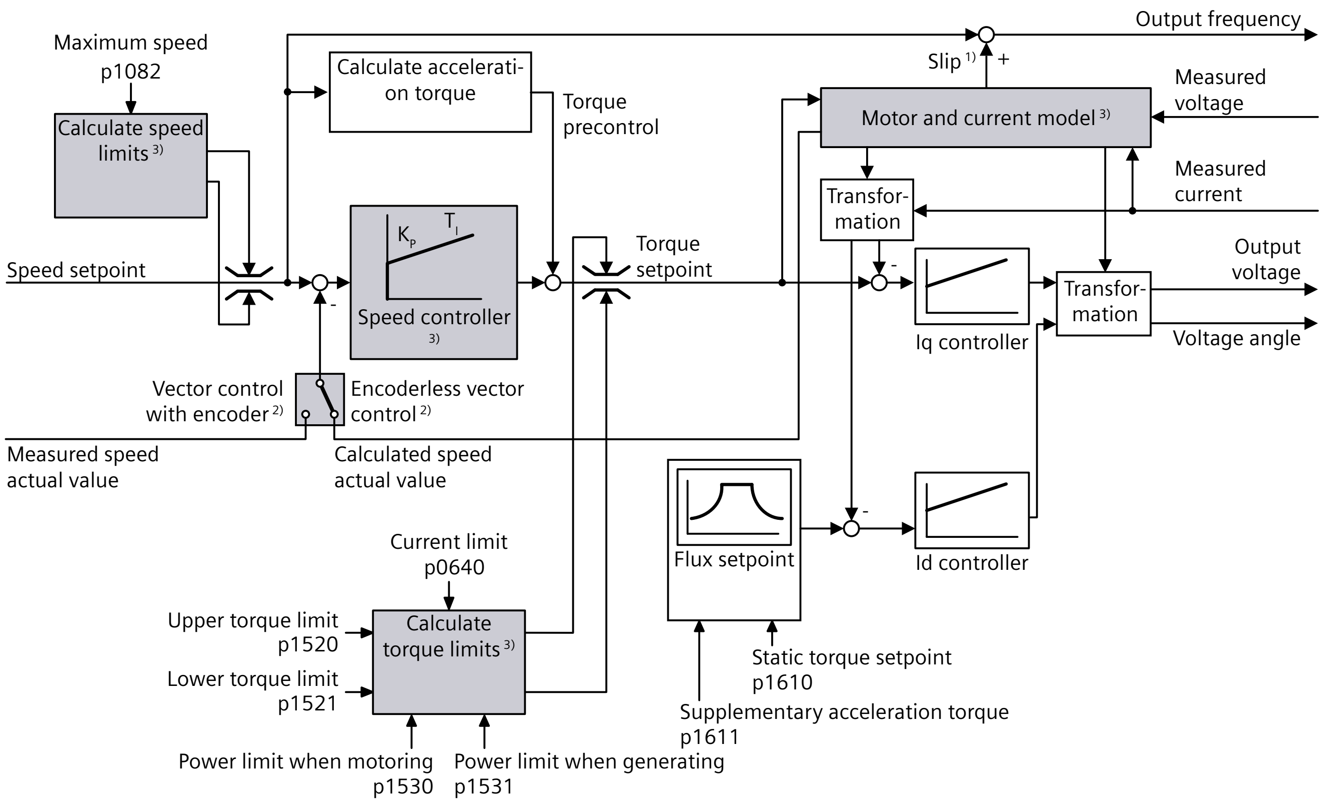
14.10.5 Speed control

14.10.5.1 Speed control

Overview

Speed control comprises current regulation and higher-level speed control.

Description of function



1) Only for induction motors

2) Select the control mode

3) Check or adapt settings

Figure 14-118 Simplified function diagram for speed control with a speed controller

Using the motor model, the converter calculates the following closed-loop control signals from the measured phase currents and the output voltage:

- Current component I_d
- Current component I_q
- Speed actual value for encoderless speed control

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). How the closed-loop control responds to the higher torque setpoint depends 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.

Parameters

The following list contains the parameters of the "Closed-loop speed control" function.

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...9	Motor model configuration	

14.10.5.2 Setting of technological application for 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.

Requirement

A license is required for the speed-controlled operation of reluctance motors at low speeds using the pulse technique.

Description of function

Depending on p0500, the following default settings of the closed-loop speed control are available.

Table 14-72 Technology application for closed-loop speed control

p0500	Technology 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 converter output voltage 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. • Applications involving pumps and fans
2	Encoderless control down to f = 0 (passive loads)	• Setting for encoderless control of induction motors, reluctance motors and permanent-magnet synchronous motors Innomotics PM 1FZ • Speed-controlled operation of induction motors at low speeds • Speed-controlled operation at low speeds using the pulse technique (a license is required) – for reluctance motors – for permanent-magnet synchronous motors Innomotics PM 1FZ • A passive load cannot accelerate the current-free motor. Examples are pumps, fans, extruders, but not hoisting gear
3	Pumps and fans, efficiency optimization	• Setting for control of induction motors • Suitable for applications without dynamic requirements for speed and load changes • Applications involving pumps and fans • Efficiency optimization Less energy consumption and reduced noise • The setting only makes sense for steady-state operation with slow speed changes. We recommend the setting 0 if load surges in operation cannot be ruled out.
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 drives with high power and a total moment of inertia at least 5 times greater than the motor moment of inertia • Increased default setting of speed actual value smoothing • Optimized default setting of the speed controller

14.10.5.3 Droop

Overview

Function "Droop" reduces the speed setpoint as a function of the torque.

Requirement

Function "Droop" is enabled using signal p1492 = 1.

Control mode "Closed-loop speed control" is active. Droop cannot be set in operating modes "Standard Drive Control" and "Dynamic Drive Control".

Description of function

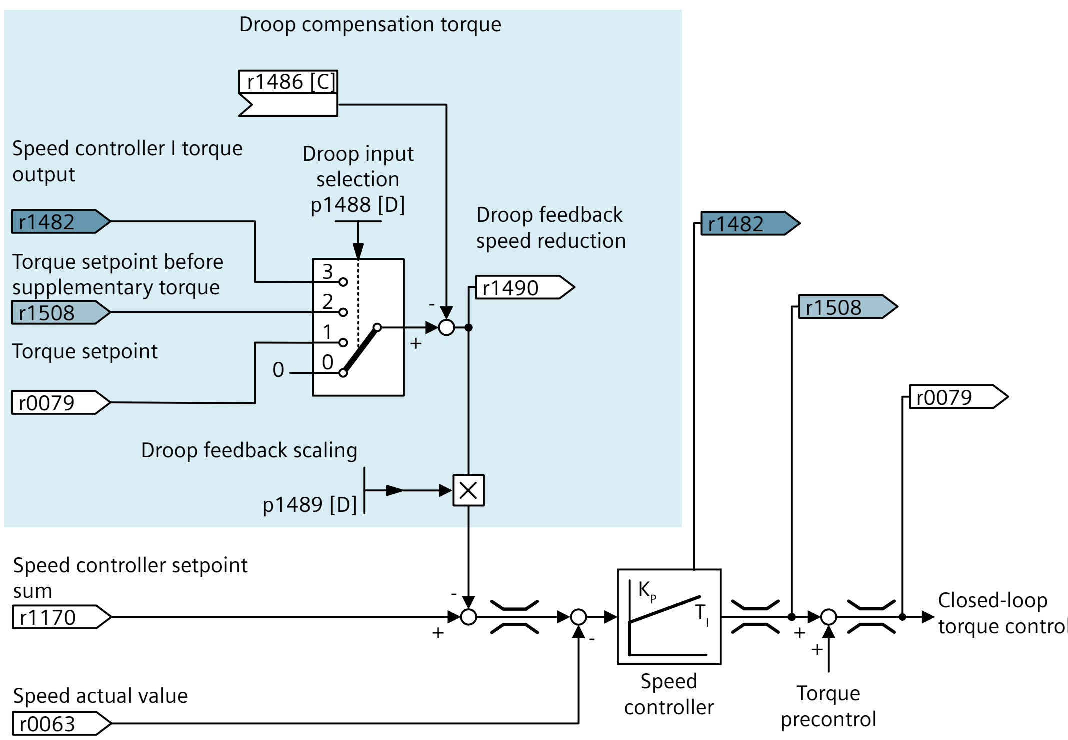


Figure 14-119 Schematic representation of the "Droop" function

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 feedback p1489 defines the extent to which the torque influences the speed setpoint.

Compensation torque r1486 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
r1482	Speed controller I torque output	[Nm]
p1488[0...n]	Droop input selection	
p1489[0...n]	Droop feedback scaling	
r1490	Droop feedback speed reduction	[rpm]
c1492[0...n]	Droop feedback enable	

14.10.5.4 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.

Description of function

When the power dips or fails, the DC link voltage in the converter decreases. 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.

The Vdc_min controller can typically accommodate power failures of up to 1 second.

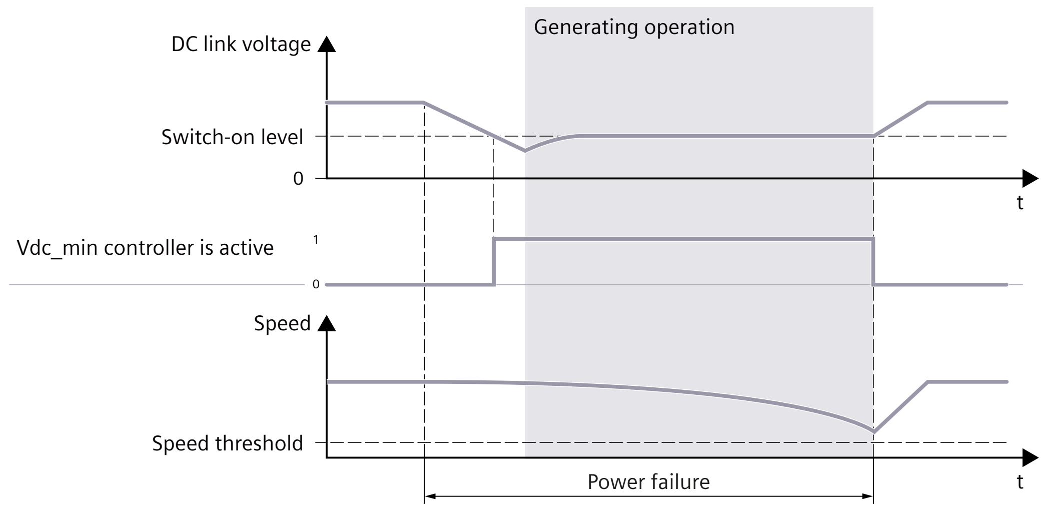


Figure 14-120 Principal mode of operation of the Vdc_min controller

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]

14.10.5.5 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.

Requirement

The Vdc_max control is suitable for applications with short-time generator operation of the motor, e.g. pumps or fans.

Excluding applications with continuous generator operation of the motor, e.g. hoists or centrifuges.

Description of function

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.

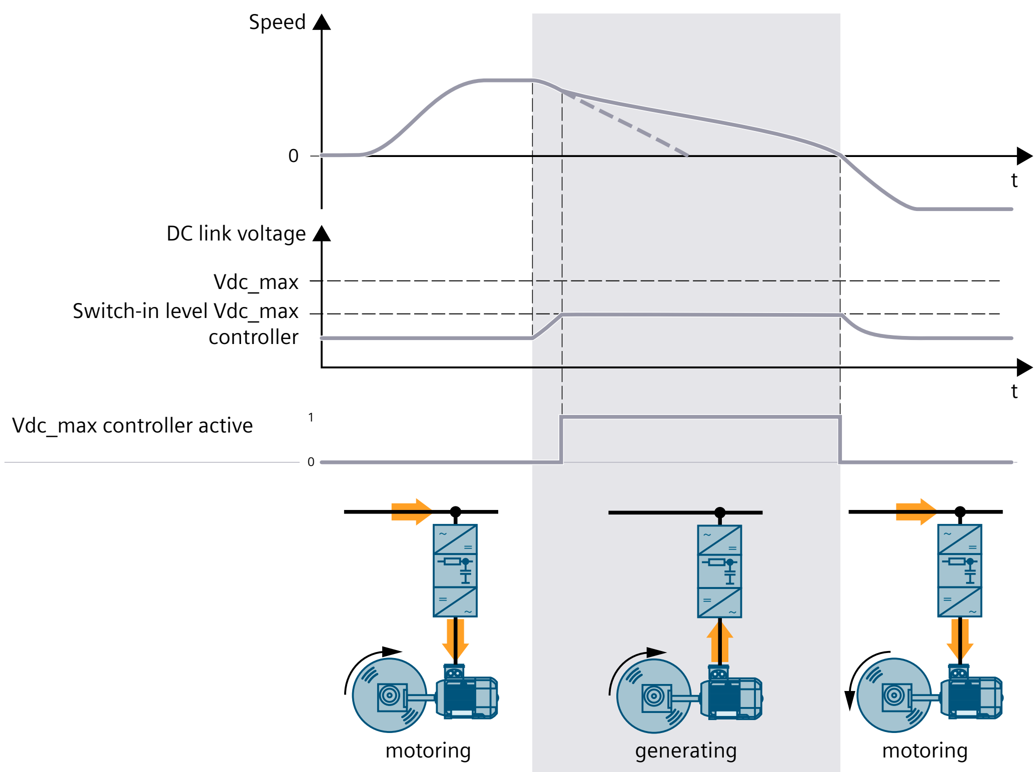


Figure 14-121 Simplified representation of the Vdc_max control

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	
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 ON level detection

14.10.5.6 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.

The pulse technique for continuously estimating the rotor position of a synchronous reluctance motor is not active.

Description of function

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	

14.10.5.7 Setting motor control for critical applications

Overview

For critical applications, for example, with high load inertia, the speed control can become unstable.

Requirement

Critical applications arise in the following constellations:

- High load moment of inertia compared with the motor moment of inertia
- Gearbox play or coupling play between the motor and load machine
- Vibrating coupling between the motor and load machine

Procedure

To handle critical applications, we recommend the following settings:

- Speed control with encoder and encoderless speed control
  - Increase p1452 (smoothing the speed actual value).
  - Increase p1472 (integral time T_I): $T_I \geq 4 \cdot$ p1452
  - If, after these measures, the speed controller does not operate with an adequate dynamic performance, then increase p1470 (gain K_P) step-by-step.
- Additional setting for speed control with encoder
  - Increase p1441 (smoothing the speed actual value): p1441 = 2 ... 4 ms.

You have set the motor control for these critical applications.

14.10.5.8 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.

Requirement

⚠ 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 commissioning.
- 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 commissioning, 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 Innomotics PM 1FZ
  – Set p1750.05 = 1.
    With this setting, use function "Encoderless closed-loop speed control of a synchronous motor from standstill" (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.

14.10.5.9 Encoderless closed-loop speed control of a synchronous motor from standstill

Overview

Function "Encoderless closed-loop speed control of a synchronous motor from standstill" (pulse technique) increases the energy efficiency of a synchronous motor and extends the range of applications:

- 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

Requirement

The "Encoderless speed control of the synchronous reluctance motor from standstill" function requires the license for the "Motor Control Extended" software option.

The function is enabled for the following motors:

- Synchronous reluctance motors
- Permanent magnet synchronous motors Innomotics PM 1FZ

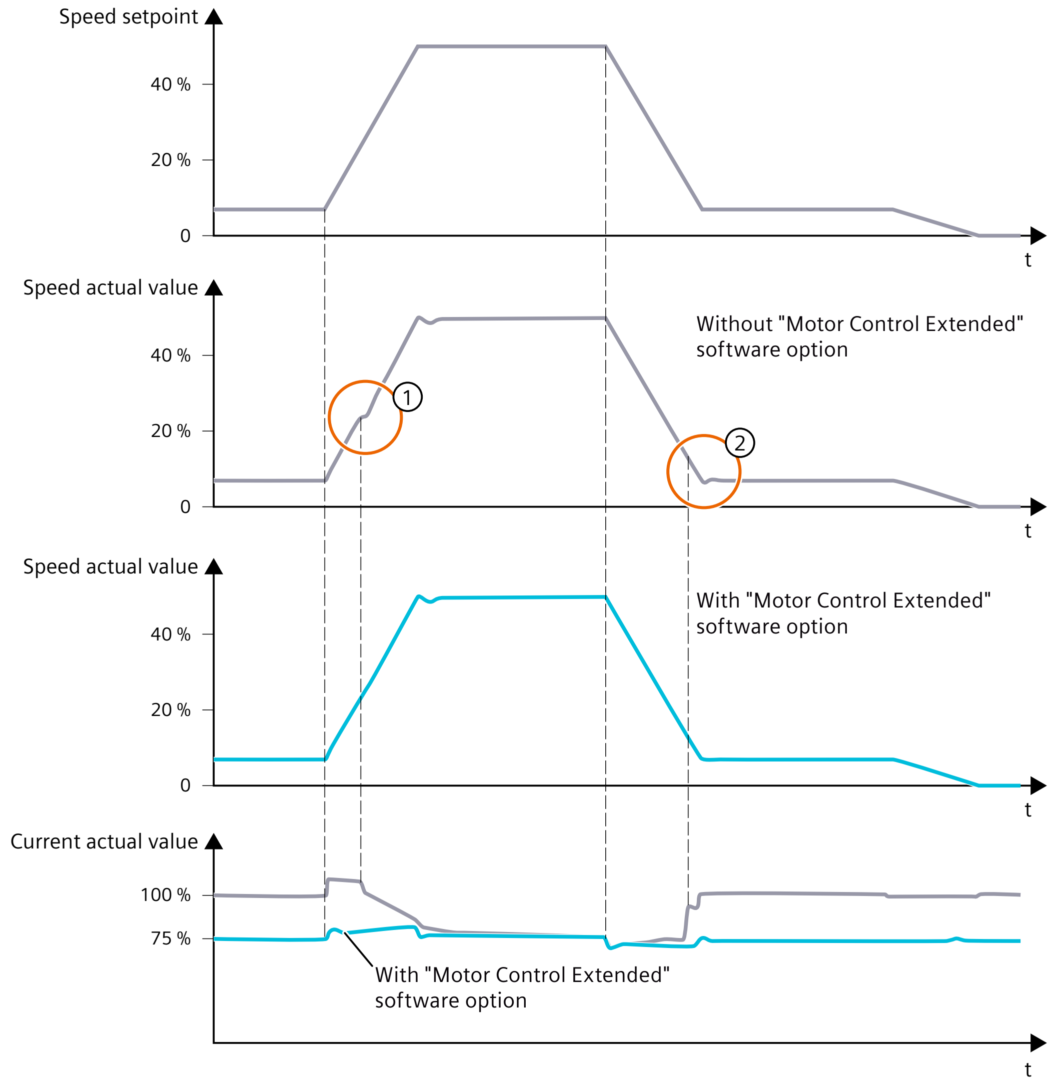
Description of function

Function "Encoderless closed-loop speed control of a synchronous motor from standstill" uses an optimized pulse technique for speeds close to 0.

The technique makes it possible to determine the rotor position and speed until standstill is reached.

p1750.05 = 1 activates the function.

The following figure gives a qualitative illustration of the differences in the actual speed value and actual current value with and without the "Motor Control Extended" software option.



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 14-122 Typical motor response with and without "Motor Control Extended" software option

Without the "Motor Control Extended" software option, the motor is in open-loop controlled operation at speeds close to 0.

The "Motor Control Extended" software option enables the closed-loop controlled operation of the motor until standstill is reached.

The "Motor Control Extended" software option 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...9	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]

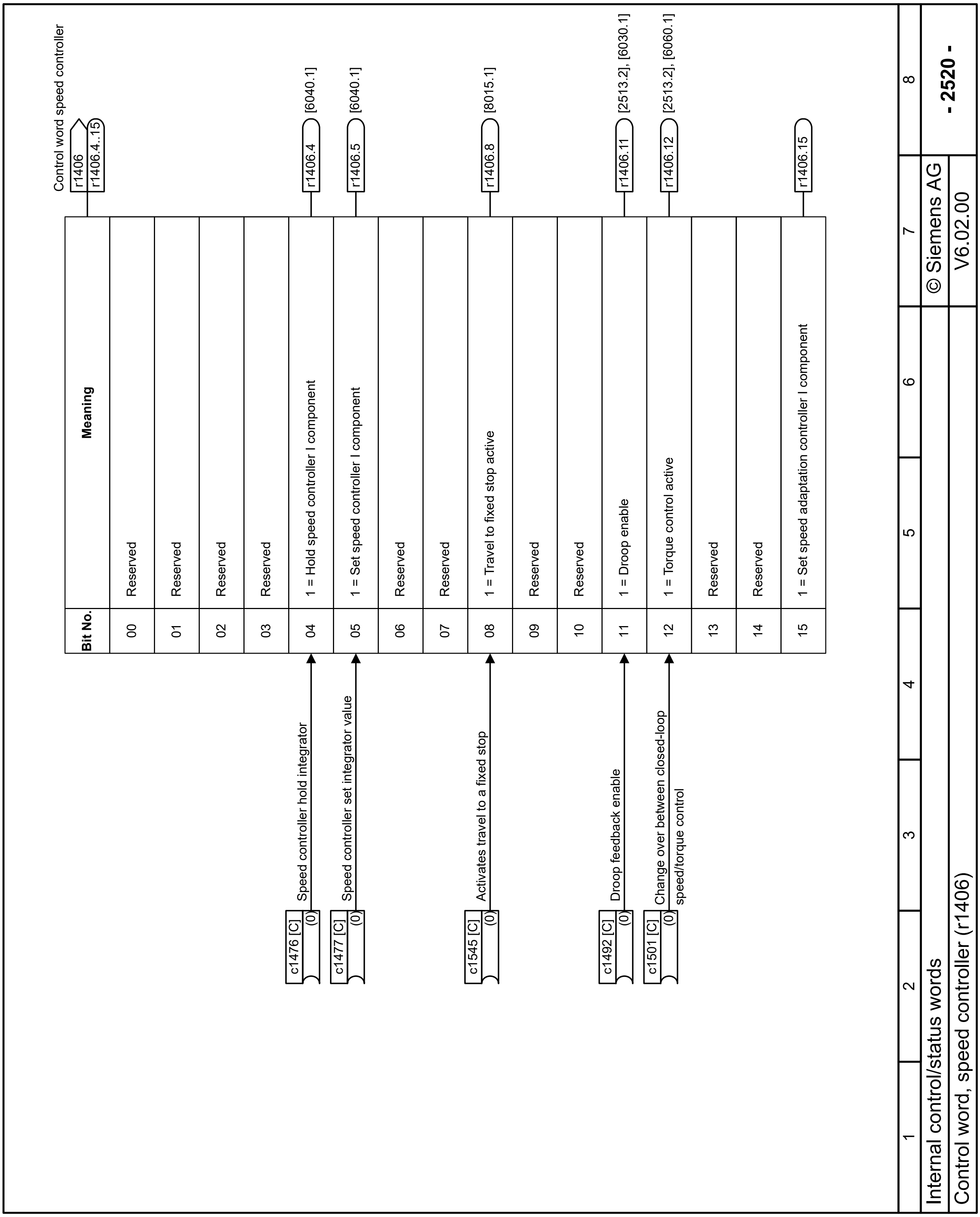


Figure 14-123 2520 - Control word speed controller

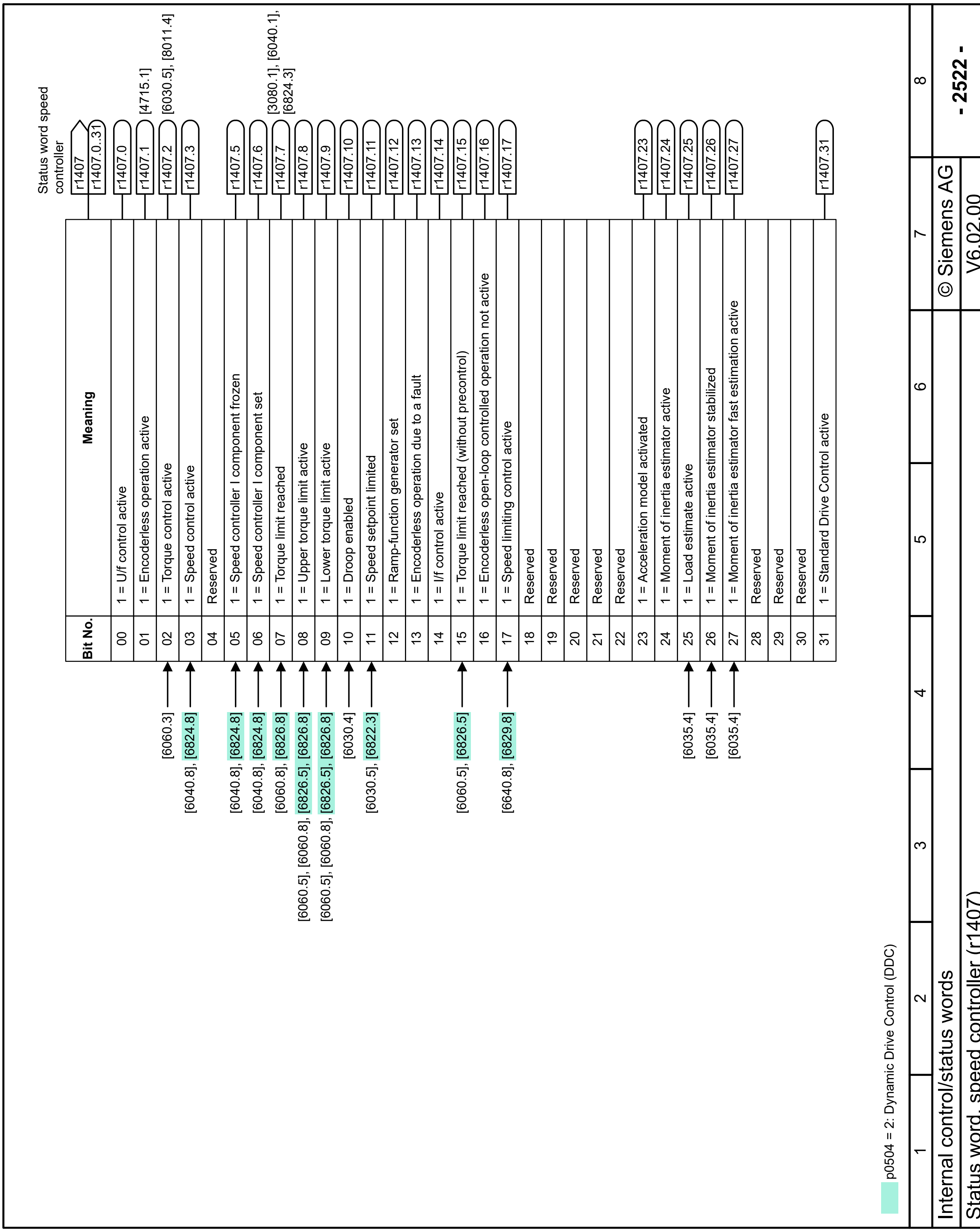


Figure 14-124 2522 - Status word speed controller

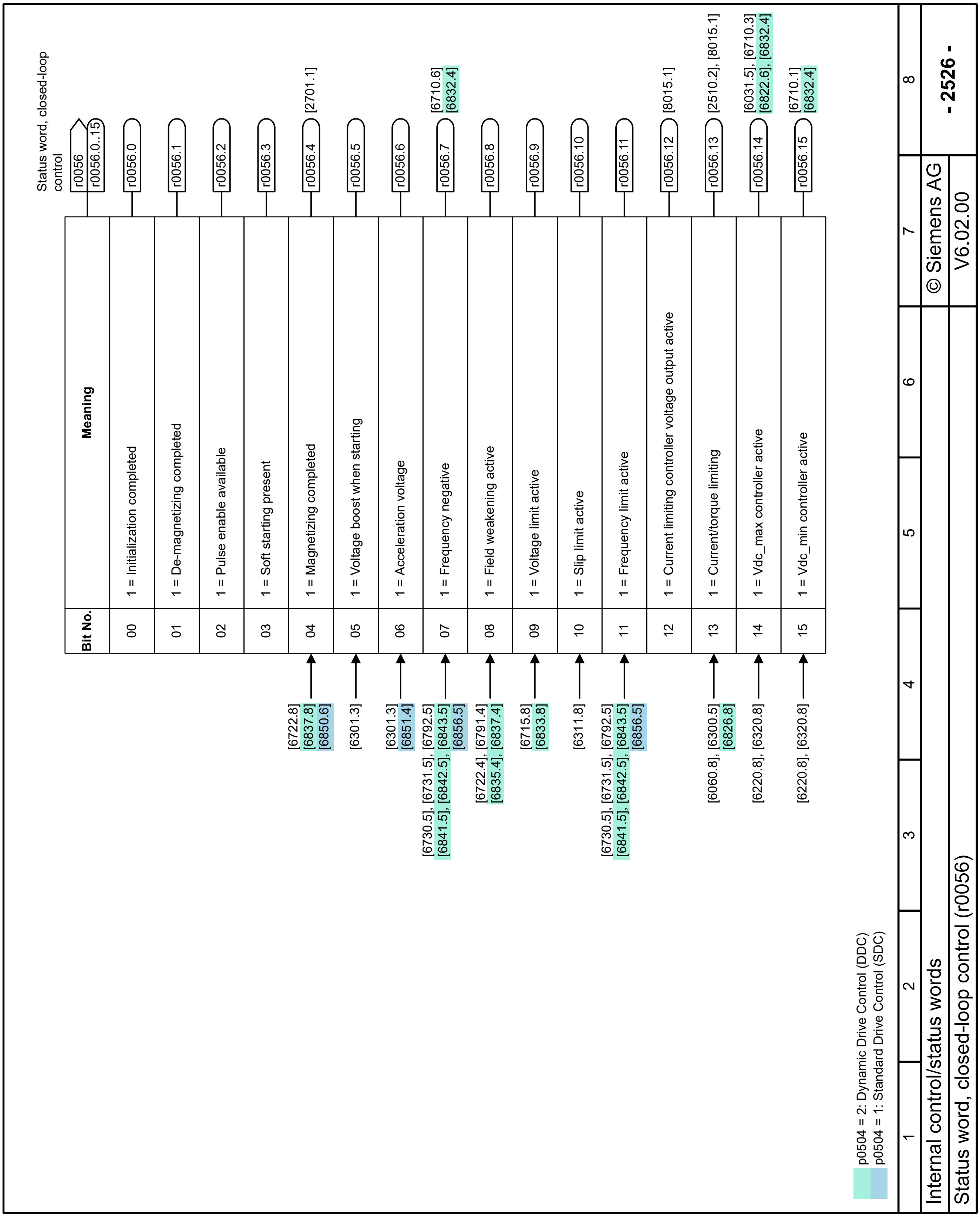


Figure 14-125 2526 - Status word closed-loop control

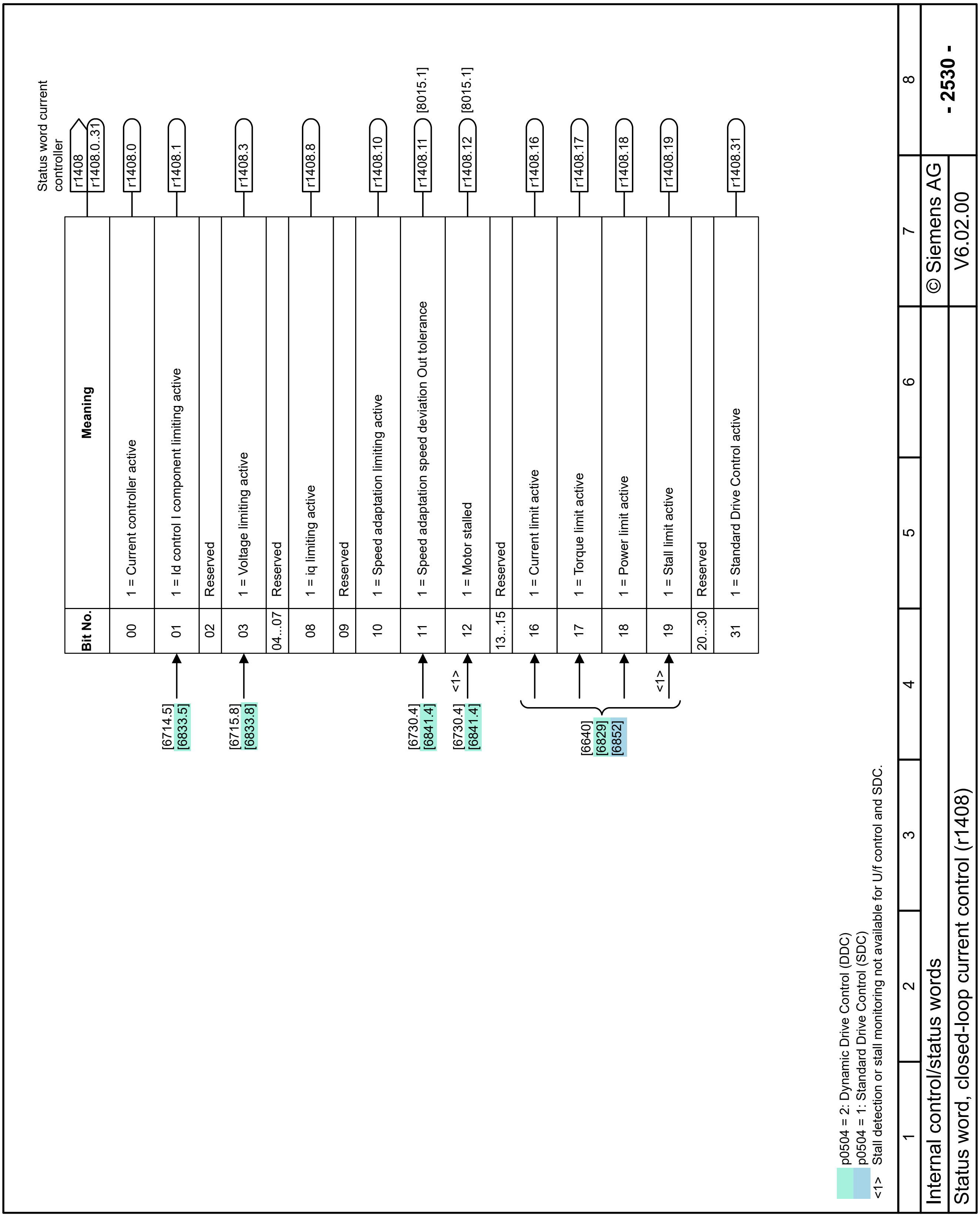


Figure 14-126 2530 - Status word closed-loop current control

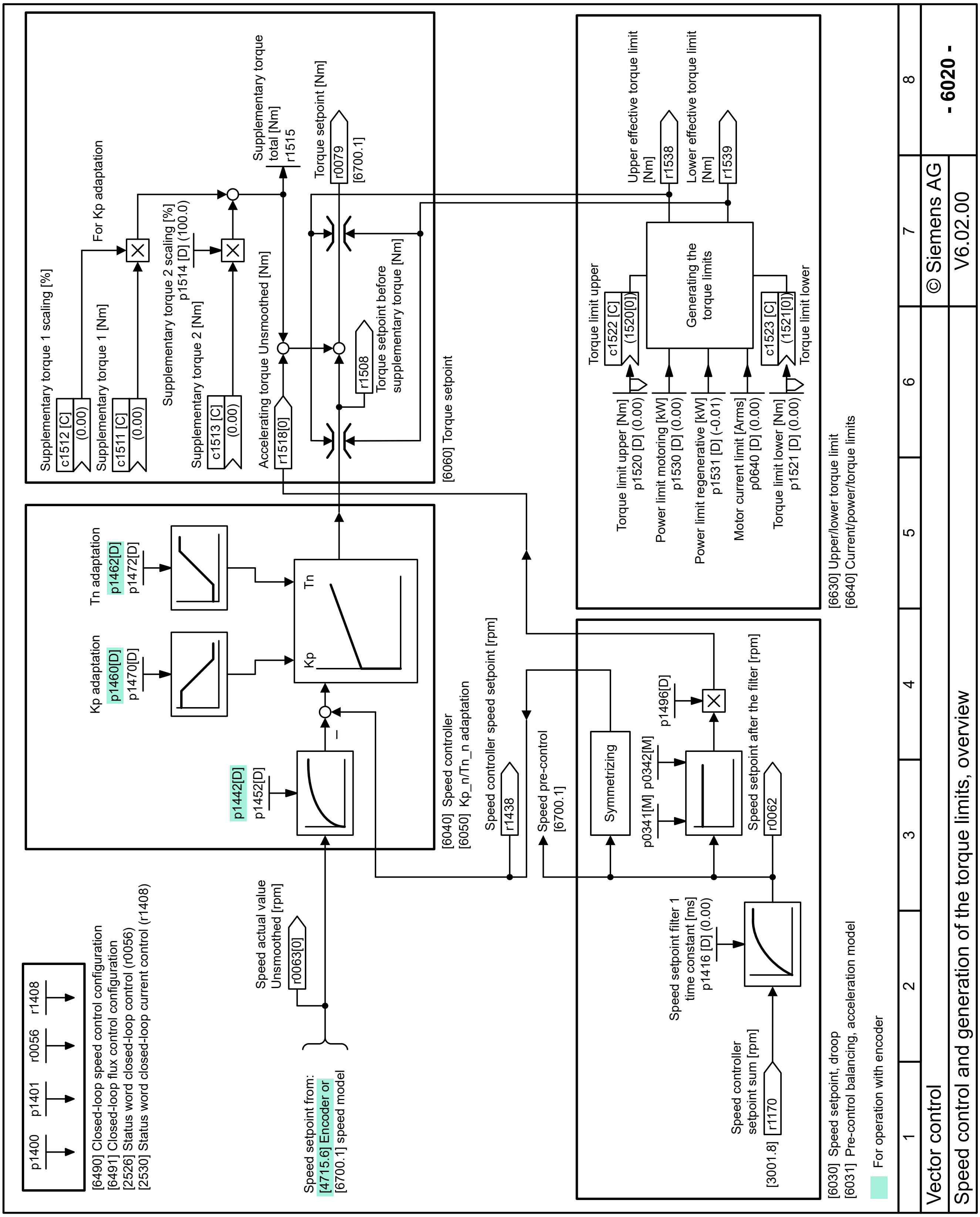


Figure 14-127 6020 - Closed-loop speed control and generation of the torque limits, overview

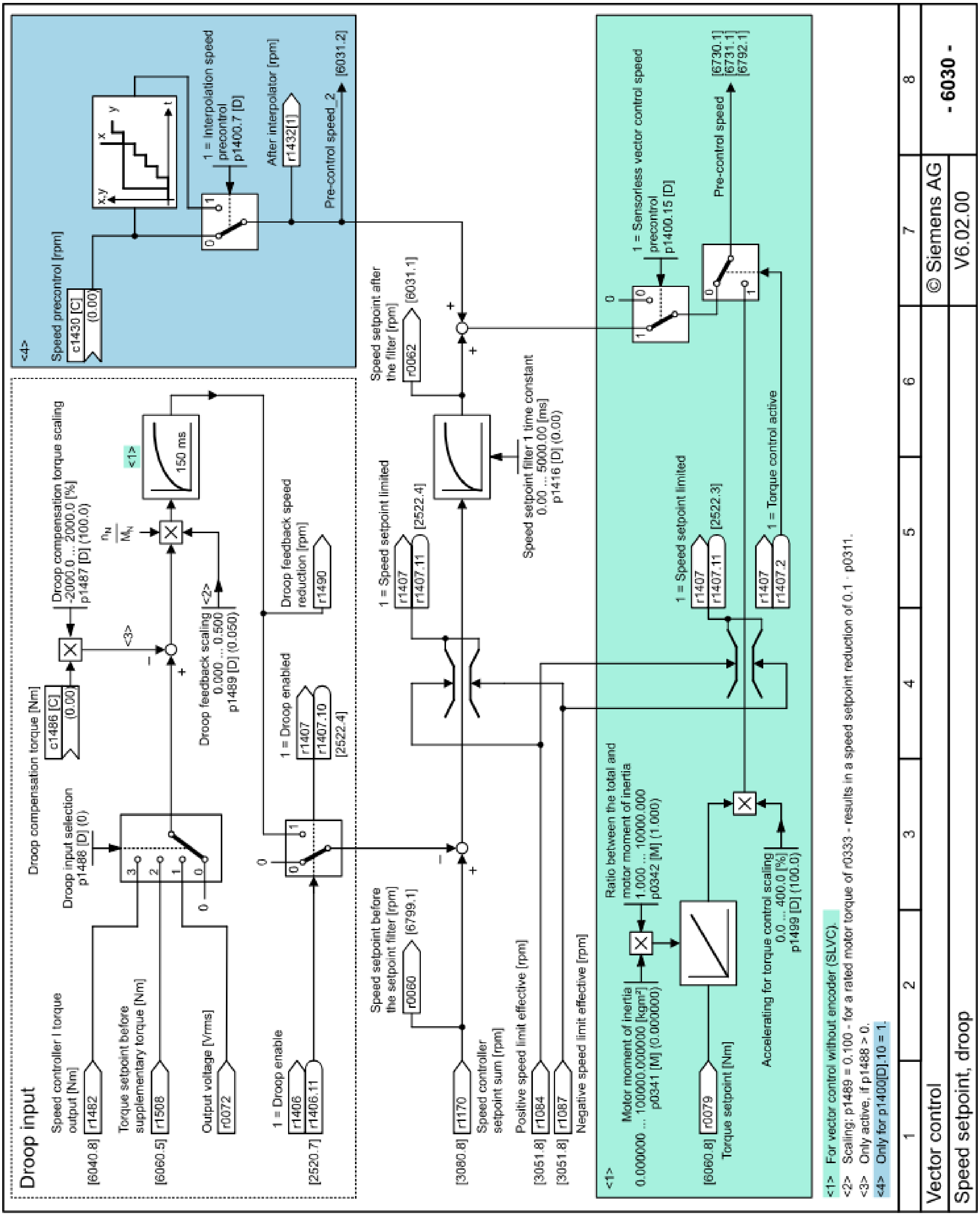


Figure 14-128 6030 - Speed setpoint, droop

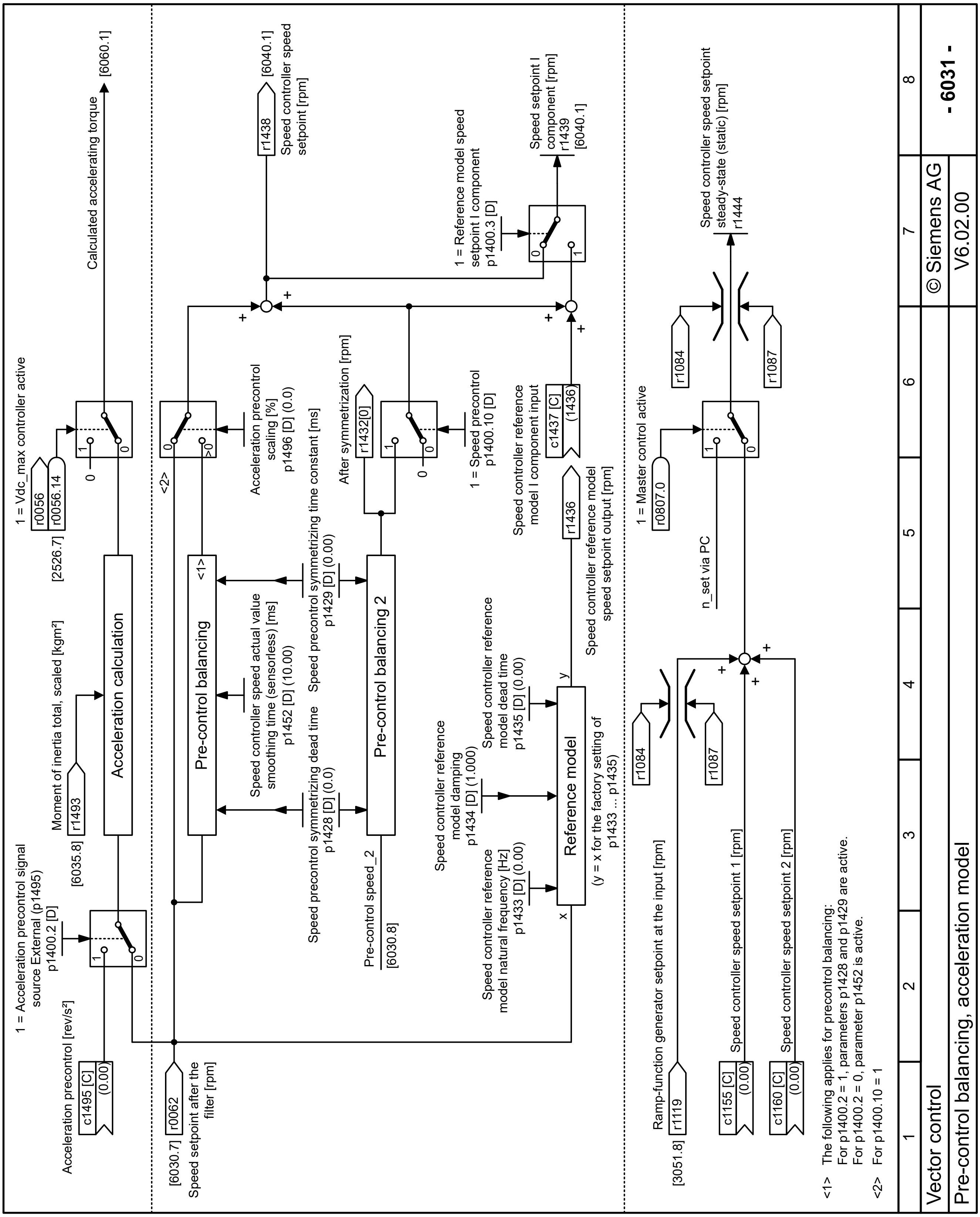


Figure 14-129 6031 - Precontrol balancing, acceleration model

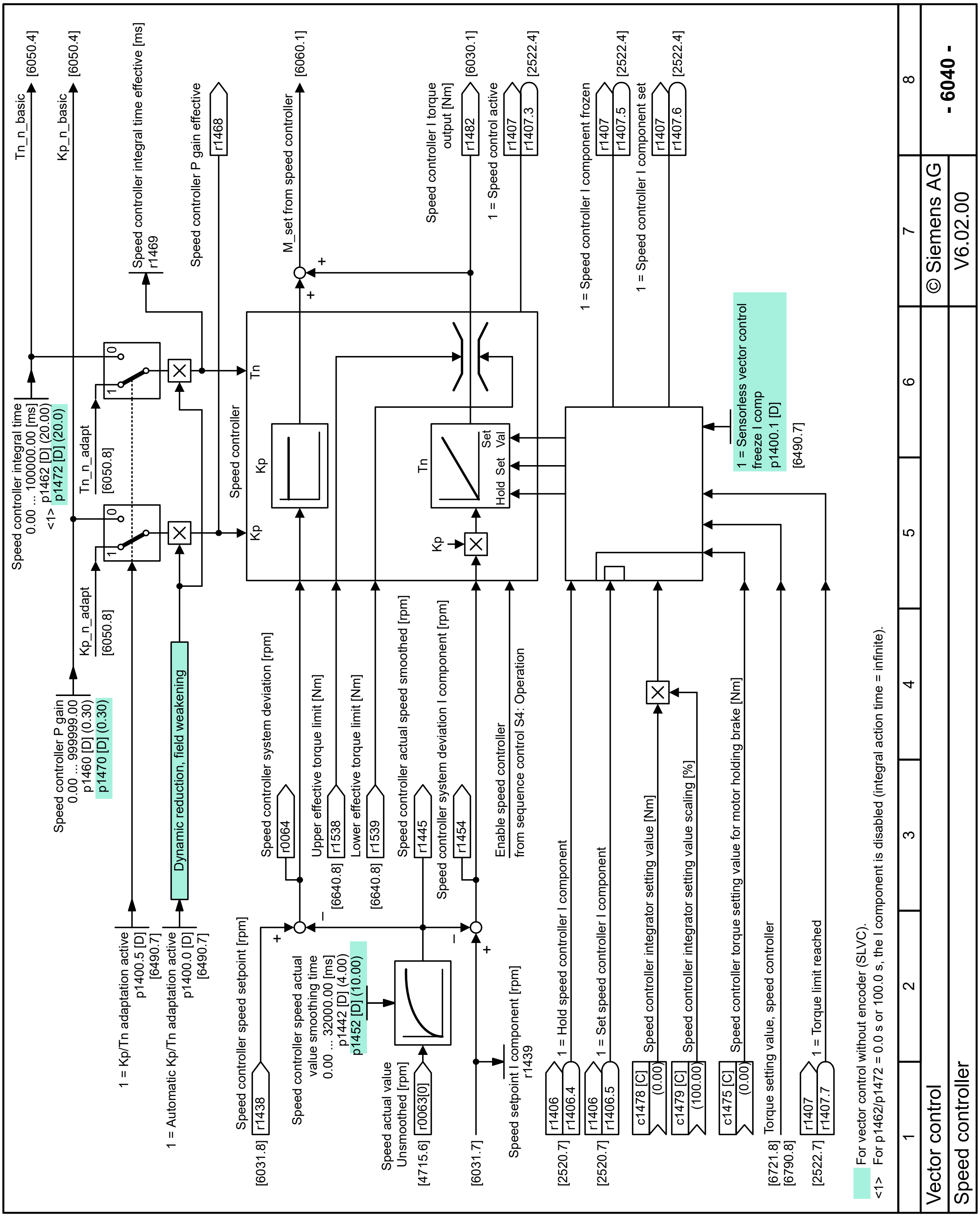


Figure 14-130 6040 - Speed controller

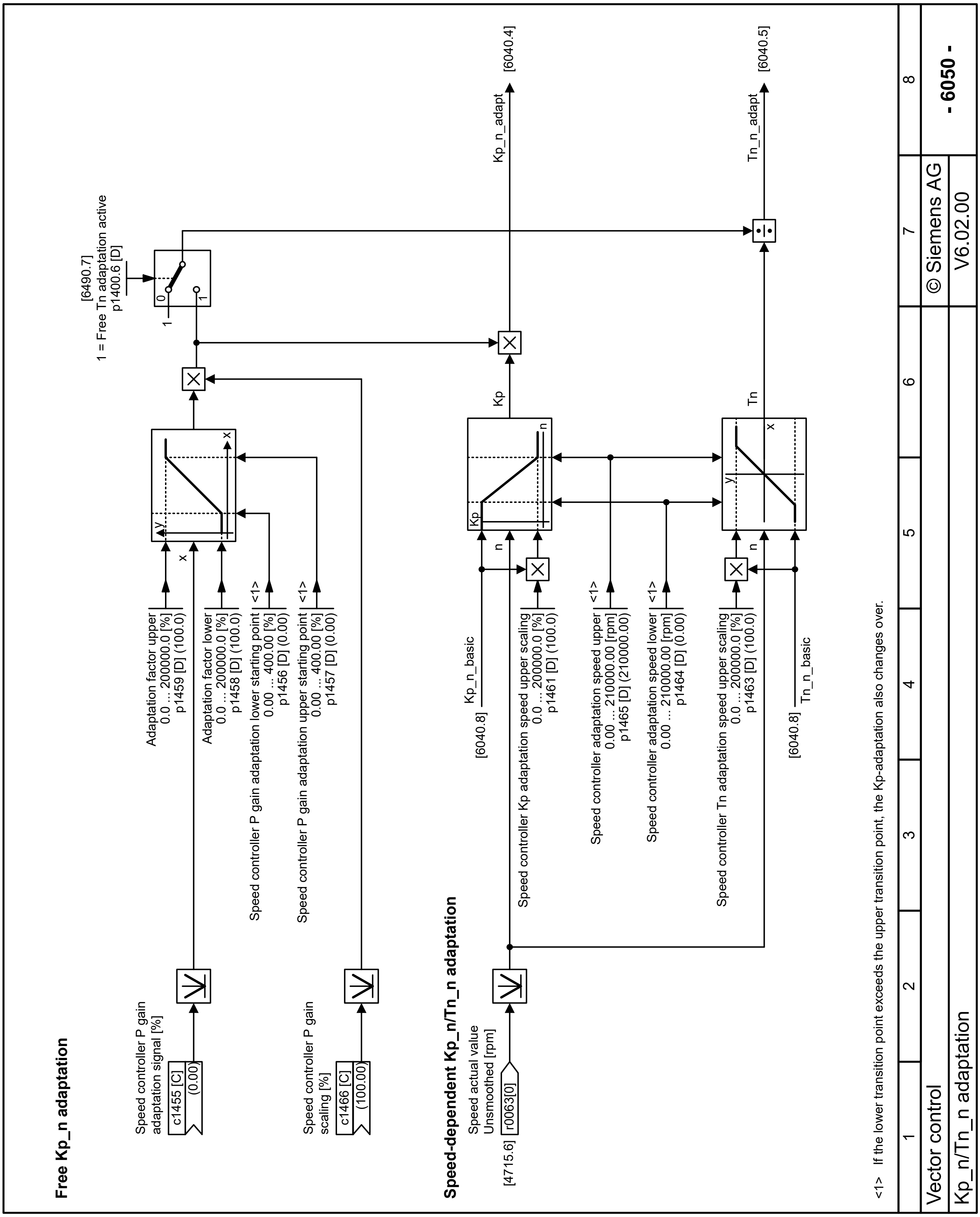


Figure 14-131 6050 - Kp_n-/Tn_n adaptation

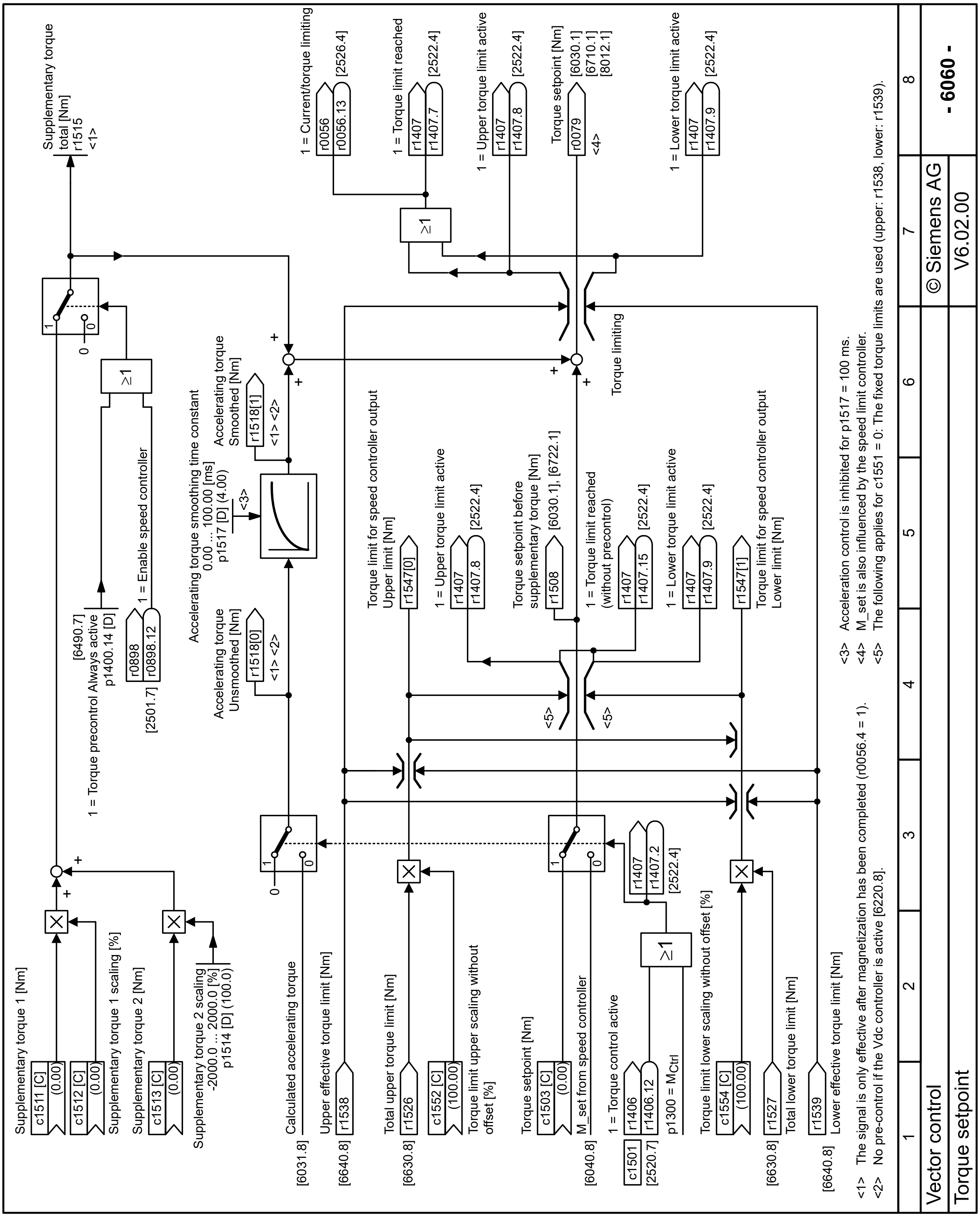


Figure 14-132 6060 - Torque setpoint

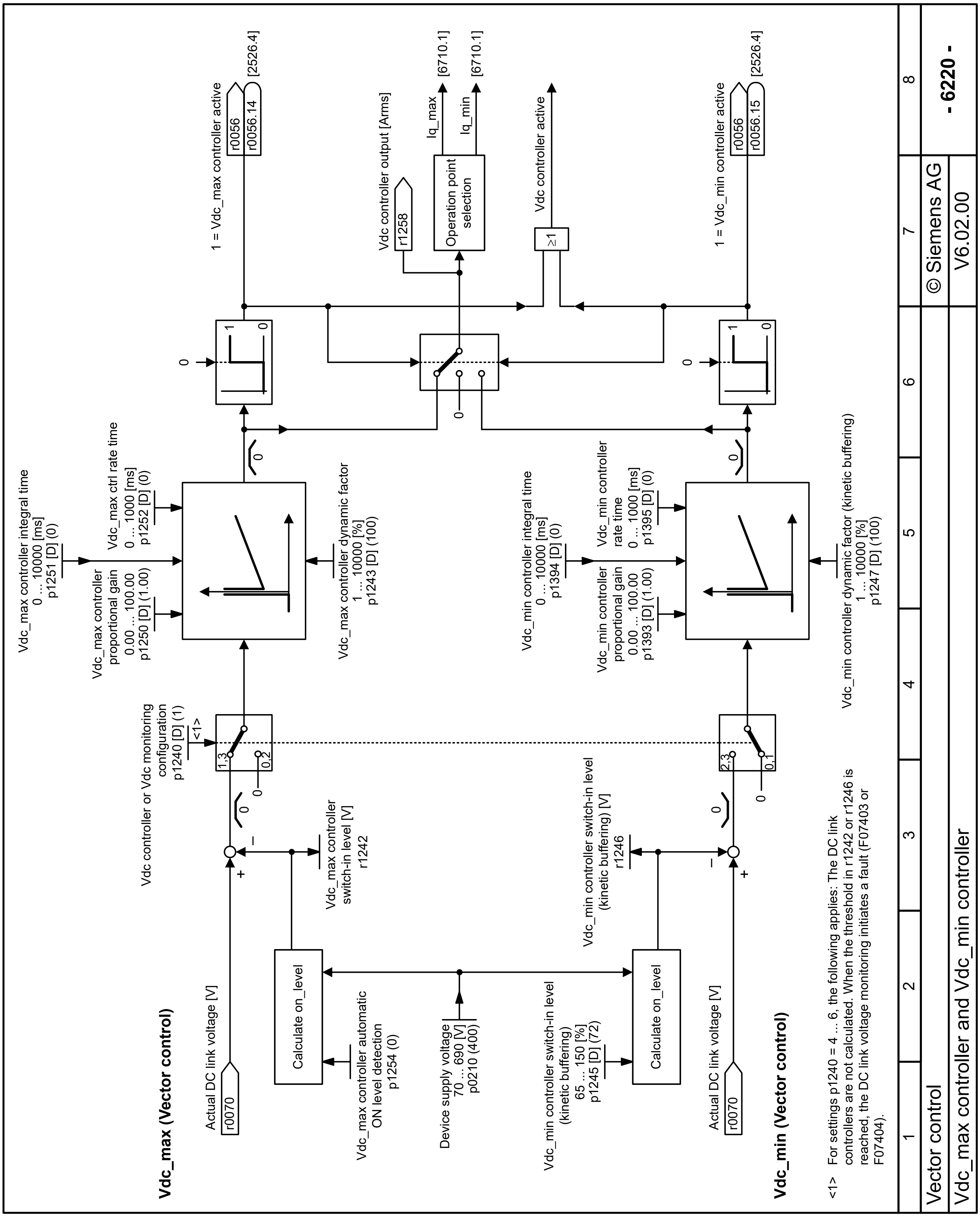


Figure 14-133 6220 - Vdc_max controller and Vdc_min controller (VECTOR)

Speed control configuration
p1400 [D]

Bit No.	Meaning	
00	1 = Automatic Kp/Tn adaptation active	[6040.2], [6824.5]
01	1 = Sensorless vector control freeze I comp	[6040.6], [6824.6]
02	1 = Acceleration precontrol signal source External (p1495)	[6822.4]
03	1 = Reference model speed setpoint I component	[6031.7]
...	Reserved	
05	1 = Kp/Tn adaptation active	[6040.2], [6824.5]
06	1 = Free Tn adaptation active	[6050.7]
07	1 = Interpolation speed precontrol	[6030.7], [6822.3]
...	Reserved	
10	1 = Speed precontrol	[6031.6], [6822.1]
...	Reserved	
14	1 = Torque precontrol Always active	[6060.4], [6826.4]
15	1 = Sensorless vector control speed precontrol	[6030.7], [6822.7]
16	1 = I component for limiting Enable	
...	Reserved	
18	1 = Moment of inertia estimator active	[6035.6], [6822.7]
...	Reserved	
20	1 = Acceleration model	[6822.6]
...	Reserved	
22	1 = Obtain moment of inertia estimator value for pulse inhibit	[6035.1]
23	1 = Acceleration model (with speed encoder)	[6822.6]
24	1 = Moment of inertia estimator fast estimation active	
25	1 = Accelerating torque instantaneous in the I/f mode	
...	Reserved	
27	0 = Load gearbox, take into account torque limit	
...	Reserved	
30	1 = Diagnostic mode SDC/DDC	
31	1 = Standard Drive Control	

1	2	3	4	5	6	7	8

Vector control
Speed control configuration
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V6.02.00
- 6490 -

Figure 14-134 6490 - Speed control configuration

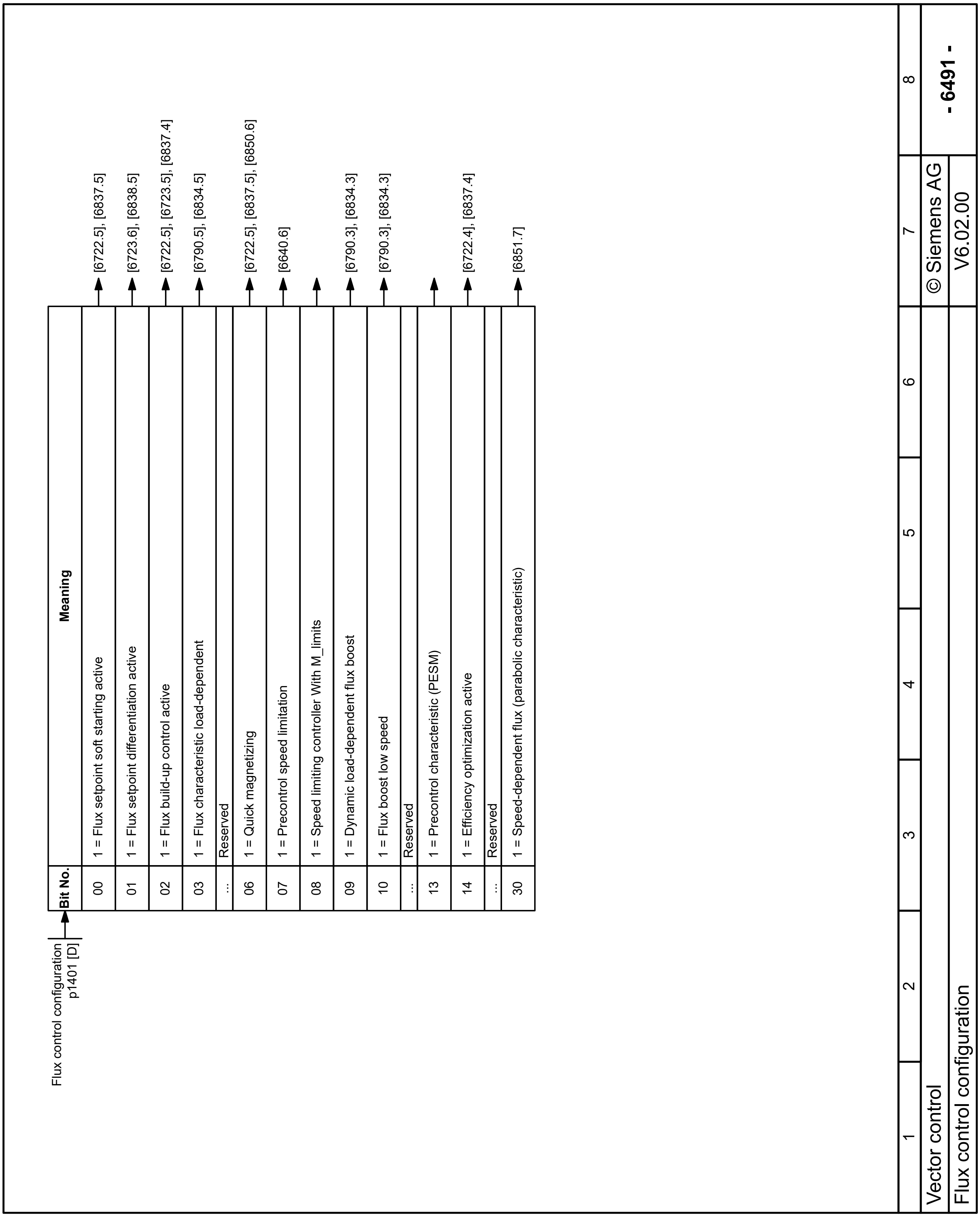


Figure 14-135 6491 - Flux control configuration

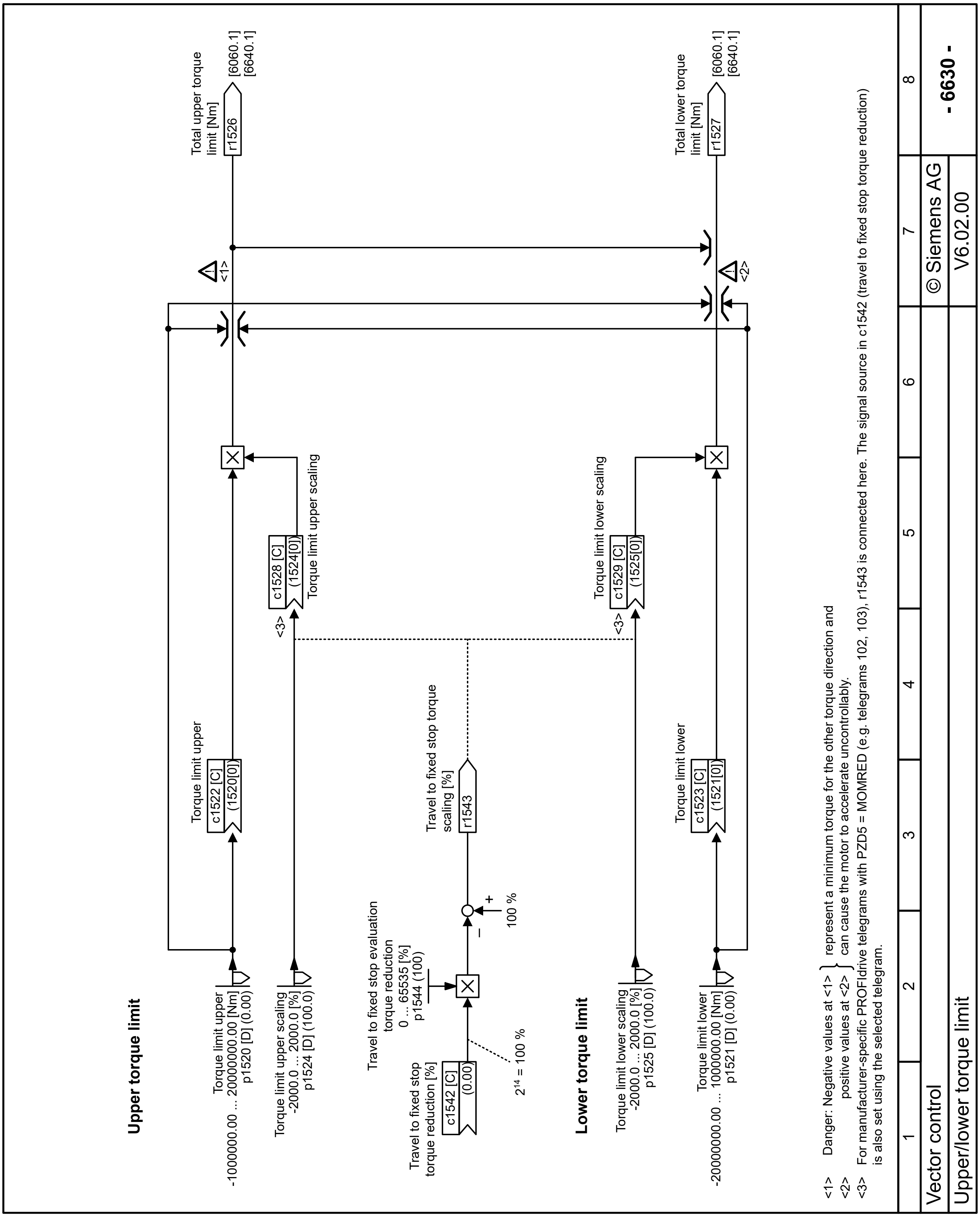


Figure 14-136 6630 - Upper/lower torque limit

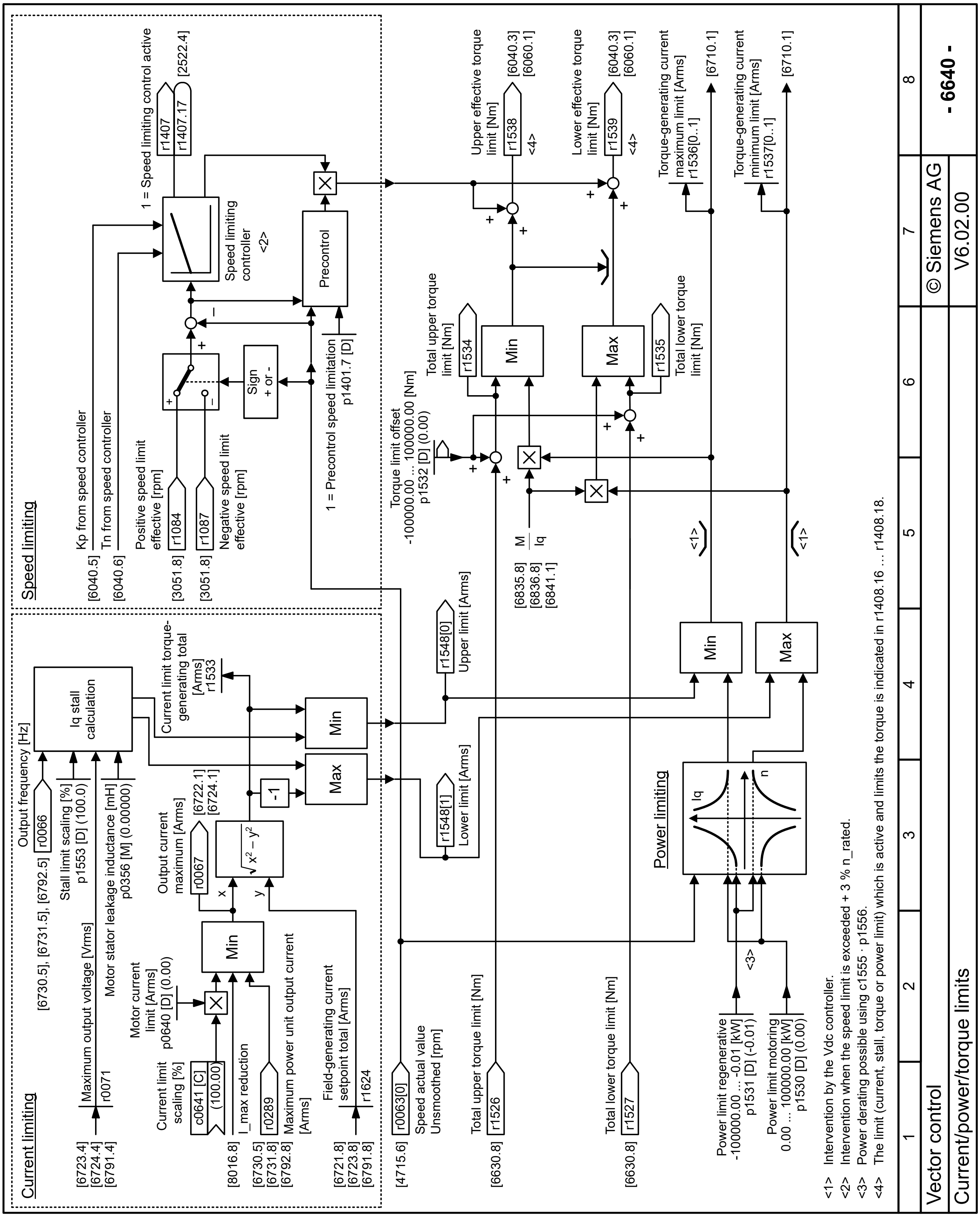


Figure 14-137 6640 - Current/power/torque limits

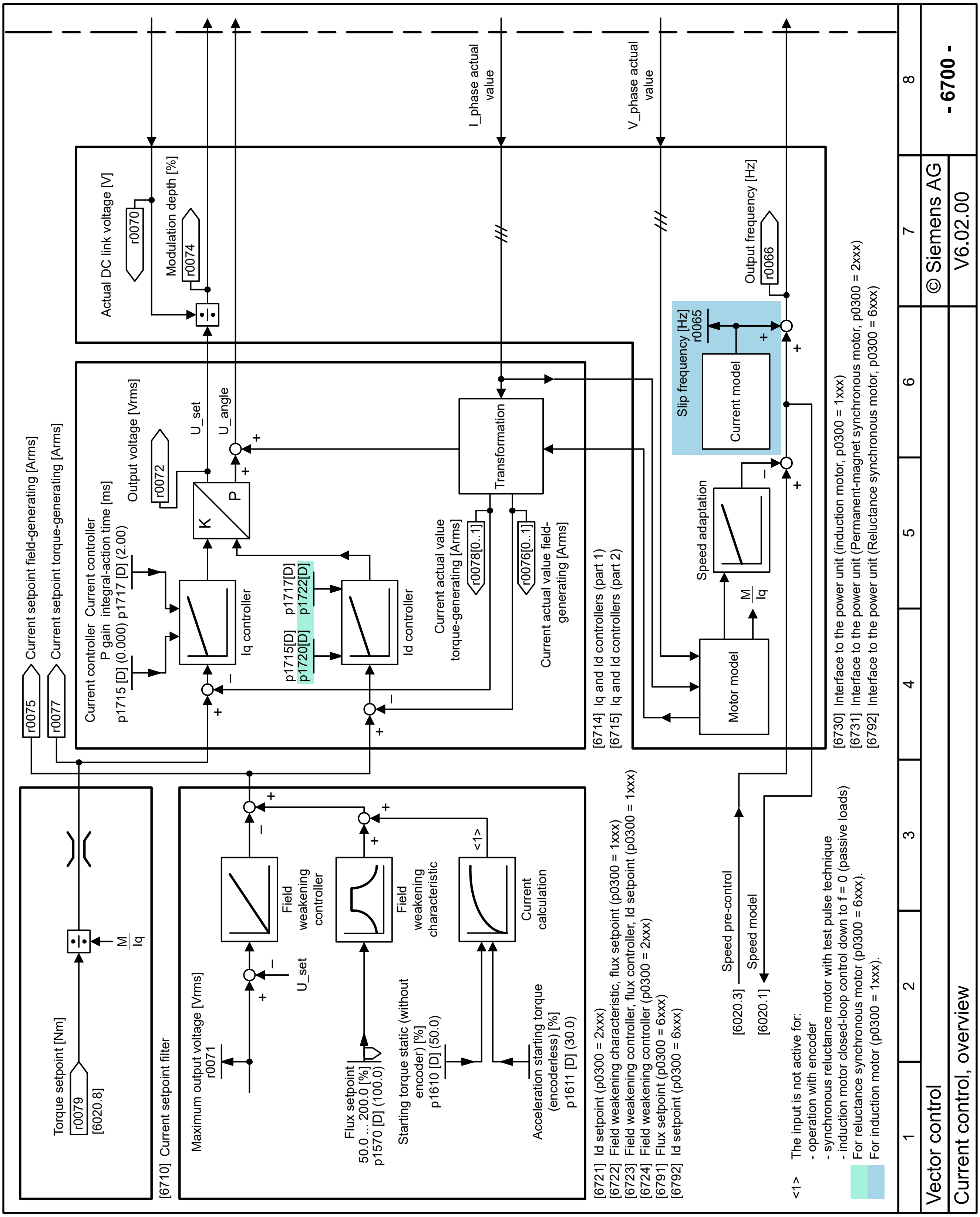


Figure 14-138 6700 - Current regulation, overview

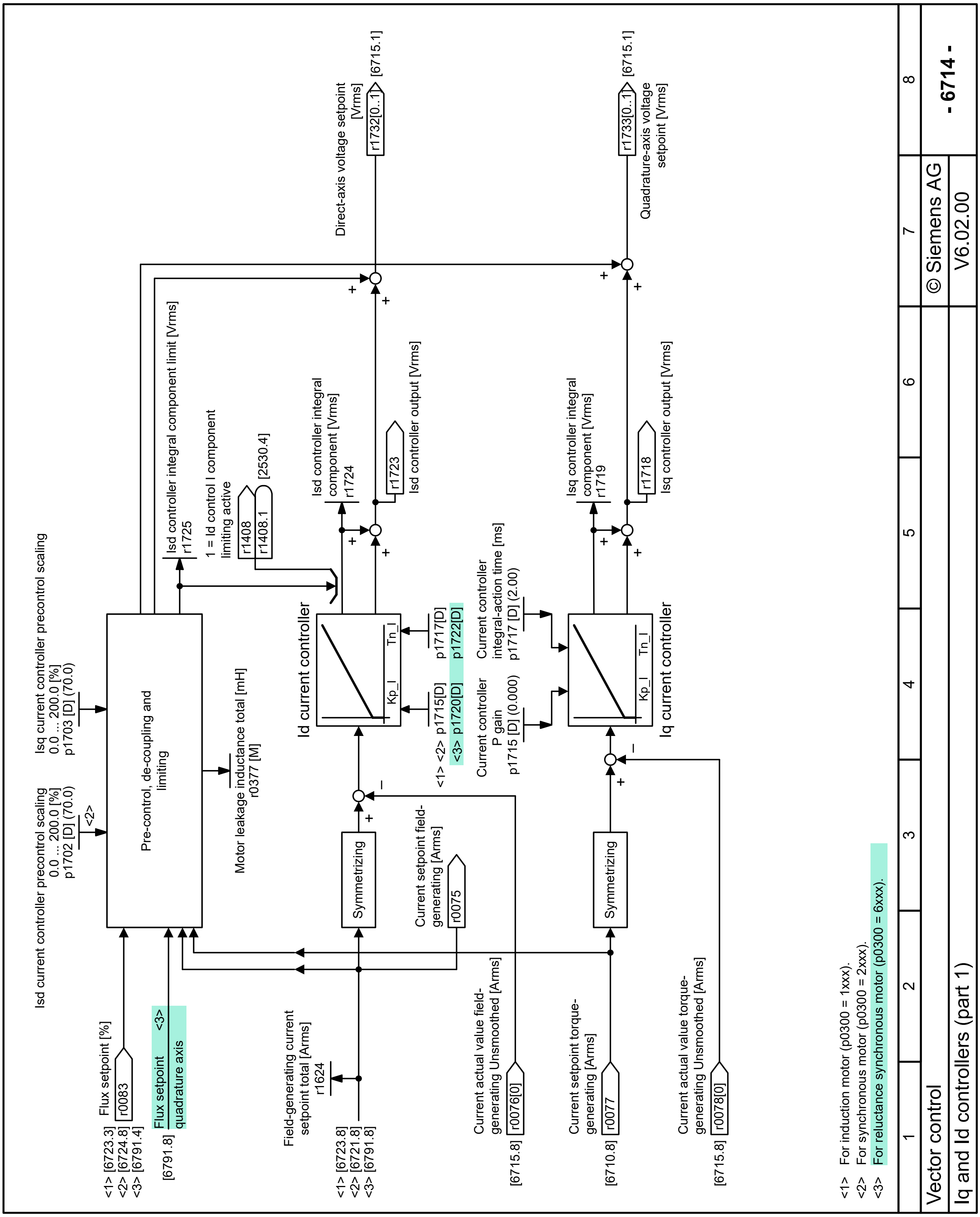


Figure 14-139 6714 - Iq and Id controllers (Part 1)

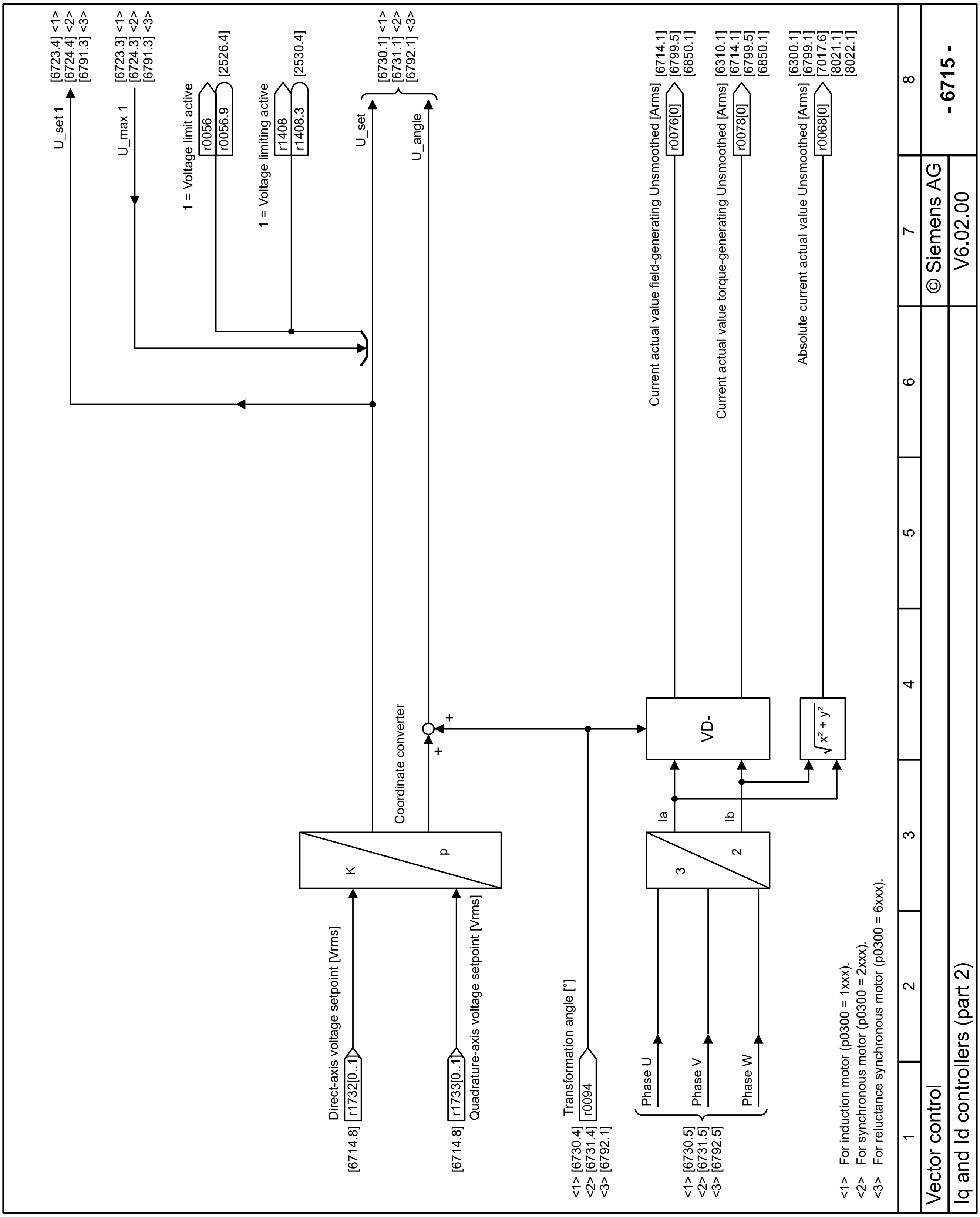


Figure 14-140 6715 - Iq and Id controllers (Part 2)

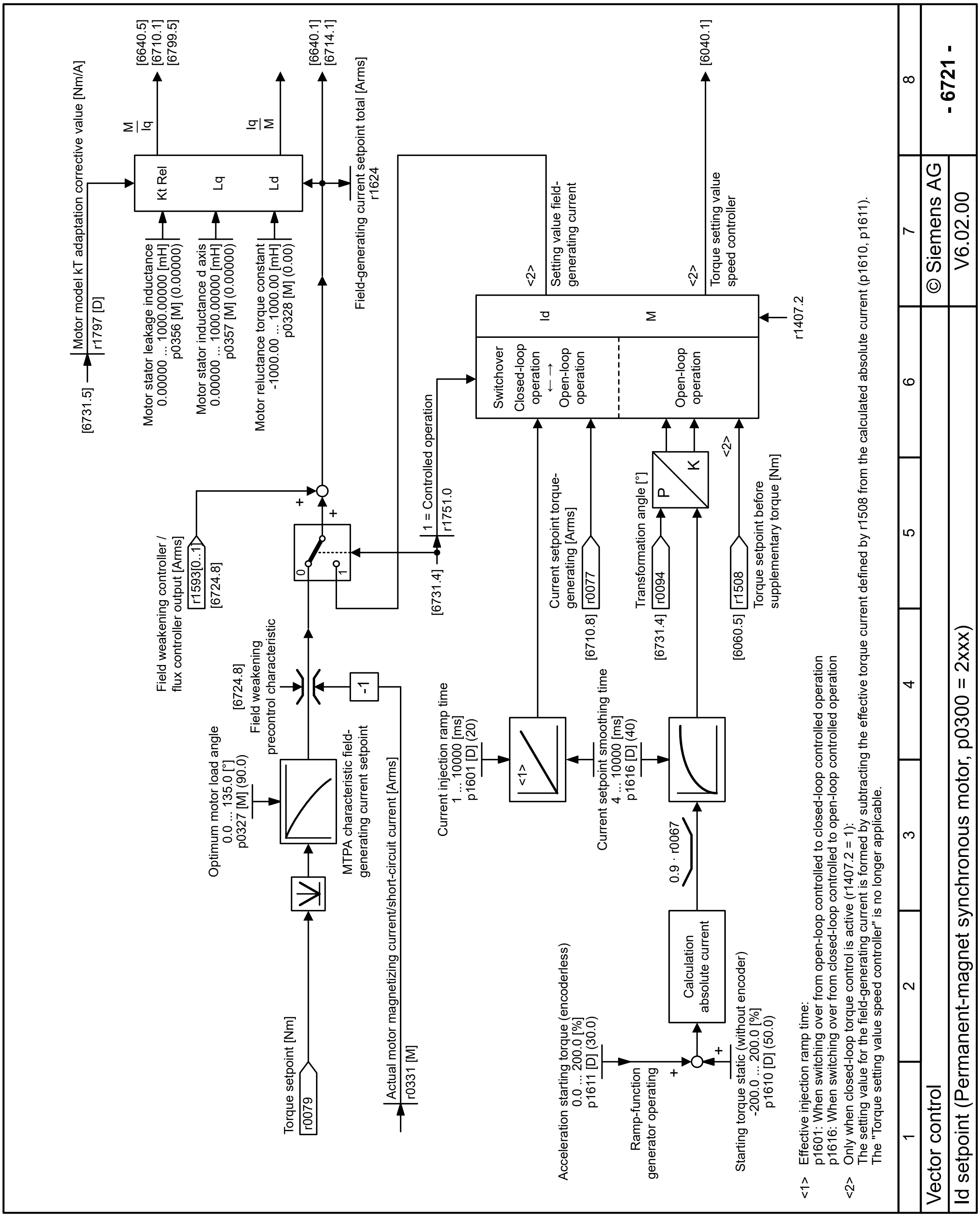


Figure 14-141 6721 - Id setpoint (permanent-magnet synchronous motor)

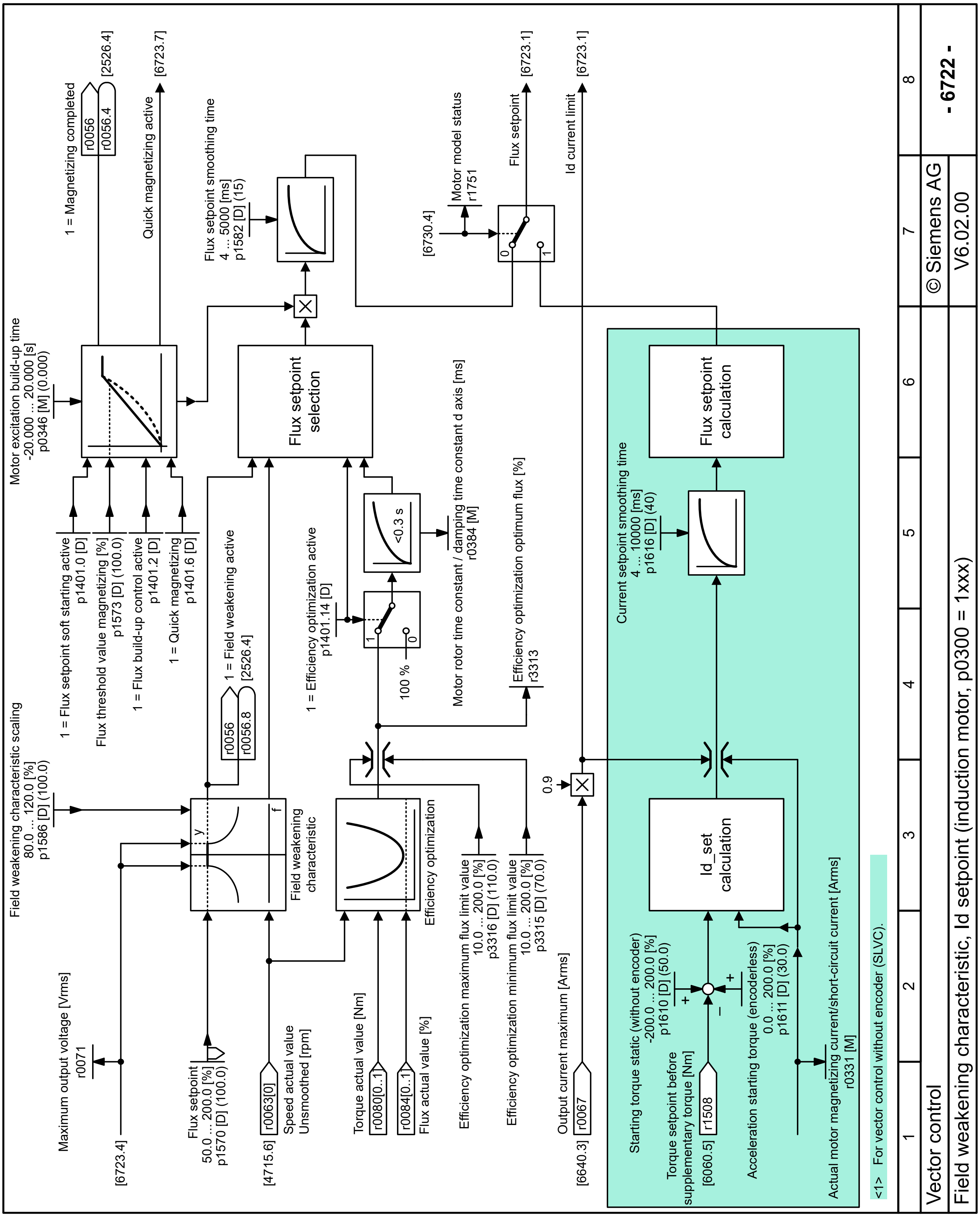


Figure 14-142 6722 - Field weakening characteristic, Id setpoint (induction motor)

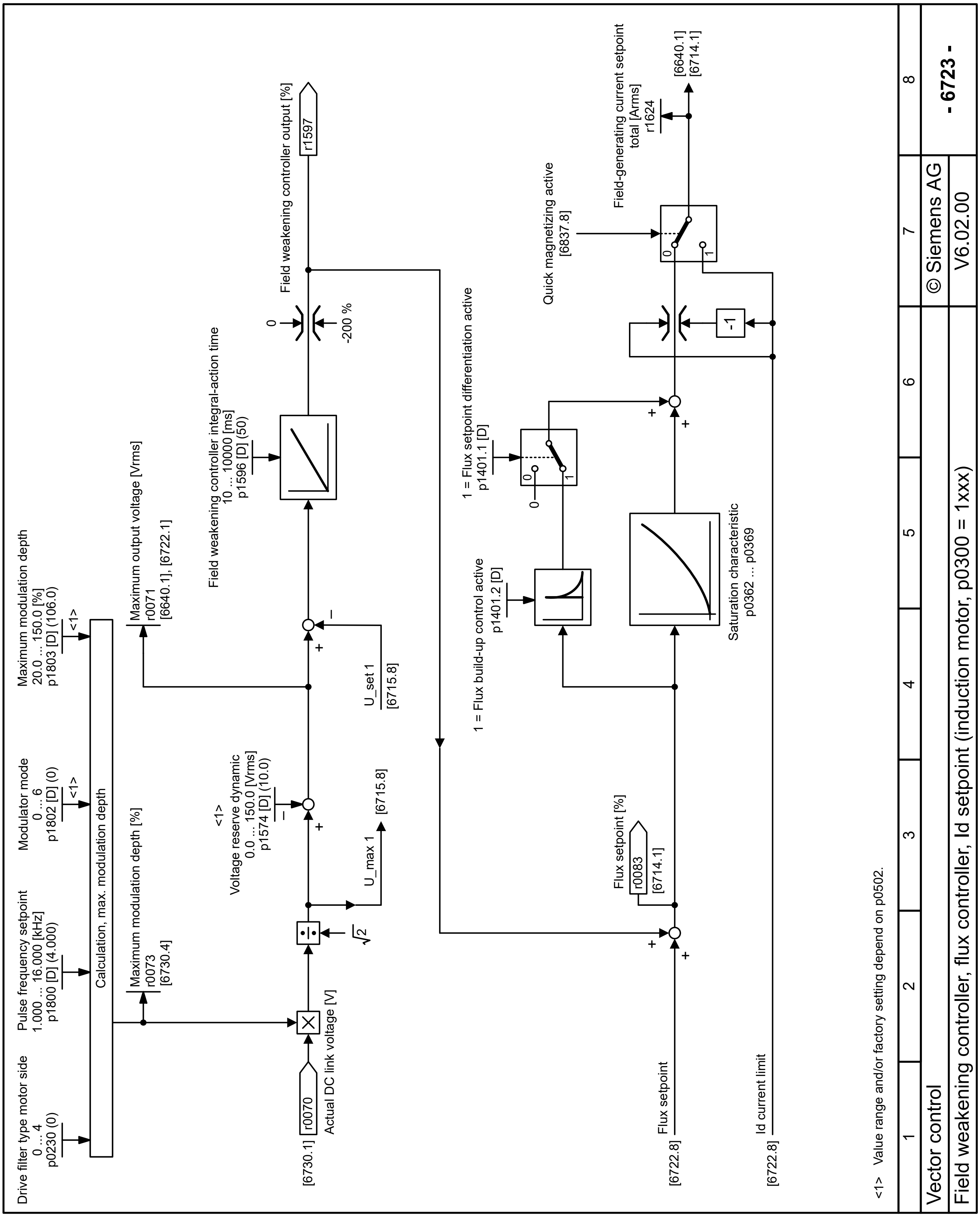


Figure 14-143 6723 – Field weakening controller, flux controller, Id setpoint (induction motor)

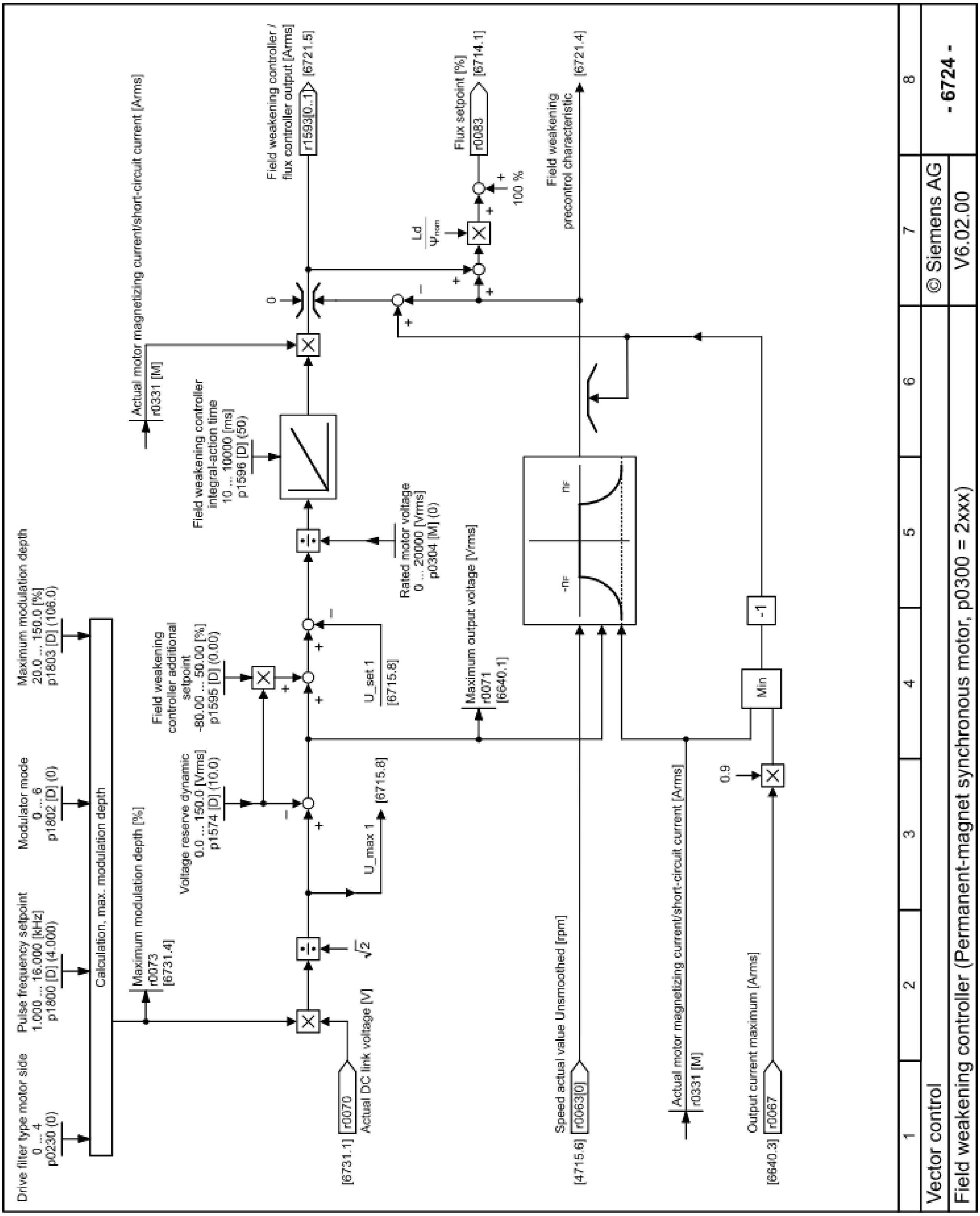


Figure 14-144 6724 - Field weakening controller (permanent-magnet synchronous motor)

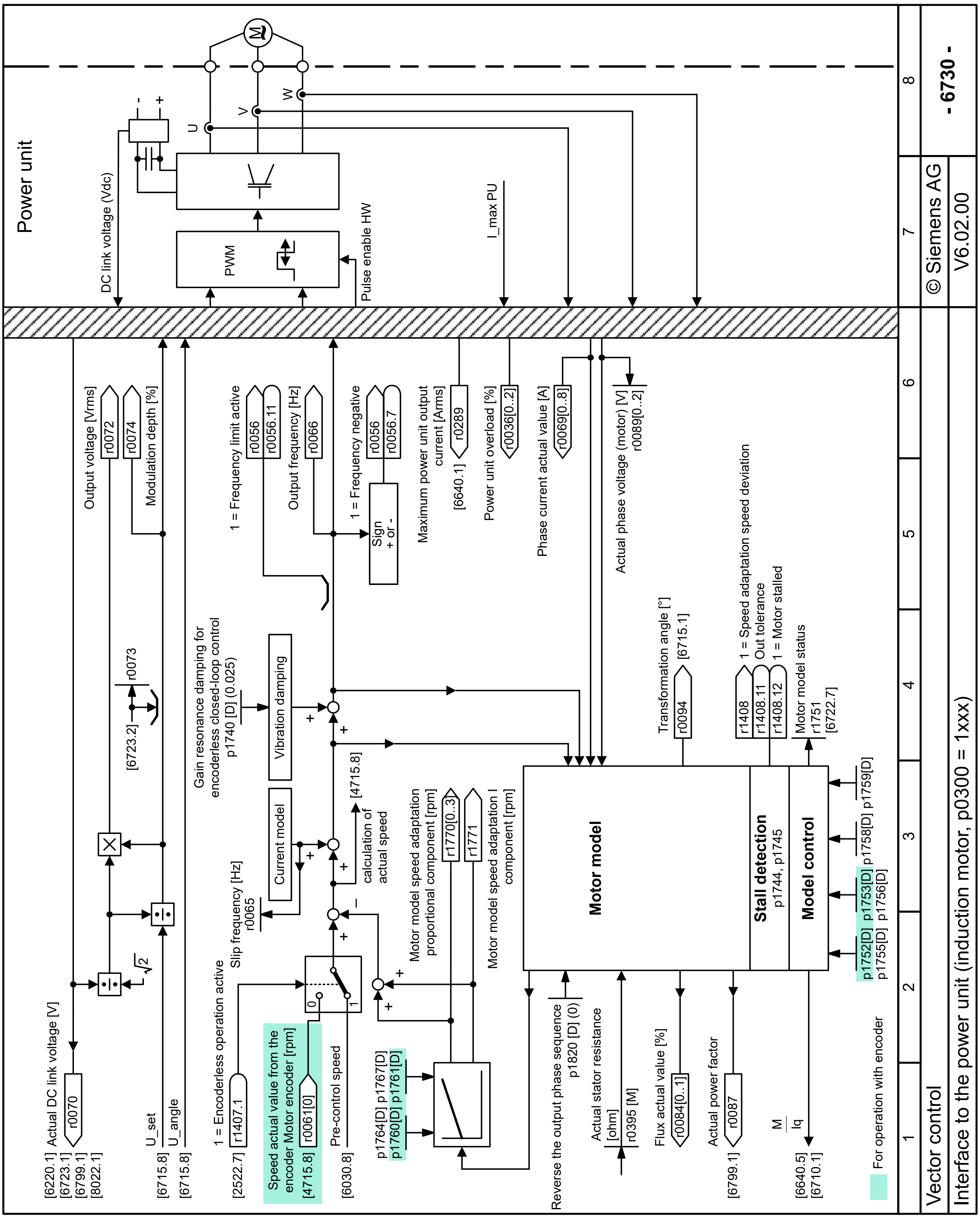


Figure 14-145 6730 - Interface to power unit (induction motor)

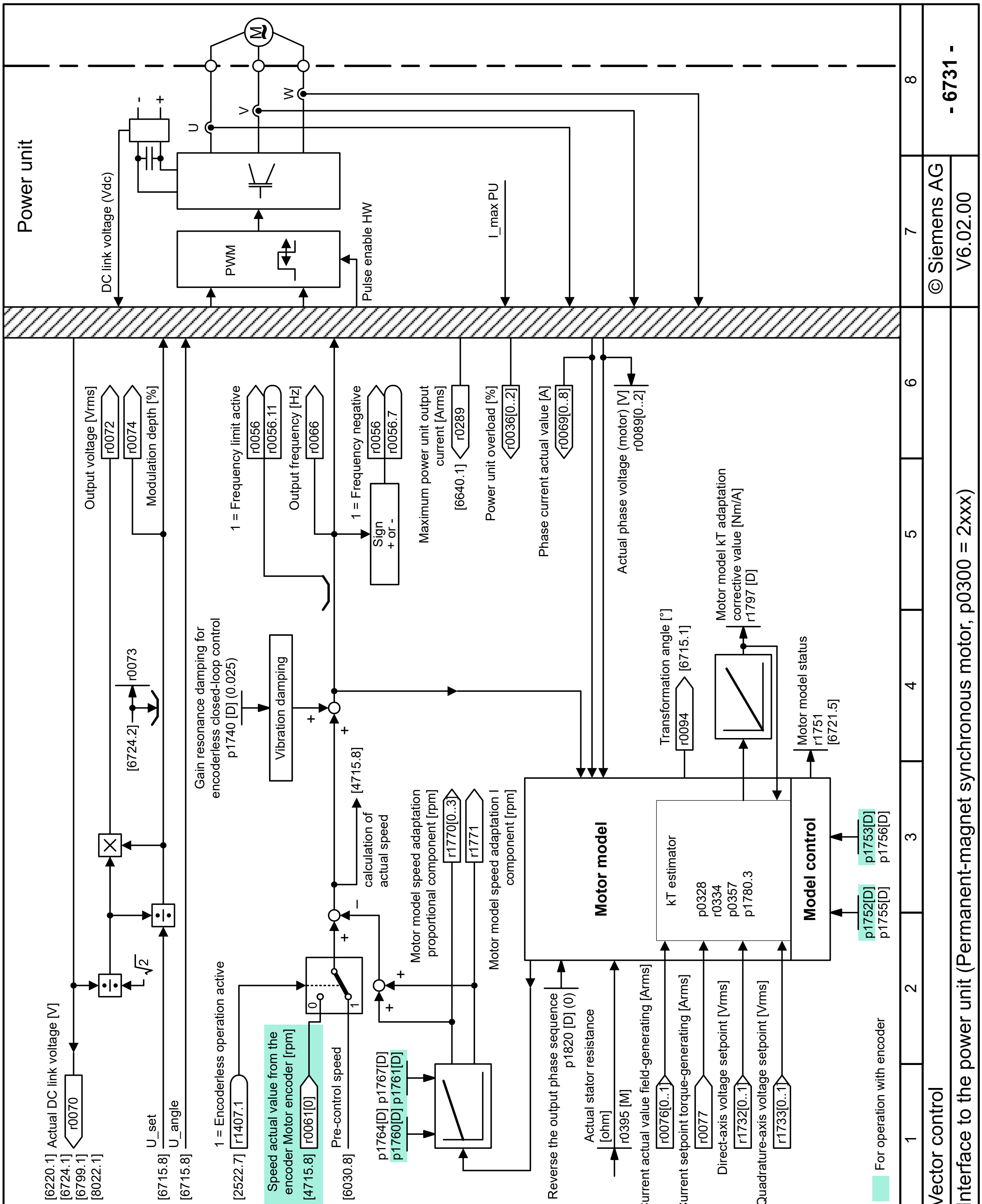


Figure 14-146 6731 - Interface to the power unit (permanent-magnet synchronous motor)

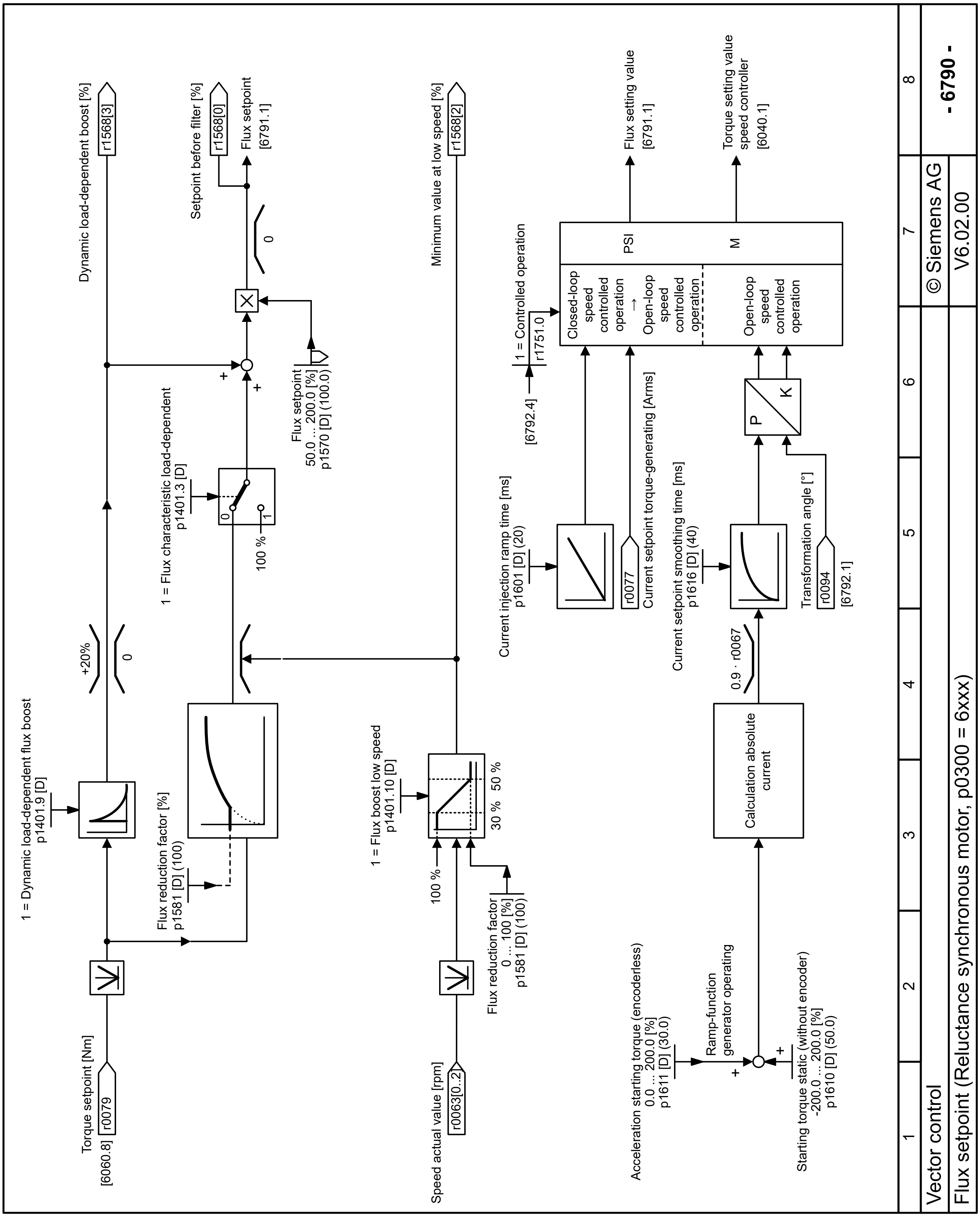


Figure 14-147 6790 - Flux setpoint (synchronous reluctance motor)

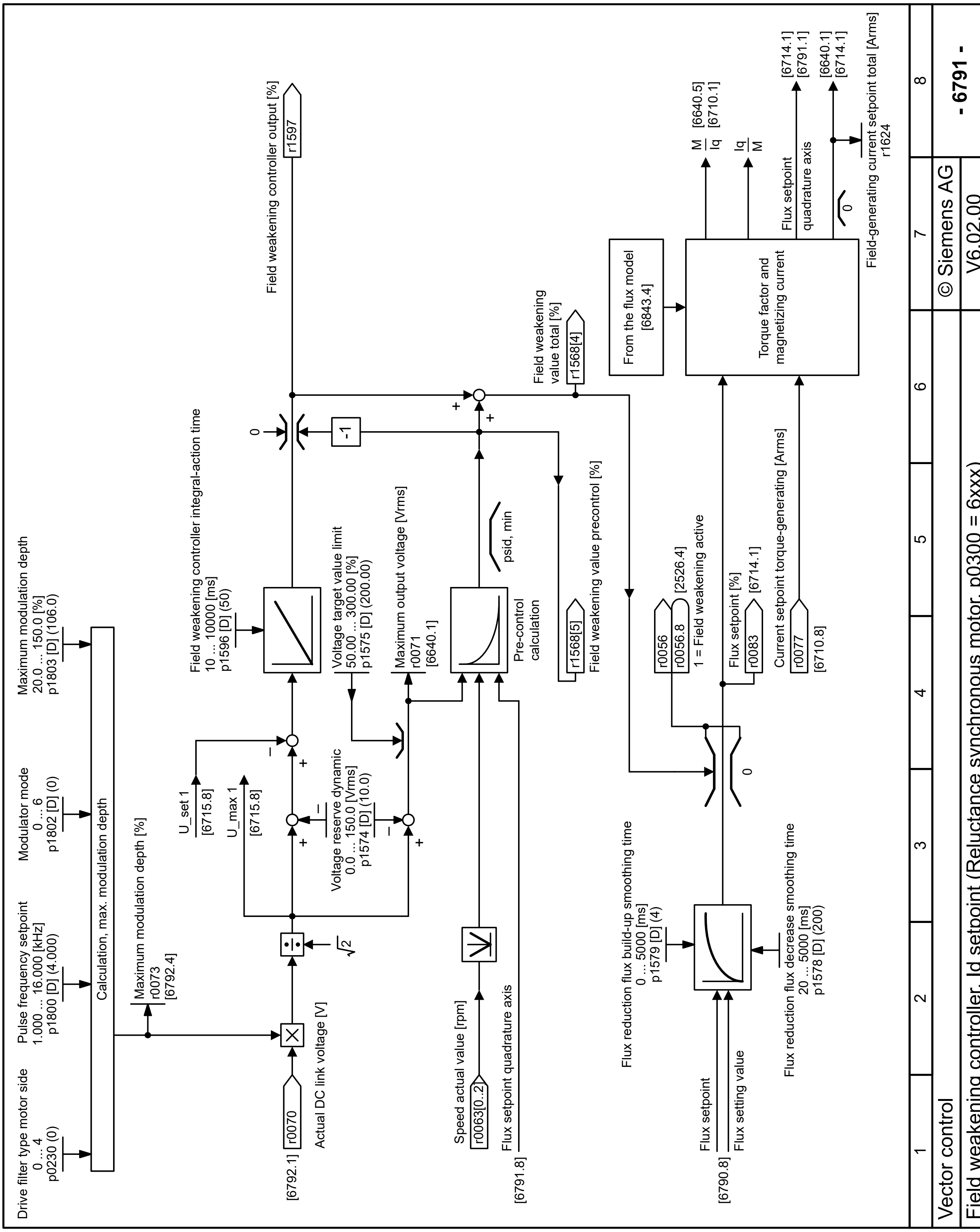


Figure 14-148 6791 - Field weakening controller, Id setpoint (synchronous reluctance motor)

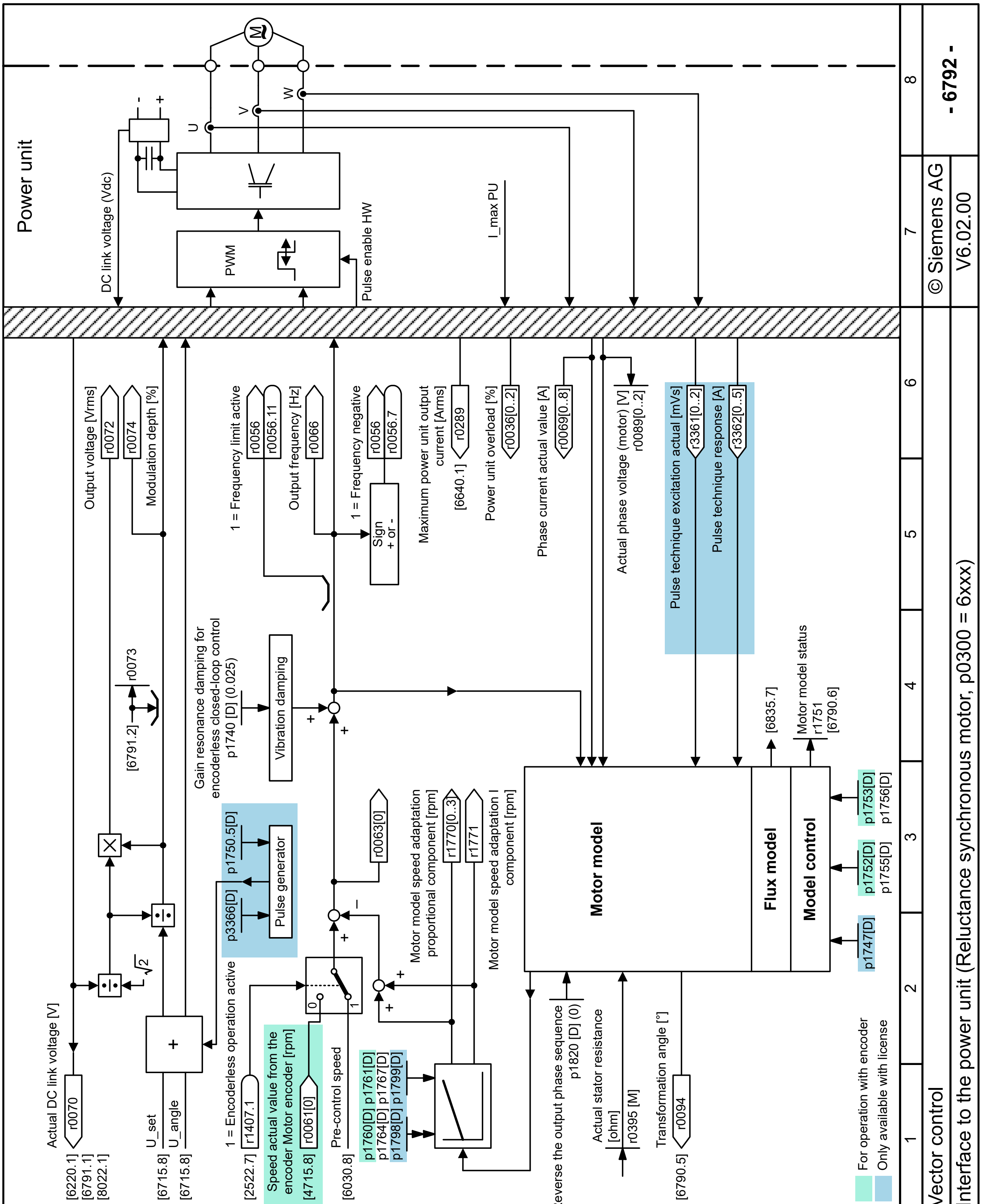


Figure 14-149 6792 - Interface to the power unit (synchronous reluctance motor)

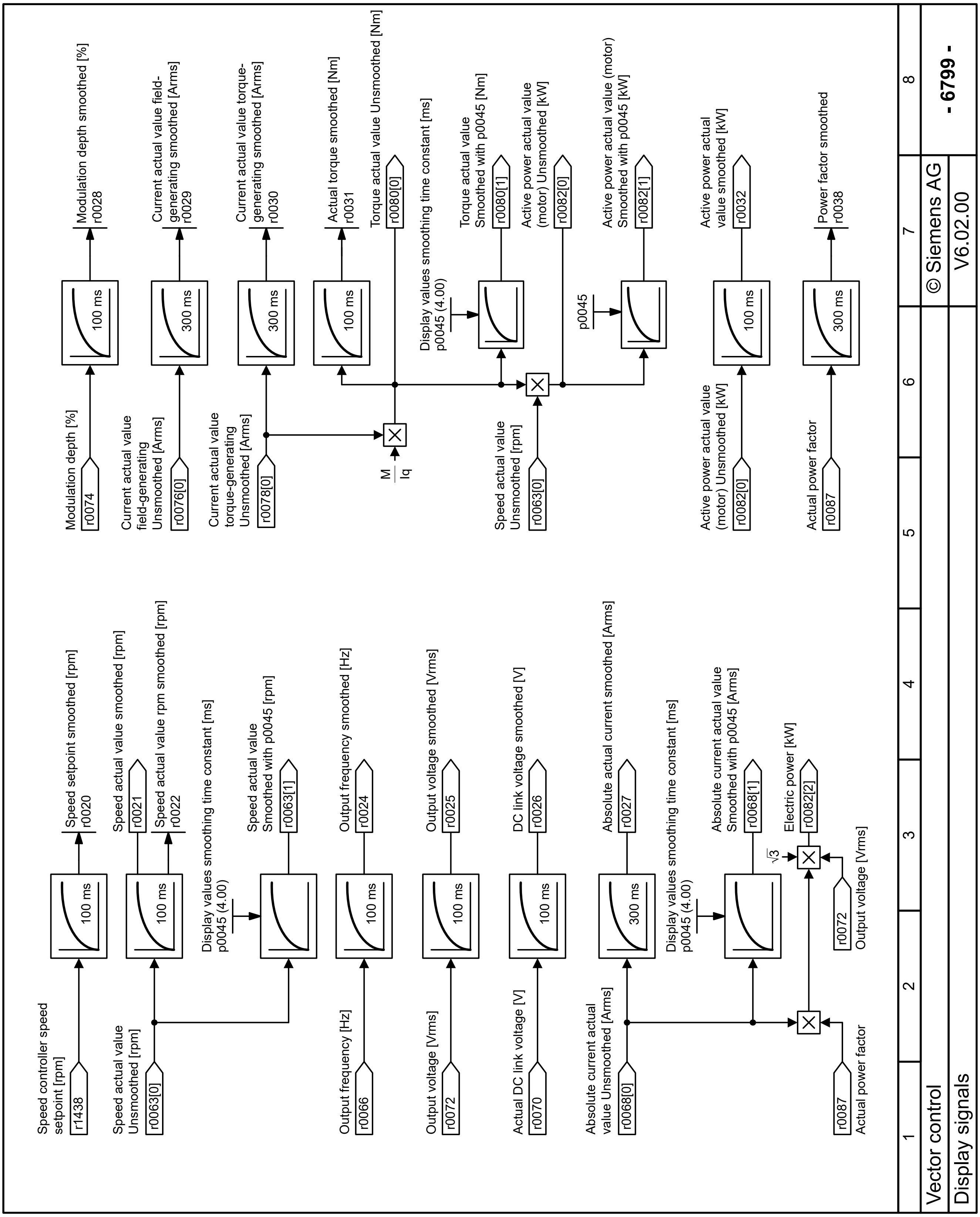


Figure 14-150 6799 - Display signals

14.10.6 Current setpoint filter

Overview

A current setpoint filter suppresses critical frequency components and thereby prevents the excitation of oscillations by the speed controller. A current setpoint filter therefore increases the achievable machine dynamics in critical applications.

Requirement

The Dynamic Drive Control operating mode or the closed-loop speed control mode is selected.

Description of function

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 14-151 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 14-152 Transfer function for a general 2nd order filter.

With the correct adjustment, it is possible to achieve a bandstop or a low-pass with reduction.

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 14-73 PT2 low-pass

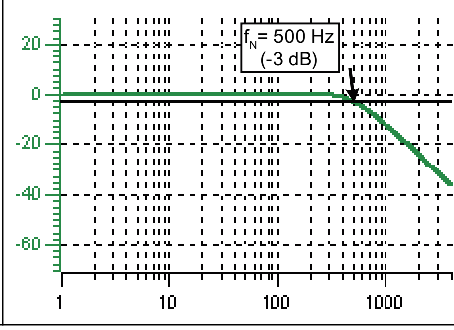
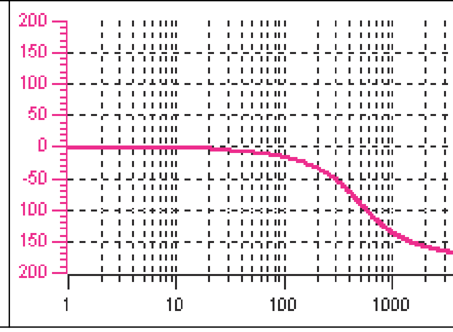
Filter parameters	Amplitude response	Phase response
Denominator natural frequency f_N = 500 Hz Denominator damping D_N = 0.7 dB		

Table 14-74 General 2nd order filter

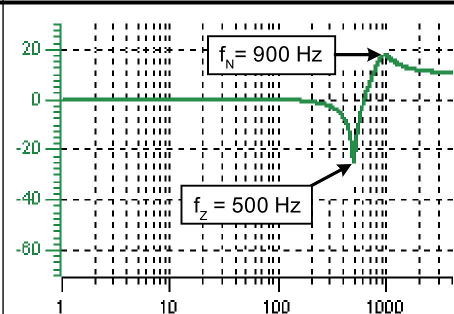
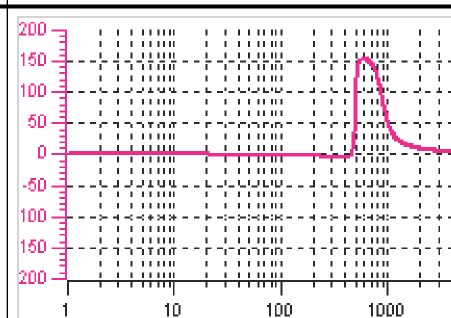
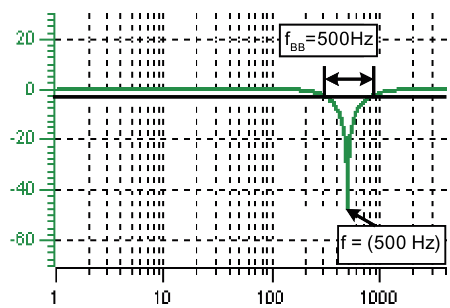
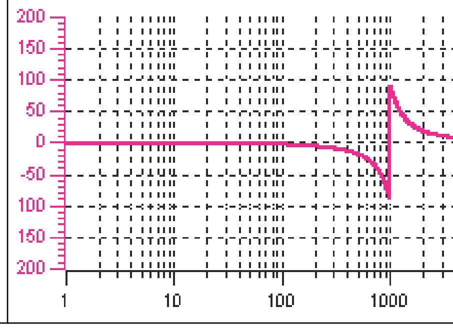
Filter parameters	Amplitude response	Phase response
Numerator natural frequency f_Z = 500 Hz Numerator damping D_Z = 0.02 dB Denominator natural frequency f_N = 900 Hz Denominator damping D_N = 0.15 dB		

Table 14-75 Bandstop with infinite notch depth and no reduction

<table>
<tr><th>Filter parameters</th><th>Amplitude response</th><th>Phase response</th></tr>
<tr><td>Blocking frequency
f_{Sp} = 500 Hz
Bandwidth (-3 dB) f_{BB} = 500 Hz
Notch depth K = -∞ dB
Reduction Abs = 0 dB</td><td>



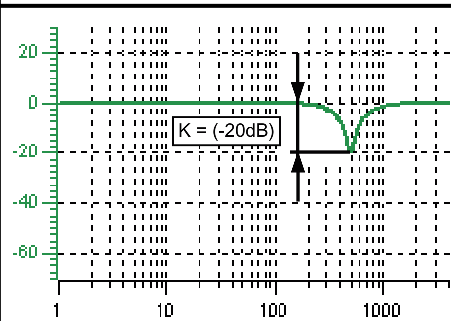
</td><td>



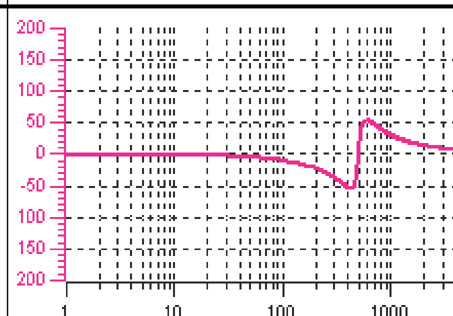
</td></tr>
<tr><td colspan="3">Settings for the general 2nd order filter:
• Numerator natural frequency $f_Z = f_{Sp}$
• Numerator damping $D_Z = 0$
• Denominator natural frequency $f_N = f_{Sp}$
• Denominator damping
$D_N = \frac{f_{BB}}{2\ f_{Sp}}$</td></tr>
</table>

Table 14-76 Bandstop with defined notch depth and no reduction

<table>
<tr><th>Filter parameters</th><th>Amplitude response</th><th>Phase response</th></tr>
<tr><td>Blocking frequency
f_{Sp} = 500 Hz
Bandwidth f_{BB} = 500 Hz
Notch depth K = -20 dB
Reduction Abs = 0 dB</td><td>

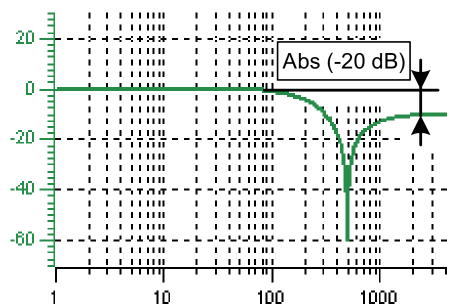
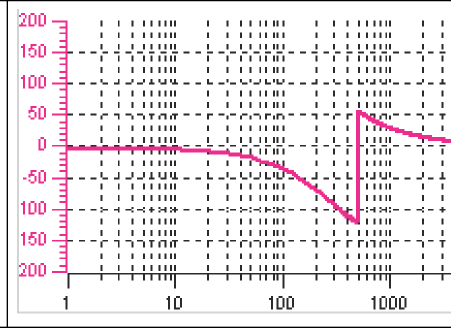


</td><td>



</td></tr>
<tr><td colspan="3">Settings for the general 2nd order filter:
• 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
$D_N = \frac{f_{BB}}{2\ f_{Sp}}$</td></tr>
</table>

Table 14-77 Bandstop with infinite notch depth and defined reduction

<table>
<tr><th>Filter parameters</th><th>Amplitude response</th><th>Phase response</th></tr>
<tr><td>Blocking frequency
f_{SP} = 500 Hz
Bandwidth f_{BB} = 500 Hz
Notch depth K = -∞ dB
Reduction Abs = -20 dB</td><td>
</td><td>
</td></tr>
<tr><td colspan="3">Settings for the general 2nd order filter:

- Numerator natural frequency

$$f_Z = \frac{\omega_Z}{2\pi} = f_{Sp}$$

- Numerator damping

$$D_Z = 10^{\frac{K}{20}} \cdot \frac{1}{2} \cdot \sqrt{\left(1 - \frac{1}{10^{\frac{Abs}{20}}}\right)^2 + \frac{f_{BB}^{\ 2}}{f_{Sp}^{\ 2} \cdot 10^{\frac{Abs}{10}}}}$$

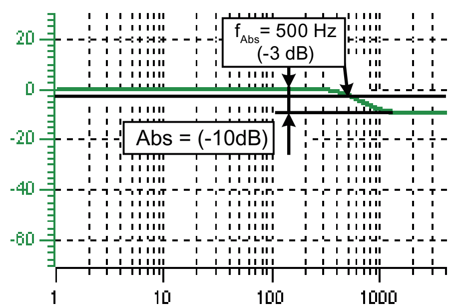
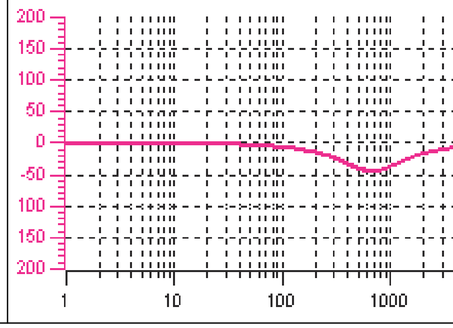
- Denominator natural frequency

$$f_N = \frac{\omega_N}{2\pi} = f_{Sp} \cdot 10^{\frac{Abs}{40}}$$

- Denominator damping

$$D_N = \frac{f_{BB}}{2\, f_{Sp} \cdot 10^{\frac{Abs}{40}}}$$
</td></tr>
</table>

Table 14-78 Low-pass with reduction

<table>
<tr><th>Filter parameters</th><th>Amplitude response</th><th>Phase response</th></tr>
<tr><td>Characteristic frequency
f_{Abs} = 500 Hz
Damping D = 0.7
Reduction Abs = -10 dB</td><td>
</td><td>
</td></tr>
<tr><td colspan="3">Settings for the general 2nd order filter:

- 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: $D_Z = 0.7$</td></tr>
</table>

Parameters

The following list contains the parameters of the "Current setpoint 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	
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	

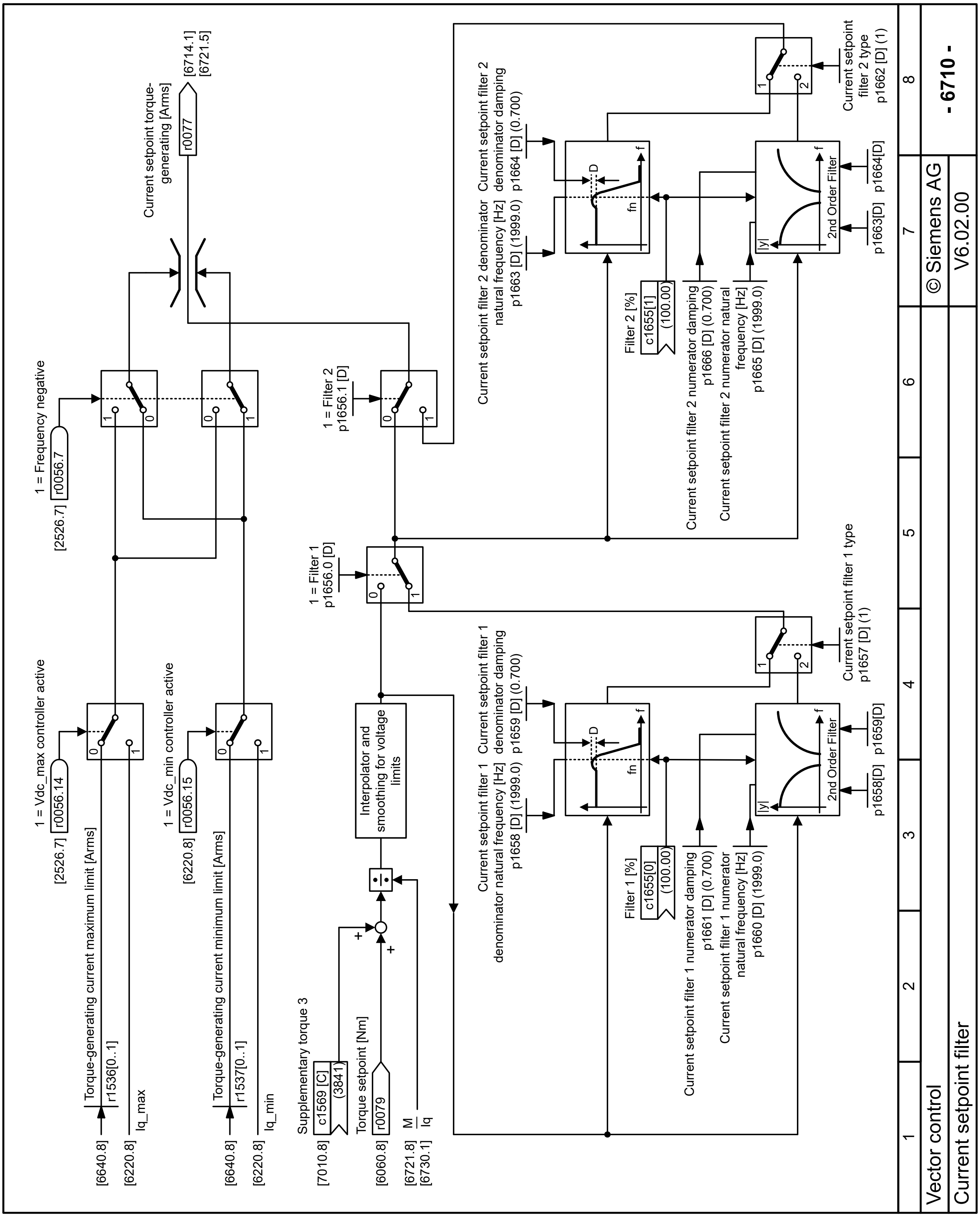


Figure 14-153 6710 - Current setpoint filter

14.10.7 Torque control

Overview

Torque control is part of the speed control and is used when the speed controller has been disabled.

Requirement

- You have set the motor data correctly during quick commissioning.
  The motor data is transferred from the nameplate and calculated with the motor data identification during quick commissioning.
- You have performed a motor data identification on the cold motor.

Description of function

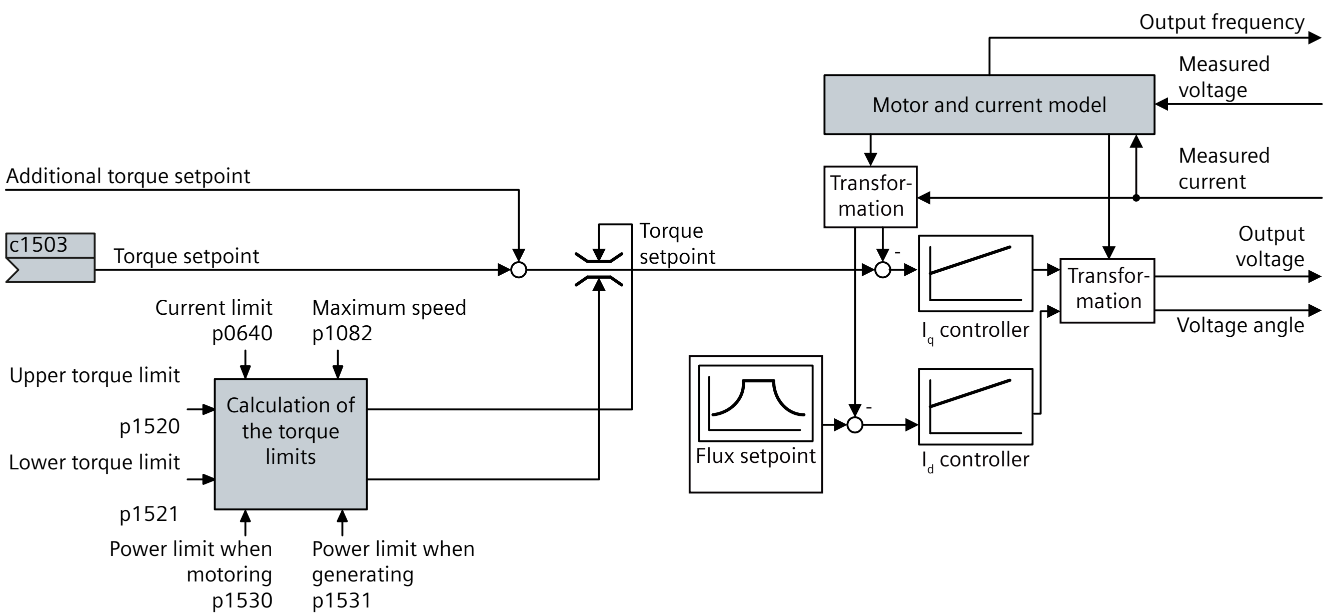


Figure 14-154 Simplified function diagram of the closed-loop torque control

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...7	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	
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 weight (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]
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 type	
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]

14.10.8 Checking the encoder signal

Overview

If you use an encoder to measure the speed, you should check the encoder signal before the encoder feedback is active.

Requirement

The encoder feedback is not yet active.

Procedure

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 rpm) and r0021 (calculated speed in rpm) 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.

You have ensured that the scaling and polarity of the encoder signal are correct.

14.10.9 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. In this way, the moment of inertia estimator minimizes overshoots after speed changes.

The more precise the value of the moment of inertia in the converter, the lower the overshoot after speed changes.

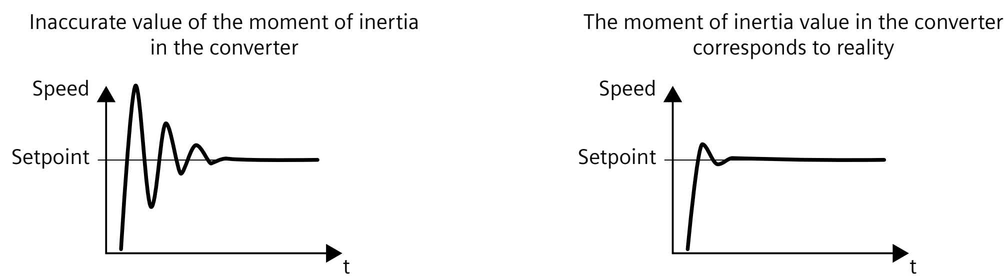


Figure 14-155 Influence of the moment of inertia on the speed

Description of function

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

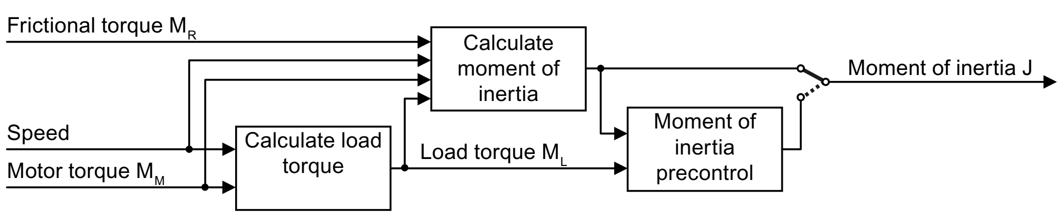


Figure 14-156 Overview of the function of the moment of inertia estimator

When using the moment of inertia estimator, we recommend that you also activate the friction characteristic.

How does the converter calculate the load torque?

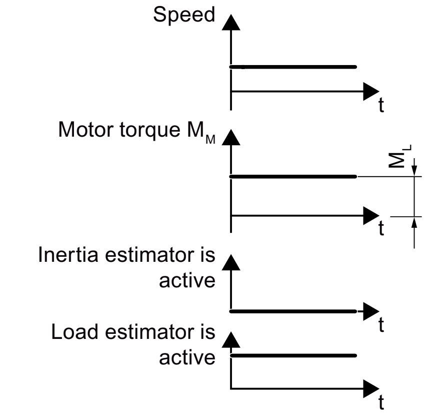


Figure 14-157 Calculation of the load torque

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/s^2 (≙ speed change 480 rpm per s)
- Acceleration × moment of inertia (r1493) < 0.9 × p1560

How does the converter calculate the moment of inertia?

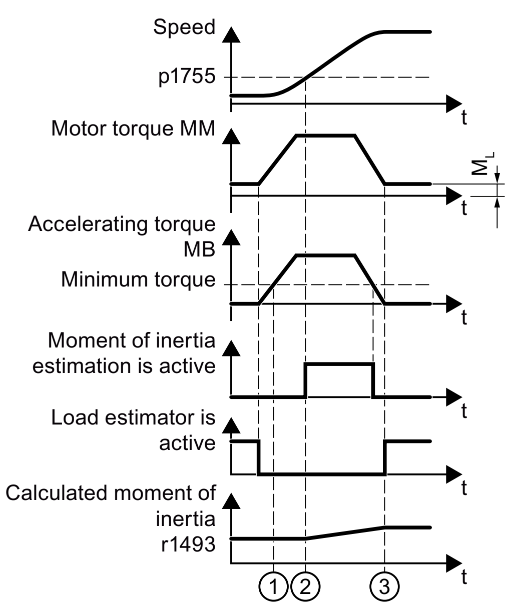


Figure 14-158 Calculation of the moment of inertia

In the case of larger speed changes, the converter initially calculates the accelerating torque M_B by subtracting load torque M_L and friction torque M_R from motor torque M_M:

$M_B = M_M - M_L - M_R$

The moment of inertia J of the motor and load is then obtained from the accelerating torque M_B and angular acceleration α (α = rate at which the speed changes):

$J = M_B / \alpha$

If all of the following conditions are met, the converter calculates the moment of inertia:

- ① The measured accelerating 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 × rated motor torque (r0333)
- ② Speed > p1755
- The converter has calculated the load torque in at least one direction of rotation.
- Acceleration setpoint > 8 $1/s^2$ (≙ speed change 480 rpm per s)

③ The converter calculates the load torque again after acceleration.

Moment of inertia precontrol

In applications where the motor predominantly runs at constant speed, the converter can rarely calculate the moment of inertia using the function described above. Moment of inertia precontrol is available for situations such as these. The moment of inertia precontrol assumes that there is an approximately 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.

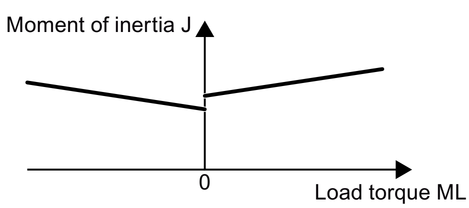


Figure 14-159 Moment of inertia precontrol

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 zero speed 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]

14.10.10 Efficiency optimization as a function of the motor operating point

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

Requirement

The converter operates an induction motor.

The speed control is active.

Description of function

Efficiency optimization is deactivated in the converter factory setting (p1401.14 = 0 signal).

The efficiency of an induction motor is determined by speed, torque and flux. The torque and speed are determined by the driven machine. Efficiency optimization therefore uses the flux as the variable quantity.

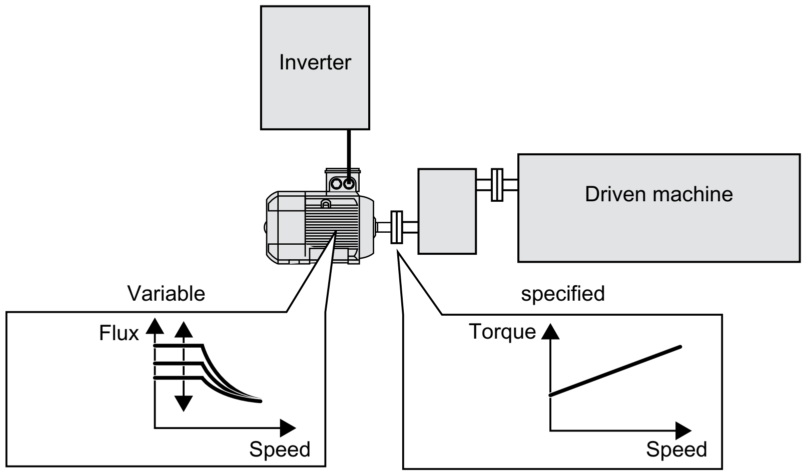


Figure 14-160 Predefined and variable quantities for motor efficiency

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.

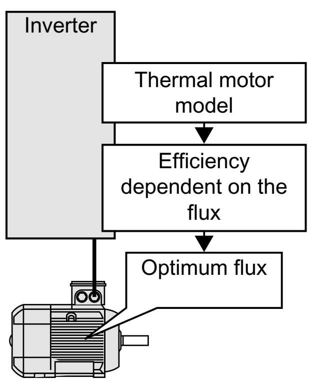


Figure 14-161 Calculating the optimum flux

Efficiency optimization sets the optimum flux in the motor.

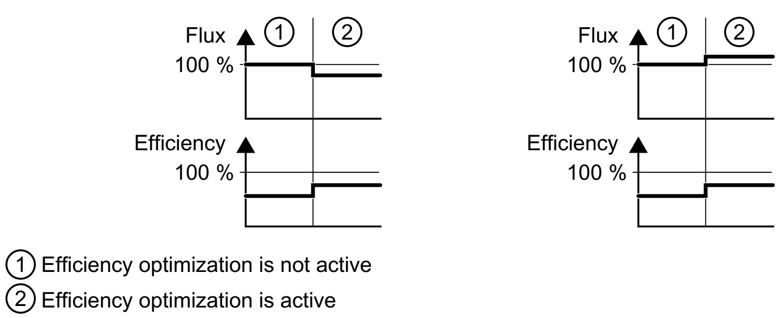


Figure 14-162 Increasing efficiency by optimizing the flux in the motor

Depending on the operating point of the motor, the flux of the reduces or increases.

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	[%]

14.10.11 Power unit Clean Power infeed

14.10.11.1 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 "G220 CPD".

Description of function

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	Infeed 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 current actual value	[Arms]
r13082	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...15	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 supply 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	Infeed actual pulse frequency	[kHz]

r13802	Infeed modulator mode	
r13807[0...2]	Infeed DC link voltage to calculate the modulation depth	[V]
p13810.0...11	Infeed modulator configuration	
r13838.0...22	Gating unit status words 1 and 2	
r13839.0...26	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...12	Infeed status word sequence control	

14.10.11.2 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 14-79 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

Signal name	Binary signal sink	Display parameters
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 14-80 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

14.10.11.3 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

14.11 Drive functions

14.11.1 Starting and stopping the motor

14.11.1.1 Sequence control when switching the motor on and off

Overview

The sequence control defines the rules for switching the motor on and off.

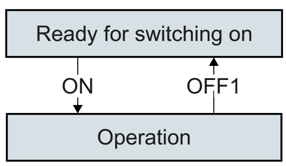


Figure 14-163 Sequence control

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".

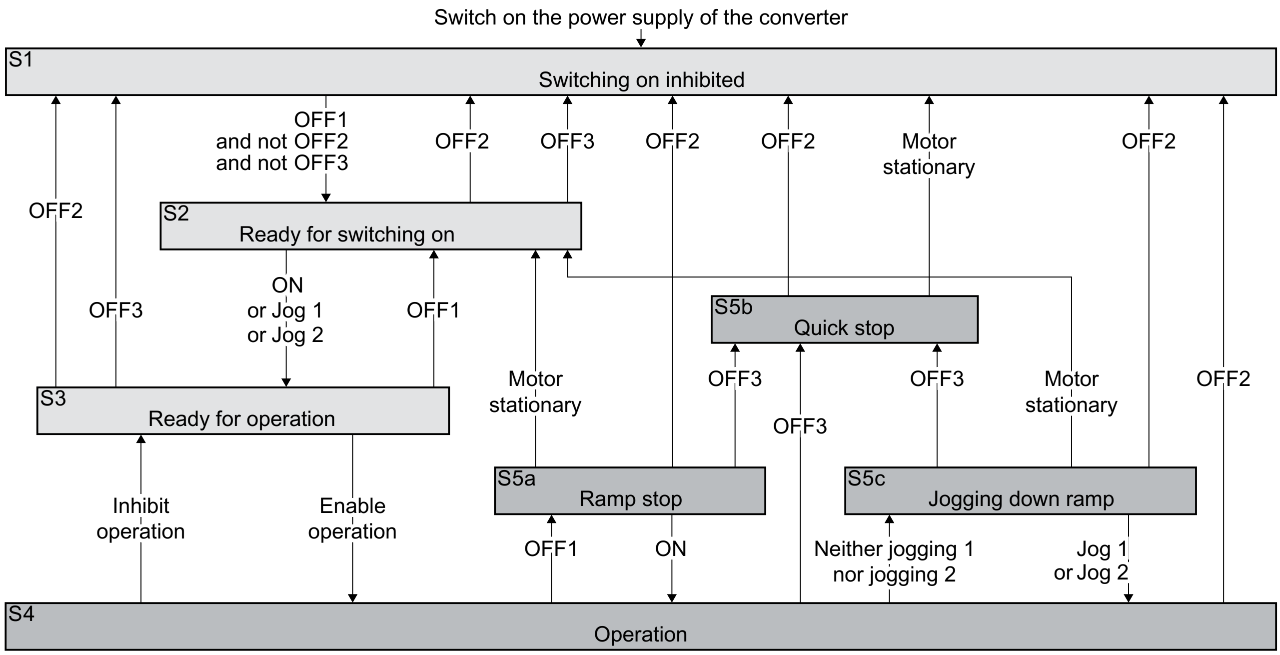


Figure 14-164 Sequence control of the converter when the motor is switched on and off

The converter states S1 ... S5c are defined in the PROFIdrive profile. The sequence control defines the transition from one state to another.

Table 14-81 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 14-82 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 signal	
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]
p1226[0...n]	Threshold for zero speed detection	[rpm]
p1227[0...n]	Zero speed detection monitoring time	[s]
p1228[0...n]	Pulse cancellation delay time	[s]

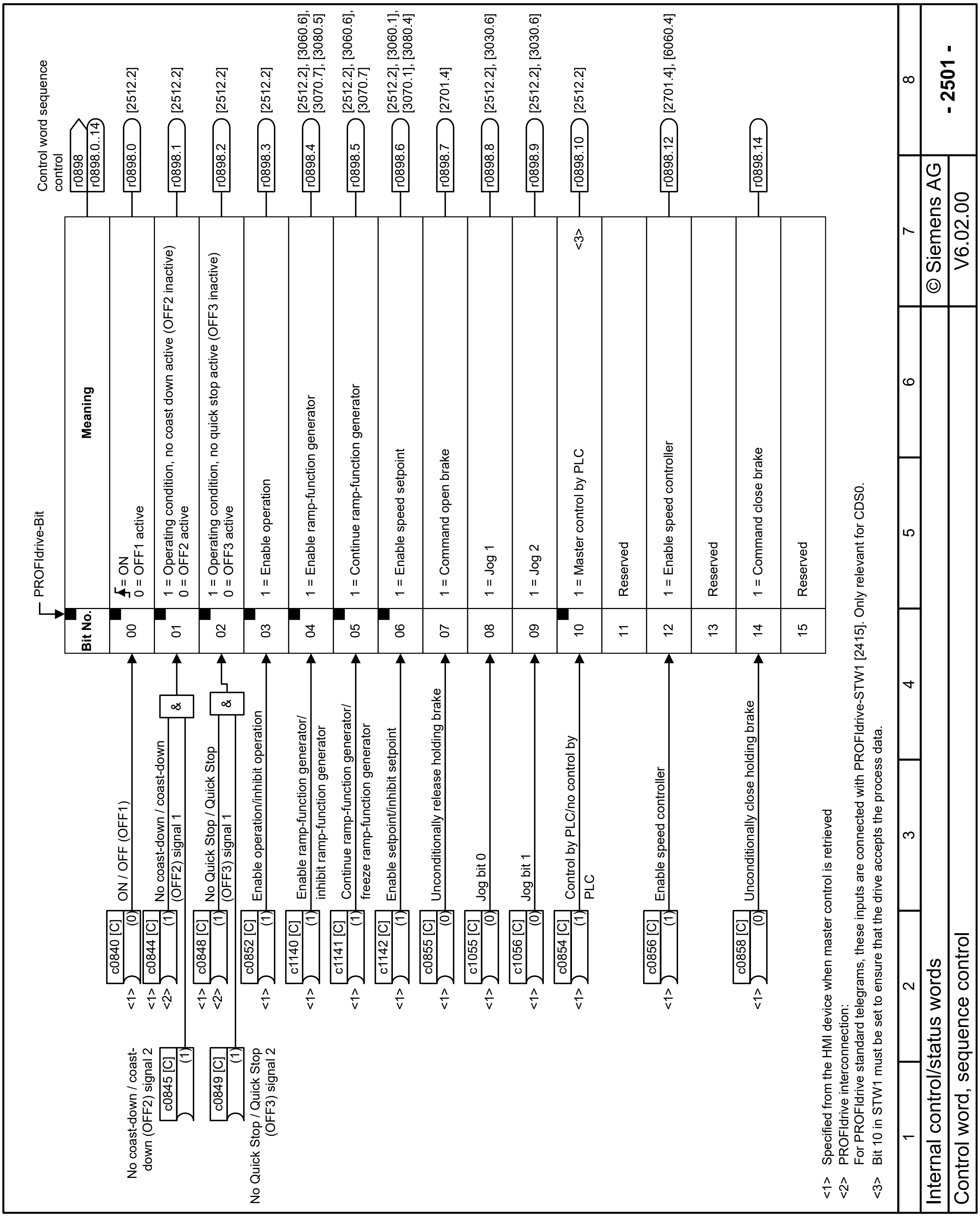


Figure 14-165 2501 - Control word sequence control

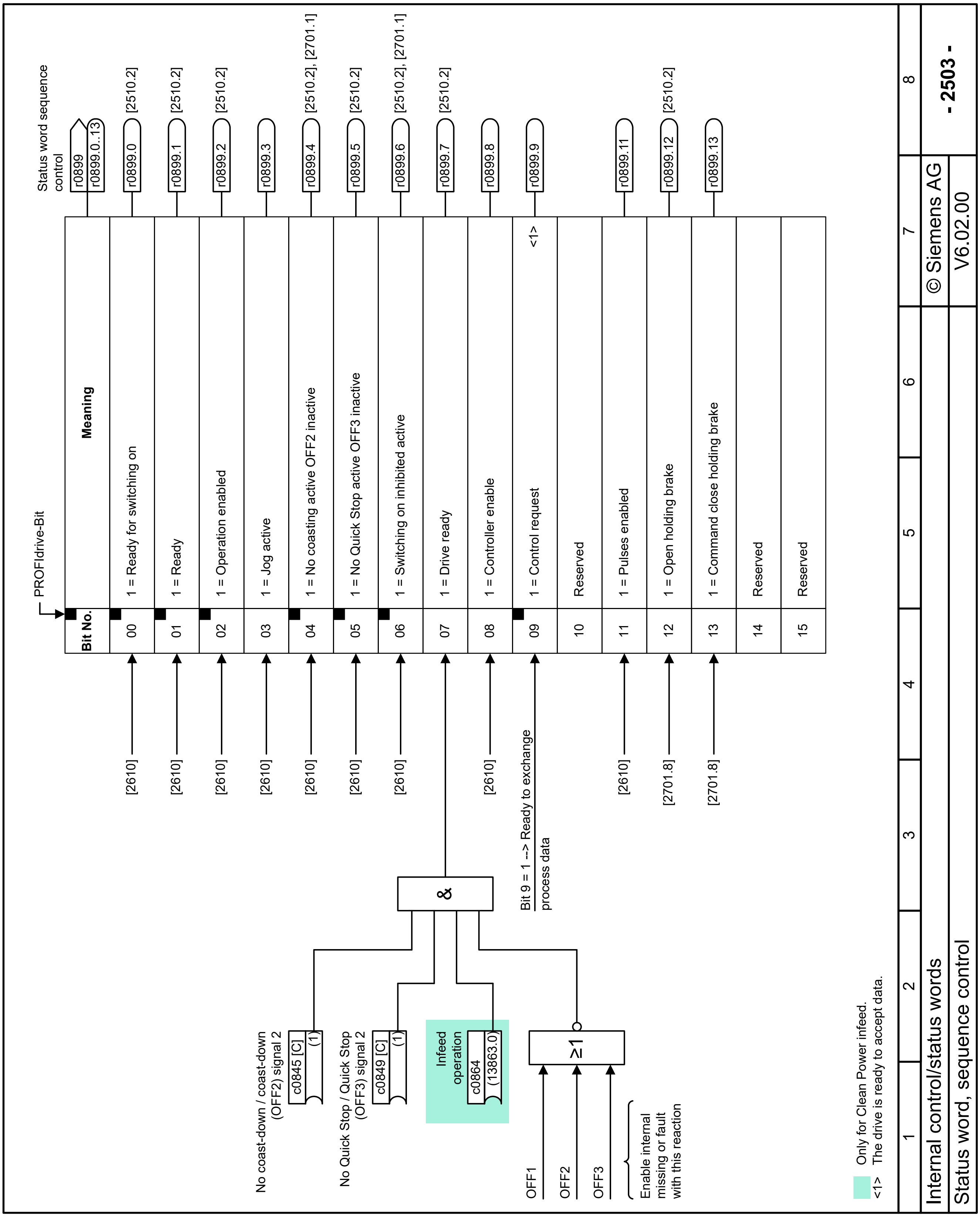


Figure 14-166 2503 - Status word sequence control

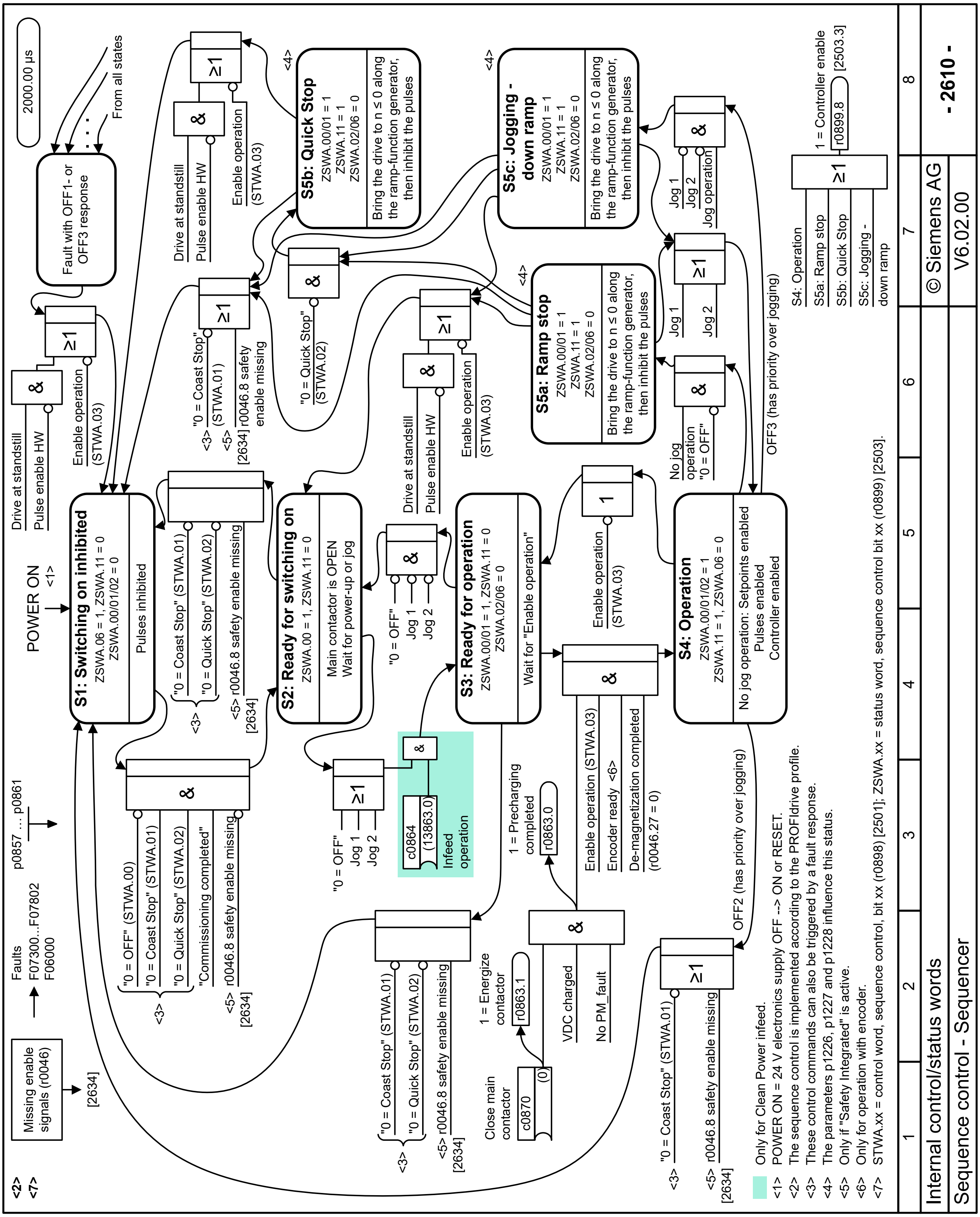


Figure 14-167 2610 - Sequence control - sequencer

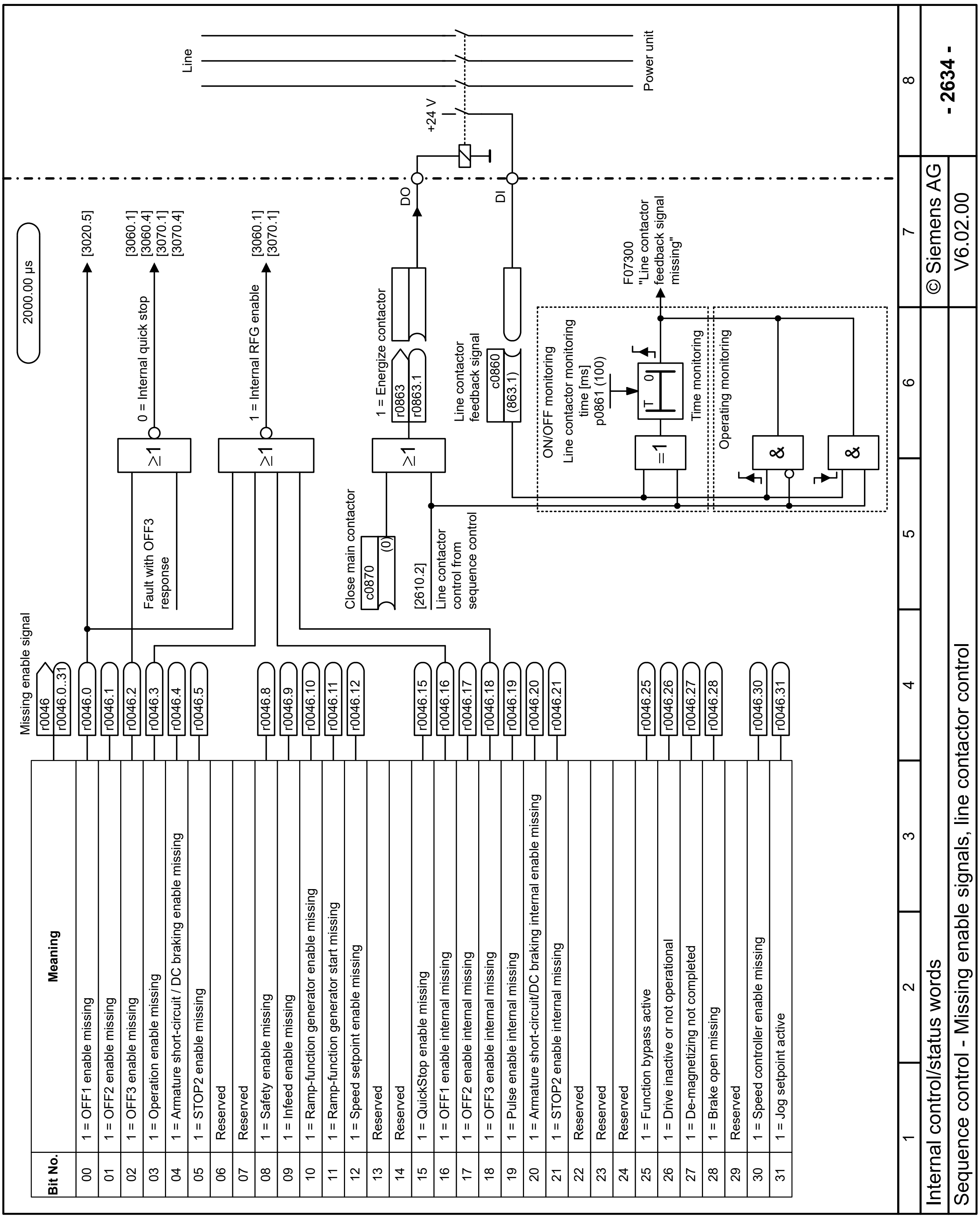


Figure 14-168 2634 - Sequence control - missing data

14.11.1.2 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.

Description of function

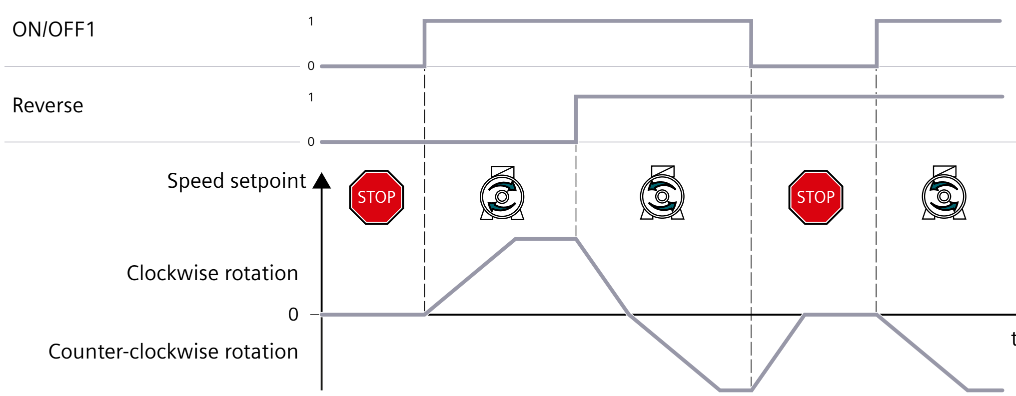


Figure 14-169 Two-wire control, ON/reverse

Table 14-83 Function table

ON/OFF1	Reverse	Function
0	0	The motor stops. The converter brakes the motor to a standstill.
0	1	
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.

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	

14.11.1.3 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.

Description of function

Two-wire control, clockwise/counter-clockwise rotation 1

The converter only accepts a new command when the motor is at a standstill.

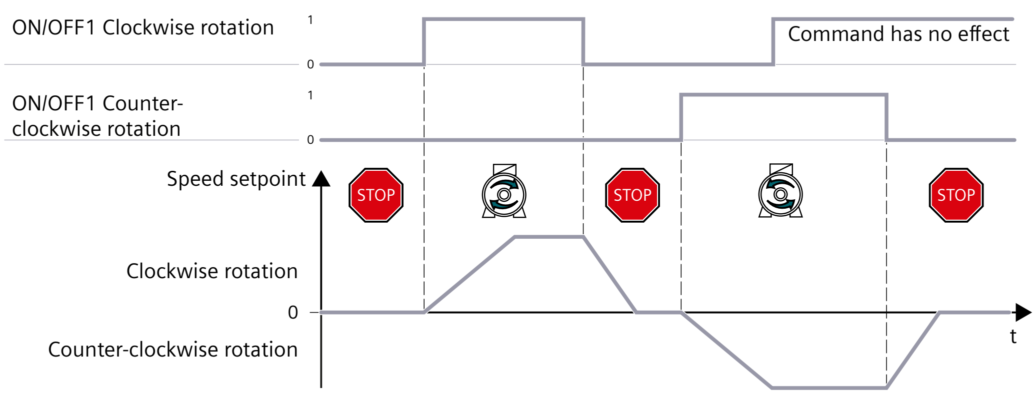


Figure 14-170 Two-wire control, clockwise/counter-clockwise rotation 1

Table 14-84 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.

Two-wire control, clockwise/counter-clockwise rotation 2

The converter accepts a new command at any time, irrespective of the motor speed.

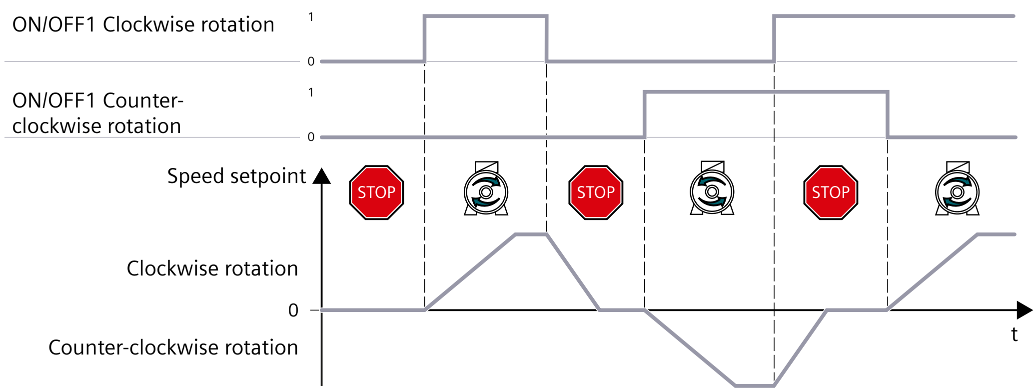


Figure 14-171 Two-wire control, clockwise/counter-clockwise rotation 2

Table 14-85 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.

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	

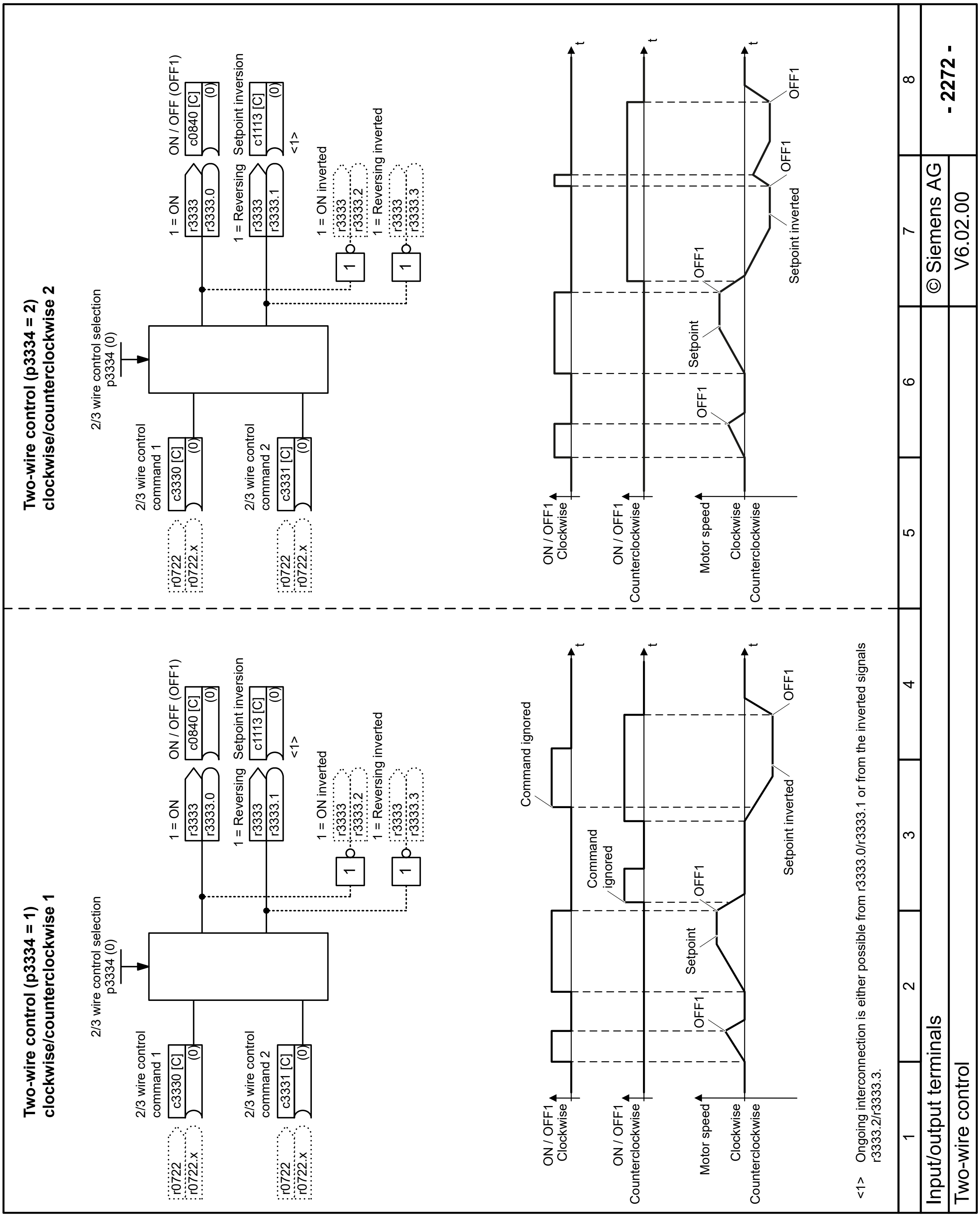


Figure 14-172 2272 - 2-wire control

14.11.1.4 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.

Description of function

Three-wire control, enable/clockwise/counter-clockwise rotation

The "Enable" command is a precondition for starting the motor. Commands "ON clockwise rotation" and "ON counter-clockwise rotation" start the motor and also select a direction of rotation. Canceling the enable stops the motor (OFF1).

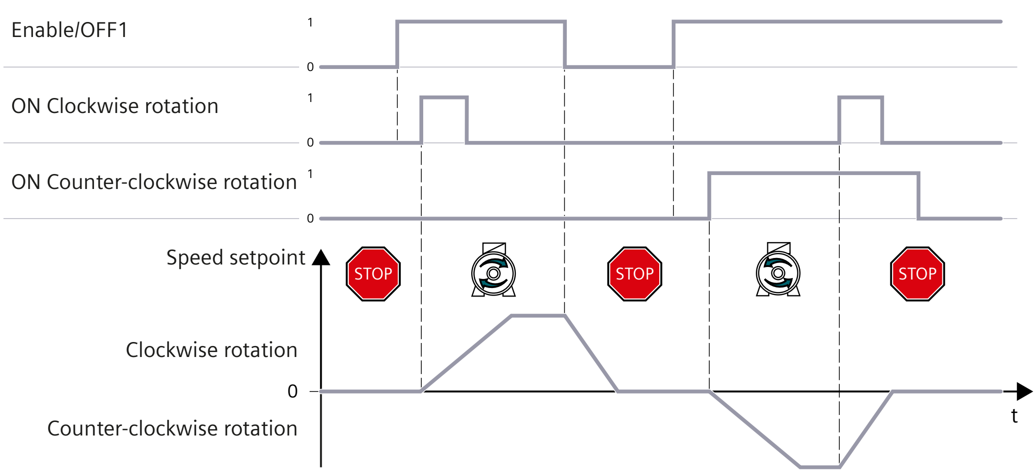


Figure 14-173 Three-wire control, enable/clockwise/counter-clockwise rotation

Table 14-86 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.
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

The "ON" command starts the motor. The "Reverse" command reverses the direction of rotation of the motor. Canceling the enable stops the motor (OFF1).

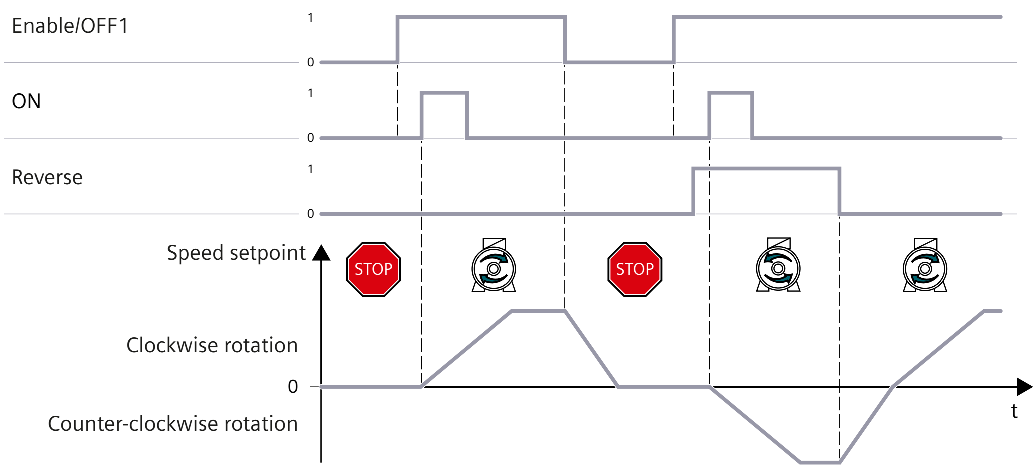


Figure 14-174 Three-wire control, enable/ON/reverse

Table 14-87 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.

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	

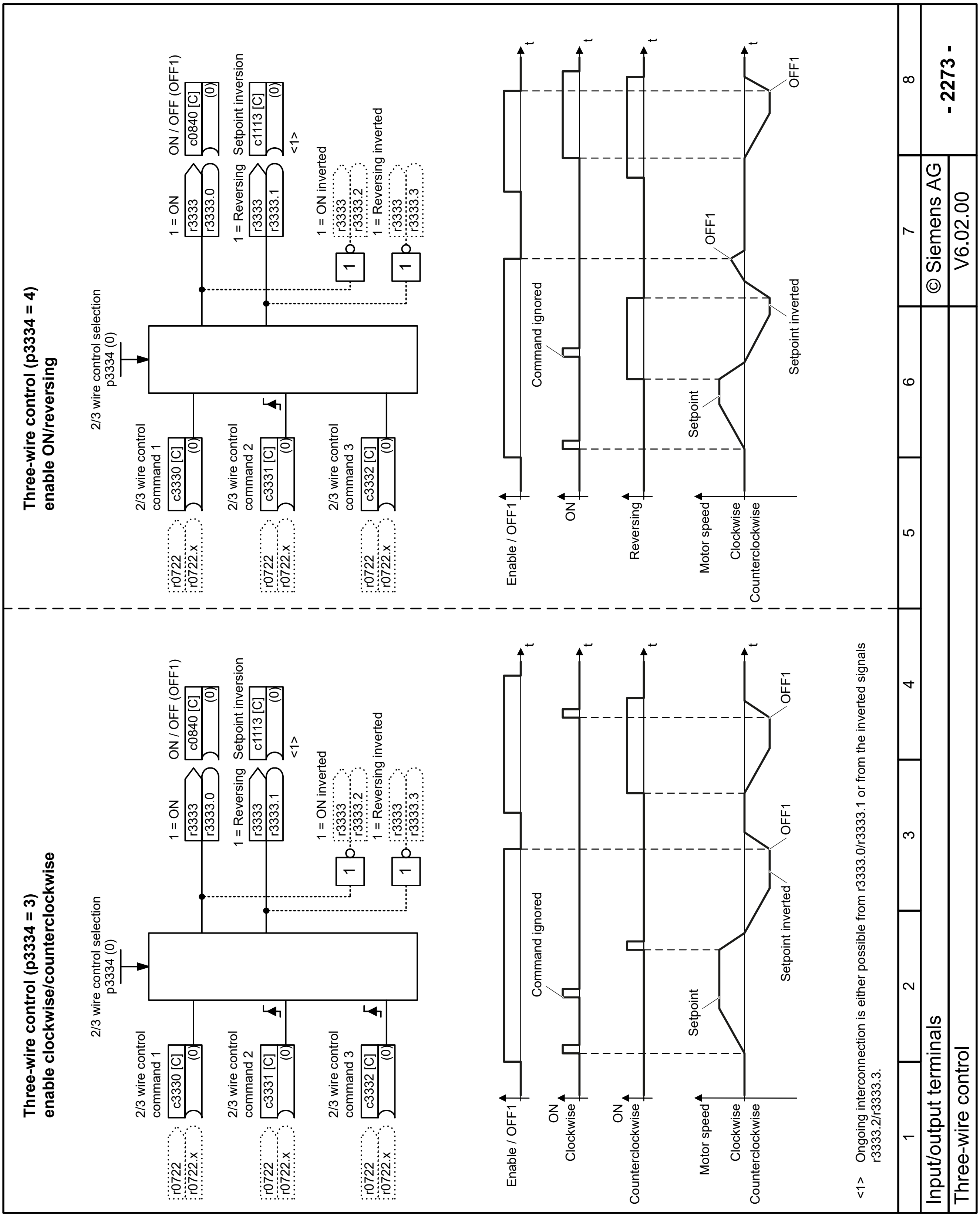


Figure 14-175 2273 - 3-wire control

14.11.2 Setting of device supply voltage

Overview

The device supply voltage is set using parameter p0210.

The device supply voltage value corresponds to the rms value of the rated phase-to-phase grid voltage.

Description of function

The device supply voltage value affects the following:

- Switch-on threshold for the braking resistor
- Activation thresholds of the Vdc_max and Vdc_min control
- Selection of the rated values of the power unit
  The setting of the parameter determines whether the power unit is operated in the lower or upper voltage range.
- Power failure monitoring

14.11.3 Units

14.11.3.1 Unit group and unit selection

Overview

Some physical units of the converter depend on the system of units selected (SI or US).

For example, power can be specified in kW or hp and torque in Nm or lbf ft. The system of units can be selected.

Description of function

Depending on the selection of the standard, a different unit is shown for the performance data of the converter and motor. Therefore, the unit is switched for some parameters.

The "Unit group" and "Unit selection" information in the parameter list constitutes additional information of parameters for which a unit changeover is possible.

The "Unit selection" shows for which parameter the unit is changed.

The units for the different standards are stored in unit groups.

Example:

Unit group: 14_6, unit selection: p0100

The parameter belongs to the unit group 14_6 and the unit is switched over via p0100.

All available unit groups and possible unit selections are listed below.

Table 14-88 Unit groups (p0100)

Unit group	Unit selection for p0100 =		Reference value for %
	0, 2	1	
7_4	Nm	lbf ft	-
8_4	N	lbf	-
14_2	W	W	-
14_6	kW	HP	-
14_13	W/A	HP/A	-
14_14	W min/1000	HP min/1000	-
14_15	W/A^2	HP/A^2	-
14_16	W min^2/1000^2	HP min^2/1000^2	-
25_1	kgm^2	lb ft^2	-
27_1	kg	lb	-
28_1	Nm/A	lbf ft/A	-
29_1	N/Arms	lbf/Arms	-
30_1	m	ft	-
47_1	kW s/K	HP s/K	-
48_1	W/K	HP/K	-
48_2	W min/1000 K	HP min/1000 K	-
48_3	W min^2/1000^2 K	HP min^2/1000^2 K	-
50_1	K/W	K/HP	-

14.11.3.2 Reference values

Overview

There is a reference value in the converter for most parameters with a physical unit.

Description of function

When the per-unit representation [%] is set, the converter scales the physical quantities based on the respective reference value.

If the reference value is changed, the significance of the scaled values also changes. Example:

- Reference speed = 1500 rpm → fixed speed = 80% corresponds to speed = 1200 rpm
- Reference speed = 3000 rpm → fixed speed = 80% corresponds to speed = 2400 rpm

The parameter list provides the associated reference value for the scaling for each parameter. For example, r0065 is scaled with reference value p2000.

If no scaling is specified in the parameter list, the converter always expresses the parameter unscaled.

14.11.4 Motor standard

Overview

The representation of the motor data is dependent on the motor standard.

Description of function

The converter represents the motor data corresponding to motor standard IEC or NEMA in the following systems of units:

- SI units
- US units

It is only possible to change the motor standard during quick commissioning.

Table 14-89 Parameters affected by the choice of motor standard

Parameter	Motor standard IEC/NEMA, p0100 =		
	0[1)] IEC motor 50 Hz, SI units	1 NEMA motor 60 Hz, US units	2 NEMA motor 60 Hz, SI units
r0206	kW	hp	kW
p0219	kW	hp	kW
p0307	kW	hp	kW
p0316	Nm/A	lbf ft/A	Nm/A
r0333	Nm	lbf ft	Nm
p0341	kgm^2	lb ft^2	kgm^2
p0344	kg	Lb	kg
r1493	kgm^2	lb ft^2	kgm^2

1) Factory setting

Parameters

The following list contains the parameters of the "Motor standard" function.

Number	Name	Unit
p0100	IEC/NEMA Standards	
r0206[0...2]	Rated power unit power	[kW]
p0219[0...1]	Braking resistor braking power	[kW]
p0307[0...n]	Rated motor power	[kW]
p0316[0...n]	Motor torque constant	[Nm/A]
r0333[0...n]	Rated motor torque	[Nm]
p0341[0...n]	Motor moment of inertia	[kgm^2]
p0344[0...n]	Motor weight (for the thermal motor model)	[kg]
r1493	Moment of inertia total, scaled	[kgm^2]

14.11.5 Data sets

14.11.5.1 Switching between different drive configurations

Overview

The converter saves different settings for operating different motors and activates the matching setting when requested by the higher-level control.

Description of function

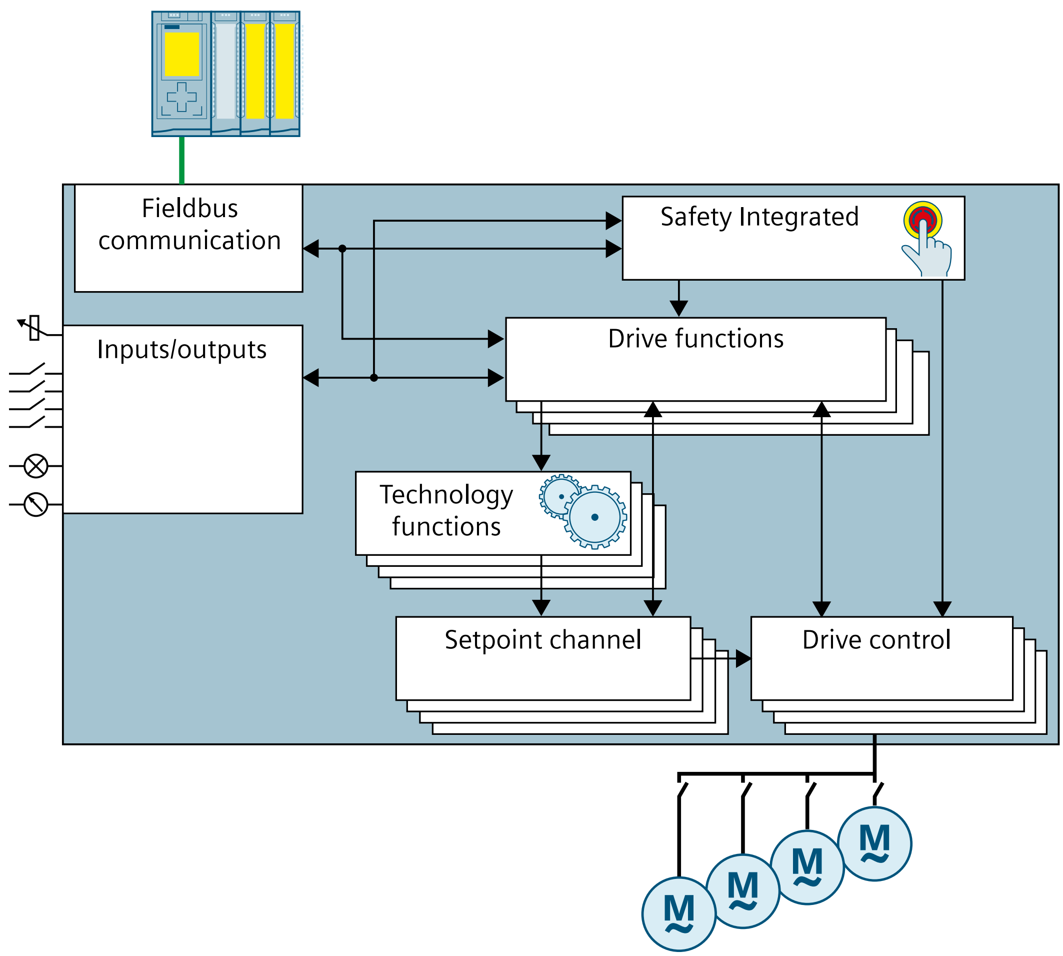


Figure 14-176 Saving different settings in the drive data sets

A drive data set contains the adjustable parameters of the following converter functions:

- Drive functions
- Technology functions
- Setpoint channel
- Drive control

p0180 determines the number of drive data sets in the converter.

The parameters of drive data set are indexed. Selecting a certain parameter index activates the corresponding parameters of the drive data set.

The converter also switches the motor data set (MDS), the encoder data set (EDS) and the power unit data set (PDS) together with the drive data set (DDS).

- Every drive data set is assigned to one motor data set (MDS).
- Every drive data set is assigned up to 2 encoder data sets (EDS).

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]
Examples of parameters of the assigned motor data set	Rated motor power	p0307[0]	p0307[1]
	Rated motor speed	p0311[0]	p0311[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)	
c0820[0...n]	Drive Data Set selection DDS bit 0	
c0821[0...n]	Drive Data Set selection DDS bit 1	
p0826[0...n]	Motor changeover motor number	

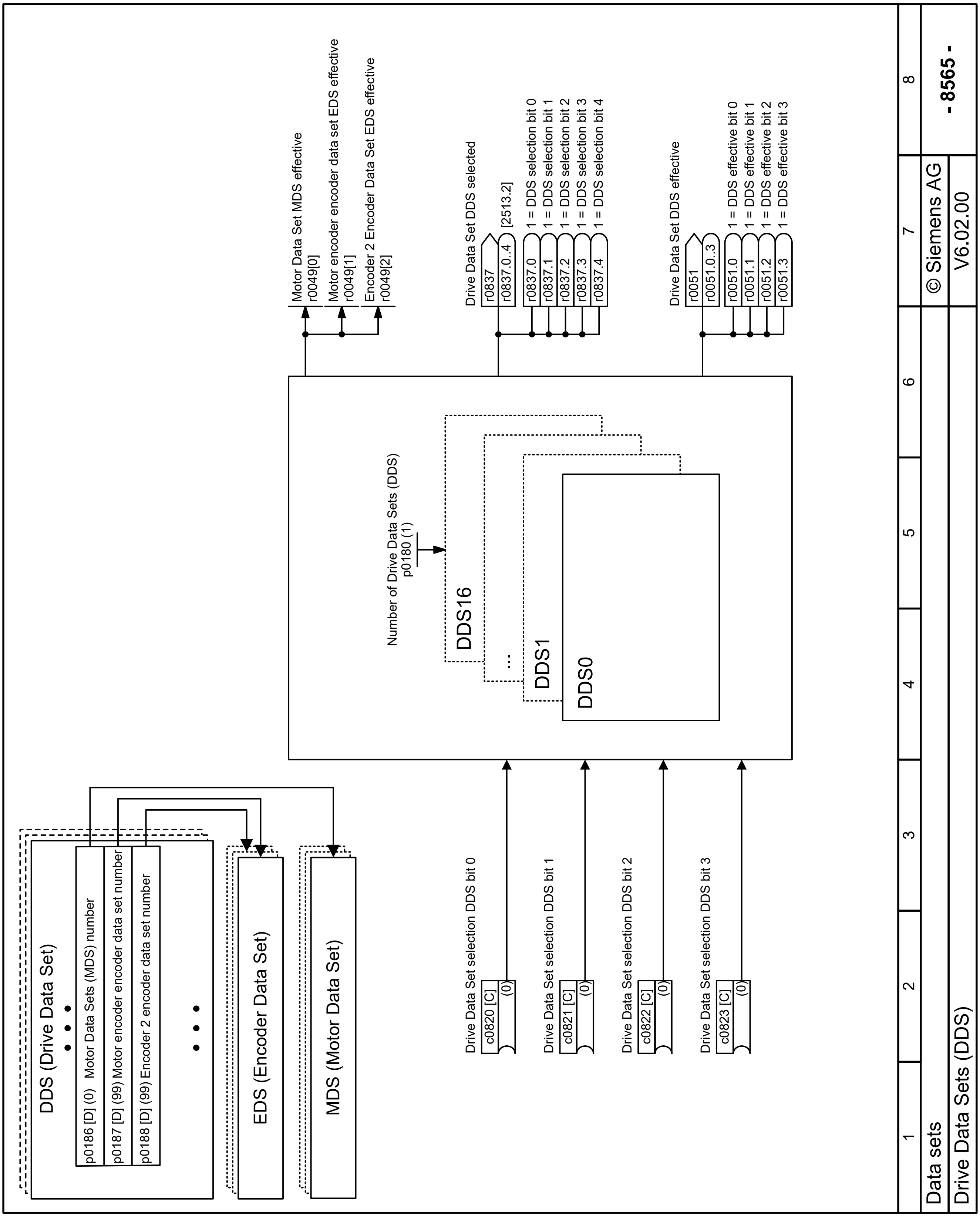


Figure 14-177 8565 - Drive Data Sets (DDS)

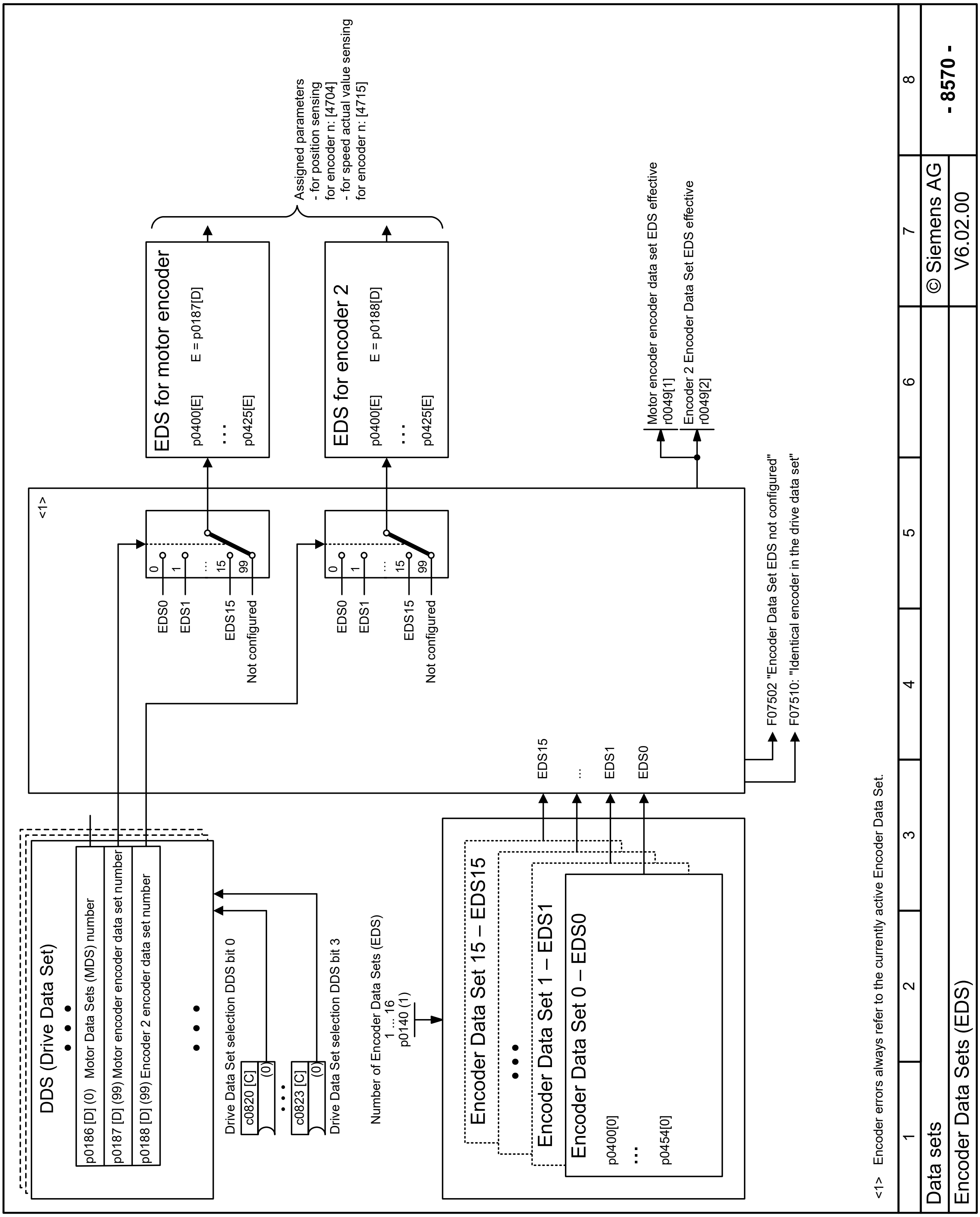


Figure 14-178 8570 - Encoder Data Sets (EDS)

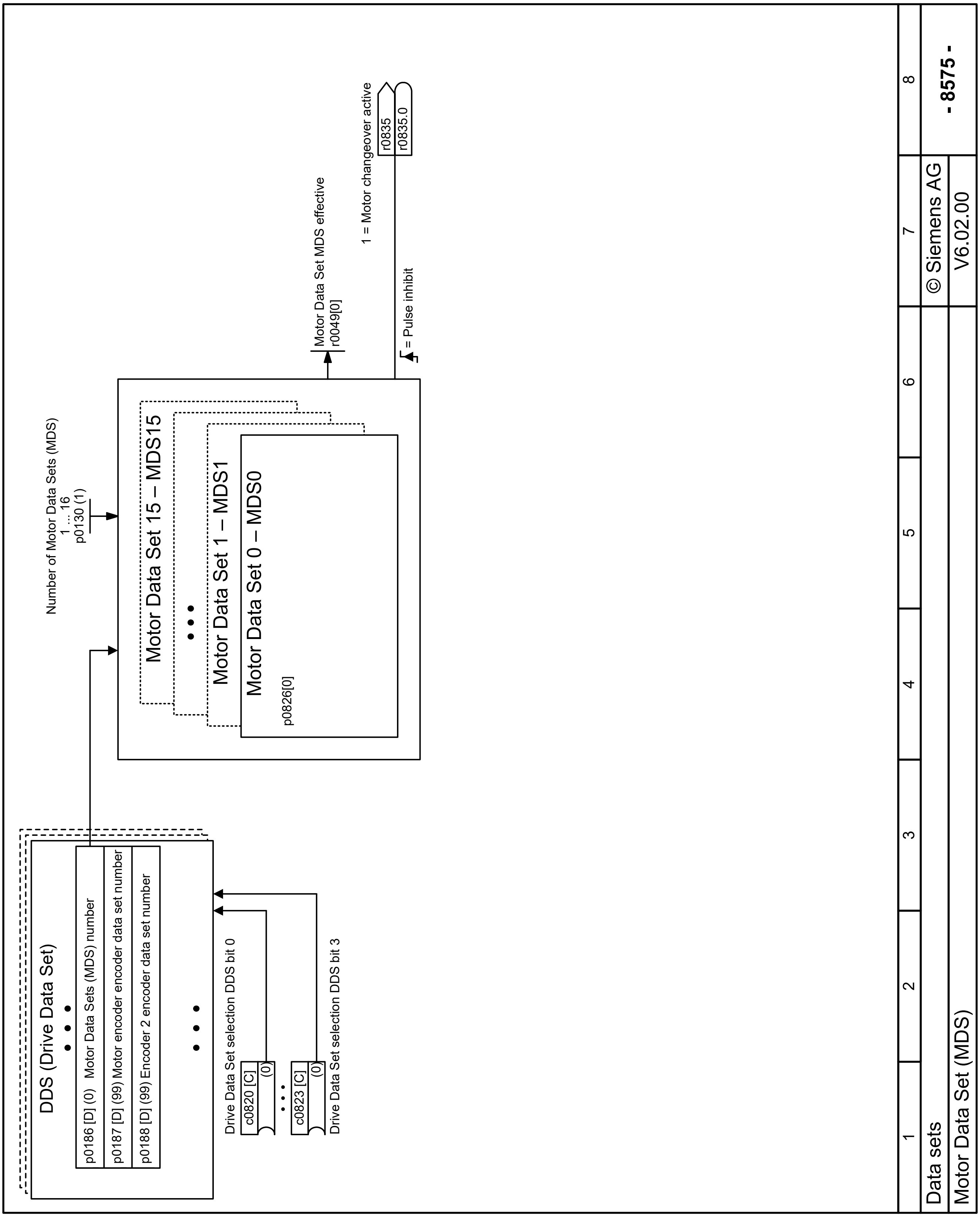


Figure 14-179 8575 - Motor Data Sets (MDS)

14.11.5.2 Switching between drive 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

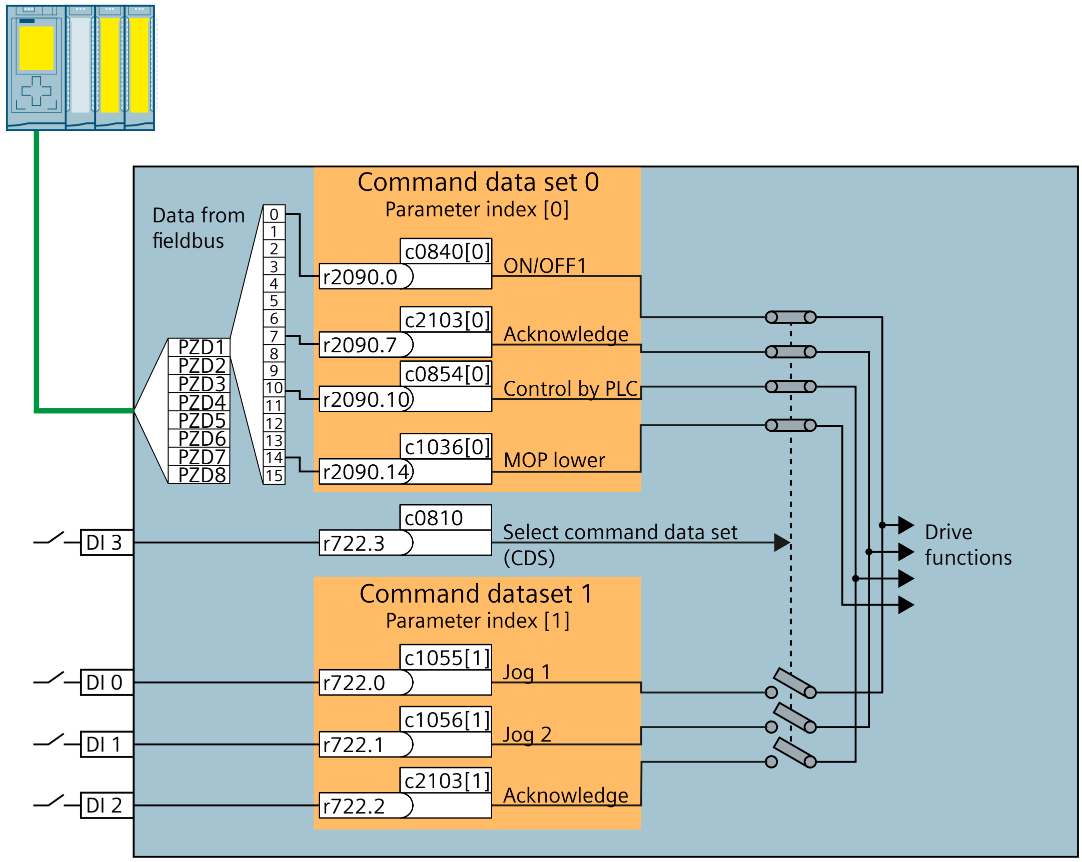


Figure 14-180 Switching command data sets

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	

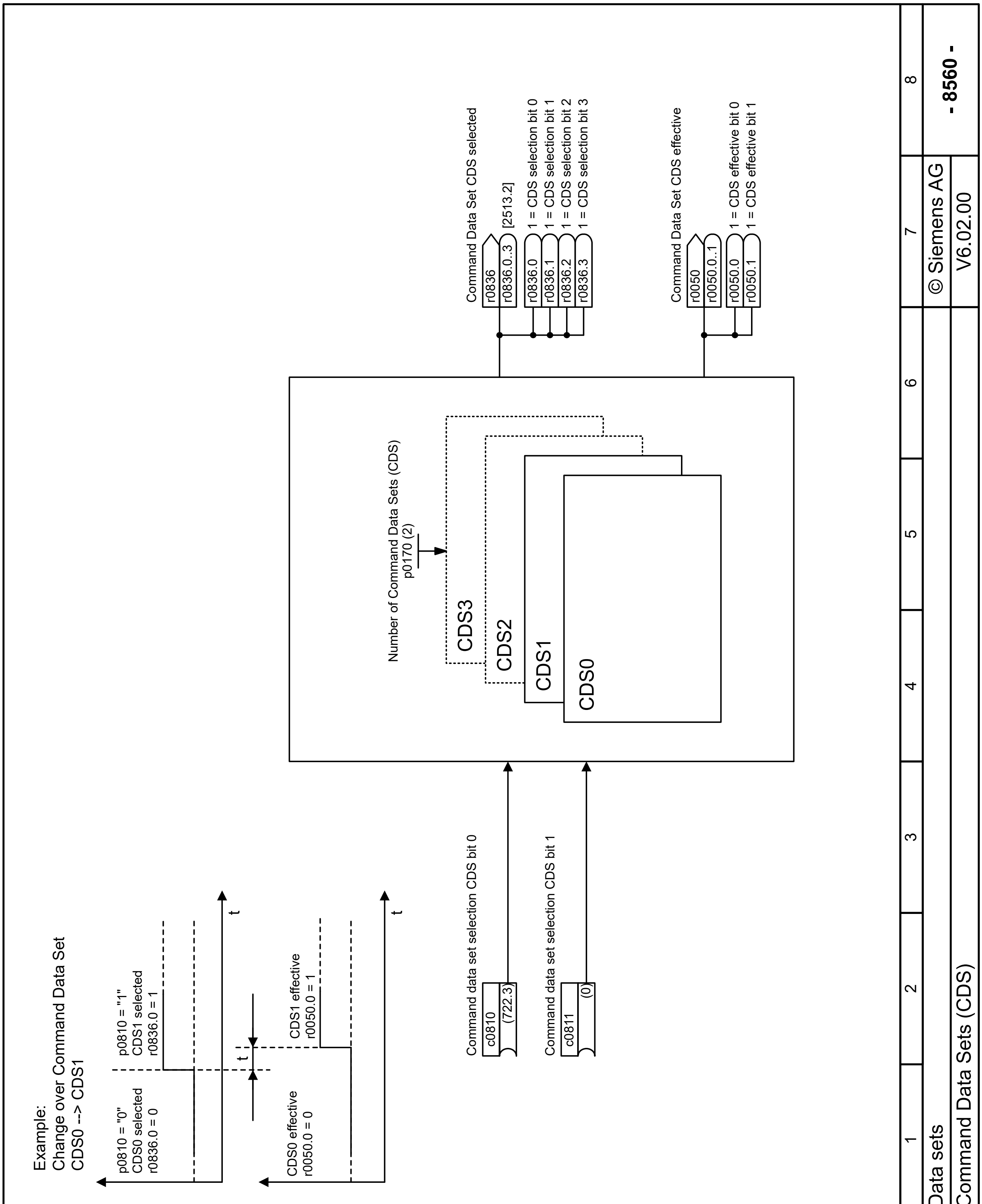


Figure 14-181 8560 - Command Data Sets (CDS)

14.11.6 Line contactor control

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.

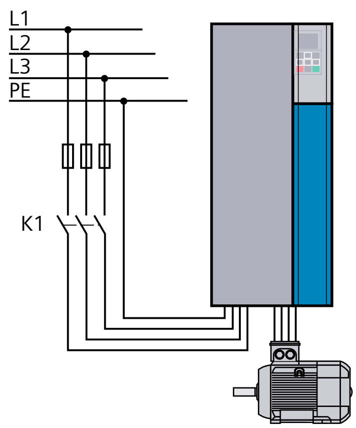


Figure 14-182 K1 line contactor

Requirement

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 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.

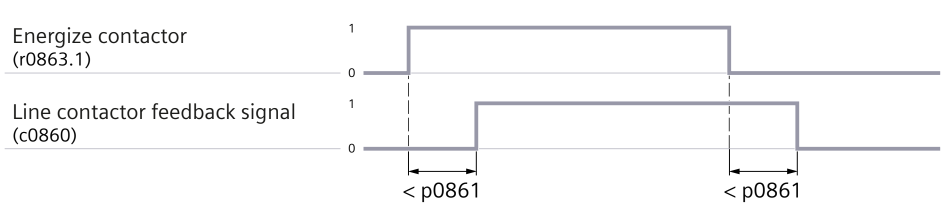


Figure 14-183 Monitoring of line contactor feedback signal

Example

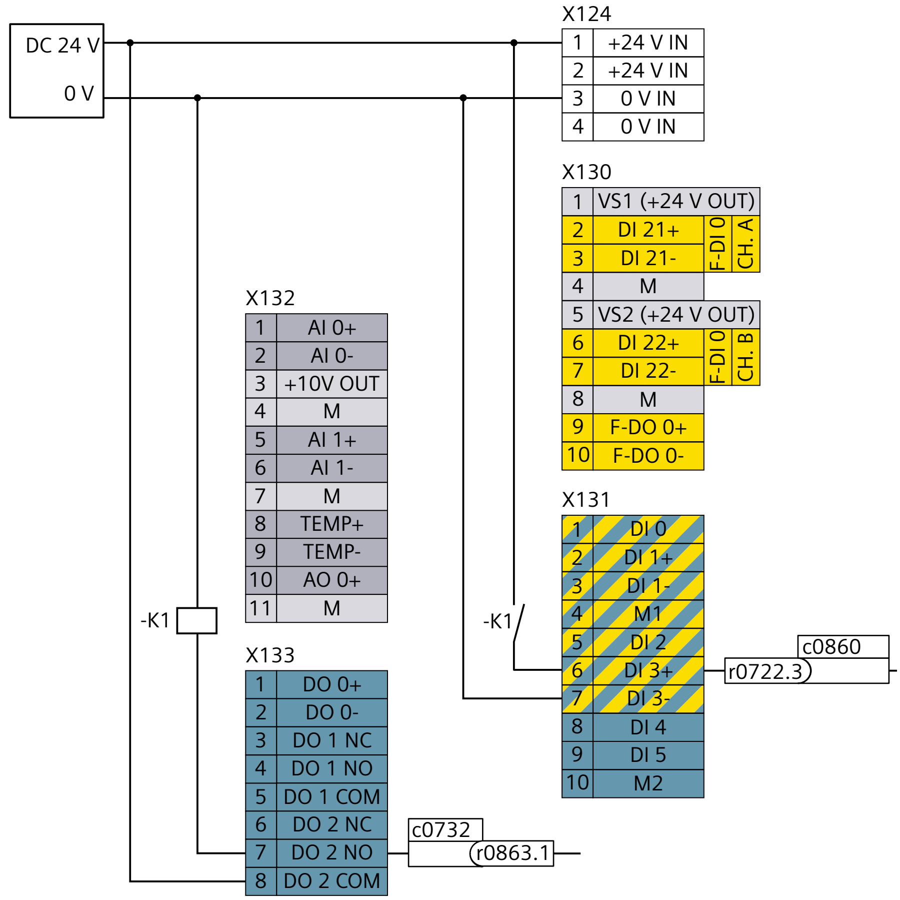


Figure 14-184 Line contactor control via DO 2, feedback signal via DI 3

Parameters

The following list contains the parameters of the "Line contactor control" function.

Number	Name	Unit
r0046.0...31	Missing enable signal	
c0732	Signal for terminal DO 2	
c0860	Line contactor feedback signal	
c0860	Line contactor feedback signal	
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	

14.11.7 Line contactor control for converters with Clean Power infeed

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.

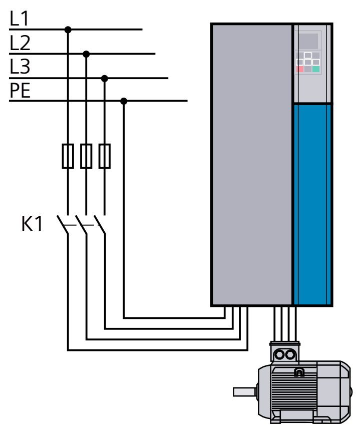


Figure 14-185 K1 line contactor

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

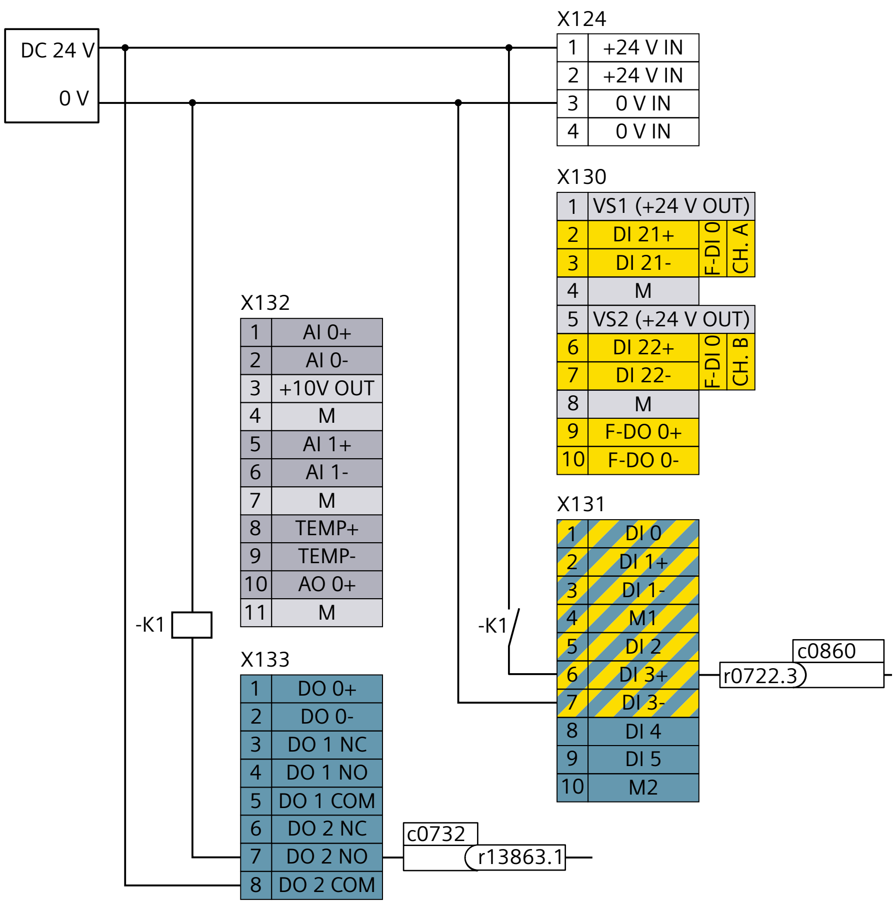


Figure 14-186 Converter with Clean Power infeed, line contactor control via DO 2, feedback signal via DI 3

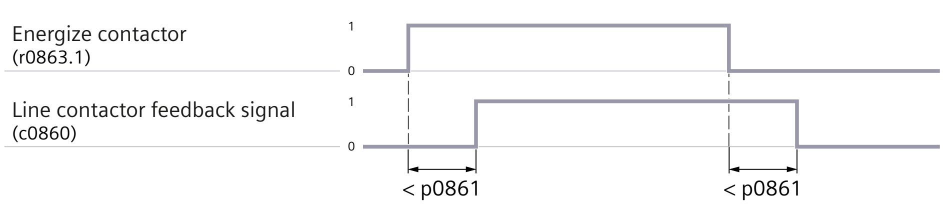


Figure 14-187 Monitoring of line contactor feedback signal

Parameters

The following list contains the parameters of the "Line contactor control CPD" function.

Number	Name	Unit
c0860	Line contactor feedback signal	
p0861	Line contactor monitoring time	[ms]
r13863.0...2	Infeed drive coupling status word/control word	

14.11.8 DC braking

Overview

With DC braking, the motor brakes the load by converting the kinetic energy of the load into heat.

Requirement

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 are:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Applications involving suspended loads, e.g. hoisting gear/cranes or vertical conveyors, are not permitted.

The DC braking function is not possible in the event of a power failure.

The DC braking function is possible only for induction motors.

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.

Description of function

The motor brakes the load without the converter having to process regenerative power.

The motor converts braking energy of the load into heat.

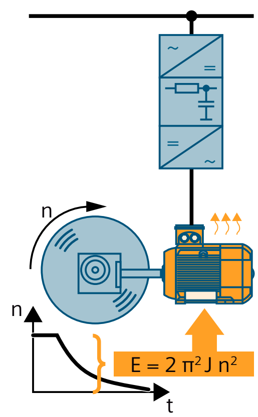


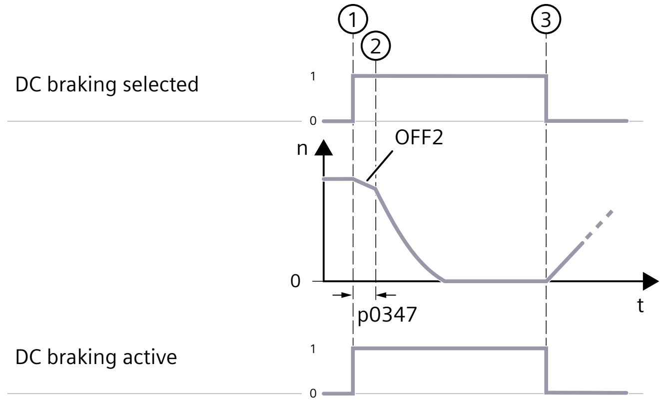
Figure 14-188 Energy flow during DC braking

Features of DC braking:

- No constant braking torque
- No braking torque at standstill

DC braking is available in 4 variants:

- Internal DC braking

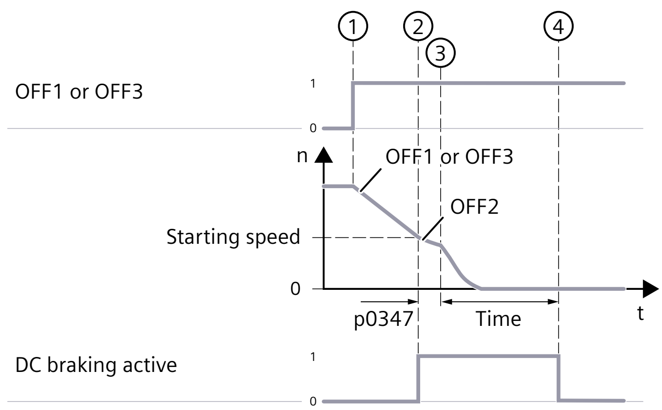


① If the binary signal sink c1230 has a 1 signal, then the converter switches off the motor current for the duration of the motor de-excitation time p0347. The drive behaves in the same way as it does in response to an OFF2 command.

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



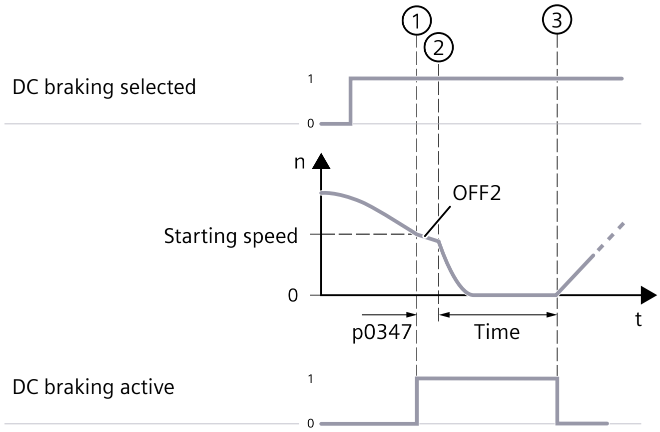
① After an OFF1 or OFF3 command, the converter brakes the motor along the OFF1 or OFF3 down ramp to the speed to start DC braking.

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.

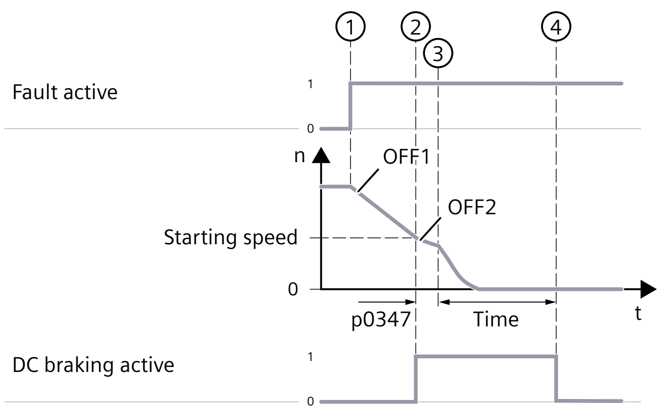
④ The converter exits DC braking after the DC braking time.

- DC braking when a starting speed is fallen below



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 when a fault occurs



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.

Parameters

The following list contains the parameters of the "DC braking" function.

Number	Name	Unit
p0347[0...n]	Motor de-excitation time	[s]
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	

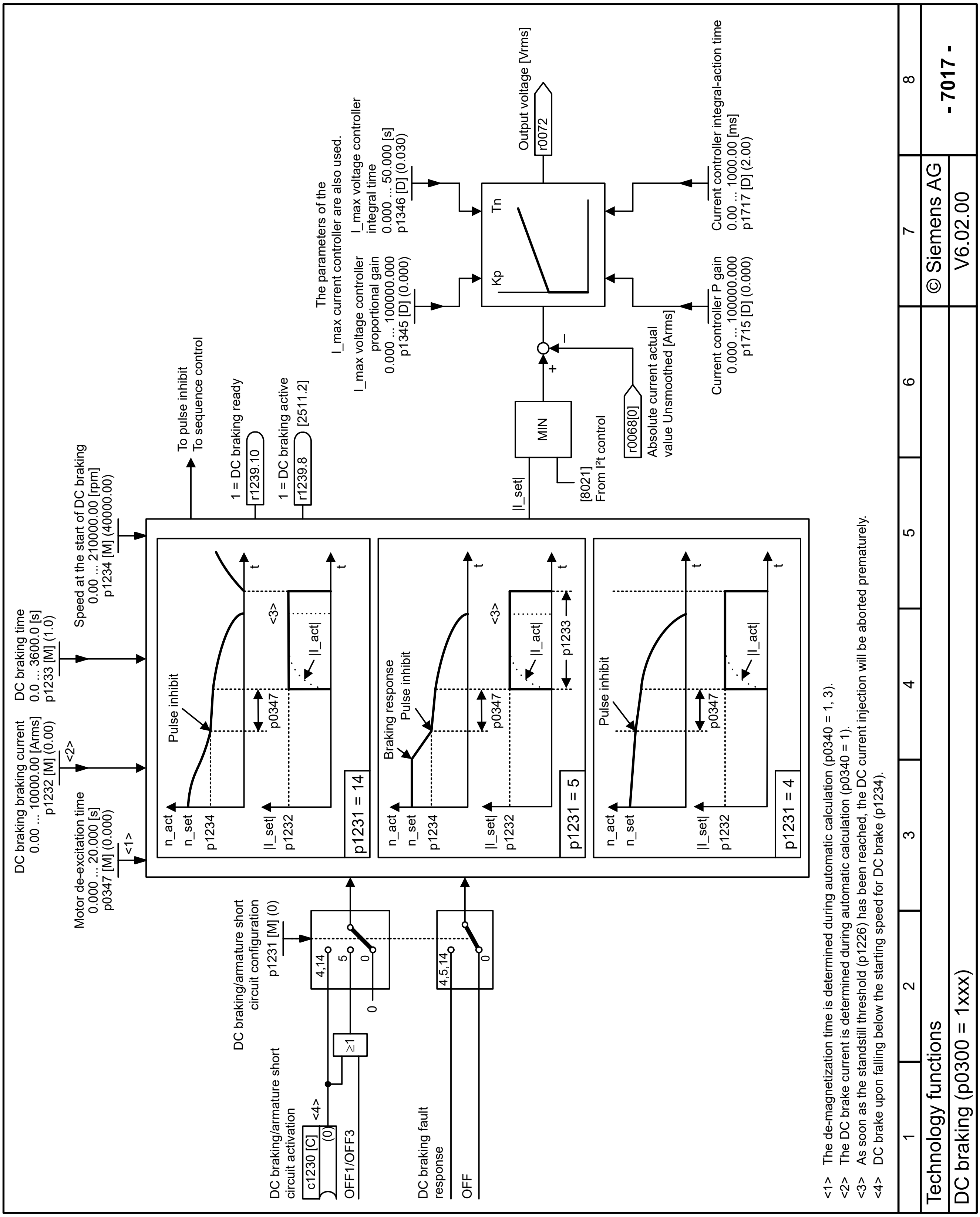


Figure 14-189 7017 - DC braking

14.11.9 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

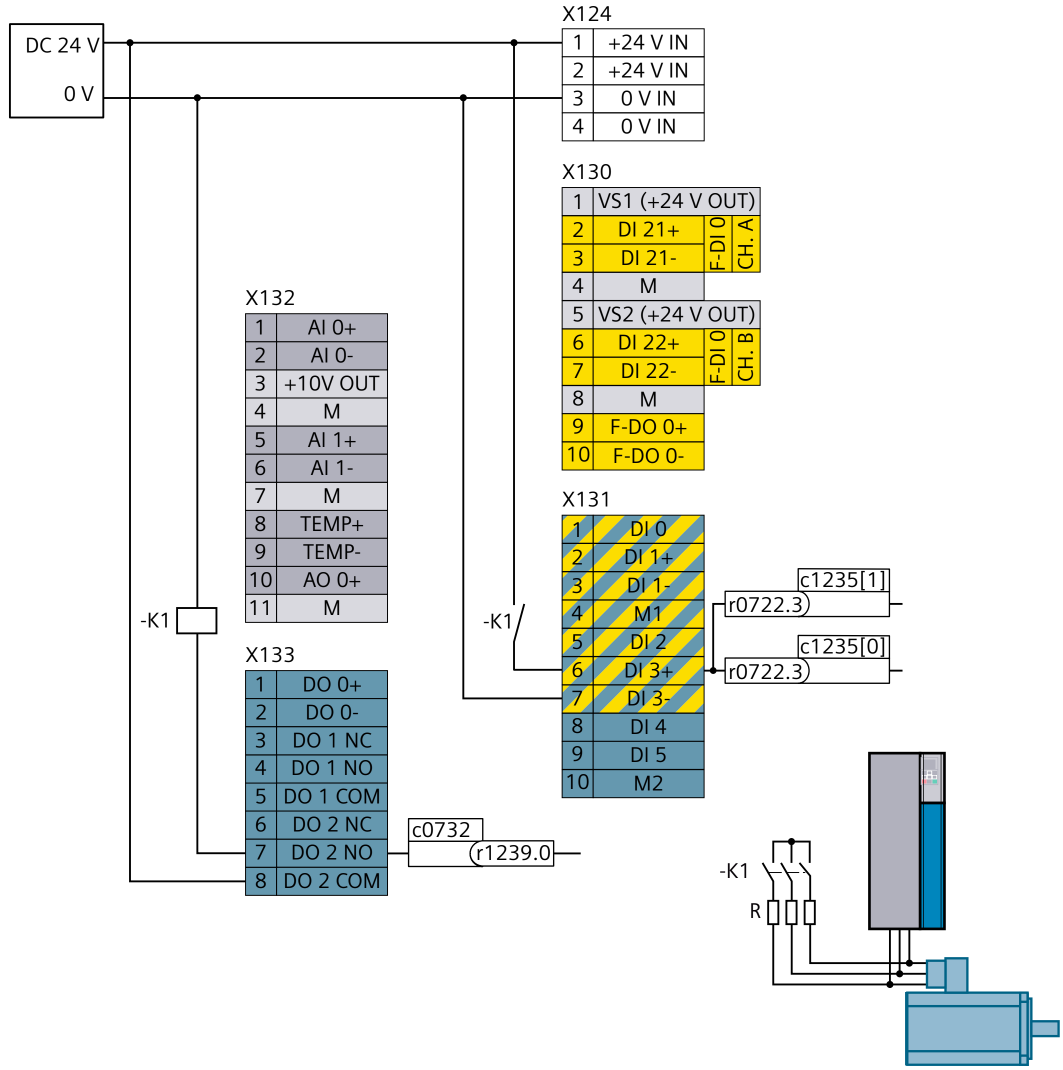


Figure 14-190 External armature short-circuit braking with feedback signal of the K1 contactor

Parameters

The following list contains the parameters of the "Armature short-circuit braking" function.

Number	Name	Unit
p0347[0...n]	Motor de-excitation time	[s]
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	

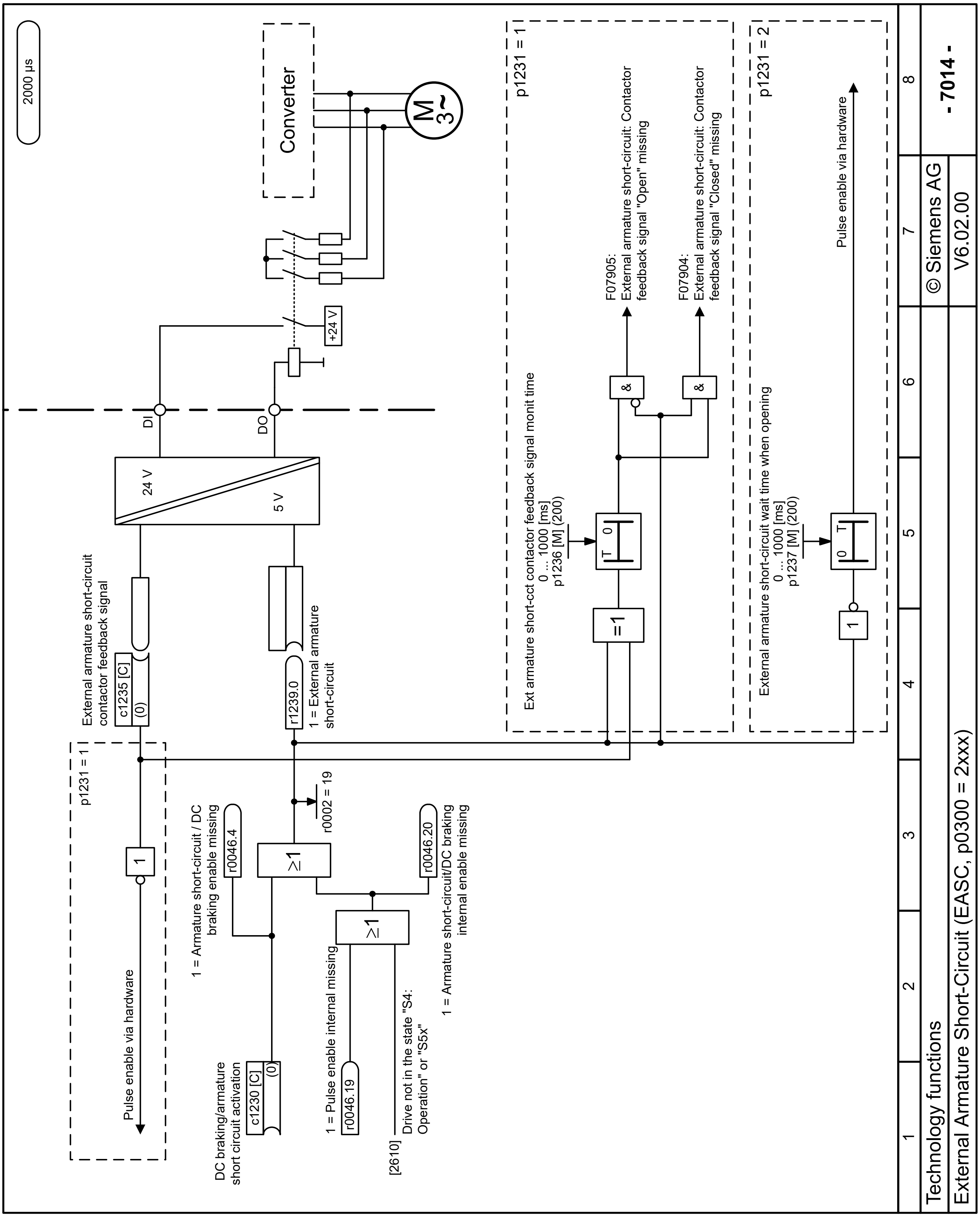


Figure 14-191 7014 – External armature short-circuit (EASC)

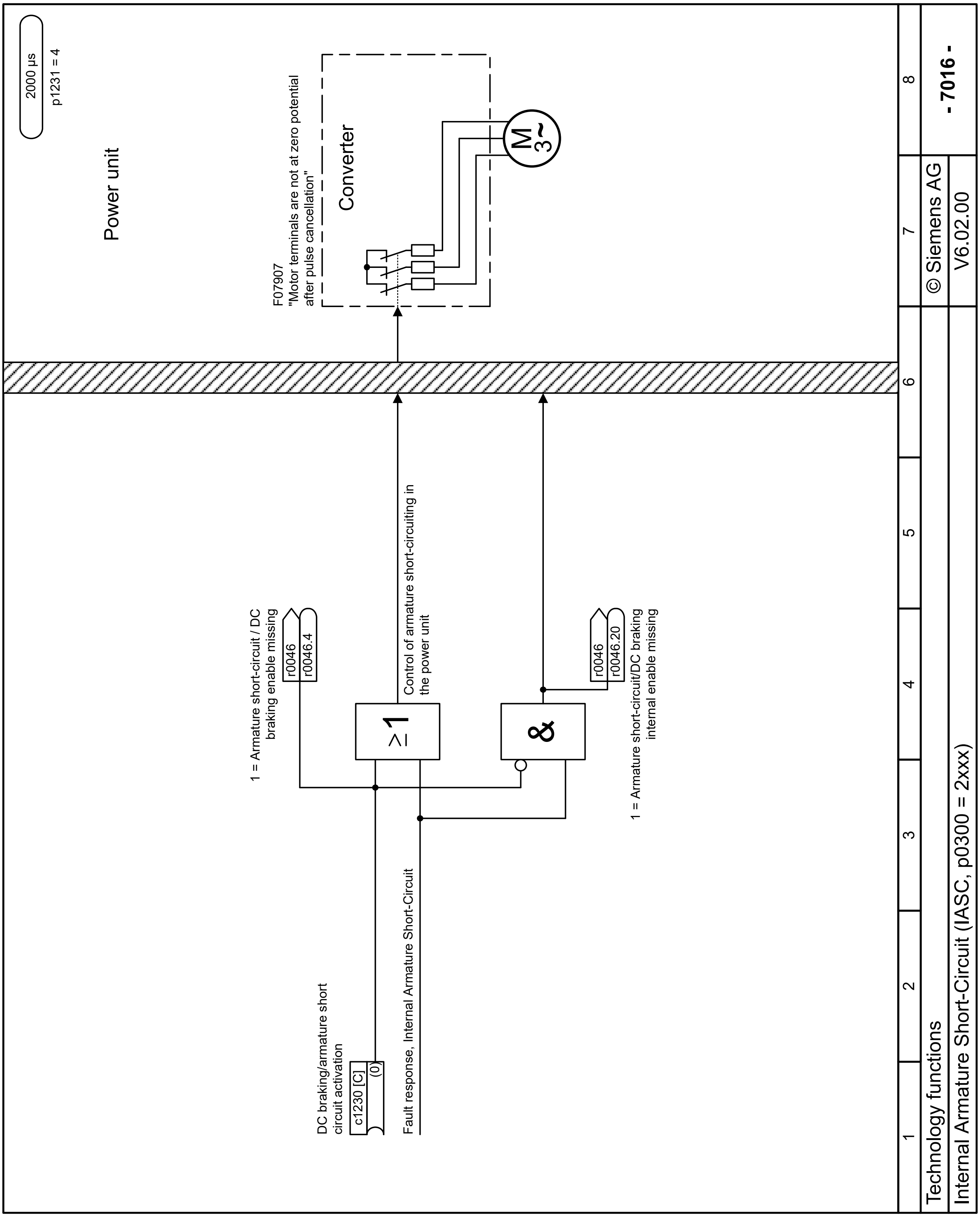


Figure 14-192 7016 – Internal armature short-circuit (IASC)

14.11.10 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.

Requirement

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 are:

- Centrifuges
- Saws
- Grinding machines
- Horizontal conveyors

Applications involving suspended loads, e.g. hoisting gear/cranes or vertical conveyors, are not permitted.

The compound braking function is not possible for a power failure.

Additional requirements:

- Compound braking is only possible with U/f control.
- The "Flying restart" function is deactivated.
- DC braking is deactivated.

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.

Description of function

The motor converts braking energy of the load into heat.

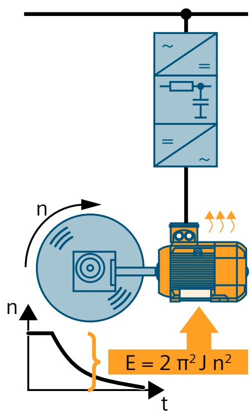


Figure 14-193 Energy flow during compound braking

Features of DC 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.

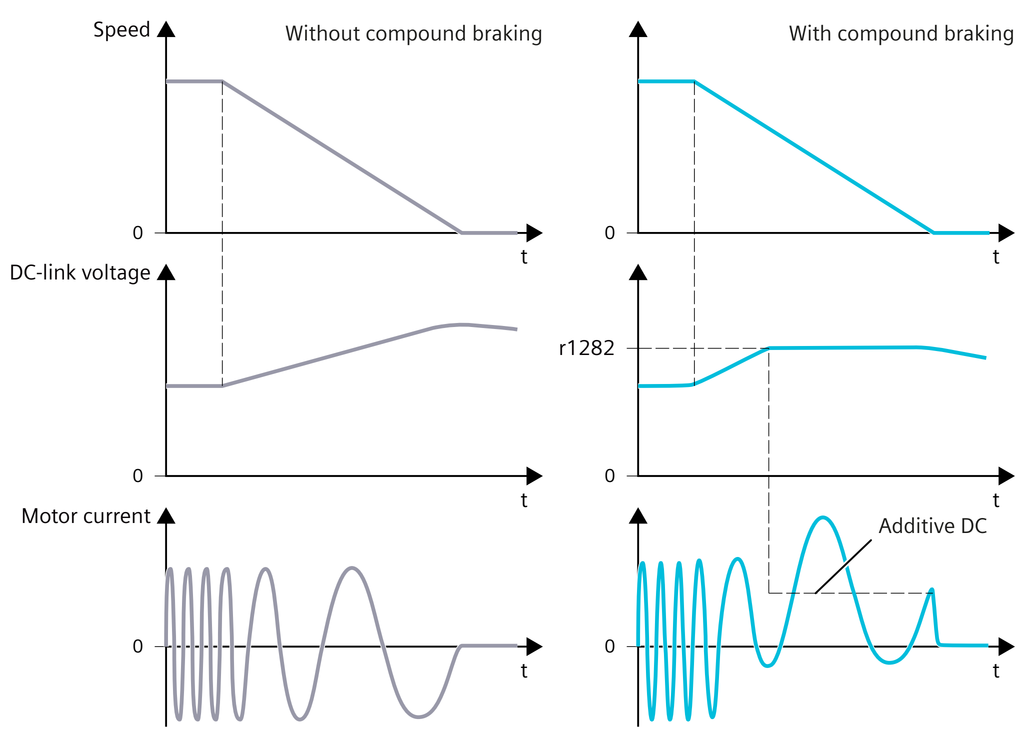


Figure 14-194 Braking of the motor with and without active compound braking

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]
p3856[0...n]	Compound braking current	[%]
r3859.0...1	Compound braking/DC quantity control status word	

14.11.11 Dynamic braking

Overview

With the help of dynamic braking, the converter brakes the motor without causing an additional temperature rise in the motor. An external braking resistor converts the braking energy of the motor into heat.

Requirement

Converter with the number "0" at the 8th position of the Article number: 6SL4113-0...

Description of function

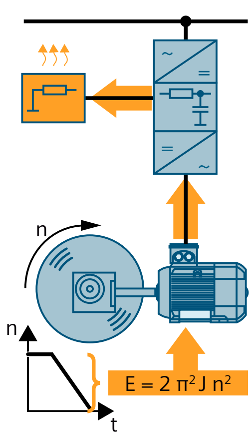


Figure 14-195 Power flow during dynamic braking

The braking resistor converts the regenerative energy E generated when the motor brakes into heat in a braking resistor.

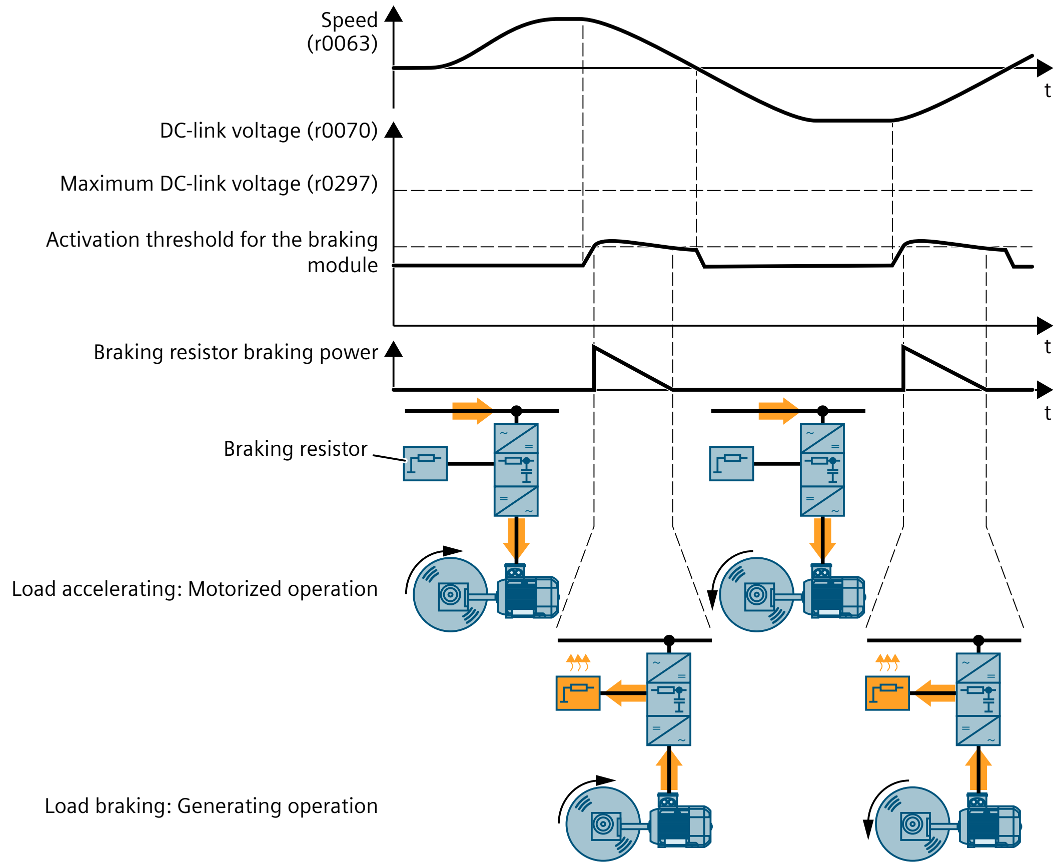


Figure 14-196 Simplified representation of dynamic braking with respect to time

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 module, the converter 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 = 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.

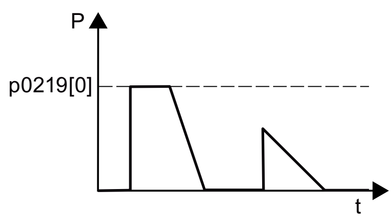


Figure 14-197 Example of maximum braking power in an application

Example

The following are typical applications for dynamic braking:

- Centrifuges
- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

More information

You can find an example for configuring and commissioning a drive with braking resistor on the Internet:

Dimensioning and commissioning of series hoisting equipment (https://support.industry.siemens.com/cs/ww/en/view/103156155)

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]
p0216	Braking resistance value	[ohm]
p0218	Braking resistor maximum power duration	[s]
r0297	DC link voltage overvoltage threshold	[V]

14.11.12 Dynamic braking for converters with Clean Power infeed

Overview

With the help of dynamic braking, the converter brakes the motor without causing an additional temperature rise in the motor. An external braking resistor converts the braking energy of the motor into heat.

Requirement

The following requirements apply for dynamic braking:

- Converter with the number "2" at the 8th position of the Article number: 6SL4113-2...
- Temperature monitoring is required for the braking resistor using a temperature sensor and a shutdown function when it overheats.
- For the braking resistor, temperature monitoring is also necessary using a thermal model in the software.
- The parameter must be completely set for third-party braking resistors.

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].

Description of function

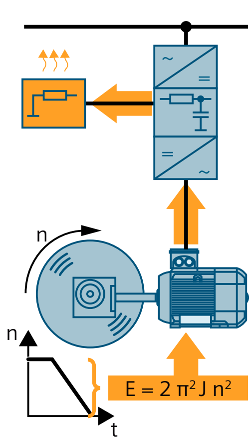


Figure 14-198 Power flow during dynamic braking

The braking resistor converts the regenerative energy E generated when the motor brakes into heat in a braking resistor.

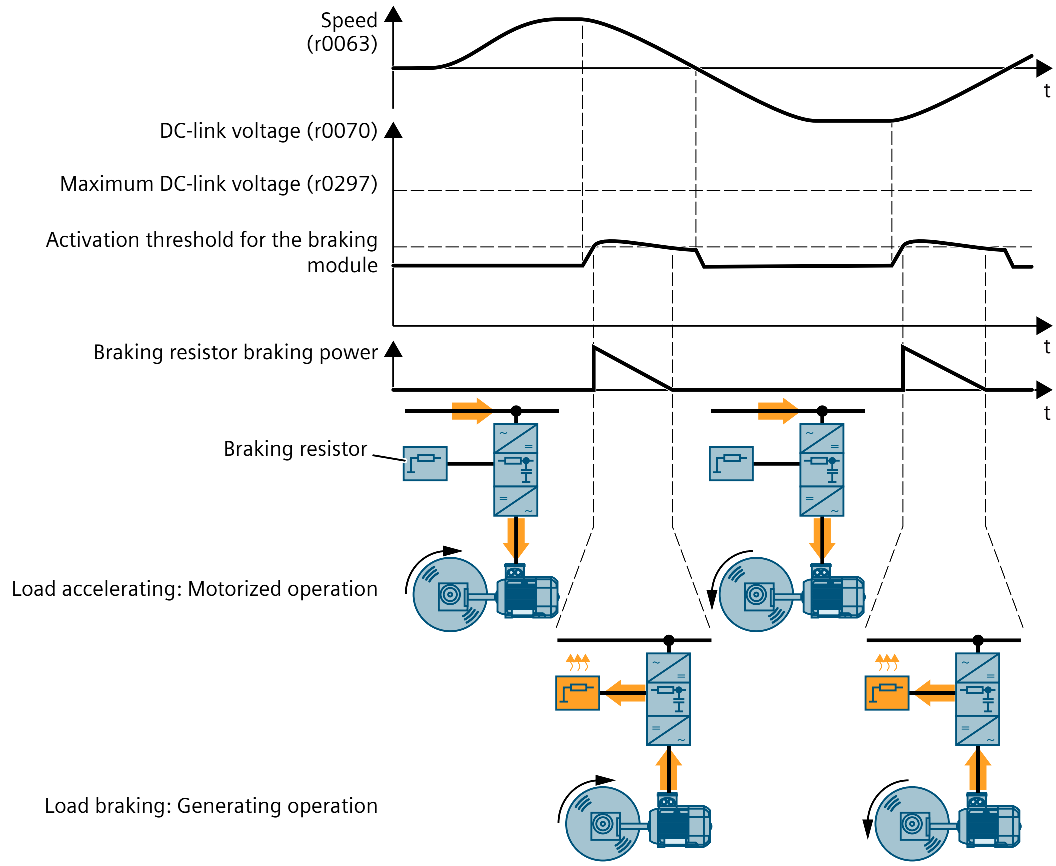


Figure 14-199 Simplified representation of dynamic braking with respect to time

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 module, then the braking module transfers the regenerative energy to the braking resistor.

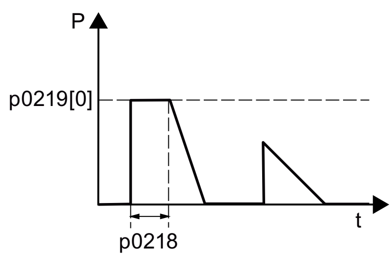
There are two upload options available for temperature monitoring of the braking resistor:

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 14-200 Example of maximum braking power in an application

Example

The following are typical applications for dynamic braking:

- Centrifuges
- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

More information

You can find an example for configuring and commissioning a drive with braking resistor on the Internet:

Dimensioning and commissioning of series hoisting equipment (https://support.industry.siemens.com/cs/ww/en/view/103156155)

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 maximum power duration	[s]
p0219[0...1]	Braking resistor braking power	[kW]
r0297	DC link voltage overvoltage threshold	[V]

14.11.13 Motor holding brake

Overview

A motor holding brake holds a switched-off motor in place.

When controlled as follows, the "Motor holding brake" function minimizes the wear of an electromechanical brake:

- The brake opens once the motor is magnetized.
- The converter switches off the motor when the motor holding brake is closed.

Requirement

The motor holding brake is connected to a digital output of the converter.

The motor holding brake is configured: p1215 = 3.

Description of function

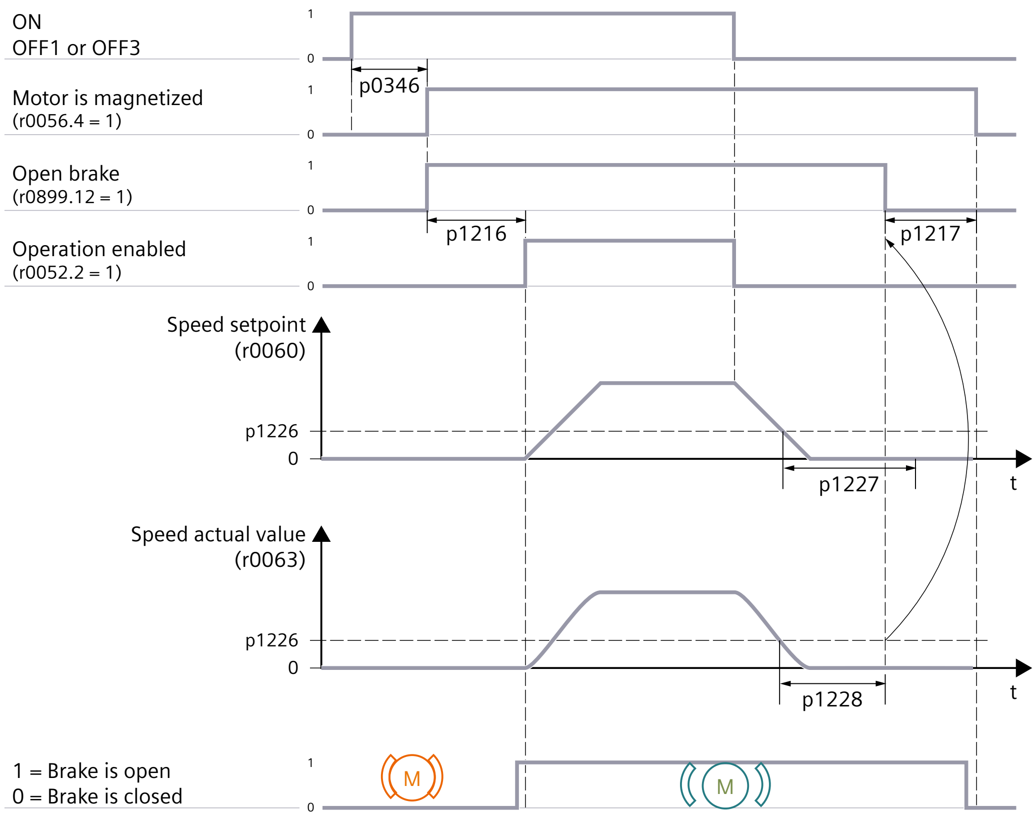


Figure 14-201 Function of the motor holding brake

The converter controls the motor 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 "Motor holding brake opening time" p1216 has ended.
    The motor 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.
  - After the "Motor holding brake closing time" p1217, the converter switches off the motor.
    The motor holding brake must have closed within the time p1217.
- After the OFF2 command
  After the OFF2 command, the brake closing time is not taken into account.
  The converter issues the command to close the motor holding brake immediately and irrespective of the motor speed.

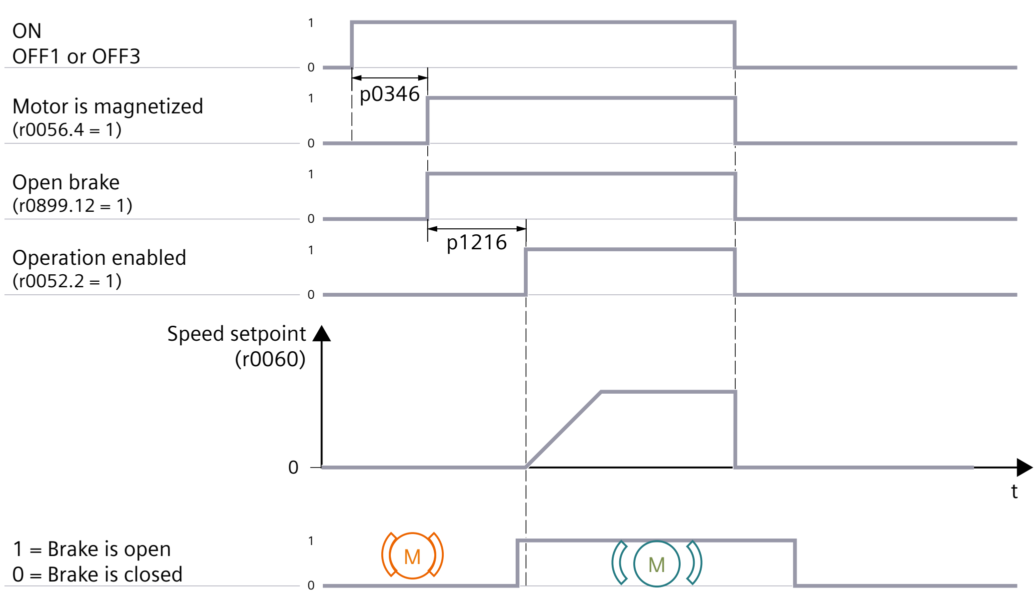


Figure 14-202 Control of the motor holding brake after OFF2

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 zero speed detection	[rpm]
p1227[0...n]	Zero speed 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]

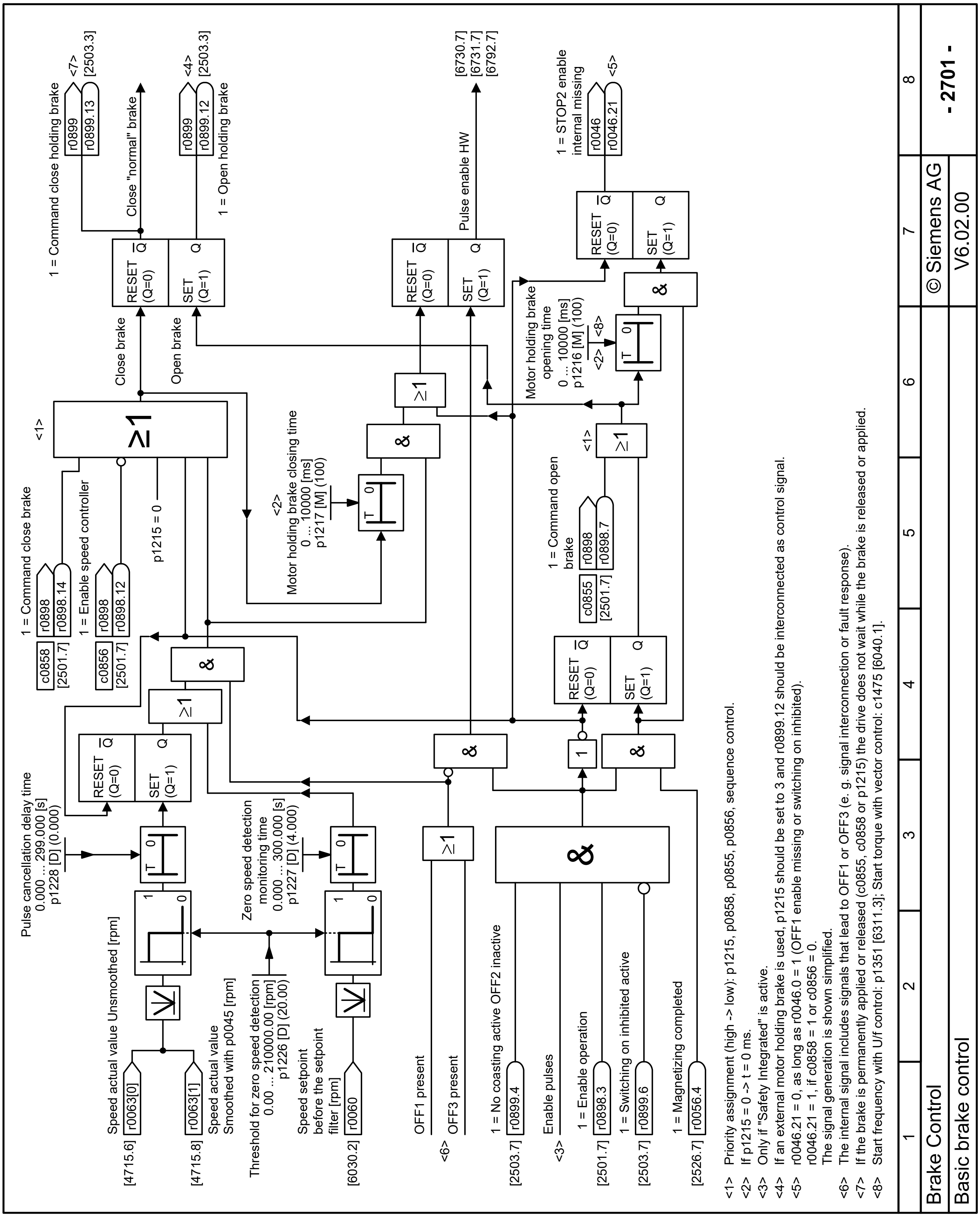


Figure 14-203 2701 - Basic brake control

14.11.14 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:

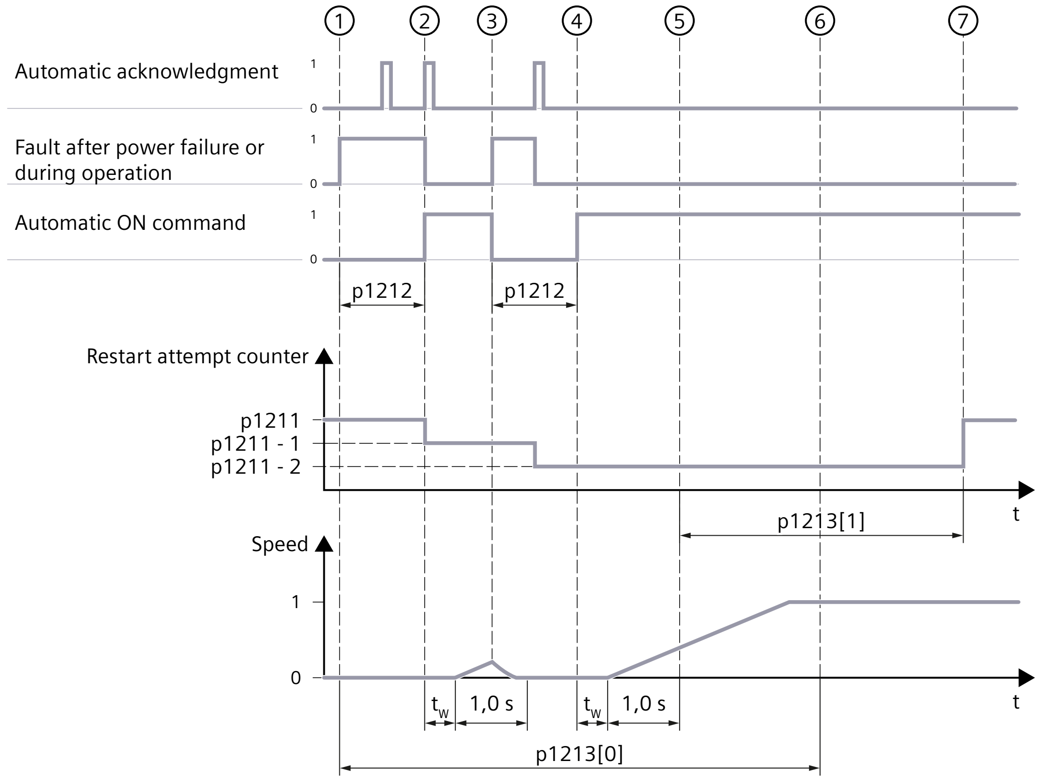
- The converter acknowledges faults automatically.
- After a fault or a power failure, the converter switches on the motor again automatically.

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 automatic restart attempts.
Fault F07320 is output if the counter value of the restart attempts < 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, fault F07320 is output

⑦ After p1213[1], the converter resets the automatic restart attempts to p1211.

Figure 14-204 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]

14.11.15 Flying restart - switching on while motor is running

Overview

If you switch on the motor while it is still rotating, a fault due to overcurrent (F30001 or F07801) is highly likely unless the "Flying restart" function is used.

Examples of applications involving an unintentionally rotating motor directly before switching on:

- 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 is driving the motor.

Requirement

Permissible drives:

- Single drive
- Mechanically coupled group drive
  Group drive without mechanical coupling is not permissible.

Description of function

The converter determines the motor speed continuously during the "Flying restart" function.

Following the ON command, the converter synchronizes its output frequency with the motor speed and magnetizes the motor. The converter sets its output frequency to 0 Hz for magnetization at motor speeds < 10% of the rated speed. If it is not possible to start in this range, p1270.2 activates a supportive search technique.

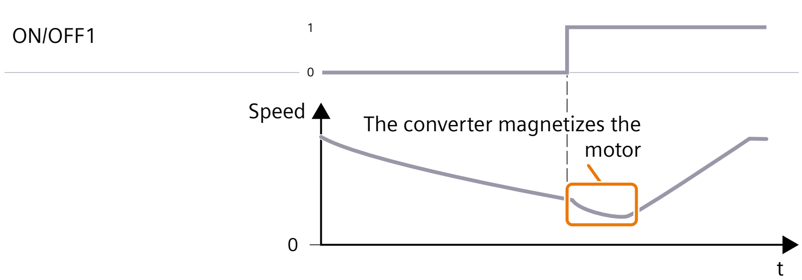


Figure 14-205 Principle of operation of the "Flying restart" function

Parameters

The following list contains the parameters of the "Flying restart" function.

Number	Name	Unit
p0346[0...n]	Motor excitation build-up time	[s]
p0347[0...n]	Motor de-excitation time	[s]
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	[%]
p1270[0...n].0...3	Flying restart configuration	

14.11.16 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.

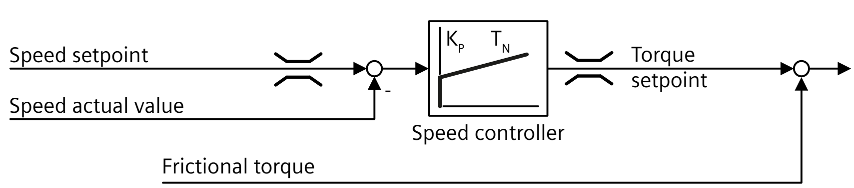


Figure 14-206 Precontrol of the speed controller with the friction torque

The converter calculates the current friction torque from a friction characteristic with 10 interpolation points.

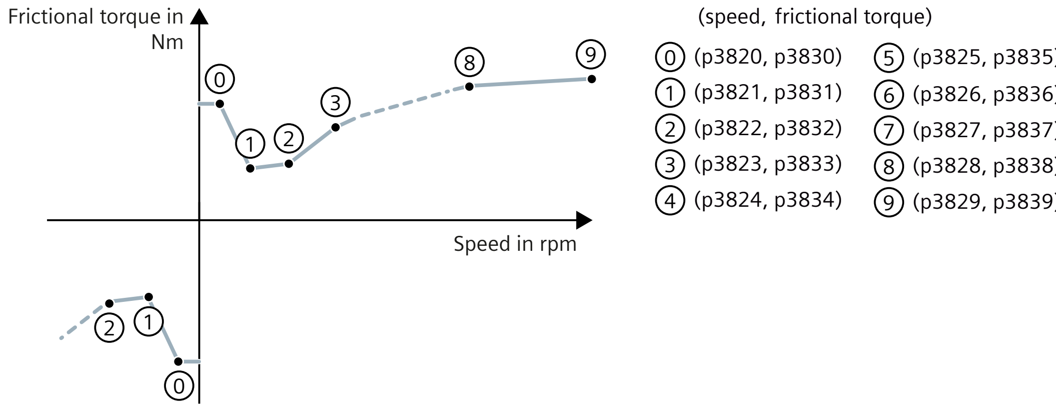


Figure 14-207 Friction characteristic

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.

14.11.17 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.

You have completed quick commissioning.

You have set the vector control.

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.

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]

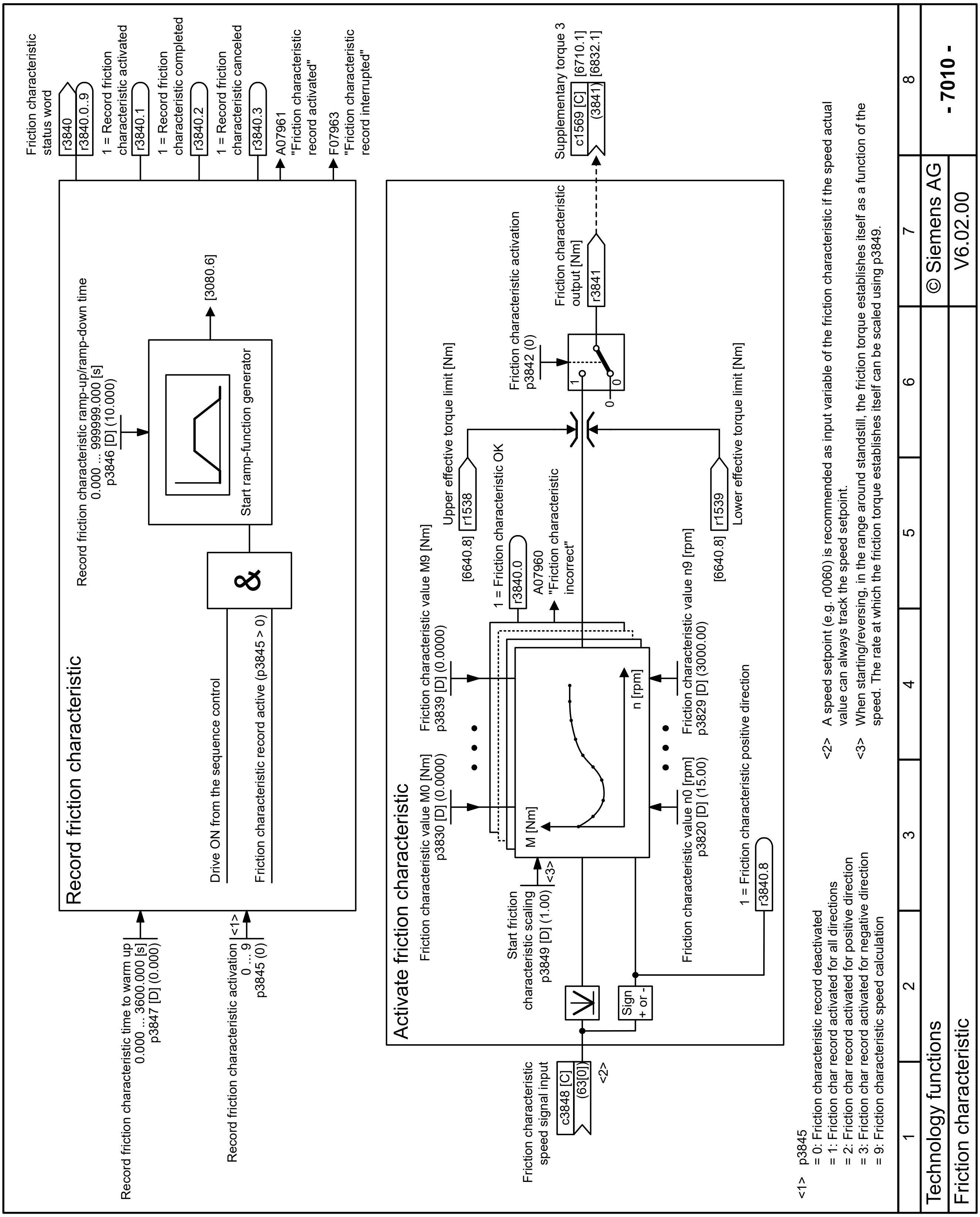
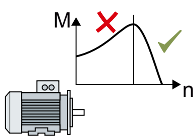


Figure 14-208 7010 - Friction characteristic

14.11.18 Messages/Monitoring functions

14.11.18.1 Stall message

Overview



If the load of a standard induction motor exceeds the stall torque of the motor, the motor can stall even during operation on the converter. A stalled motor is stationary and does not develop sufficient torque to accelerate the load.

The "Stall message" function detects the overload of a standard induction motor. The function stops the motor and generates a suitable message.

Description of function

If error signal r1746 exceeds the parameterized error threshold p1745, the converter sets status signal r1408.12 = 1, thus detecting the stalling of the drive. After a defined delay time p2178, the converter outputs fault F07902.

The function is only effective in the low-speed range.

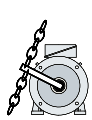
Parameters

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	

14.11.18.2 Blocking message

Overview



The "Blocking message" function detects that a stuck load machine is preventing the motor from rotating. The function stops the motor and generates a suitable message.

Description of function

If the speed lies below the speed threshold p2175 for the time p2177 and the motor current simultaneously reaches the current limit, the converter signals "Motor blocked" and fault F07900.

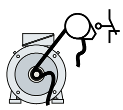
Parameters

The following list contains the parameters of the "Blocking message" function.

Number	Name	Unit
p0045	Display values smoothing time constant	[ms]
r0063[0...2]	Speed actual value	[rpm]
p2175[0...n]	Motor blocked speed threshold	[rpm]
p2177[0...n]	Motor blocked delay time	[s]
r2198.0...13	Status word monitoring 2	

14.11.18.3 Speed deviation monitoring

Overview



The function calculates and monitors the speed or velocity of a machine component.

Description of function

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.

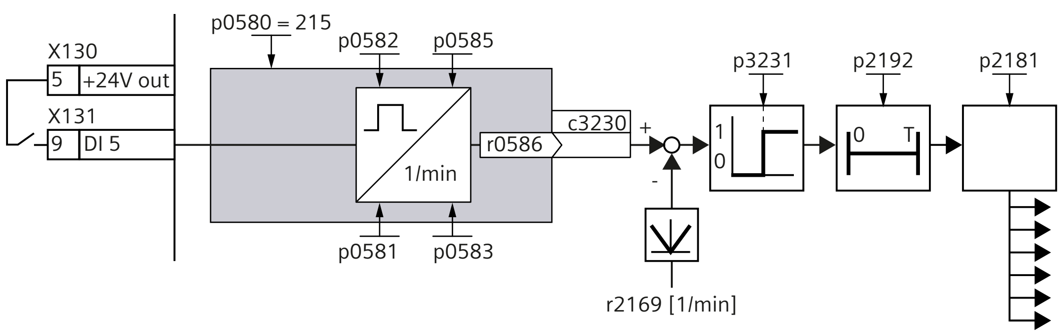


Figure 14-209 Speed deviation monitoring

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.

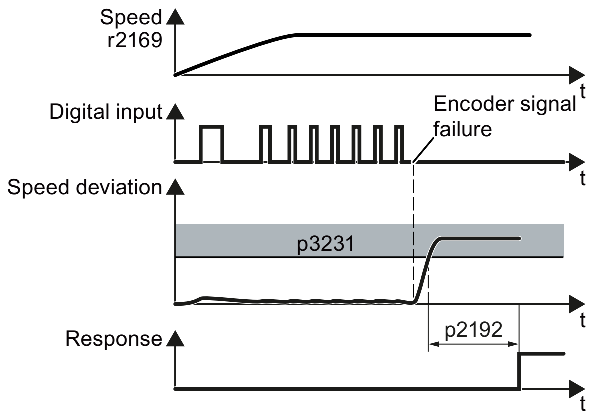


Figure 14-210 Time response of the speed monitoring

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

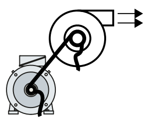
Parameters

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]

14.11.18.4 Load monitoring for torque

Overview



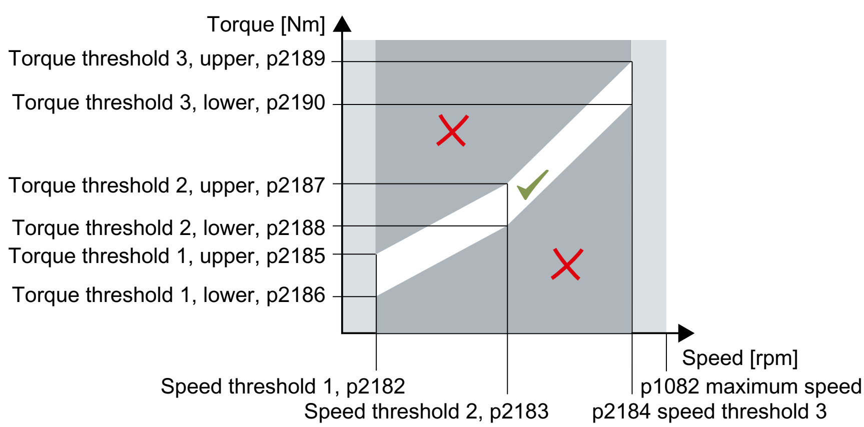
The "Load monitoring for torque" function assumes that a specific torque is associated with each speed for pumps and fans.

Description of function

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.

The converter monitors the torque for a lower torque value and an upper torque value using an envelope curve as a function of speed.



If the torque is in the impermissible range for longer than time p2192, the converter responds according to the setting 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

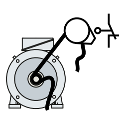
The following list contains the parameters of the "Load monitoring for torque" function.

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	

14.11.18.5 Load monitoring failure detection

Overview



The "Load monitoring failure detection" function evaluates a periodic binary signal. A missing signal indicates that the motor and the load are no longer mechanically coupled.

Description of function

The converter monitors the speed or velocity of a machine component using an electromechanical or electronic sensor, e.g. a proximity switch.

The converter evaluates whether the sensor periodically delivers a 24 V signal during motor operation. If the sensor signal is missing for time p2192, the converter signals fault F07936.

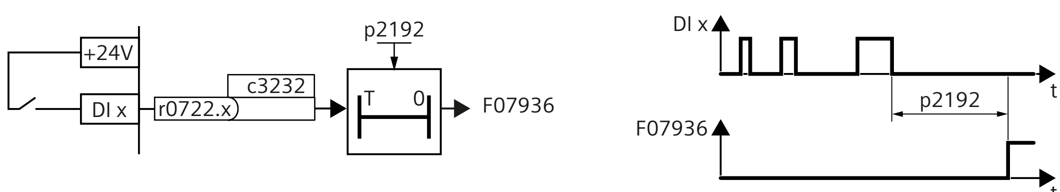


Figure 14-211 Function diagram and time response of the load monitoring failure detection

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 pumps or conveyor belts

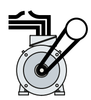
Parameters

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)	

14.11.18.6 No-load monitoring

Overview



The no-load monitoring evaluates the motor current and detects an interrupted phase in the motor cable.

Description of function

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	

14.11.18.7 Converter protection by means of temperature monitoring

Overview

To maintain operation, the converter monitors its load and for an impending overload condition reduces its losses.

Requirement

The following effects determine the converter temperature and can result in an overload condition:

- The ambient temperature
- The ohmic losses increasing with the output current
- The increase of switching losses with pulse frequency

Description of function

The converter monitors the following values to be able to respond quickly to an impending overload condition:

- Motor current
- DC link current
- Active power
- Chip temperature of the power electronics
- Heat sink temperature

For an impending overload condition, the converter attempts to reduce its load. The converter responds differently depending on the setting of parameter p0290.

Overload response when p0290 = 0

The converter signals an alarm for an impending overload condition.

The overload response depends on the control mode that has been set:

- For closed-loop speed control, the converter reduces the output current.
- For U/f control, the converter reduces the speed.

Once the impending overload condition has been removed, the converter re-enables the output current or speed.

If the overload response does not prevent a converter overload, then the converter switches off the motor and issues a fault.

Overload response when p0290 = 1

The converter signals an alarm for an impending overload condition.

For an overload condition, the converter switches off the motor and issues a fault.

Overload response when p0290 = 2

We recommend this setting for loads with a parabolic speed-torque characteristic, e.g. for fans.

The converter signals an alarm for an impending overload condition.

When an alarm is active, the converter responds in 2 stages:

- Stage 1: Reduction of the pulse frequency
  The converter only responds with stage 1 for an excessively high chip temperature of the power electronics or for an excessively high heat sink temperature.
  If the converter is operated with an increased pulse frequency, when an alarm is active, then the converter reduces its pulse frequency starting at the pulse frequency setpoint p1800.
  Once the impending overload condition has been removed, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.
- Stage 2: Reduction of the output current
  The converter responds as follows if stage 1 is not possible or was not successful:
  - For closed-loop speed control, the converter reduces the output current.
  - For U/f control, the converter reduces the speed.

  Once the impending overload condition has been removed, the converter re-enables the output current or speed.

If the overload response does not prevent a converter overload, then the converter switches off the motor and issues a fault.

Overload response when p0290 = 3

The converter signals an alarm for an impending overload condition.

If the converter is operated with an increased pulse frequency, when an alarm is active, then the converter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

The converter only reduces the pulse frequency for an excessively high chip temperature of the power electronics or for an excessively high heat sink temperature.

Once the impending overload condition has been removed, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.

If the overload response does not prevent a converter overload, then the converter switches off the motor and issues a fault.

Overload response when p0290 = 12

The converter signals an alarm for an impending overload condition.

When an alarm is active, the converter responds in 2 stages:

- Stage 1: Reduction of the pulse frequency
  The converter only responds with stage 1 for an excessively high chip temperature of the power electronics or for an excessively high heat sink temperature.
  If the converter is operated with an increased pulse frequency, when an alarm is active, then the converter reduces its pulse frequency starting at the pulse frequency setpoint p1800.
  Once the impending overload condition has been removed, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.
- Stage 2: Reduction of the output current
  The converter responds as follows if stage 1 is not possible or was not successful:
  - For closed-loop speed control, the converter reduces the output current.
  - For U/f control, the converter reduces the speed.

  Once the impending overload condition has been removed, the converter re-enables the output current or speed.

If the overload response does not prevent a converter overload, then the converter switches off the motor and issues a fault.

Overload response when p0290 = 13

We recommend this setting for driven loads with a high starting torque.

The converter signals an alarm for an impending overload condition.

If the converter is operated with an increased pulse frequency, when an alarm is active, then the converter reduces its pulse frequency starting at the pulse frequency setpoint p1800.

The converter only reduces the pulse frequency for an excessively high chip temperature of the power electronics or for an excessively high heat sink temperature.

When the overload has been eliminated, the converter increases the pulse frequency back to the pulse frequency setpoint p1800.

If the overload response does not prevent a converter overload, then the converter switches off the motor and issues a fault.

Parameters

The following list contains the parameters of the "Converter protection by means of temperature monitoring" function.

Number	Name	Unit
r0036[0...2]	Power unit overload	[%]
p0290	Power unit overload response	
p0292[0...1]	Power unit temperature alarm threshold	[°C]
p1800[0...n]	Pulse frequency setpoint	[kHz]

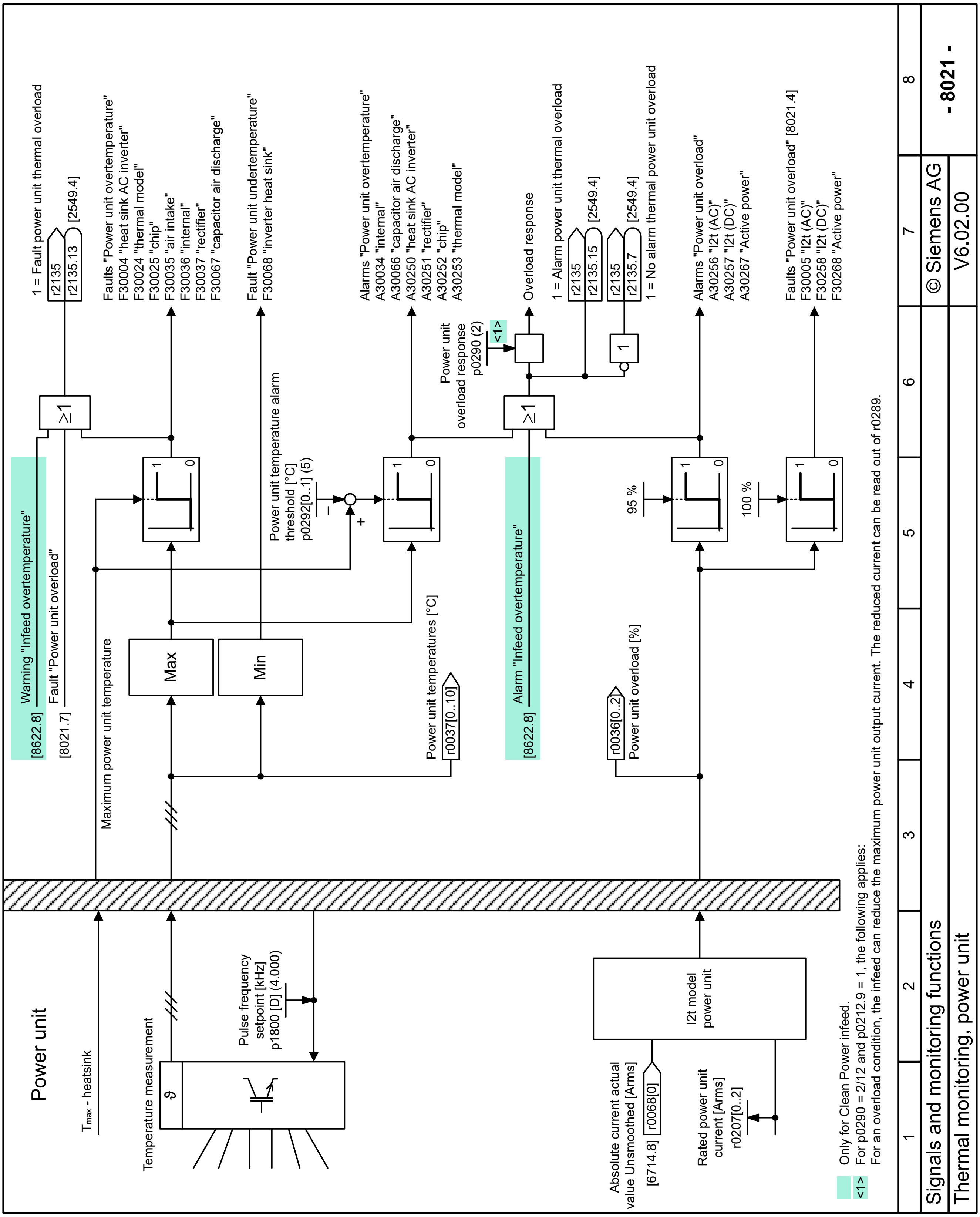


Figure 14-212 8021 - Thermal monitoring power unit

14.11.18.8 Motor protection with temperature sensor KTY84

Overview

To protect the motor against overtemperature, the converter evaluates a KTY84 sensor.

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.

Description of function

With a KTY84 sensor, the converter evaluates the motor temperature in the range -48 °C ... +248 °C.

You set the temperature for the alarm and fault thresholds with parameters p0604 and p0605, respectively.

- Alarm overtemperature (A07910)
  - Motor temperature > p0604 and p0610 = 0
- Overtemperature fault (F07011)
  The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring:

- Wire break
  After 100 milliseconds, the converter transitions into fault state F07016.
- Short-circuit
  After 100 milliseconds, the converter transitions into fault state F07016.

Parameter p0607 defines the time that elapses between the output of alarm and fault for a temperature sensor error.

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]

14.11.18.9 Motor protection with temperature sensor Pt100

Overview

To protect the motor against overtemperature, the converter can evaluate the Pt100 sensor.

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.

Description of function

With a Pt100 sensor, the converter evaluates the motor temperature in the range -48 °C to +248 °C.

You set the temperature for the alarm and fault thresholds with parameters p0604 and p0605, respectively.

- Alarm overtemperature (A07910)
  - Motor temperature > p0604 and p0610 = 0
- Overtemperature fault (F07011)
  The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring

- Wire break:
  After 100 milliseconds, the converter transitions into fault state F07016.
- Short-circuit:
  After 100 milliseconds, the converter transitions into fault state F07016.

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]

14.11.18.10 Motor protection with temperature sensor Pt1000

Overview

To protect the motor against overtemperature, the converter can evaluate the Pt1000 sensor.

Description of function

With a Pt1000 sensor, the converter evaluates the motor temperature in the range -48 °C ... +248 °C.

You set the temperature for the alarm and fault thresholds with parameters p0604 and p0605, respectively.

- Alarm overtemperature (A07910)
  - Motor temperature > p0604 and p0610 = 0
- Overtemperature fault (F07011)
  The converter responds with a fault in the following cases:
  - Motor temperature > p0605
  - Motor temperature > p0604 and p0610 > 0

Sensor monitoring

- Wire break:
  After 100 milliseconds, the converter transitions into fault state F07016.
- Short-circuit:
  After 100 milliseconds, the converter transitions into fault state F07016.

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	

14.11.18.11 Motor protection with temperature switch

Overview

To protect the motor against overtemperature, the converter can evaluate a temperature switch, such as a bimetal switch.

Description of function

The converter interprets a resistance ≥ 100 Ω as an open bimetallic switch and responds according to the setting for 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	

14.11.18.12 Motor protection with temperature sensor PTC

Overview

To protect the motor against overtemperature, the converter can evaluate a PTC sensor.

Description of function

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 responds with alarm A07015.
  If the alarm is present for longer than 100 milliseconds, the converter shuts down with fault F07016.

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]

14.11.18.13 Motor protection for synchronous motors by means of temperature calculation, Model 1

Overview

The converter calculates the motor temperature based on a thermal motor model.

Description of function

Thermal motor model 1 determines the motor temperature of synchronous and synchronous reluctance motors from the continuous measurement of motor current and the thermal time constant of the motor model.

If the thermal motor model is used together with a temperature sensor, e.g. a Pt1000, then the converter corrects the model according to the measured temperature.

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 p612 is changed after commissioning, the alarm and fault thresholds p5390 and p5391 must be checked.

Parameters

The following list contains the parameters of the "Motor protection by means of temperature calculation" function.

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	Mot_temp_mod 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]

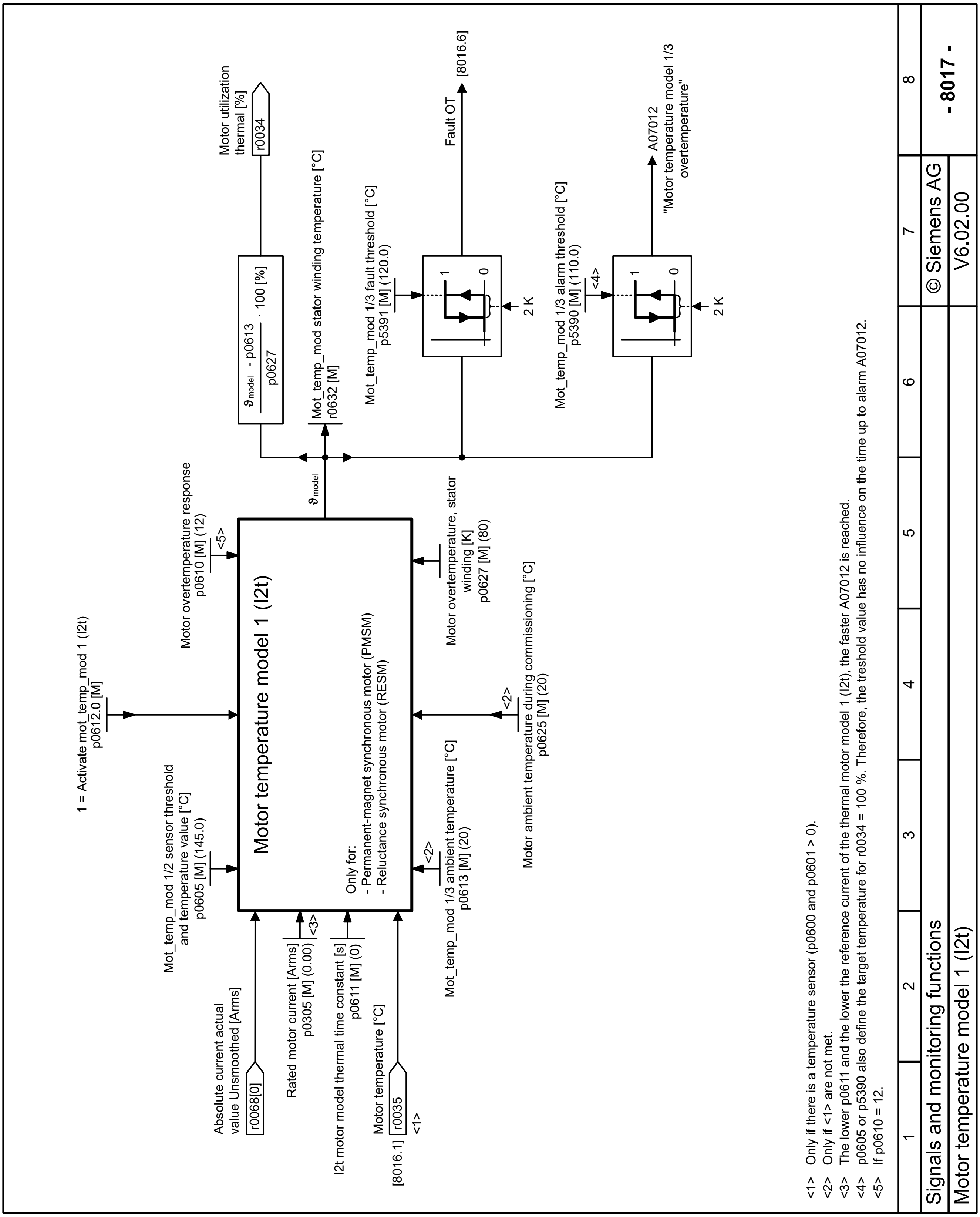


Figure 14-213 8017 - Motor temperature model 1 (I2t)

14.11.18.14 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.

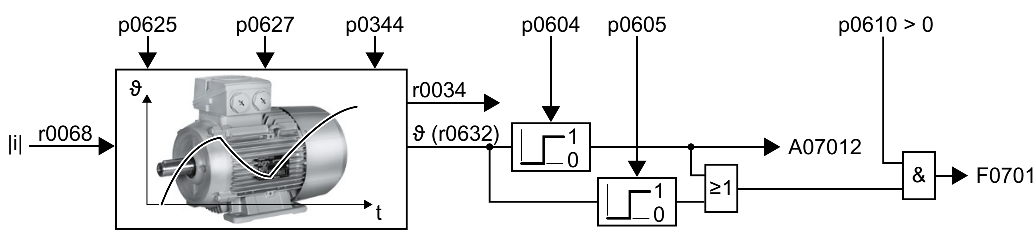


Figure 14-214 Thermal motor model 2 for induction motors

Parameters

The following list contains the parameters of the "Motor protection by means of temperature calculation" function.

Number	Name	Unit
p0344[0...n]	Motor weight (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	Mot_temp_mod activation	
p0617[0...n]	Stator thermally relevant iron component	[%]
p0618[0...n]	Stator thermally relevant copper component	[%]
p0619[0...n]	Rotor thermally relevant weight	[%]
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 stator iron temperature	[°C]

r0632[0...n]	Mot_temp_mod stator winding temperature	[°C]
r0633[0...n]	Mot_temp_mod rotor temperature	[°C]

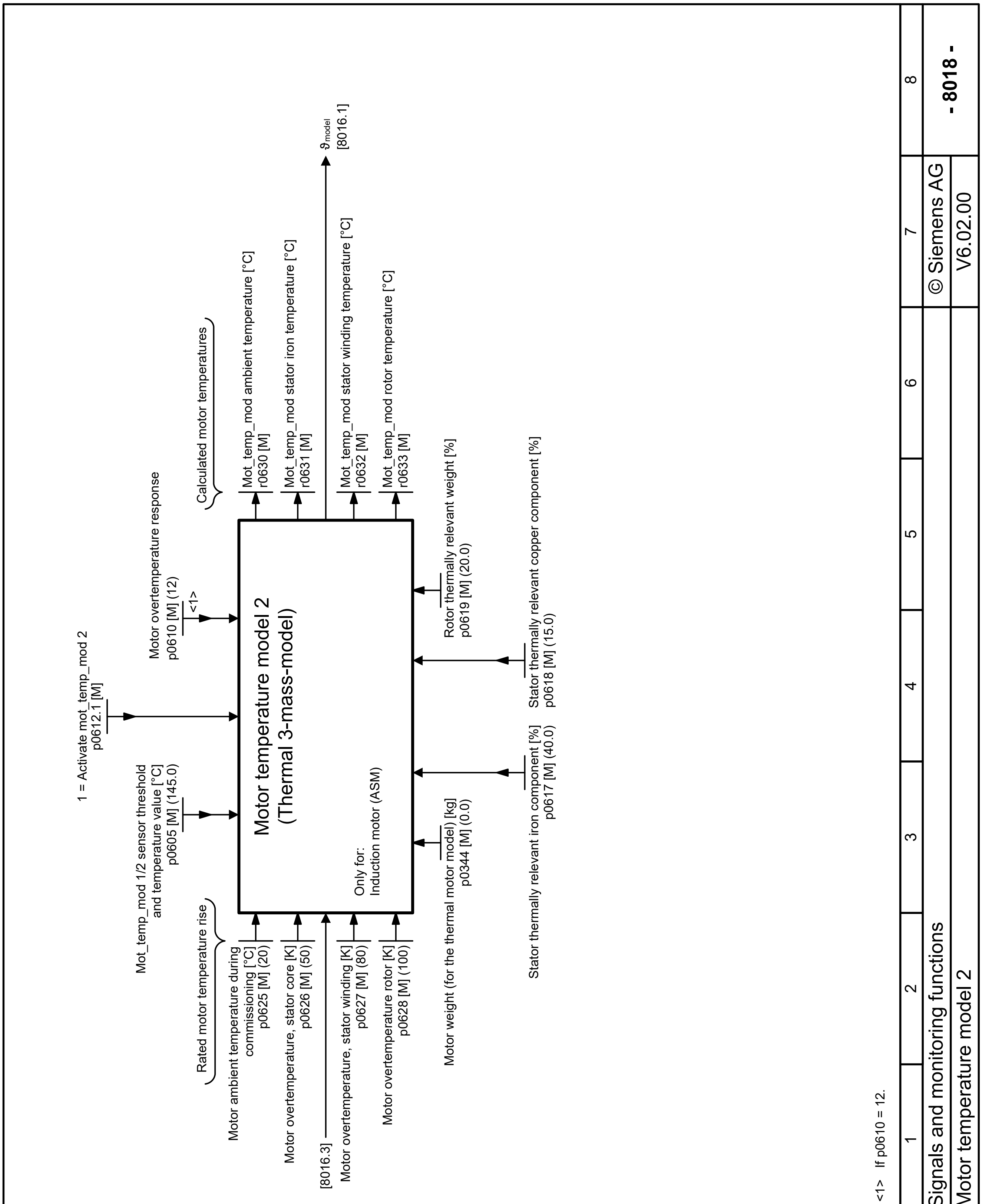


Figure 14-215 8018 - Motor temperature model 2

14.11.18.15 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 the "Motor protection by means of temperature calculation" function.

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]
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]
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...5]	Mot_temp remaining time until fault	[s]
r5387[0...n]	Mot_temp_mod 3 timer	[s]
c5388	Motor temperature inhibit current reduction	
r5389.0...8	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]

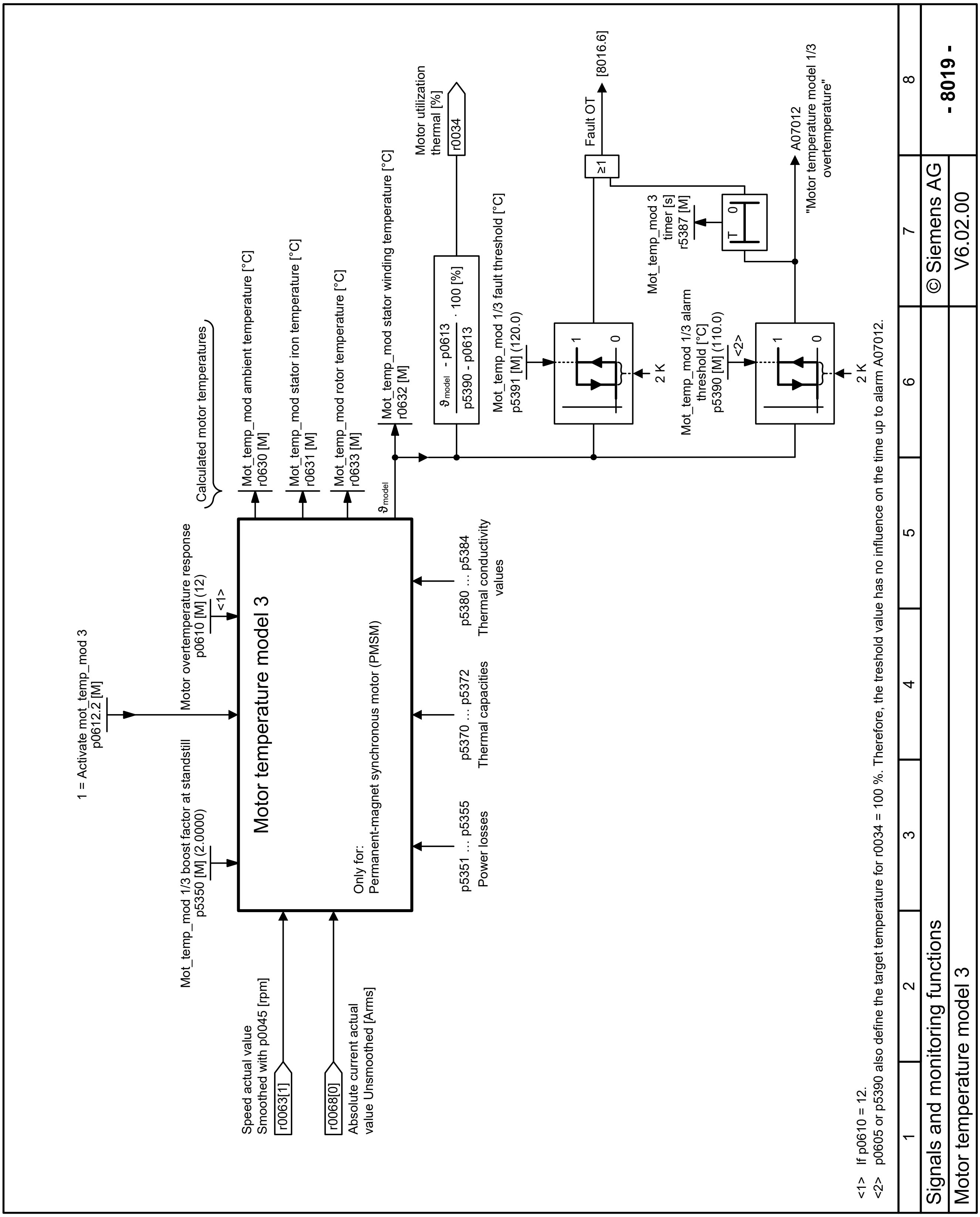


Figure 14-216 8019 – Motor temperature model 3

14.11.18.16 Setting motor overload protection according to UL 61800-5-1

Overview

If you operate the motor with a temperature sensor, the converter complies with motor overload protection according to UL 61800-5-1 Ed.2.

You must make some additional settings if you operate the motor without a temperature sensor.

Requirement

Requirements:

- You have completed quick setup with the correct motor data.
- You are operating the motor without a temperature sensor.

Procedure

To activate motor overload protection according to UL 61800-5-1 Ed. 2, proceed as follows:

1. Set p5375.0 = 1
2. Set p5375.1 = 1

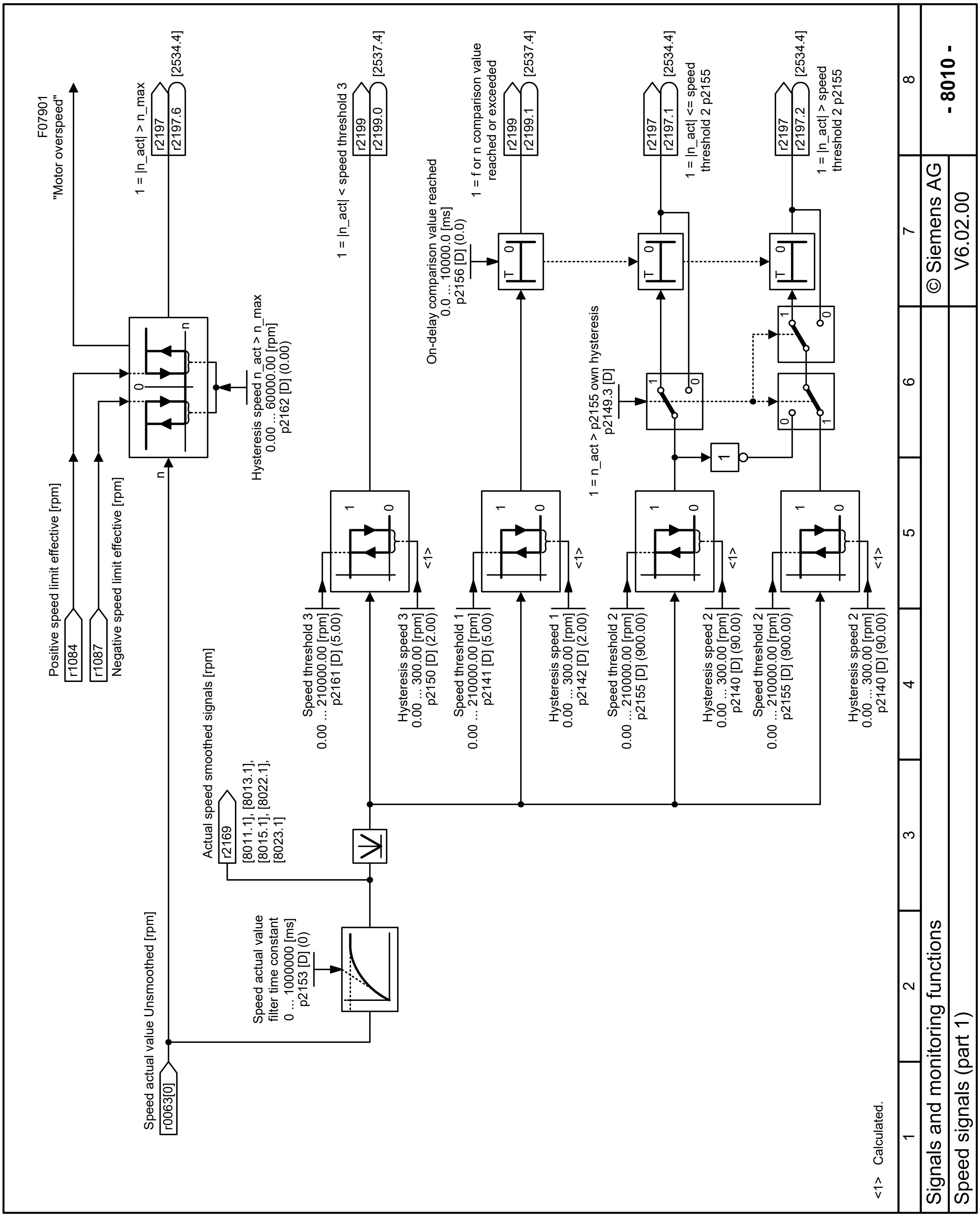


Figure 14-217 8010 – Speed messages (part 1)

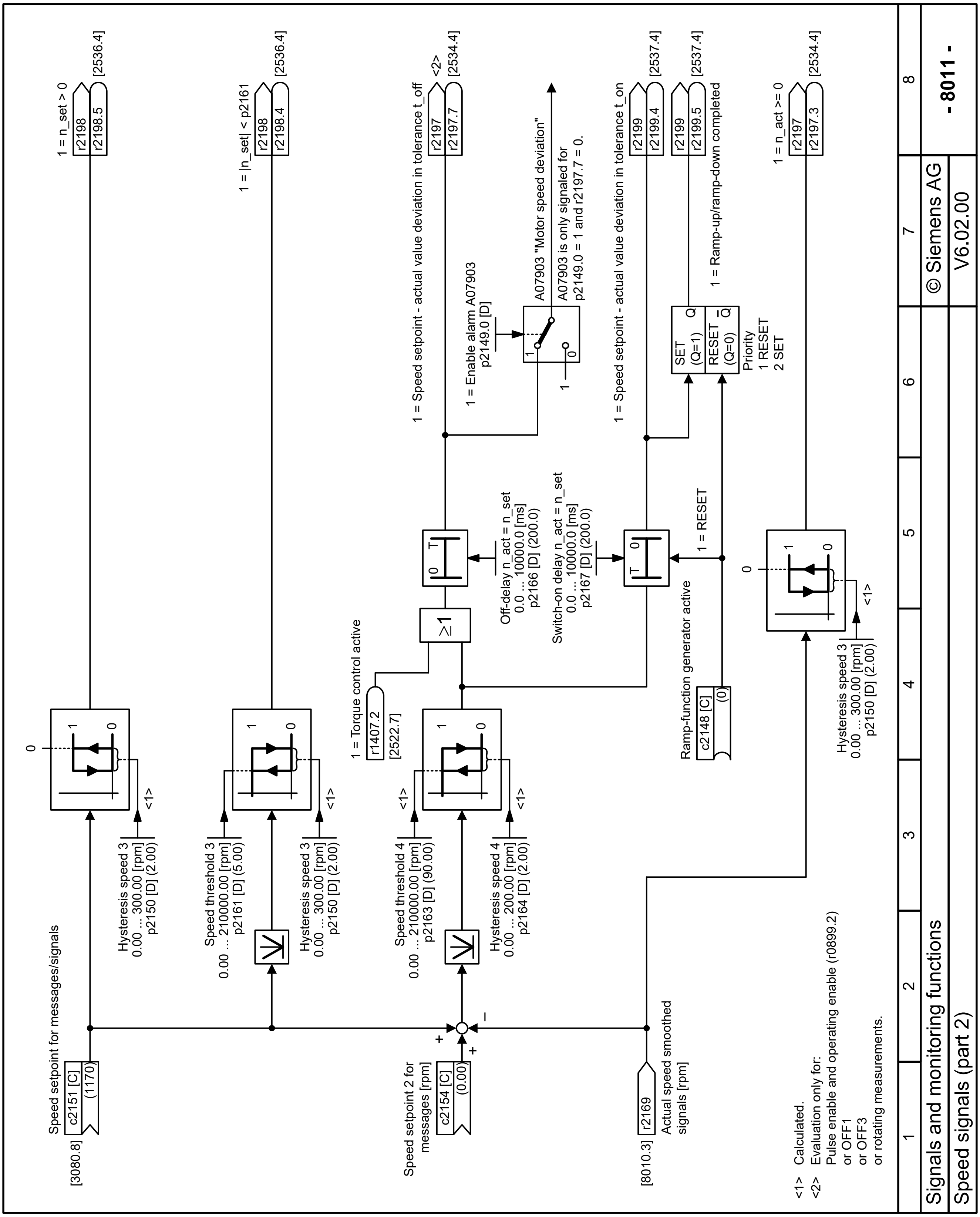


Figure 14-218 8011 – Speed messages (part 2)

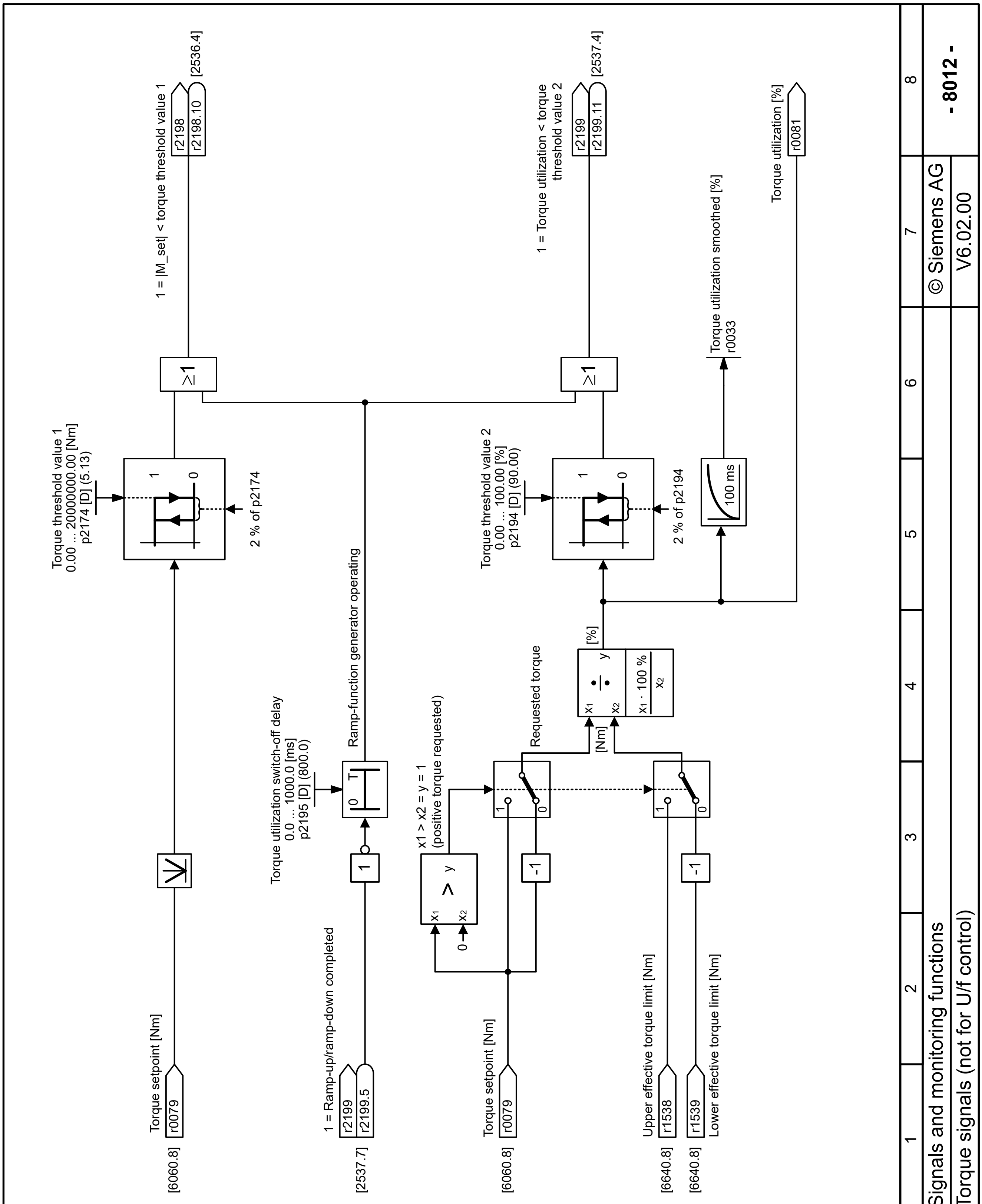


Figure 14-219 8012 - Torque messages

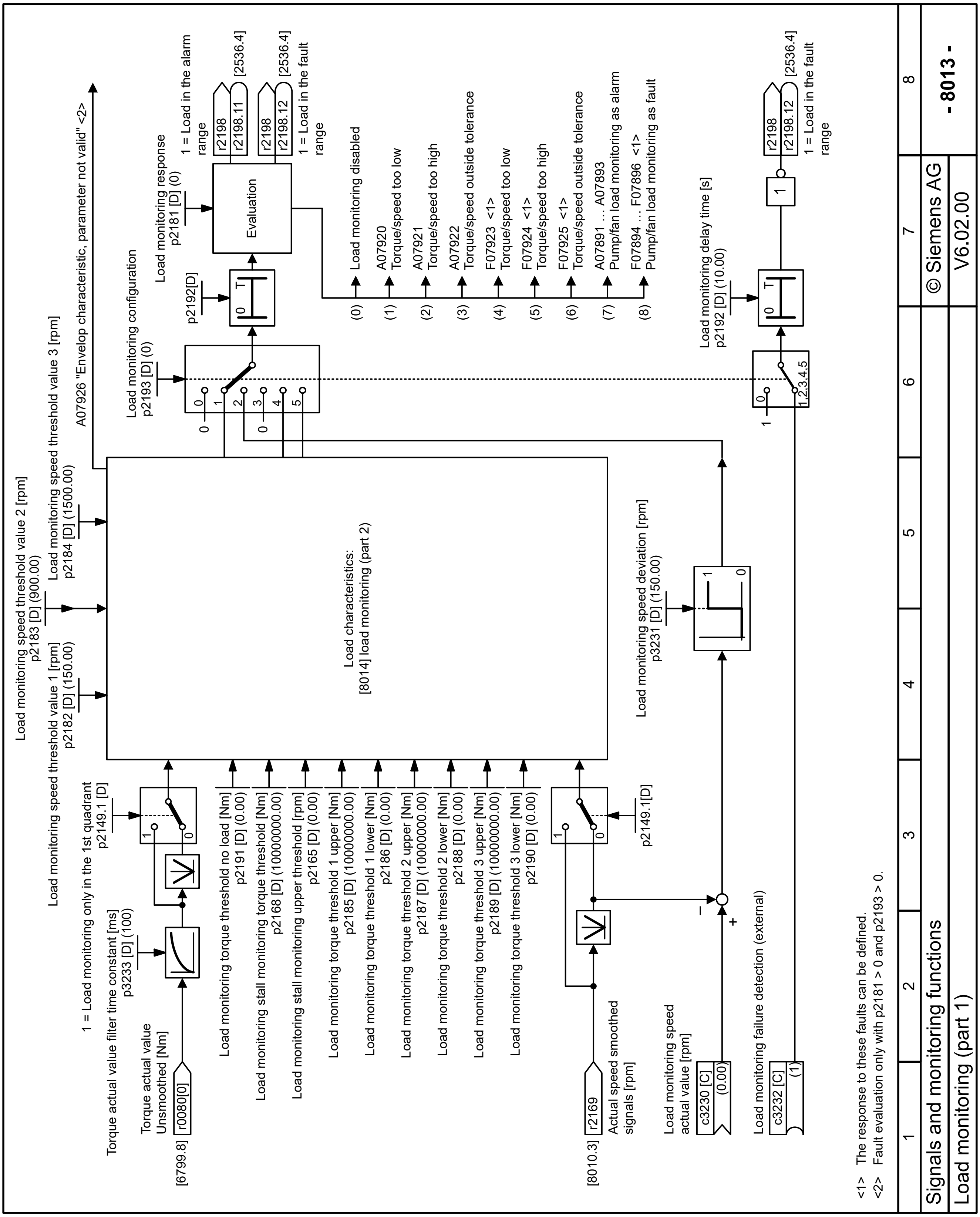


Figure 14-220 8013 - Load monitoring (Part 1)

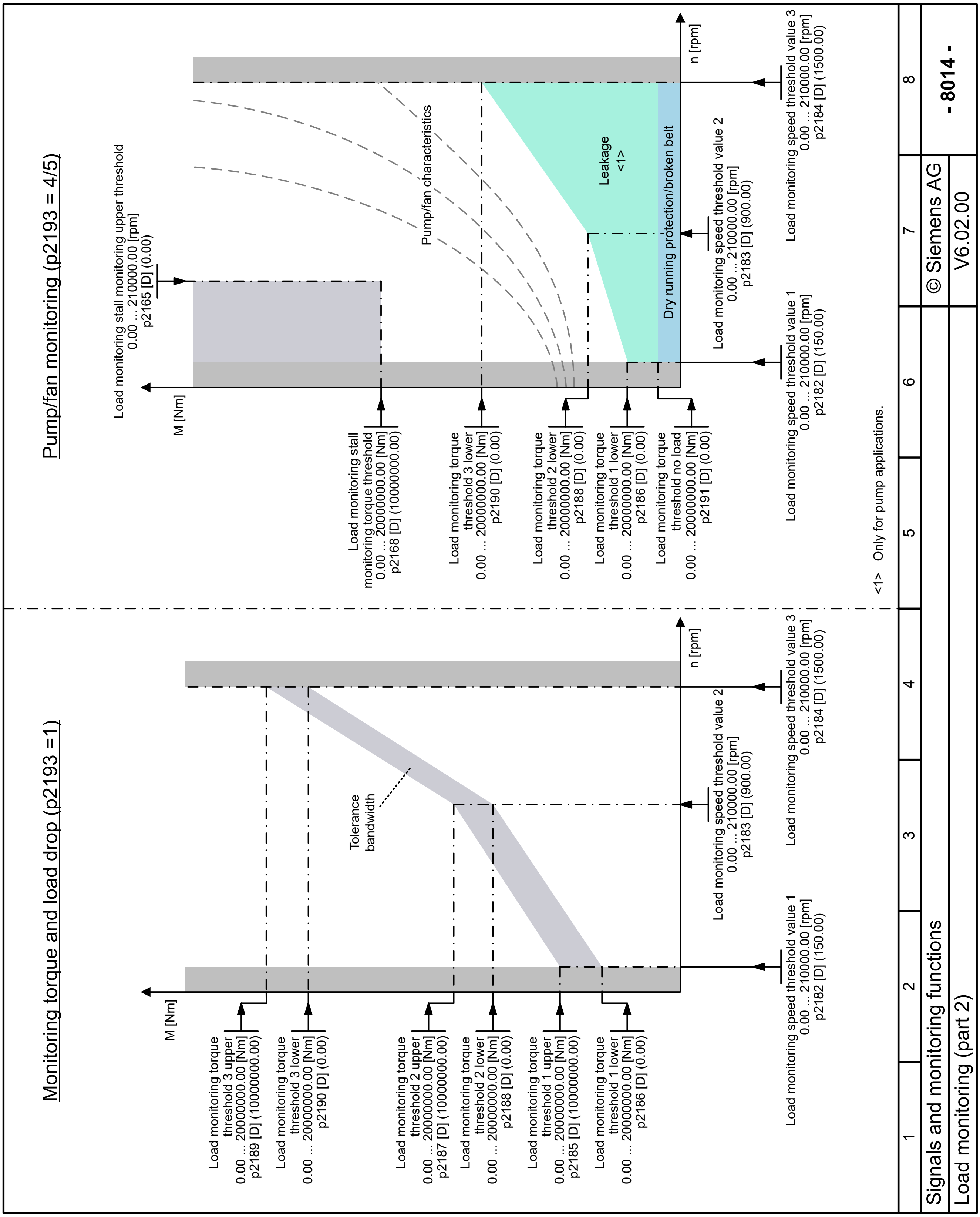


Figure 14-221 8014 - Load monitoring (Part 2)

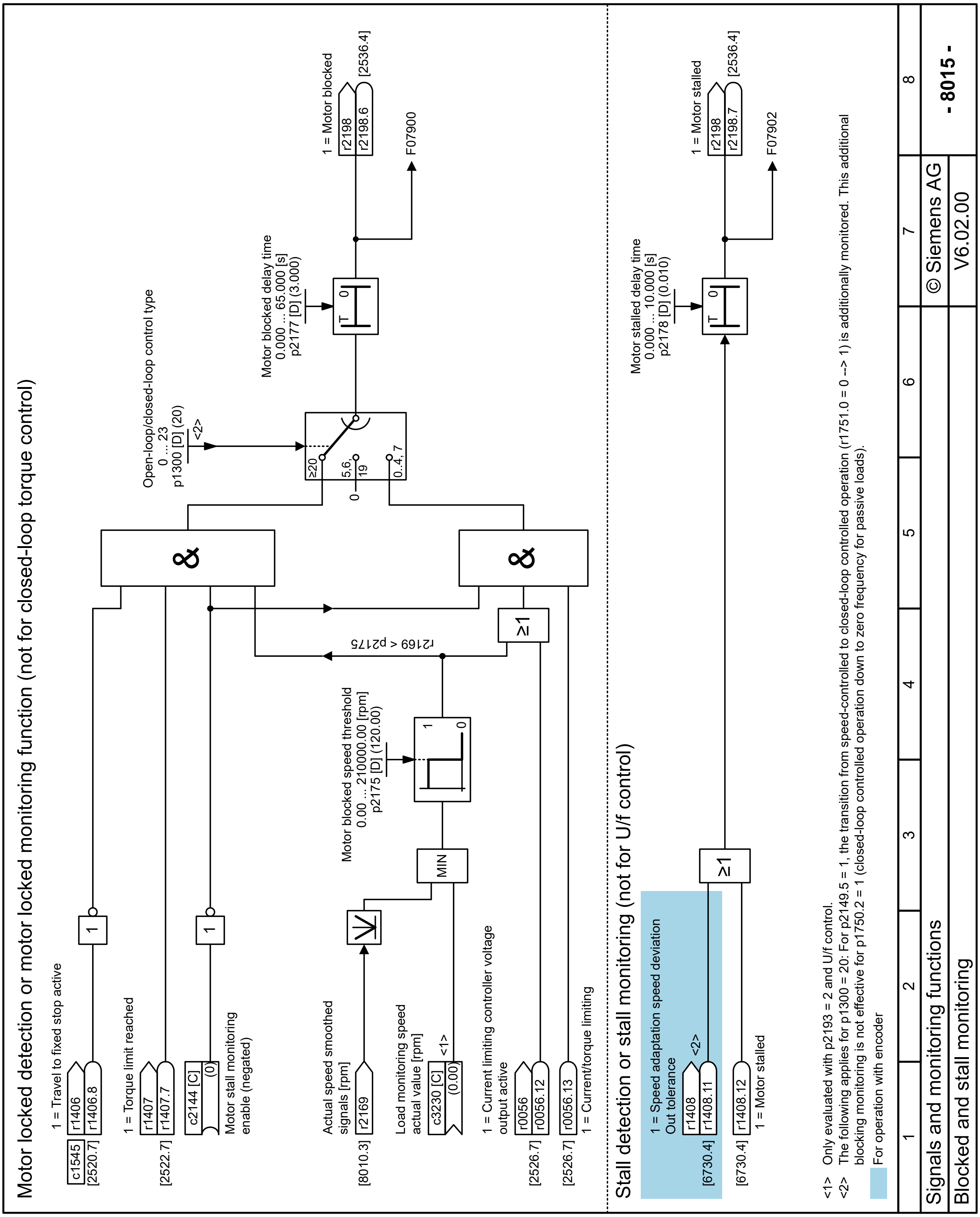


Figure 14-222 8015 - Blocking and tilt monitoring

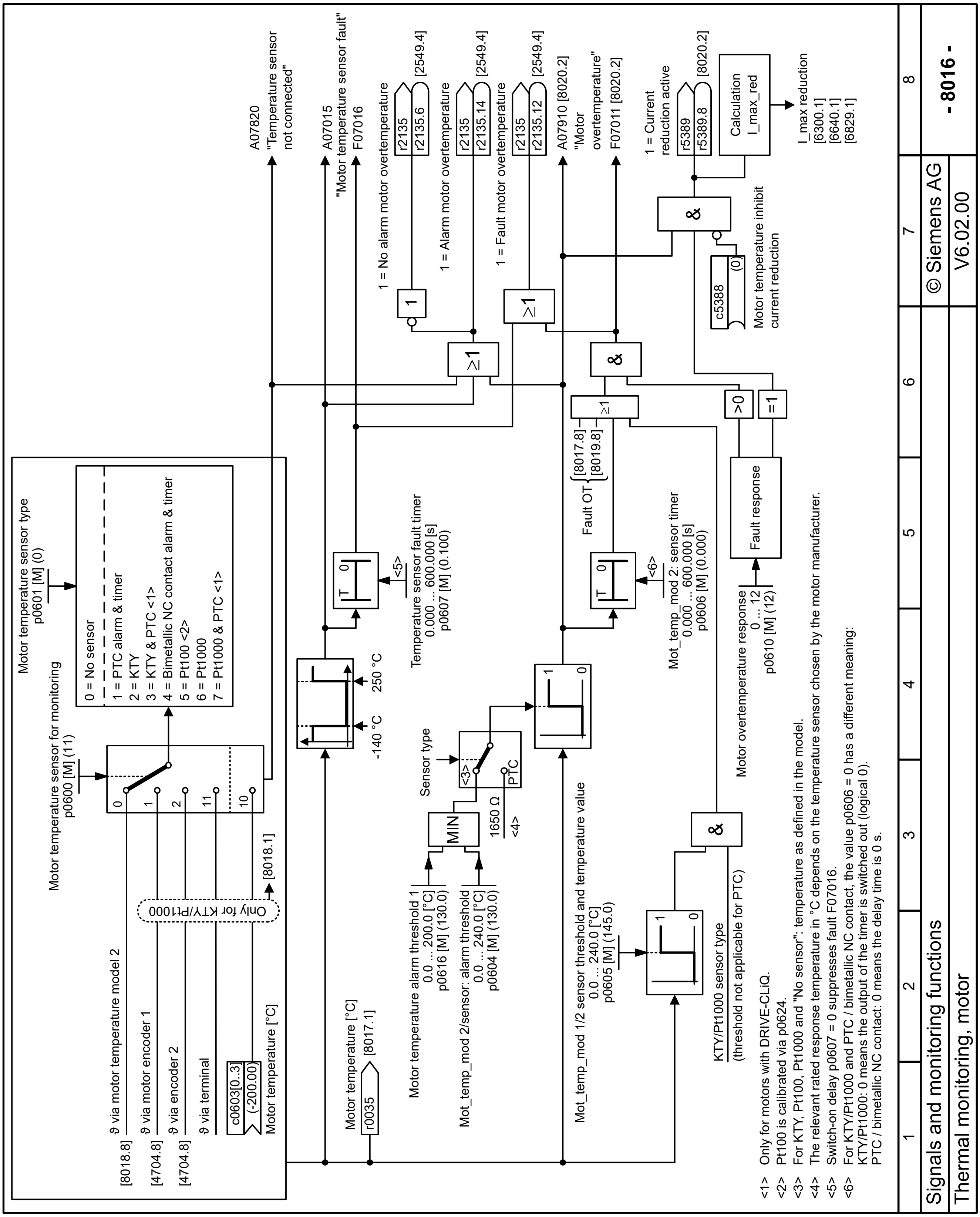


Figure 14-223 8016 - Thermal monitoring motor

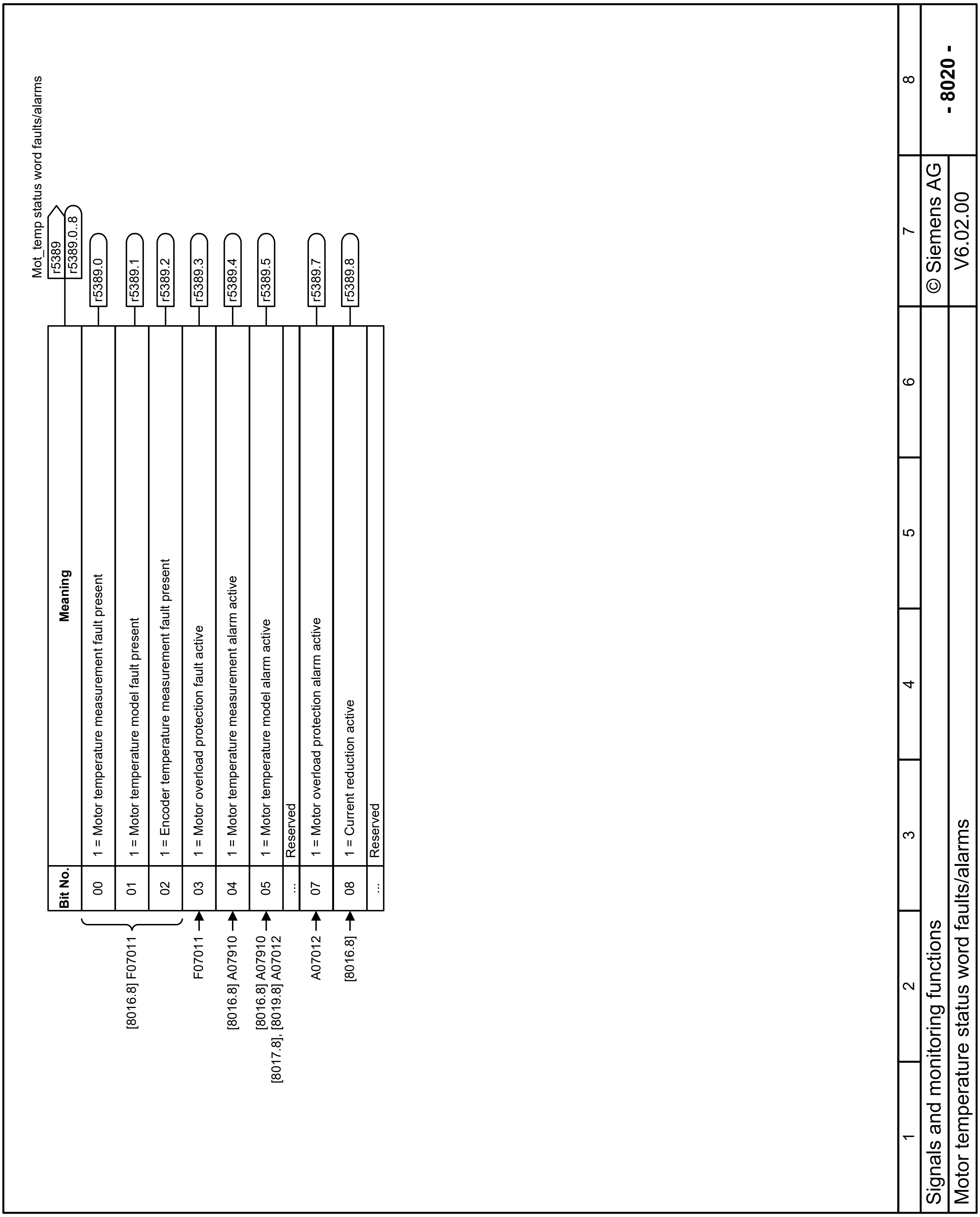


Figure 14-224 8020 - Motor temperature status word faults/alarms

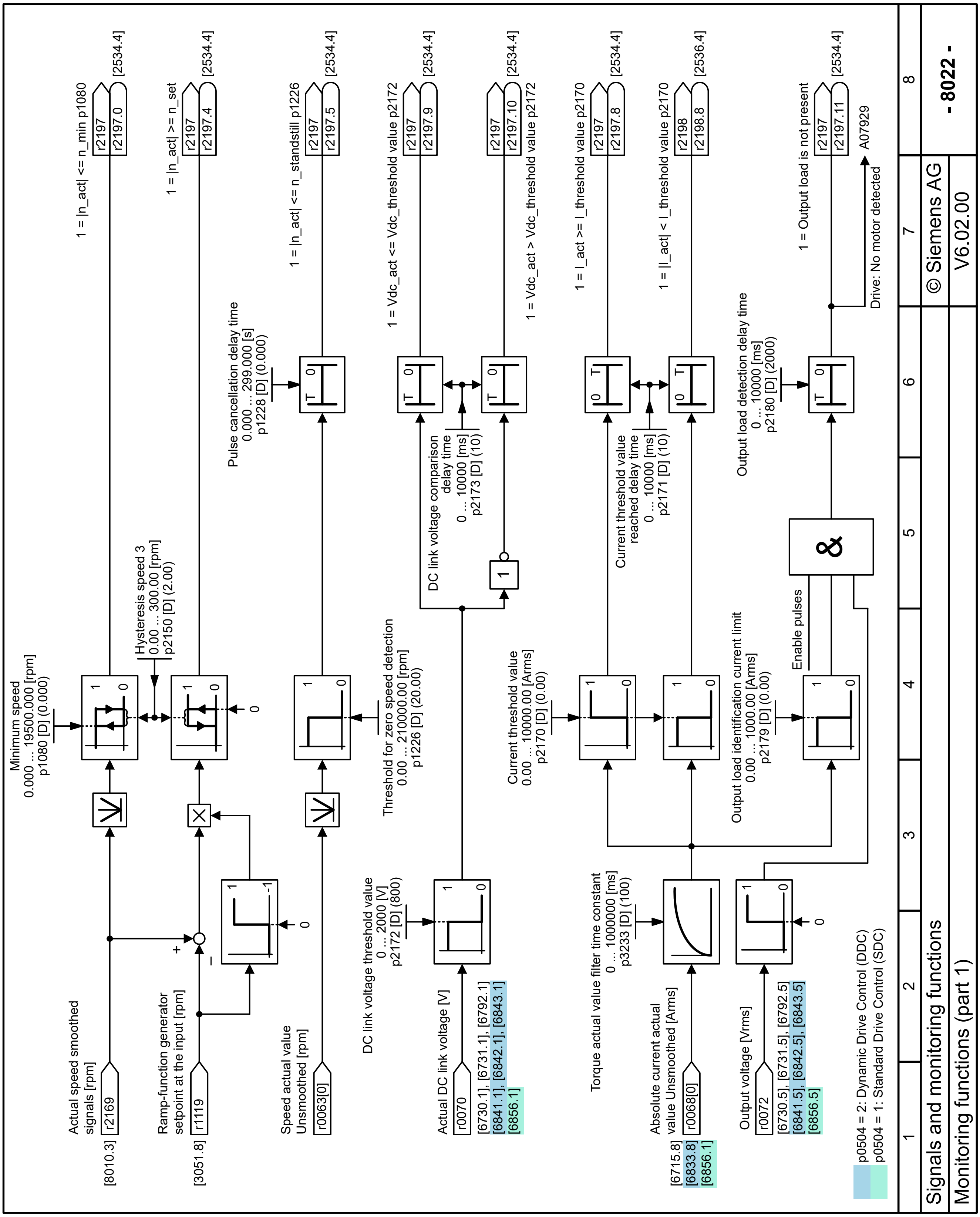


Figure 14-225 8022 – Monitoring functions (part 1)

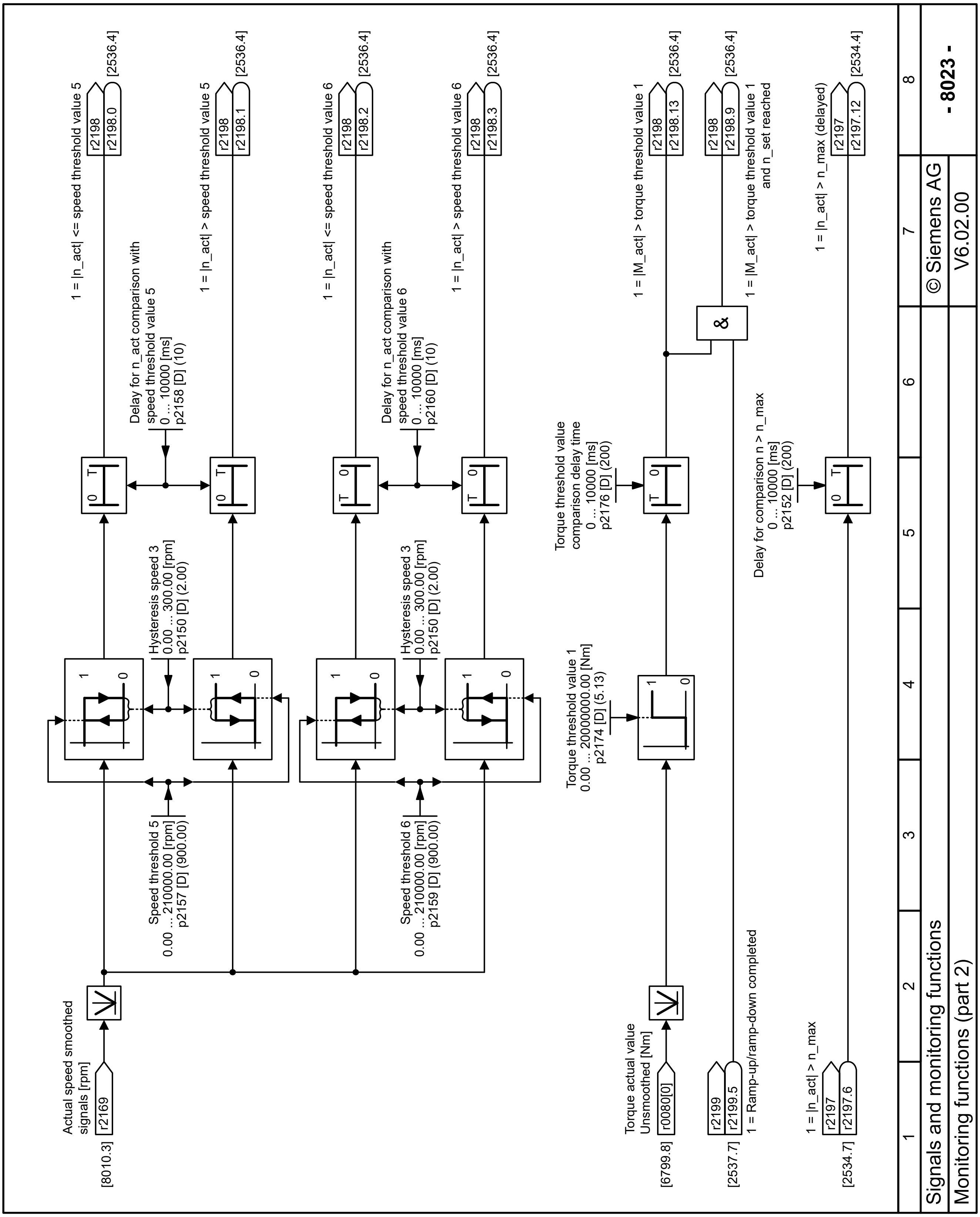


Figure 14-226 8023 – Monitoring functions (part 2)

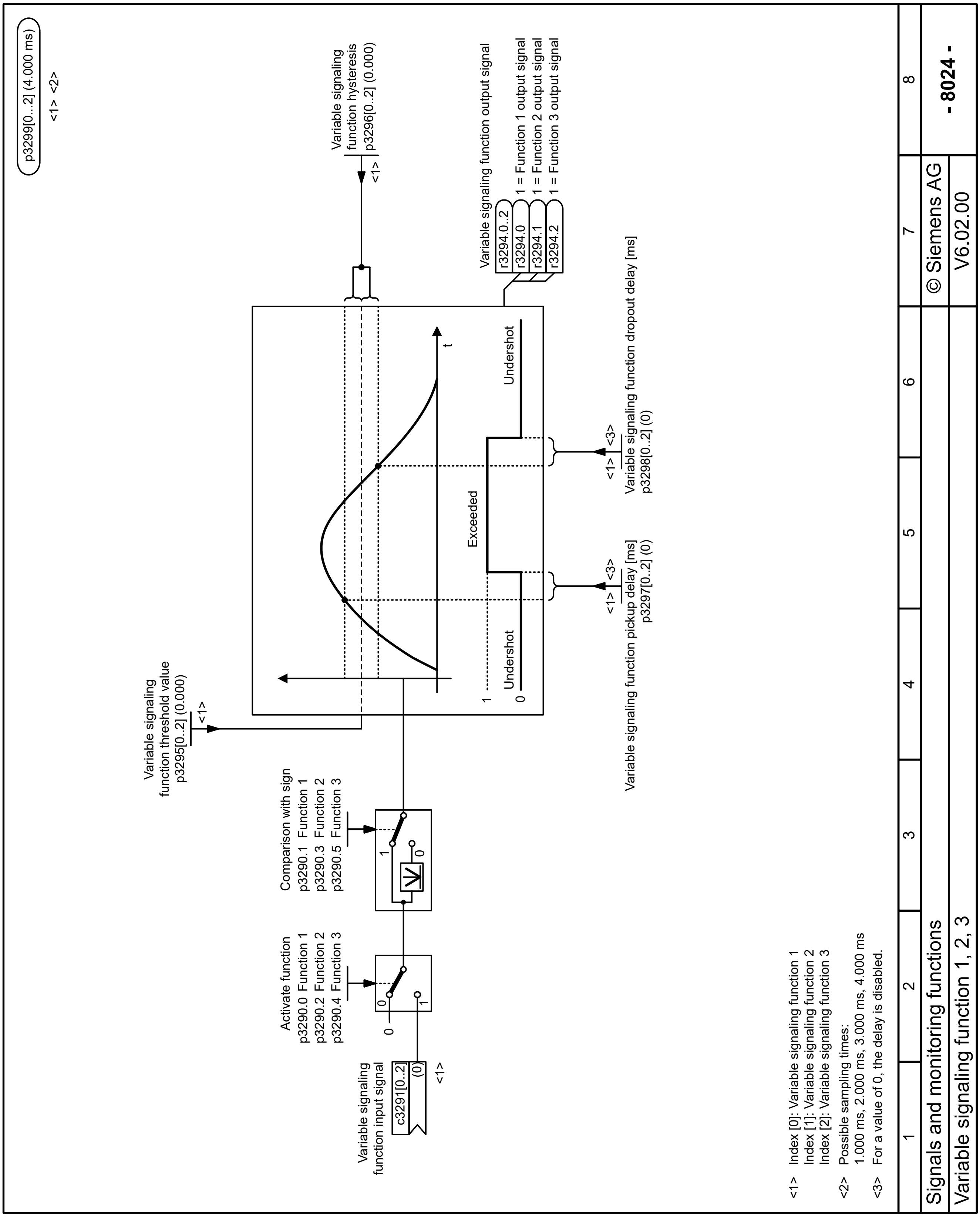


Figure 14-227 8024 - Variable messages 1, 2, 3

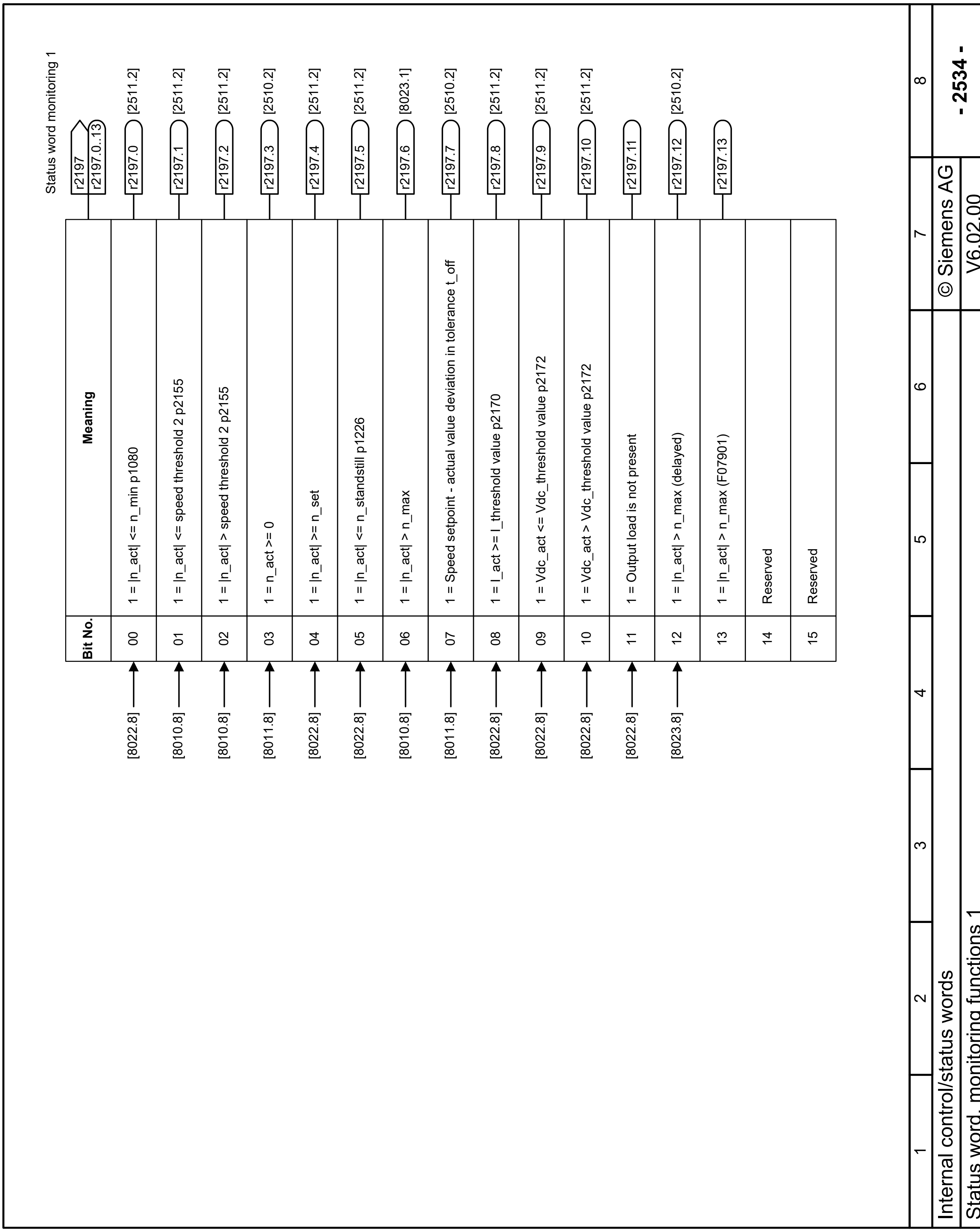


Figure 14-228 2534 - Status word monitoring functions 1

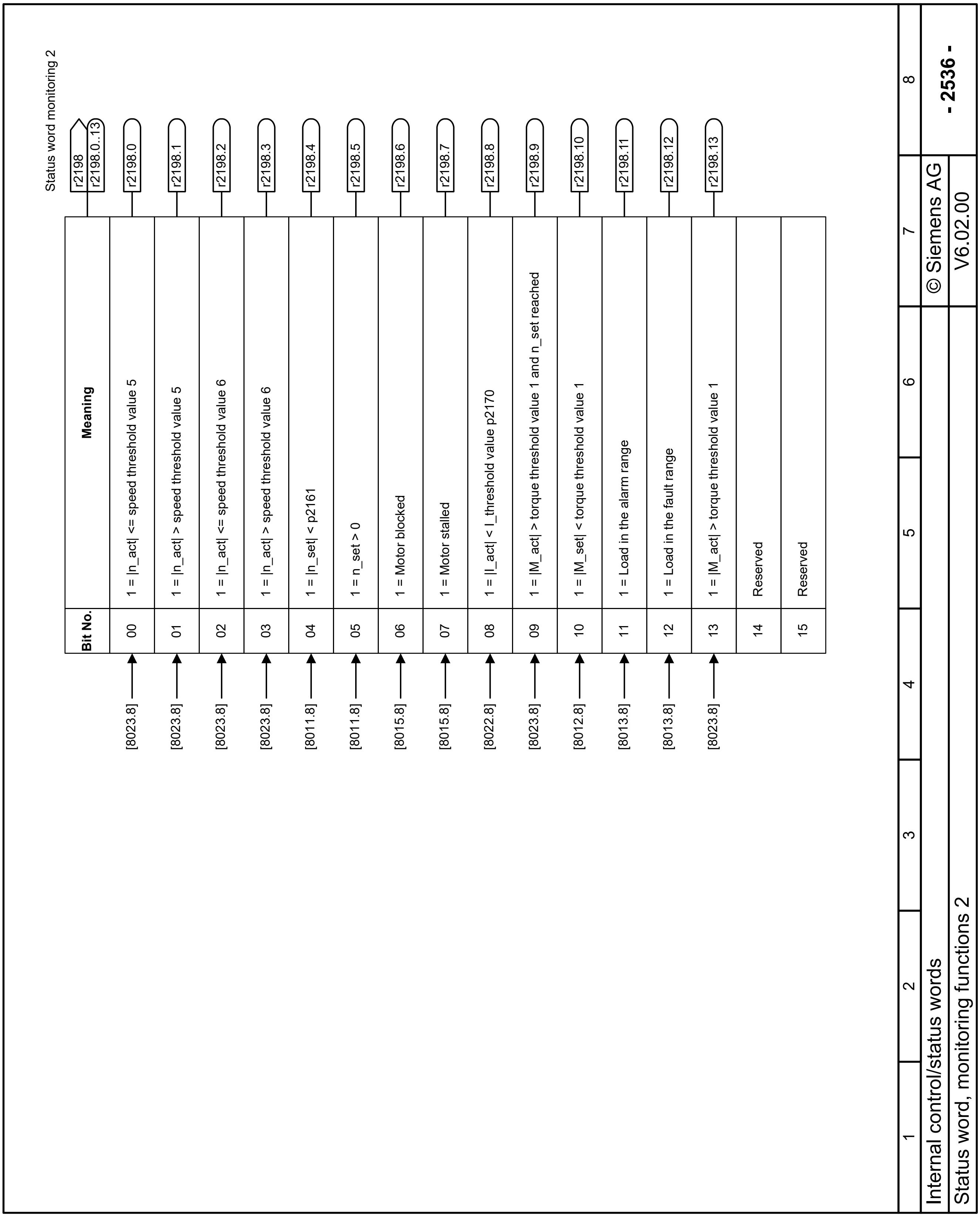


Figure 14-229 2536 - Status word monitoring functions 2

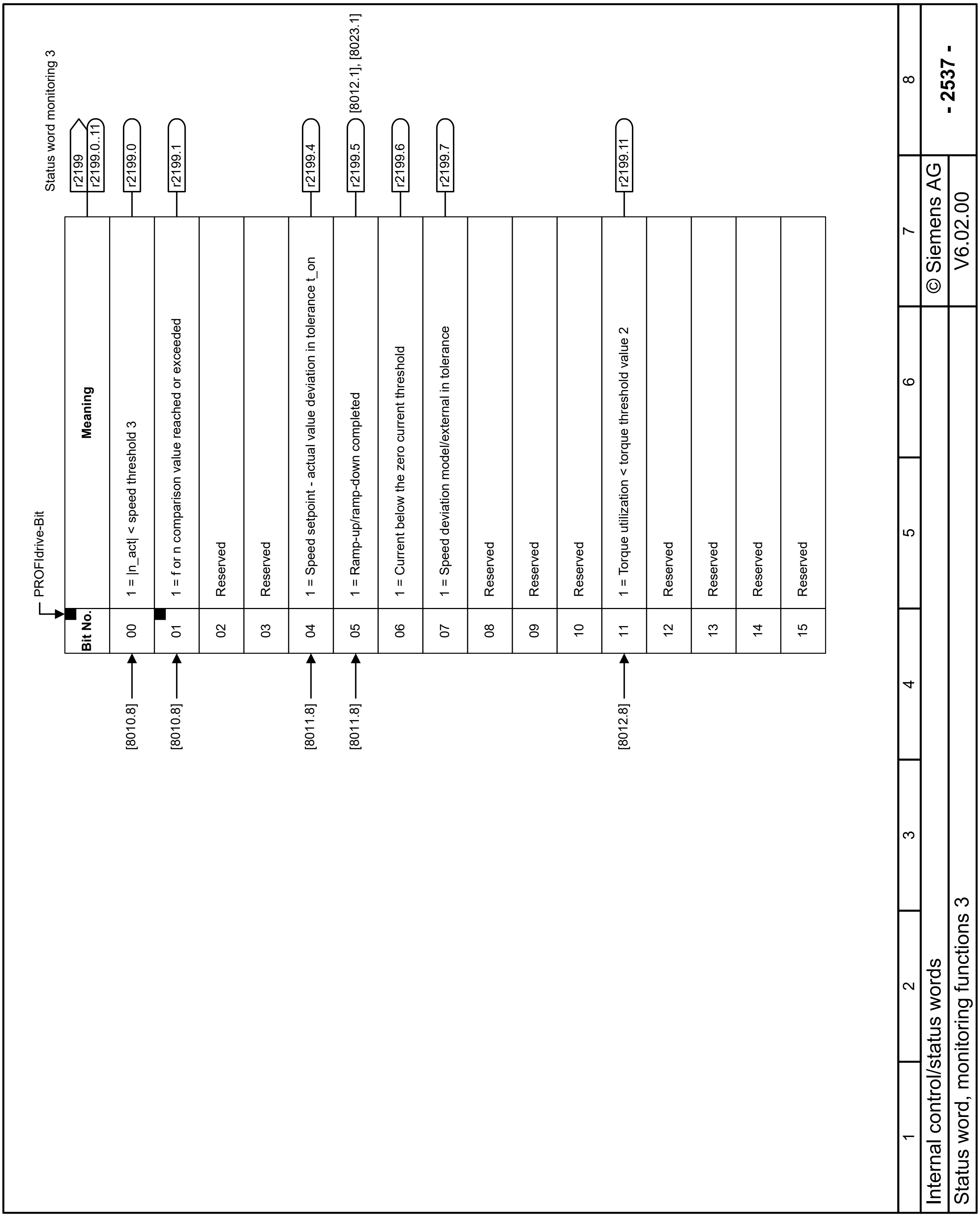


Figure 14-230 2537 - Status word monitoring functions 3

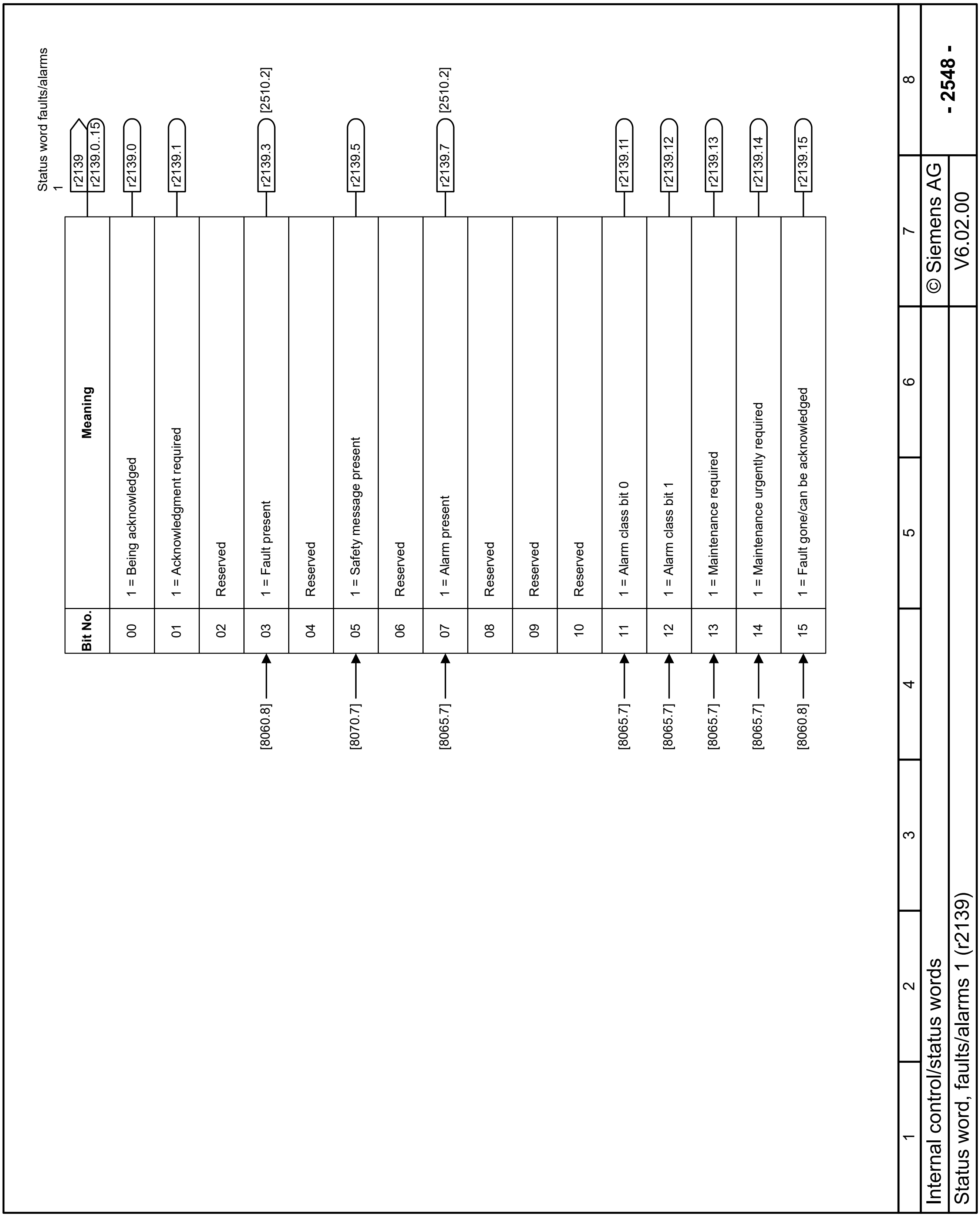


Figure 14-231 2548 - Status word faults/alarms 1

14.12 Safety Integrated

14.12.1 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.

14.12.2 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

Benchmarks for establishing whether or not a sufficient level of functional safety has been achieved include the probability of hazardous failures, the fault tolerance and the quality that is to be guaranteed by avoiding systematic faults. This is expressed in the standards using specific classification. In IEC 61800-5-2, IEC 62061 "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Category" and "Performance Level" (PL).

14.12.3 Safety Integrated Functions

Overview

Safety Integrated Functions are used to reduce risk in safety-related applications.

Requirement

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. Machines or plants, however, can only be operated safely in conjunction with Safety Integrated if the machine OEM carefully complies with the following:

- 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.
- Carefully constructs and configures 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 by other means.
- 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

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 Function 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.

- Close all protective devices after changing or replacing.
  Persons must not be present in the danger zone.
- 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 motion immediately after switching on the supply voltage

The Safety Integrated Functions cannot be selected immediately after switching on the supply voltage. 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. Accidents can result in death or severe injuries.

- Close all protective devices before the system runs up.
  Persons must not be present in the danger zone.

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).

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 the Safety Integrated Functions
- Connection
- Hardware components

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.

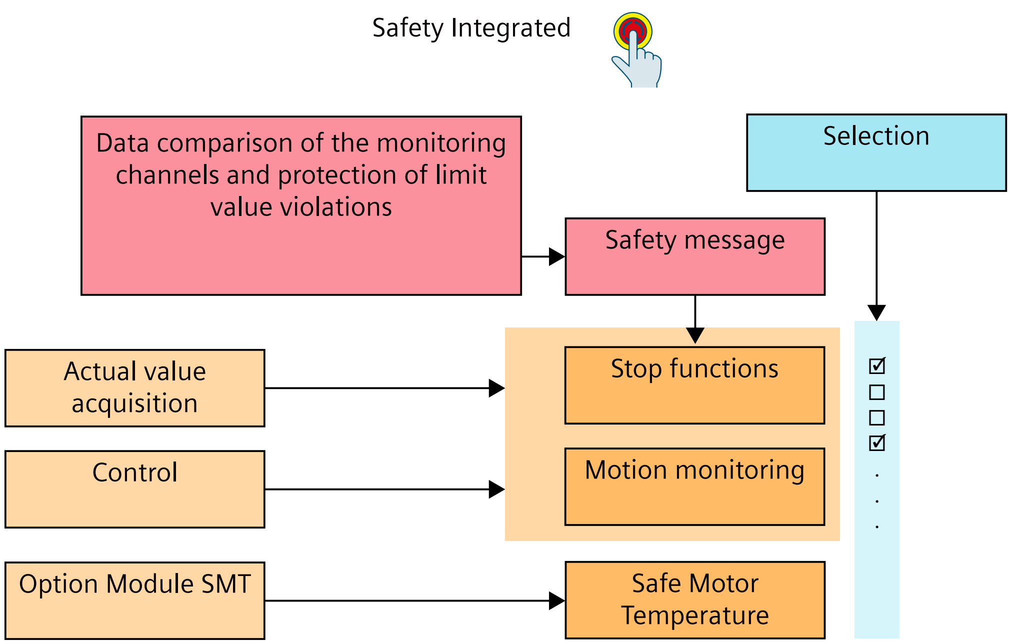


Figure 14-232 Overview of Safety Integrated Functions

The Safety Integrated Functions are in conformance with the following standards:

- Safety Integrity Level (SIL) 3 to IEC 61800-5-2
- Performance Level (PL) e according to EN ISO 13849-1
- Category 3 or 4 according to EN ISO 13849-1

The Safety Integrated Functions correspond to the functions according to IEC 61800-5-2 and IEC 61800-5-3.

Table 14-90 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

Converter	SIL	PL	Category
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 inputs

14.12.4 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 EN 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 (https://new.siemens.com/global/en/products/automation/topic-areas/safety-integrated/factory-automation/support/tia-safety-evaluation-tool.html)

14.12.5 EMERGENCY OFF and EMERGENCY STOP

Overview

In plants, systems and machines a distinction must be made between EMERGENCY OFF and EMERGENCY STOP.

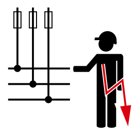
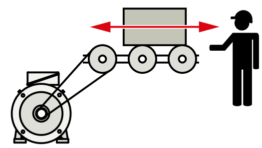
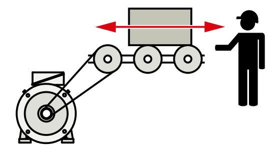
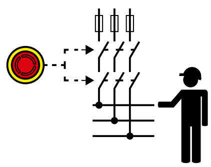
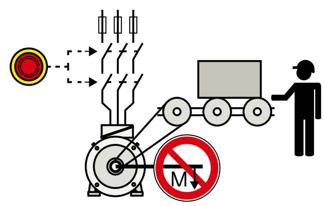
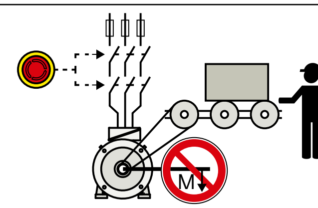
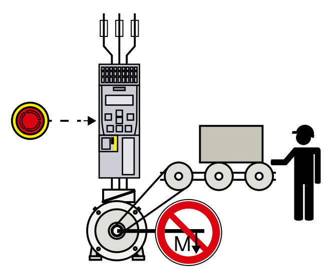
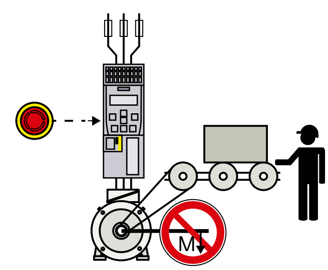
The Safe Torque Off (STO) and Safe Stop 1 (SS1) Safety Integrated Functions are suitable for implementing an EMERGENCY STOP, but are not suitable for implementing an EMERGENCY OFF.

Description of function

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 14-91 The distinction between EMERGENCY OFF and EMERGENCY STOP

Action:	**EMERGENCY OFF**	**EMERGENCY STOP**	**EMERGENCY STOP**
		Stop category 0 according to IEC 60204-1	**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 supply voltage. However, switching off the voltage is not required as a risk-reduction measurement.	

14.12.6 Stop functions

14.12.6.1 Safe Torque Off (STO)

Overview

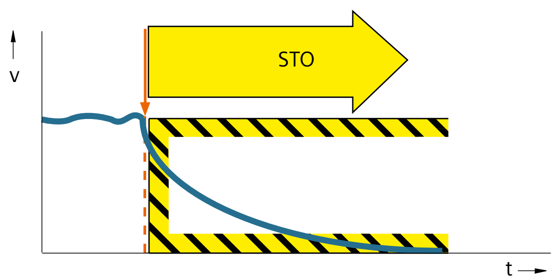


Figure 14-233 Overview STO

The Safe Torque Off (STO) function prevents the torque-generating supply of energy to the motor and prevents the motor from unexpectedly starting.

Requirement

STO is enabled 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.

- 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.

WARNING

Danger due to short, limited motion

If two power transistors simultaneously fail in the power unit (one in the upper and one in the lower inverter bridge), then this can cause brief, limited movement.

The maximum movement can be:

- Synchronous rotary motors: Max. movement = 180° / no. of pole pairs
- Synchronous linear motors: Max. movement = pole width

Description of function

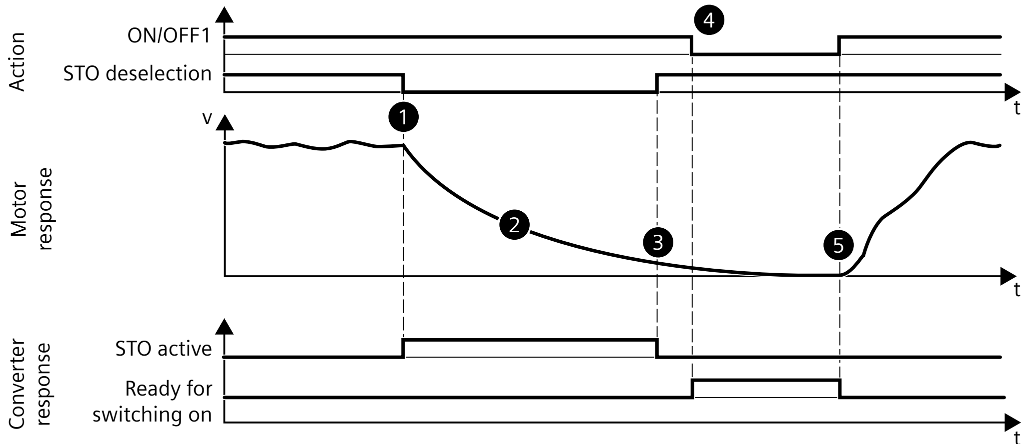


Figure 14-234 Flow diagram STO

Action		Motor/converter response
①	Selection of STO	• The converter detects selection of STO and signals the status "STO active" (r9722.0). • The converter interrupts the torque-generating energy feed to the motor. • 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
p9603.0...1	SI control	
p9604.0...30	SI enable	
r9720.0...15	SI control word	
r9722.0...15	SI status signals	

c10022	SI STO input terminal
r10352.0...17	SI STO select cause

14.12.6.2 Safe Stop 1 (SS1) - overview

Overview

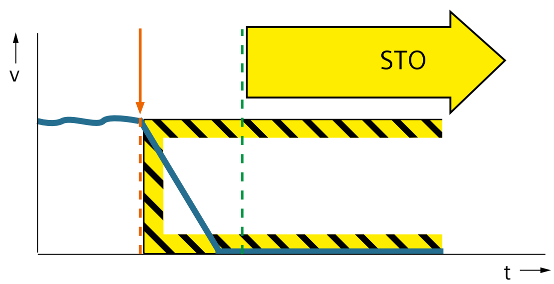


Figure 14-235 Overview SS1

Safe Stop 1 (SS1) stops a dangerous movement of a machine component.

Note

SS1 cannot be interrupted

- If SS1 is deselected again during this time, the STO function is selected and deselected again by the drive immediately after the delay time has elapsed or the speed has dropped below the shutdown speed. This terminates the SS1 function normally. It cannot be interrupted.
- During the delay time, SS1 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.

Requirement

SS1 is enabled 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.

Description of function

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 14-92 Versions of the function

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 14-93 SS1 application example

Example	Possible solution
A converter must brake a motor as quickly as possible after the EMERGENCY STOP button has been actuated. It is not permissible that the stationary motor undesirably restarts.	Select SS1 via a failsafe digital input or via PROFIsafe.

14.12.6.3 Safe Stop 1 with time control (SS1-t)

Overview

With SS1-t, the converter stops the motor along the OFF3 ramp within the set delay time. After the delay time elapses, irrespective of the current speed, the converter activates the Safe Torque Off (STO) function.

Description of function

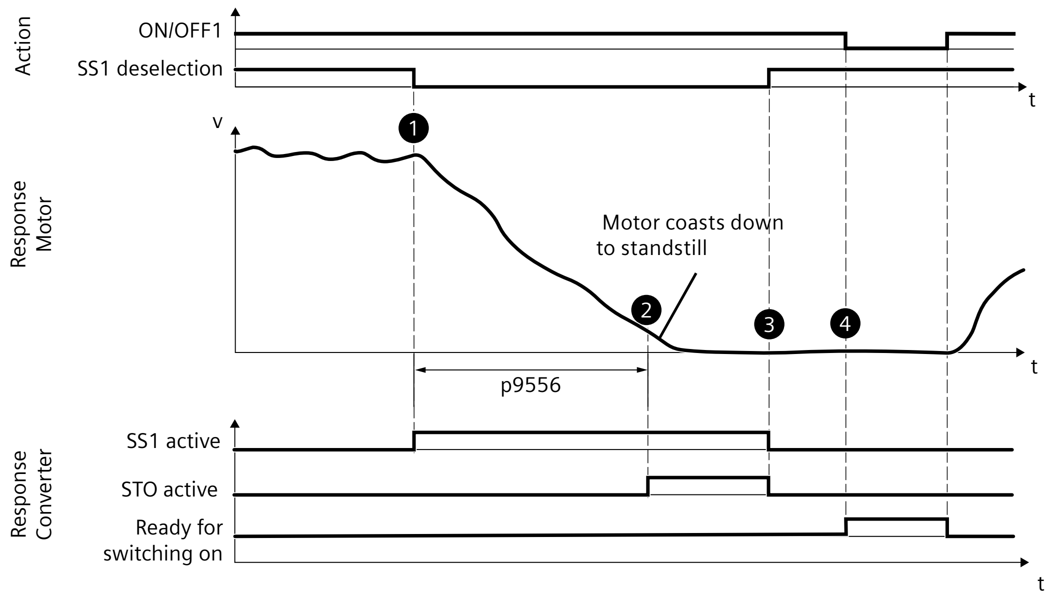


Figure 14-236 Flow diagram Safe Stop 1 with time control (SS1-t)

Action		Motor/converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.1). • The converter starts the transition time SS1 to STO (p9556). • The converter stops the motor along the OFF3 ramp. Stopping along the OFF3 ramp is not monitored. • Deselecting SS1 after the time ① does not interrupt the stop-ping of the motor.
②	Transition to STO	• The transition time from SS1 to STO (p9556) has elapsed. • The converter activates STO and signals the status "STO active" (r9722.0) and the 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 deselection of SS1. • The converter deactivates STO.
④	Signal change at ON/OFF1 from 1 to 0	• The converter is ready to start again.

Parameters

The following list contains the parameters of the "Safe Stop 1 with time control (SS1-t)" function.

Number	Name	Unit
p1135[0...n]	OFF3 ramp-down time	[s]
p9556	SI transition time SS1 to STO	[ms]
p9603.0...1	SI control	
p9604.0...30	SI enable	
p9606	SI SS1 function specification	
r9720.0...15	SI control word	
r9722.0...15	SI status signals	
c10023	SI SS1 input terminal	
r10353.0...17	SI SS1 select cause	

14.12.6.4 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 speed, Safe Torque Off (STO) becomes active.

Description of function

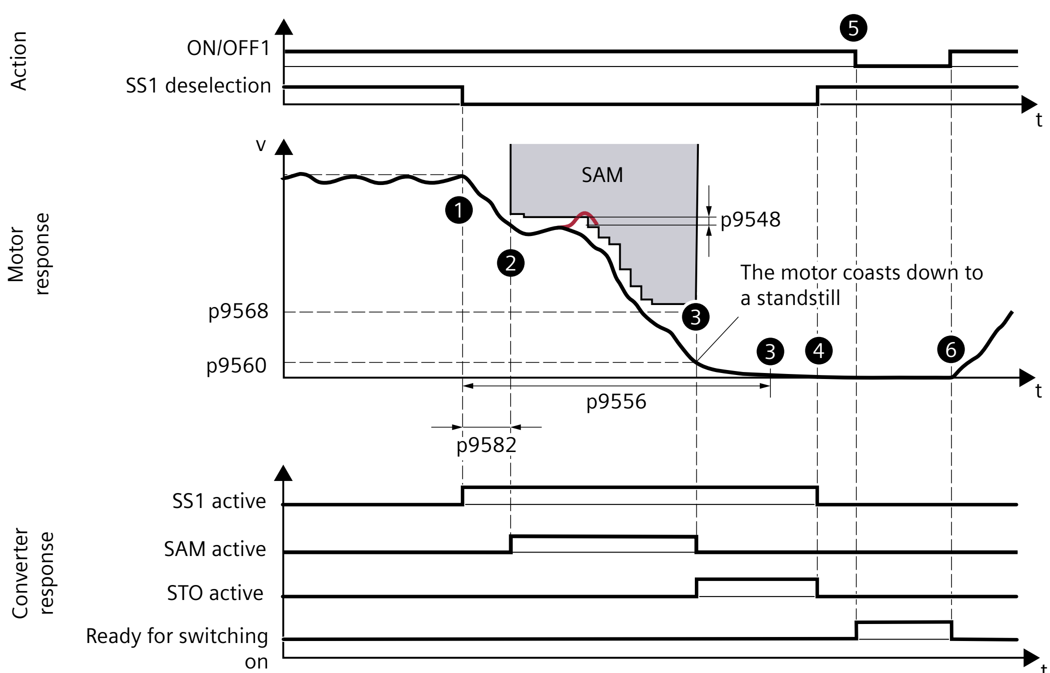


Figure 14-237 Flow diagram Safe Stop 1 with acceleration monitoring (SS1-a)

Action		Motor/converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.1). • The converter starts the transition time SS1 to STO (p9556) and the SAM delay time (p9582). • The converter stops the motor along the OFF3 ramp. • Deselecting SS1 after the time ① does not interrupt the stopping of the motor.
②	Braking along an OFF3 ramp with SAM monitoring	• The SAM delay time elapses. With SAM, the converter monitors whether the motor impermissibly accelerates. • The SAM limit value follows the falling motor speed: The converter reduces the SAM monitoring speed in steps when the absolute value of the motor speed is less than the previous SAM monitoring speed. It is not possible to increase the SAM monitoring speed. • If the motor speed exceeds the SAM monitoring speed by more than the speed tolerance (p9548), then the converter signals a fault and activates STO. • If the motor speed reaches the SAM limit value (p9568), then the converter limits the value for the SAM monitoring to p9568 + p9548. • As long as the speed decreases, the converter continuously adds the configurable tolerance p9548 to the current speed and the monitoring of the speed adjusts accordingly. If the speed temporarily increases, the monitoring threshold remains at the last value.
③	Transition to STO	• SAM ends when the motor speed falls below the STO shutdown speed (p9560), or the SS1 to STO (p9556) transition time expires. • The converter activates STO. • The converter activates STO even if SS1 is deselected in the meantime. • The converter signals the status "STO active" (r9722.0). • 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 deselection of SS1. 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 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	[ms]
p9603.0...1	SI control	
p9604.0...30	SI enable	
p9606	SI SS1 function specification	
r9714[0...4]	SI diagnostics velocity	[mm/min]
r9714[0...4]	SI diagnostics velocity	[rpm]
r9720.0...15	SI control word	
r9722.0...15	SI status signals	
c10023	SI SS1 input terminal	
r10353.0...17	SI SS1 select cause	

14.12.6.5 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 the safe brake ramp monitoring (SBR).

Description of function

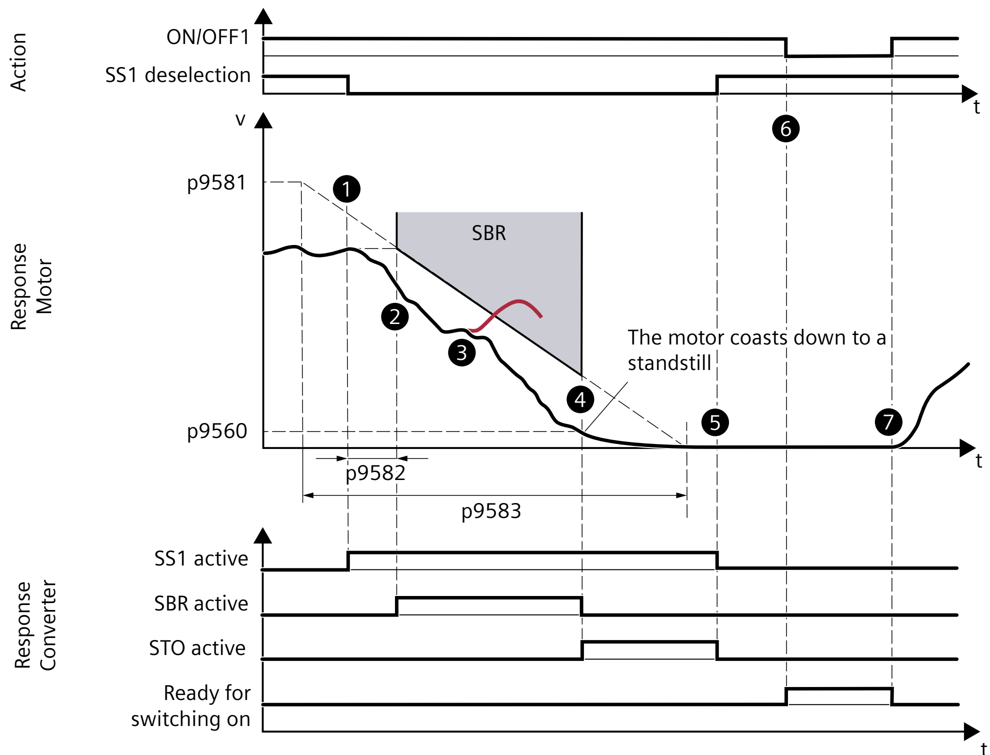


Figure 14-238 Flow diagram Safe Stop 1 with braking ramp monitoring (SS1-r)

Action		Motor/converter response
①	Selection of SS1	• The converter detects selection of SS1 and signals the status "SS1 active" (r9722.1). • The converter stops the motor along the OFF3 ramp. • Deselecting SS1 after the time ① does not interrupt the stopping of the motor. • The converter starts the SBR delay time p9582.
②	Braking along an OFF3 ramp with SBR monitoring	• The SBR delay time has elapsed. • The converter starts the Safe Brake Ramp SBR. The safe brake ramp starts with the speed value of time ①. p9583 and p9581 define the gradient of the safe brake ramp SBR.
③	Violation of the SBR monitoring	• The converter monitors whether the motor exceeds the set safe brake ramp when braking. • If the motor speed fails to follow the braking ramp, the converter signals a fault and activates STO.

④	Transition to STO	• SBR ends as soon as the actual speed value is below the STO switch-off speed (p9560). • The converter activates STO. • The converter activates STO even if SS1 is deselected in the meantime. • The converter signals the status "STO active" (r9722.0). • 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.
⑤	Deselection of SS1	• The converter detects deselection of SS1. • 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 braking ramp monitoring (SS1-r)" function.

Number	Name	Unit
p1135[0...n]	OFF3 ramp-down time	[s]
p9560	SI STO shutdown velocity	[mm/min]
p9560	SI STO shutdown velocity	[rpm]
p9581	SI SBR reference velocity	[mm/min]
p9581	SI SBR reference velocity	[rpm]
p9582	SI SAM/SBR delay time	[ms]
p9583	SI SBR reference time	[s]
p9603.0...1	SI control	
p9604.0...30	SI enable	
p9606	SI SS1 function specification	
r9714[0...4]	SI diagnostics velocity	[mm/min]
r9714[0...4]	SI diagnostics velocity	[rpm]
r9720.0...15	SI control word	
r9722.0...15	SI status signals	
c10023	SI SS1 input terminal	
r10353.0...17	SI SS1 select cause	

14.12.6.6 Setting the SS1 delay time

Description

Select the SS1 delay time so that before the torque is shut down with STO, the motor can completely ramp down along the OFF3 ramp, 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.

Use the following procedure to select the SS1 delay time:

With parameterized motor holding brake

SS1 delay time (p9556) ≥ OFF3 ramp-down time (p1135) + pulse cancellation delay time (p1228) + motor holding brake closing time (r1217)

Without parameterized motor holding brake

SS1 delay time (p9556) ≥ OFF3 ramp-down time (p1135) + pulse cancellation + delay time (p1228)

14.12.7 Motion monitoring

14.12.7.1 Safely-Limited Speed (SLS)

Overview

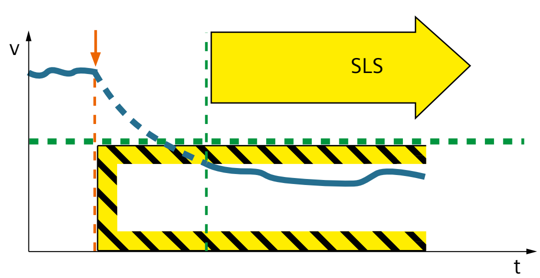


Figure 14-239 Overview SLS

With Safely-Limited Speed (SLS), the converter monitors the motor speed. The converter stops the motor if the motor speed is too high.

Description of function

Safely-Limited Speed (SLS) has 4 independent SLS limit values that can be switched between during operation. If the motor speed violates the currently selected SLS limit value, the converter initiates a set stop response.

This figure illustrates the change from a higher SLS limit value to a lower SLS limit value. For the change from a lower SLS limit value to a higher SLS limit value, there is no SLS delay time. The new SLS limit value is active immediately.

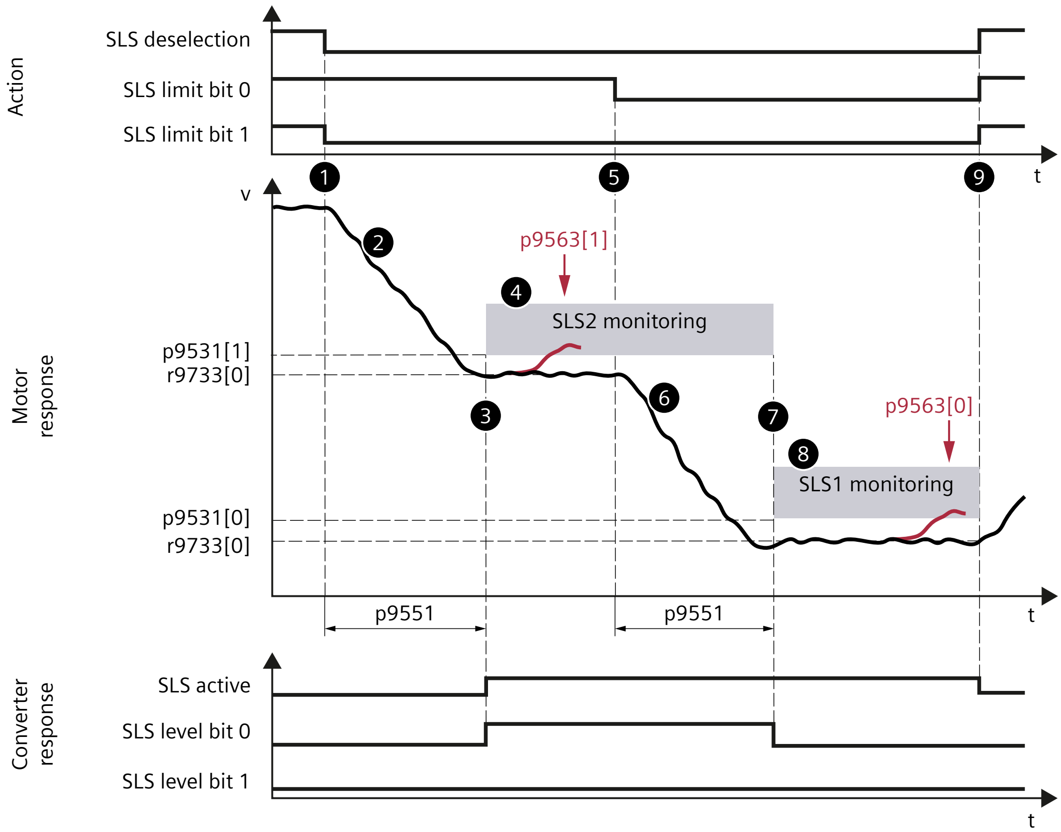


Figure 14-240 SLS with change between two SLS limit values

Action		Motor/converter response
①	Selection of SLS	• The converter detects the selection of SLS. • The converter detects when the SLS2 limit value is selected. 1) • The converter starts the SLS delay time (p9551).
②	Braking below the SLS limit value	• The motor follows the setpoint of the higher-level control and brakes. 2) • The actual speed must remain below the SLS2 limit value until the SLS delay time has elapsed.
③	Activation of the SLS limit value	• Monitoring of the SLS2 limit value (p9531[1)] is effective once the SLS delay time (p9551) has elapsed. • The converter signals the status "SLS active" (r9722.4) and the active SLS level (r9722.9 = 1, r9722.10 = 0).
④	Violation of the SLS limit	• If the motor speed violates the SLS2 limit value, the converter initiates the set stop response p9563[1].
⑤	Change to SLS1 limit value	• The converter detects when the SLS1 limit value is selected. 1) 3) • The converter starts the SLS delay time (p9551). The SLS2 limit value remains while the SLS delay time is active.
⑥	Braking below the SLS limit value	• The motor follows the setpoint of the higher-level control and brakes. 2) • The actual speed must remain below the SLS1 limit value until the SLS delay time has elapsed.

⑦	Activation of 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 (r9722.9 = 0, r9722.10 = 0).
⑧	Violation of the SLS limit	• If the motor speed violates the SLS1 limit value, the converter initiates the set stop response p9563[0].
⑨	Deselection of SLS	• The converter detects deselection of SLS. • The motor accelerates to the setpoint of the higher-level control

1) The signals for selecting the SLS limits differ, depending on the control:

- Control of the SLS limits via PROFIsafe Selection of an SLS limit with 1 signal

- Control of the SLS limits via F-DI Selection of an SLS limit with 0 signal

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]

3) Recommendation for setting the SLS limit values: SLS1 limit value < SLS2 limit value < ... < SLS3 limit value.

Example

SLS is suitable for machines where hazards due to excessive speeds are possible. In the following work steps, the use of SLS is particularly useful for direct contact between man and machine:

- During commissioning
- During setup
- For maintenance work

Table 14-94 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 speed of the machine component.
To protect the drill chuck from destruction, a turning machine must not exceed a certain maximum speed 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]
p9533	SI SLS setpoint speed limiting	[%]
p9551	SI SLS delay time for limit value change	[ms]
p9563[0...3]	SI SLS stop response	
p9603.0...1	SI control	

p9604.0...30	SI enable
r9720.0...15	SI control word
r9722.0...15	SI status signals
c10026	SI SLS input terminal
c10027	SI SLS limit bit 0 input terminal
c10028	SI SLS limit bit 1 input terminal
r10356.0...1	SI SLS select cause

14.12.7.2 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.

Description of function

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 according to the changed SLS limit value.

With the scaled SLS1 limit value, too, the SLS2, SLS3 and SLS4 limit values can be selected with r9720.9 and r9720.10.

An invalid value in S_SLS_LIMIT_A results in the stop response parameterized in p9563[0].

14.12.7.3 Limitation of the speed setpoint for SLS

Overview

For Safely-Limited Speed (SLS), it is useful to limit the speed setpoint with the higher-level control.

Description of function

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

14.12.7.4 Safe Speed Monitor (SSM)

Overview

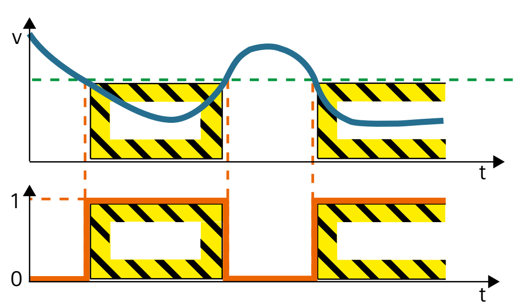


Figure 14-241 Overview SSM

Safe Speed Monitor (SSM) safely detects when the speed falls below a speed limit in both directions of motion. SSM is a pure signaling function. The converter provides a safety-related signal for further processing.

If the speed of the motor exceeds the SSM limit value, no stop response is initiated, contrary to other Safety Integrated Functions.

Description of function

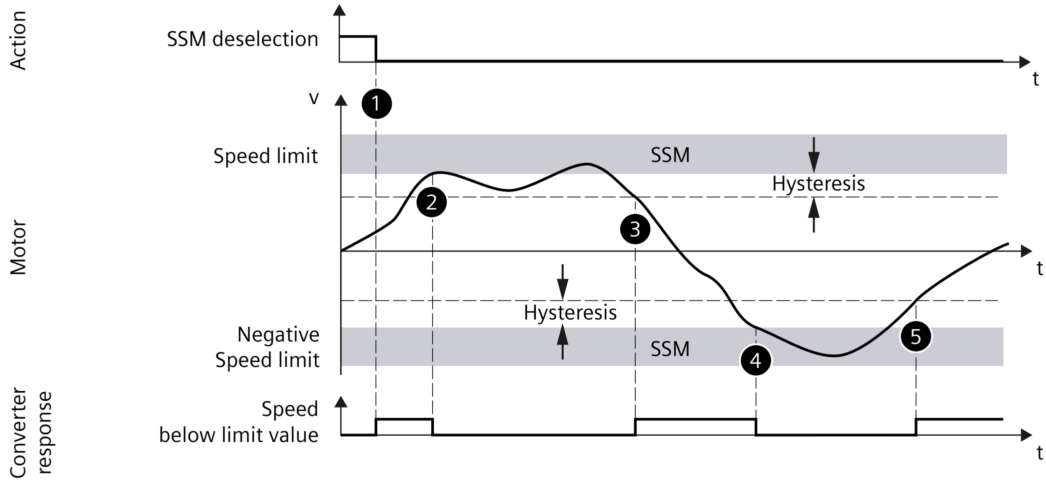


Figure 14-242 Representation of SSM

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).
2	Exceeding the velocity limit	• If the speed of the motor exceeds the speed limit, the converter resets the signal "Speed below limit value" (p9722.15 = 0).
3	Falling below the velocity limit	• If the speed of the motor falls below the speed limit minues the hysteresis, the converter sets the signal "Speed below limit value" (p9722.15 = 1).
4	Falling below the negative velocity limit	• If the speed of the motor falls below the negative speed limit, the converter resets the signal "Speed below limit value" (p9722.15 = 0).
5	Exceeding the negative velocity limit	• If the speed of the motor exceeds the negative speed limit plus the hysteresis, the converter sets the signal "Speed below limit value" (p9722.15 = 1).

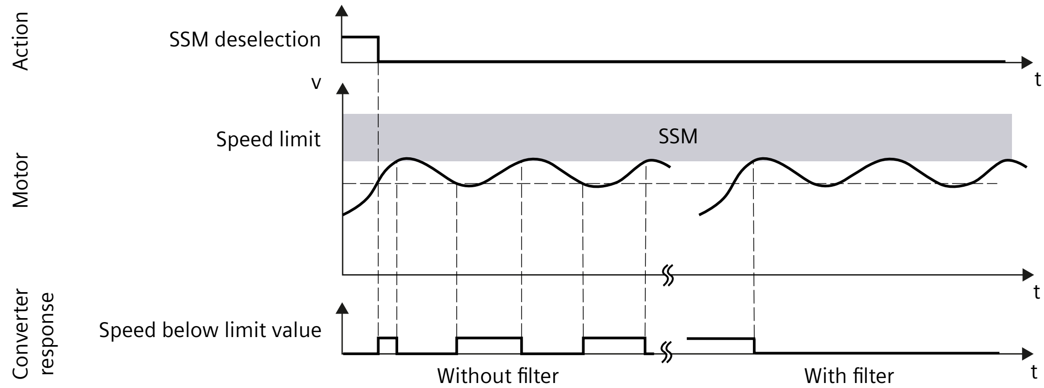


Figure 14-243 Principle of operation of the signal filter

The signal filter smooths the speed measured value.

The filter reduces signal changes of the SSM feedback when monitoring speeds that lie just below the speed limit.

An active filter results in a time delay of the SSM feedback.

The response of the signal filter can be set using the filter time (p9545).

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.

Note

SSM initial value when running up

The initial value of the SSM signal when running up can be adapted using p9507.9.

- p9507.9 = 0 means "SSM status signal when running up initialized to '1'".
- p9507.9 = 1 means "SSM status signal when running up initialized to '0'".

Parameters

The following list contains the parameters of the "Safe Speed Monitor (SSM)" function.

Number	Name	Unit
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]
p9603.0...1	SI control	
p9604.0...30	SI enable	
r9714[0...4]	SI diagnostics velocity	[mm/min]
r9714[0...4]	SI diagnostics velocity	[rpm]

r9720.0...15	SI control word
r9722.0...15	SI status signals
c10035	SI SSM input terminal

14.12.7.5 Safe Direction (SDI)

Overview

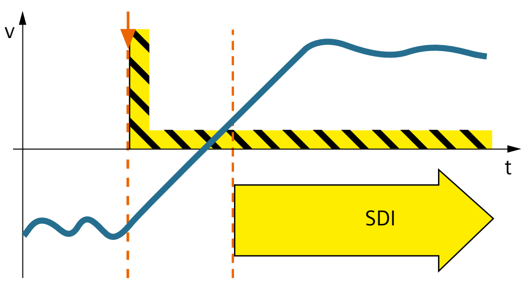


Figure 14-244 Overview SDI

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 an SDI-specific stop response.

The following SDI variants are available, depending on the direction of motion:

- SDI positive (SDI+)
- SDI negative (SDI-)

Description of function

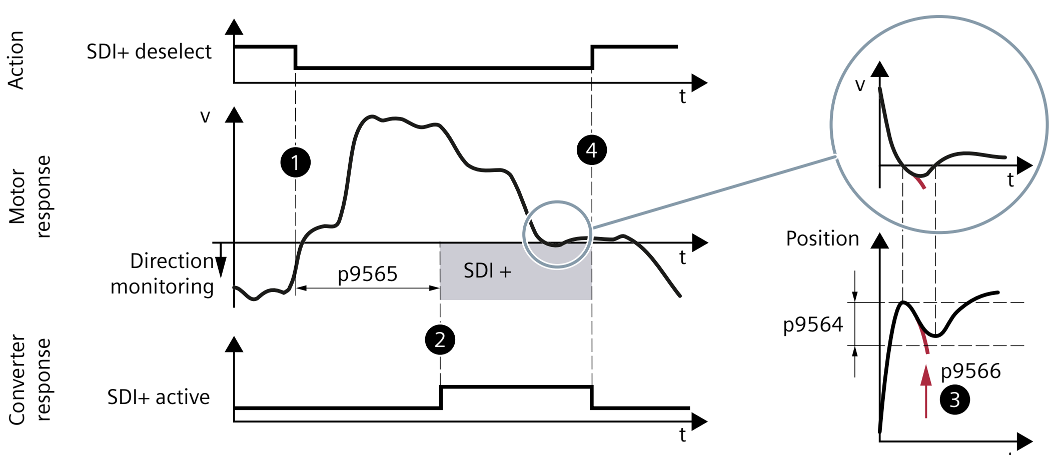


Figure 14-245 SDI+ with tolerance violation and direction of movement monitoring

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)]
③	SDI tolerance exceeded	• 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)].
④	Deselection of SDI+	• The converter detects deselection of SDI+. • 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) If signal c1052 is interconnected with r9733[1], then the converter automatically brakes the motor.

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	
p9603.0...1	SI control	
p9604.0...30	SI enable	
r9720.0...15	SI control word	
r9722.0...15	SI status signals	
r9733[0...2]	SI effective setpoint velocity limiting	[rpm]
c10030	SI SDI positive input terminal	
c10031	SI SDI negative input terminal	
r10360.0...1	SI SDI positive select cause	
r10361.0...1	SI SDI negative select cause	

14.12.7.6 Limitation of the speed setpoint for SDI

Overview

For Safe Direction (SDI) it makes sense to limit the speed setpoint with the higher-level control.

Description of function

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

14.12.8 Safe Motor Temperature (SMT)

Overview

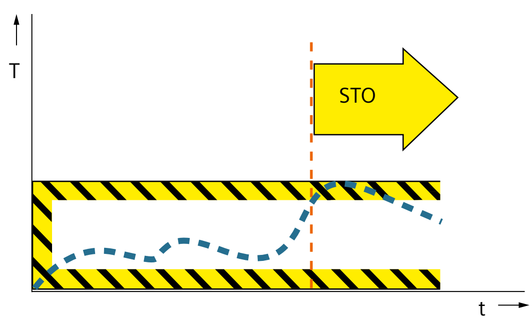


Figure 14-246 Overview SMT

Safe Motor Temperature (SMT) prevents the motor temperature from exceeding a specified limit. SMT is used to protect against overtemperature of a motor that is used in a potentially explosive atmosphere.

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.

Description of function

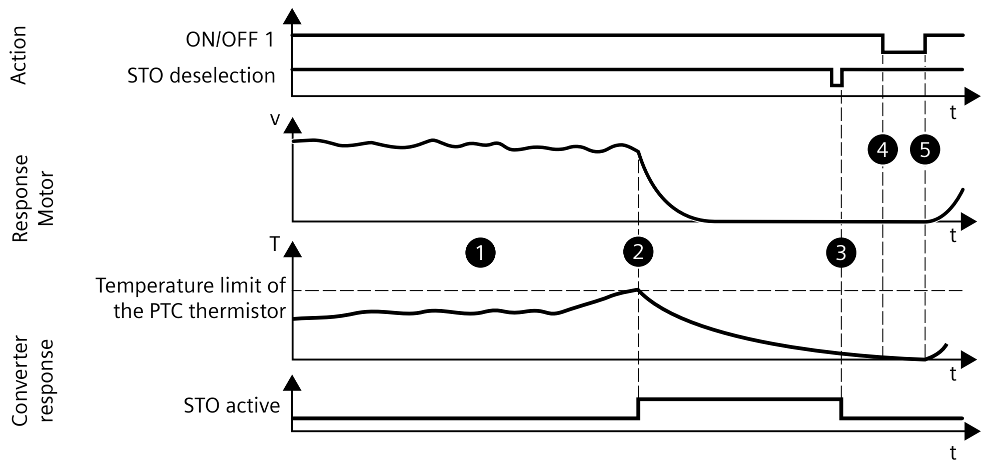


Figure 14-247 Flow diagram SMT

Action		Converter/motor response
①		• The OM-SMT monitors the motor temperature through the PTC thermistor mounted on the motor side.
②		• The electrical resistance in the PTC thermistor jumps above the switch-off limit. • The OM-SMT identifies when a temperature is exceeded. • The OM-SMT responds with fault C35550 "Motor overtemperature". • 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.
③	Selection and deselection of 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.
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

SMT is used to protect against overtemperature of a motor 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
p9604.0...30	SI enable	

14.12.9 Selection of the Safety Integrated Functions

Overview

The function selection offers the following setting options:

- Enable and inhibit each Safety Integrated Function
- Actual value acquisition and monitoring cycle
- Defining the axis type

Requirement

Certain Safety Integrated Functions require a license.

The SMT function requires the OM-SMT Option Module.

Description of function

Table 14-95 Safety Integrated Functions for every control type

Control type	STO[1]	SS1 [2]	SLS	SSM	SDI	SMT
PROFIsafe	x	x	x	x	x	SMT is independent of the control type.
PROFIsafe and Emergency Stop via terminals	x	x	x	x	x	
Terminals	x	x	x	x	x	

The Safety Integrated Function requires the "Safety Extended" license.

1) STO is enabled in the factory setting, and preassigned at failsafe digital input F-DI 0. When delivered, wire jumpers are inserted at the F-DI 0. When using STO, remove the wire jumpers from F-DI 0 and connect an appropriate sensor (e.g. Emergency Stop pushbutton). The wire jumpers remain inserted at the F-DI 0 if STO is not used.

2) SS1-t does not require a license. SS1-a and SS1-r require a license.

Safety Integrated Functions are enabled with factory settings after function selection (p9604).

The stop responses (STO and SS1) must always be parameterized because the stop responses stop the motor in the event of an error and for a limit value violation. If the STO and SS1 functions are also to be controlled via PROFIsafe and/or F-DI, then STO and SS1 must also be enabled.

The actual value acquisition cycle (p9511) is preassigned with 1 ms and the monitoring cycle (p9500) with 4 ms. The following must be observed when the values are changed:

- If the values are increased, the response time of the monitoring functions lengthens.
- The monitoring cycle must be a multiple of the actual value acquisition cycle.
- For motion monitoring functions with encoder, the actual value acquisition cycle must be an integer multiple of the current controller cycle p0115[0].

Selecting the axis type influences the actual value acquisition and switches over the units.

Parameters

The following list contains the parameters of the "Safety Integrated function selection" function.

Number	Name	Unit
p0115[0...6]	Sampling times for internal control loops	[µs]
p9500	SI monitoring clock cycle	[ms]
r9502	SI axis type	
p9511	SI actual value sensing cycle	[ms]
p9603.0...1	SI control	
p9604.0...30	SI enable	

14.12.10 Safe actual value acquisition/mechanical system

Overview

Safe actual value acquisition using an encoder makes the actual values of the motor available to the Safety Integrated Functions. The encoder or the Sensor Module generates the actual value and transfers it to the converter.

Requirement

Only use motor encoders suitable for Safety Integrated to safely sense the drive actual values.

The following encoders are approved for safe actual value acquisition:

- DRIVE-CLiQ encoder
- Incremental encoder sin/cos 1 Vpp connected to the Sensor Module Cabinet SMC20
  To prevent the A/B track signals with valid levels from becoming static ("freezing"), encoders must contain purely analog signal processing and generation.

The following applies when using encoders from other manufacturers:

- Machine OEMs must subject the encoder mounting to the motor shaft or at the linear drive to a failure mode effects analysis (FMEA). More detailed information on FMEA is provided in DIN EN 61800-5-2.
- The FMEA must rule out any fault involving the encoder mounting being released from the motor shaft or the linear drive. The encoder no longer correctly maps motion if its mounting becomes loose.

Settings

The safe actual value acquisition can be configured for linear and rotary axis types.

The actual value acquisition cycle (p9511) is preassigned 1 ms, and the monitoring cycle (p9500) is preassigned 4 ms. The following must be observed when the values are changed:

- If the values are increased, then the response time of the motion monitoring lengthens.
- The monitoring cycle must be a 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].

Selecting the axis type influences the actual value acquisition and switches over the units.

Configuration of the actual value acquisition/mechanical system encompasses the following settings:

- Encoder data
- Leadscrew pitch for linear axes
- Gearbox ratios:
  Configuring the gearbox between the encoder and load with encoder revolutions and load revolutions.
- Direction of rotation reversal:
  Sets whether the gearbox inverts the direction of rotation.

The properties of safe actual value acquisition determine the best possible values for motion monitoring:

- Safe maximum velocity
  - The permissible maximum velocity on the load side results from the encoder type used and the encoder parameterization.
  - When the maximum velocity is exceeded, it is no longer possible to acquire safe encoder actual values for the motion monitoring.
- Safe position accuracy
  By acquiring the actual values, this position accuracy is the best possible.

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 the "Actual value acquisition/mechanical system" function.

Number	Name	Unit
p0408[0...n]	Rotary encoder pulse number	
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)	[°]
r9634	SI safe maximum speed encoder detected (rotary)	[rpm]
r9635	SI safe position accuracy encoder detected (rotary)	[°]
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...4]	SI diagnostics velocity	[mm/min]
r9714[0...4]	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]

14.12.11 Control

14.12.11.1 Control via PROFIsafe

Overview

After PROFIsafe has been configured, Safety Integrated Functions can be selected and deselected, and safety faults can be safely acknowledged using PROFIsafe telegrams.

Description of function

The PROFIsafe configuration encompasses the following settings:

Table 14-96 PROFIsafe settings

Settings	Explanation
PROFIsafe telegram number (p9611)	Selection of the PROFIsafe telegram PROFIsafe telegrams can be used for various purposes: • Telegram 30: Control of the functions • Telegram 902: Control of the functions + transfer of the F-DI status via PROFIsafe (c10050) + transfer of the SLS limit value via PROFIsafe (p9604.9) Supplementary telegram 700 is available if you wish to provide non-safety-related diagnostics of the safety functions on the higher-level control system.
F-source address (p9613) F-destination address (9610) F-monitoring time (p9614)	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. A valid, current PROFIsafe telegram must have been received from the F-CPU within the monitoring time. This ensures the following: • Detecting failures and faults • Responses are initiated that keep the F-system in a safe state or transition it into a safe state
Response to PROFIsafe failure (p9612)	Selection option for the stop response of the converter in the event of a PROFIsafe communication failure or 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]

14.12.11.2 Telegram 30

Overview

Via a 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.

Description of function

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

14.12.11.3 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.

Description of function

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	S_CYCLE_COUNT	---
PZD05	---		S_XIST32	---
PZD06	---			

14.12.11.4 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).

Description of function

<table>
<tr><th colspan="6">Safety control word 1 (S_STW1)</th></tr>
<tr><th colspan="6">Failsafe control → Converter</th></tr>
<tr><th>Bit</th><th>Safety Integrated Function</th><th colspan="4">Explanation</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">STO</td><td>1</td><td colspan="3">Deselect STO</td></tr>
<tr><td>0</td><td colspan="3">Select STO</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">SS1</td><td>1</td><td colspan="3">Deselect SS1</td></tr>
<tr><td>0</td><td colspan="3">Select SS1</td></tr>
<tr><td>02, 03</td><td colspan="5">Reserved</td></tr>
<tr><td rowspan="2">04</td><td rowspan="2">SLS</td><td>1</td><td colspan="3">Deselect SLS</td></tr>
<tr><td>0</td><td colspan="3">Select SLS</td></tr>
<tr><td>05, 06</td><td colspan="5">Reserved</td></tr>
<tr><td rowspan="2">07</td><td rowspan="2">Failsafe acknowledgment</td><td>0</td><td colspan="3">-</td></tr>
<tr><td>1 → 0</td><td colspan="3">Acknowledge "Internal event" for a 1 → 0 signal change</td></tr>
<tr><td>08</td><td colspan="5">Reserved</td></tr>
<tr><td>09</td><td>SLS limit value bit 0</td><td rowspan="2">Select SLS limit value</td><td></td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>10</td><td>SLS limit value bit 1</td><td>SLS1
SLS2
SLS3
SLS4</td><td>0
0
1
1</td><td>0
1
0
1</td></tr>
<tr><td>11</td><td colspan="5">Reserved</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">SDI positive</td><td>1</td><td colspan="3">Deselect SDI with positive direction of rotation</td></tr>
<tr><td>0</td><td colspan="3">Select SDI with positive direction of rotation</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">SDI negative</td><td>1</td><td colspan="3">Deselect SDI with negative direction of rotation</td></tr>
<tr><td>0</td><td colspan="3">Select SDI with negative direction of rotation</td></tr>
<tr><td>14</td><td colspan="5">Reserved</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">SSM</td><td>1</td><td colspan="3">Deselect SSM</td></tr>
<tr><td>0</td><td colspan="3">Select SSM</td></tr>
</table>

<table>
<tr><th colspan="5">Safety status word 1 (S_ZSW1)</th></tr>
<tr><th colspan="5">Converter → Failsafe control</th></tr>
<tr><th>Bit</th><th>Safety status</th><th colspan="3">Explanation</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">STO active</td><td>1</td><td colspan="2">STO is active</td></tr>
<tr><td>0</td><td colspan="2">STO is not active</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">SS1 active</td><td>1</td><td colspan="2">SS1 is active</td></tr>
<tr><td>0</td><td colspan="2">SS1 is not active</td></tr>
<tr><td>02, 03</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">04</td><td rowspan="2">SLS active</td><td>1</td><td colspan="2">SLS is active</td></tr>
<tr><td>0</td><td colspan="2">SLS is not active</td></tr>
<tr><td>05, 06</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">07</td><td rowspan="2">Internal event</td><td>1</td><td colspan="2">The converter signals an "internal event"</td></tr>
<tr><td>0</td><td colspan="2">Fault-free operation</td></tr>
<tr><td>08</td><td colspan="4">Reserved</td></tr>
<tr><td>09</td><td>Active SLS limit value bit 0</td><td></td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>10</td><td>Active SLS limit value bit 1</td><td>SLS1
SLS2
SLS3
SLS4</td><td>0
0
1
1</td><td>0
1
0
1</td></tr>
<tr><td>11</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">SDI positive active</td><td>1</td><td colspan="2">SDI positive direction of rotation is active</td></tr>
<tr><td>0</td><td colspan="2">SDI positive direction of rotation is not active</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">SDI negative active</td><td>1</td><td colspan="2">SDI negative direction of rotation is active</td></tr>
<tr><td>0</td><td colspan="2">SDI negative direction of rotation is not active</td></tr>
<tr><td>14</td><td colspan="4">Reserved</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">Status SSM</td><td>1</td><td colspan="2">Absolute value of the speed is less than or equal to the SSM limit value</td></tr>
<tr><td>0</td><td colspan="2">Absolute value of the speed is greater than the SSM limit value</td></tr>
</table>

14.12.11.5 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).

Description of function

<table>
<tr><th colspan="6">Safety control word 2 (S_STW2)</th></tr>
<tr><th colspan="6">Failsafe control → Converter</th></tr>
<tr><th>Bit</th><th>Safety Integrated Function</th><th colspan="4">Explanation</th></tr>
<tr><td rowspan="2">00</td><td rowspan="2">STO</td><td>1</td><td colspan="3">Deselect STO</td></tr>
<tr><td>0</td><td colspan="3">Select STO</td></tr>
<tr><td rowspan="2">01</td><td rowspan="2">SS1</td><td>1</td><td colspan="3">Deselect SS1</td></tr>
<tr><td>0</td><td colspan="3">Select SS1</td></tr>
<tr><td>02, 03</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">04</td><td rowspan="2">SLS</td><td>1</td><td colspan="3">Deselect SLS</td></tr>
<tr><td>0</td><td colspan="3">Select SLS</td></tr>
<tr><td>05, 06</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">07</td><td rowspan="2">Failsafe acknowledgment</td><td>0</td><td colspan="3">-</td></tr>
<tr><td>1 → 0</td><td colspan="3">Acknowledge "Internal event" for a 1 → 0 signal change</td></tr>
<tr><td>08</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td>09</td><td>SLS limit value bit 0</td><td colspan="2" rowspan="2">Select SLS limit value</td><td></td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>10</td><td>SLS limit value bit 1</td><td>SLS1
SLS2
SLS3
SLS4</td><td>0
0
1
1</td><td>0
1
0
1</td></tr>
<tr><td>11</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">SDI positive active</td><td>1</td><td colspan="3">Deselect SDI with positive direction of rotation</td></tr>
<tr><td>0</td><td colspan="3">Select SDI with positive direction of rotation</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">SDI negative active</td><td>1</td><td colspan="3">Deselect SDI with negative direction of rotation</td></tr>
<tr><td>0</td><td colspan="3">Select SDI with negative direction of rotation</td></tr>
<tr><td>14</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">SSM</td><td>1</td><td colspan="3">Deselect SSM</td></tr>
<tr><td>0</td><td colspan="3">Select SSM</td></tr>
<tr><td>16 … 31</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
</table>

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, 03	Reserved	–	–
04	SLS active	1	SLS is active
		0	SLS is not active
05, 06	Reserved	–	–

<table>
<tr><th colspan="6">Safety status word 2 (S_ZSW2)</th></tr>
<tr><th colspan="6">Converter → Failsafe control</th></tr>
<tr><th>Bit</th><th>Safety status</th><th colspan="4">Explanation</th></tr>
<tr><td rowspan="2">07</td><td rowspan="2">Internal event</td><td>1</td><td colspan="3">The converter signals an "internal event"</td></tr>
<tr><td>0</td><td colspan="3">Fault-free operation</td></tr>
<tr><td>08</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">09</td><td rowspan="2">Active SLS limit value bit 0</td><td colspan="2"></td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td colspan="2">SLS1</td><td>0</td><td>0</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">Active SLS limit value bit 1</td><td colspan="2">SLS2</td><td>0</td><td>1</td></tr>
<tr><td colspan="2">SLS3</td><td>1</td><td>0</td></tr>
<tr><td colspan="2">SLS4</td><td>1</td><td>1</td></tr>
<tr><td>11</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">SDI positive active</td><td>1</td><td colspan="3">SDI positive direction of rotation is active</td></tr>
<tr><td>0</td><td colspan="3">SDI positive direction of rotation is not active</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">SDI negative active</td><td>1</td><td colspan="3">SDI negative direction of rotation is active</td></tr>
<tr><td>0</td><td colspan="3">SDI negative direction of rotation is not active</td></tr>
<tr><td>14</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">Status SSM</td><td>1</td><td colspan="3">The absolute value of the speed is less than the SSM limit</td></tr>
<tr><td>0</td><td colspan="3">The absolute value of the speed is equal to or greater than the SSM limit</td></tr>
<tr><td>16 … 23</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
<tr><td rowspan="2">24</td><td rowspan="2">F-DI 0</td><td>1</td><td colspan="3">F-DI 0 has 0 signal</td></tr>
<tr><td>0</td><td colspan="3">F-DI 0 has 1 signal</td></tr>
<tr><td rowspan="2">25</td><td rowspan="2">F-DI 1</td><td>1</td><td colspan="3">F-DI 1 has 0 signal</td></tr>
<tr><td>0</td><td colspan="3">F-DI 1 has 1 signal</td></tr>
<tr><td rowspan="2">26</td><td rowspan="2">F-DI 2</td><td>1</td><td colspan="3">F-DI 2 has 0 signal</td></tr>
<tr><td>0</td><td colspan="3">F-DI 2 has 1 signal</td></tr>
<tr><td>27 … 31</td><td>Reserved</td><td>–</td><td colspan="3">–</td></tr>
</table>

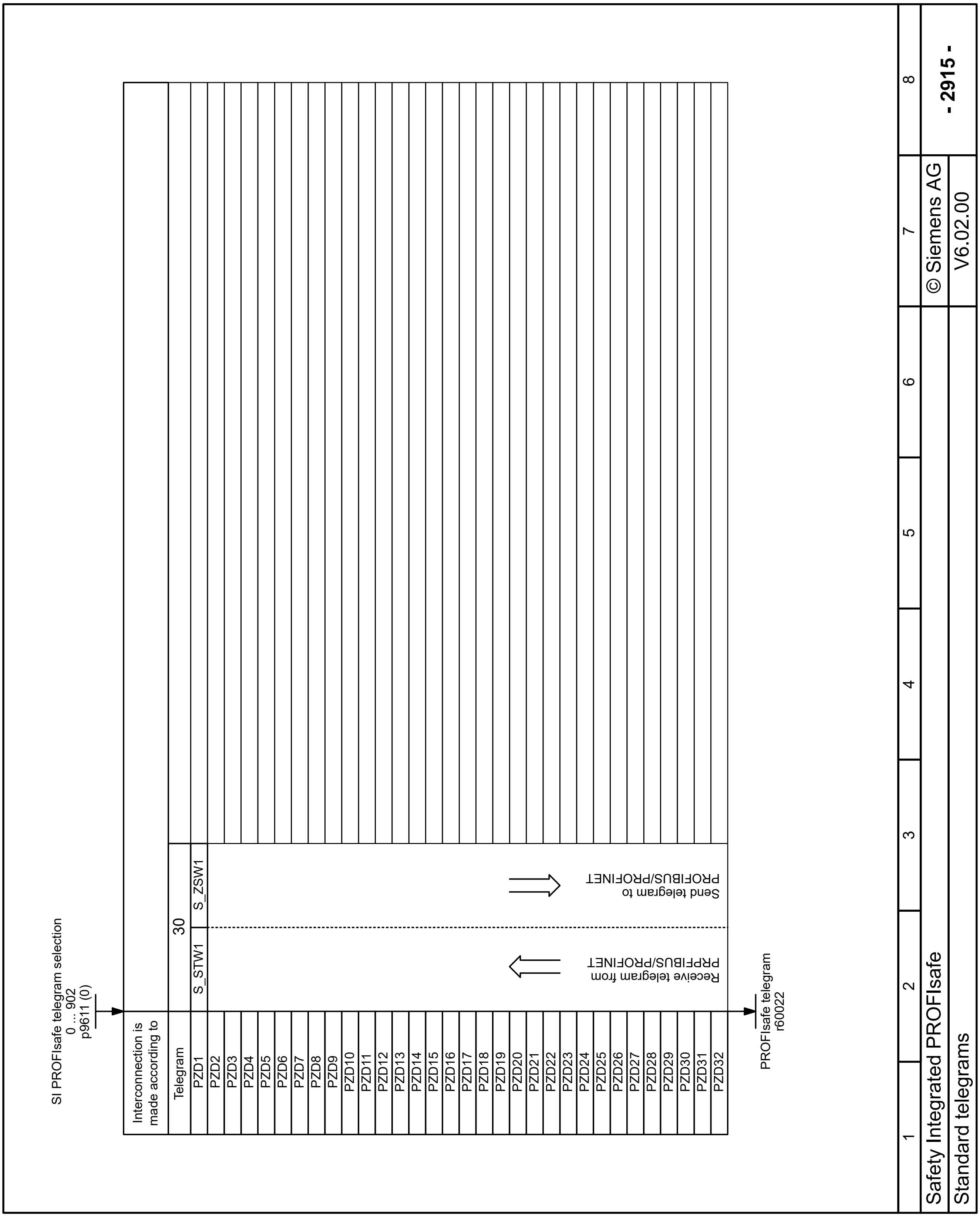


Figure 14-248 2915 - Standard telegrams

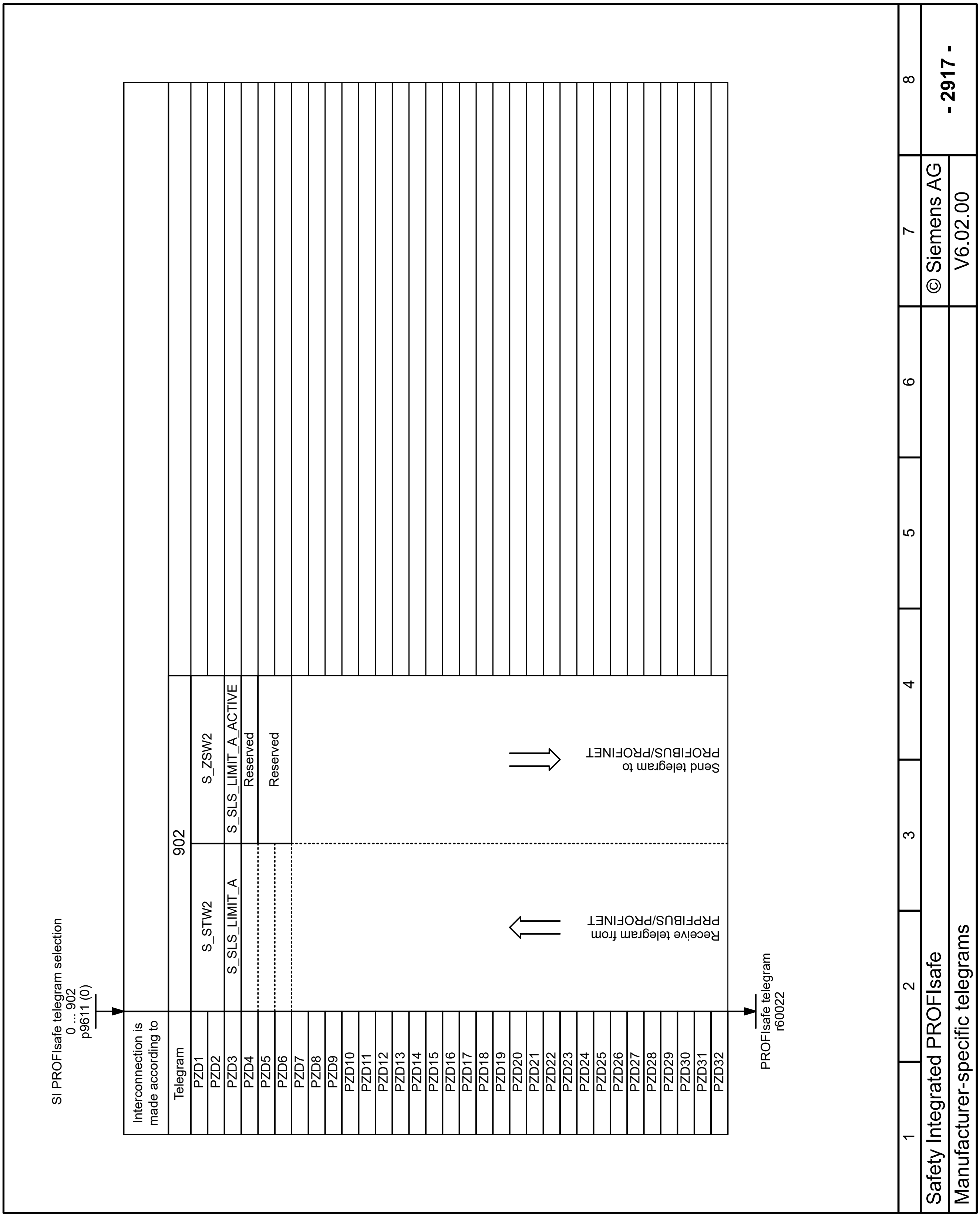


Figure 14-249 2917 - Manufacturer-specific telegrams

14.12.11.6 Transferring the F-DI status via PROFIsafe

Overview

The configuration of the transfer of the F-DI status defines the input mode of an F-DI, and activates the transfer of an F-DI state to the F-control.

Requirement

A PROFIsafe telegram with transfer of the F-DI status is set.

The F-DI to be transferred is fully configured:

- Discrepancy time
- Input filter
- Self-test

Description of function

c10050 selects the F-DI whose status the converter transfers to the F-control via PROFIsafe.

Parameters

The following list contains the parameters of the function "Transfer F-DI status via PROFIsafe".

Number	Name	Unit
c10050[0...2]	SI status F-DI via PROFIsafe	

14.12.11.7 Control via PROFIsafe and EMERGENCY STOP via terminals

Overview

After configuration, PROFIsafe communication and a stop function for EMERGENCY STOP via terminals are defined.

Description of function

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)

14.12.11.8 Control via terminals

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.

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	
p10040.0...2	SI F-DI input mode	

14.12.11.9 Discrepancy time

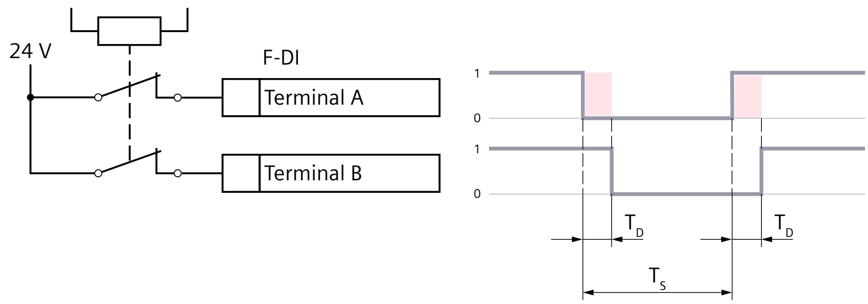
Overview

The converter tolerates brief, different logical signal states at a fail-safe digital input.

Description of function

With electromechanical sensors, e.g. EMERGENCY STOP buttons or position switches, 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 14-250 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.

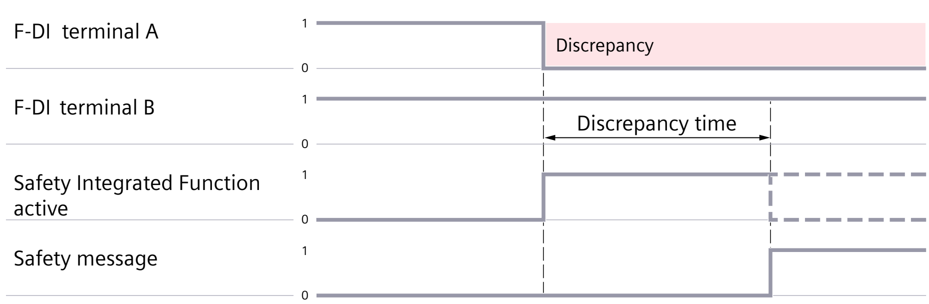


Figure 14-251 Safety message for continuous discrepancy at F-DI terminals

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]

14.12.11.10 Input filter

Overview

The input filter suppresses unwanted brief signal changes at a failsafe digital input (F-DI).

Description of function

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	

14.12.11.11 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.

Requirement

If the self-test of the fail-safe input is activated, then the length of dark pulse must be longer than 0.5 ms.

Description of function

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 supply voltage VS 1 at the terminal block X130 generates dark pulses, to diagnose the control circuit, for example.
  The self-test detects a short-circuit to ground and to 24 V.

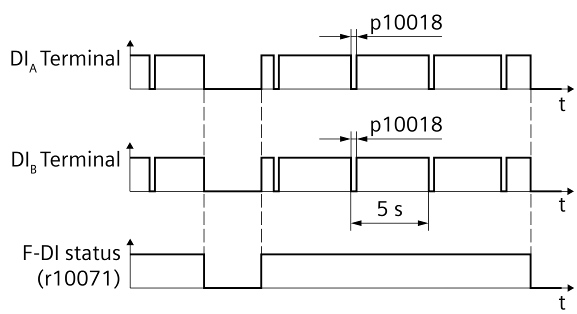


Figure 14-252 Dark pulses through switchable supply voltage VS 1

P10018 determines the length of the dark pulse. The cycle of the dark pulses has a fixed value of 5 seconds.
The debounce time prevents an unwanted response of the converter to the self-test: p10017 > p10018 + 2 ms.

- Self-test using internally specified staggered dark pulses: p10041 = 2
The converter provides both switchable supply voltages VS 1 and VS 2 at terminal block X130. VS 1 and VS 2 generate dark pulses, to diagnose the control circuit, for example.
The fail-safe digital input must be connected to different supply voltages:
  – Terminal DI_A is powered from VS 1
  – Terminal DI_B is powered from VS 2

  The self-test using specified dark pulses with VS 1 and VS 2 (p10041 = 2) detects a short-circuit to ground and 24 V and a cross circuit.

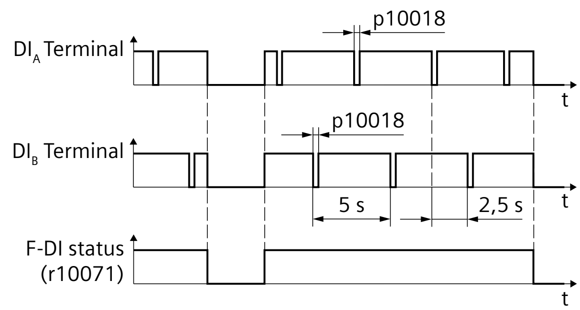


Figure 14-253 Dark pulses through switchable supply voltages VS 1 and VS 2.

  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.
  The debounce time prevents an unwanted response of the converter to the self-test: p10017 > p10018 + 2 ms.

- Self-test with externally specified dark pulses: p10041 = 3
An external control, e.g. F-PLC, generates dark pulses at the input terminals of a fail-safe digital input.

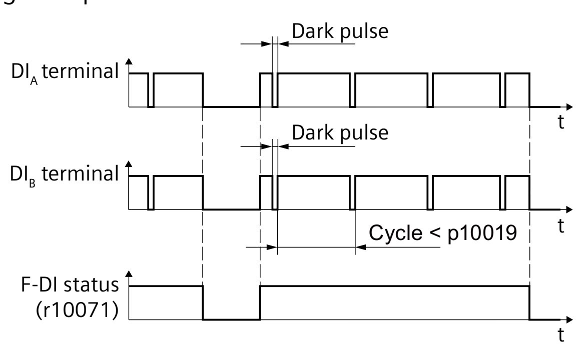


Figure 14-254 Dark pulses from external control system

  The length of the dark pulse is predefined by the external control system. The maximum wait time for dark pulses (p10019) can be parameterized.
  The debounce time prevents an unwanted response of the converter to the self-test: p10017 > length of the dark pulse of the external control system + 2 ms.
  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 the "Online self-test 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	

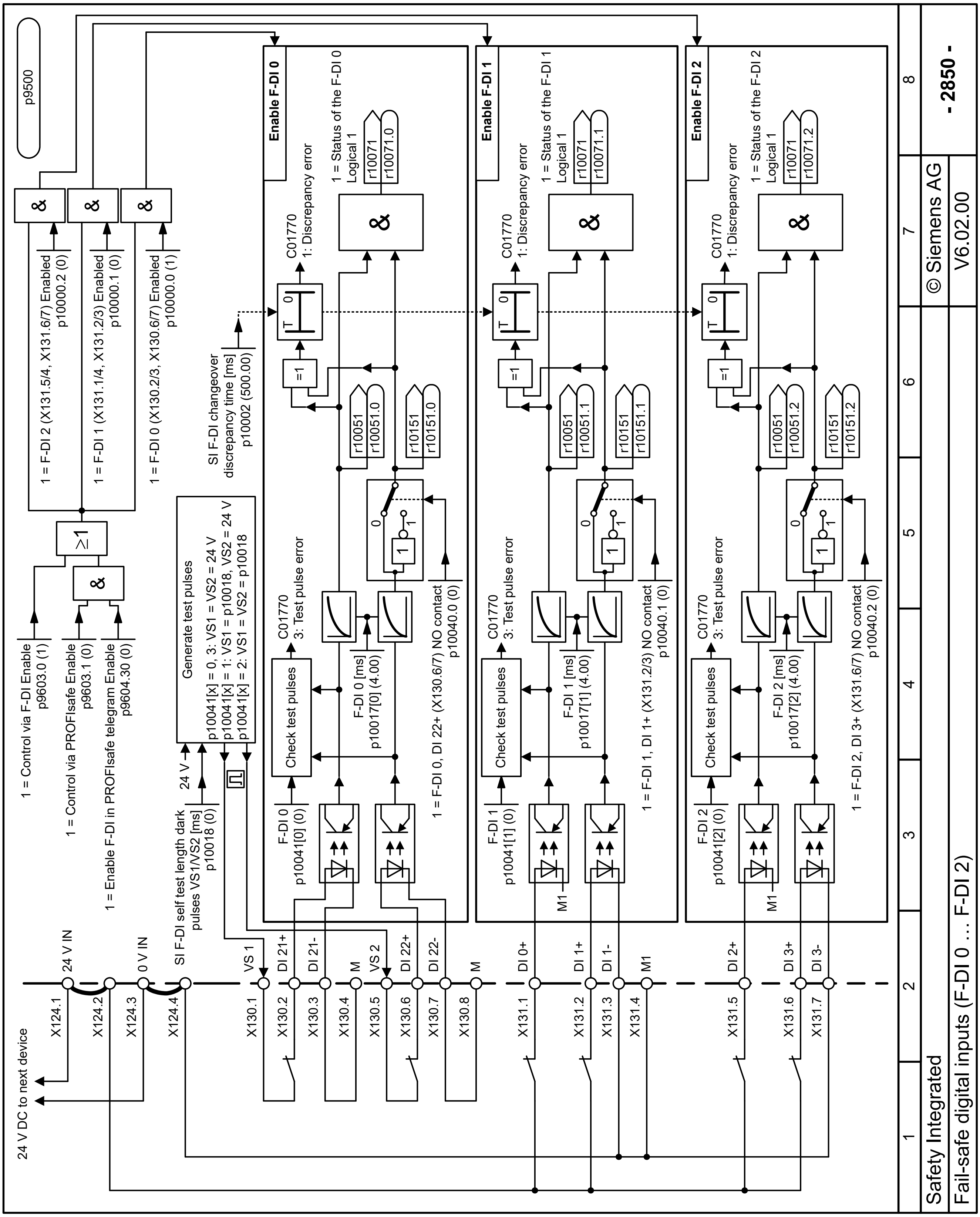


Figure 14-255 2850 - Fail-safe digital inputs (F-DI 0 ... F-DI 2)

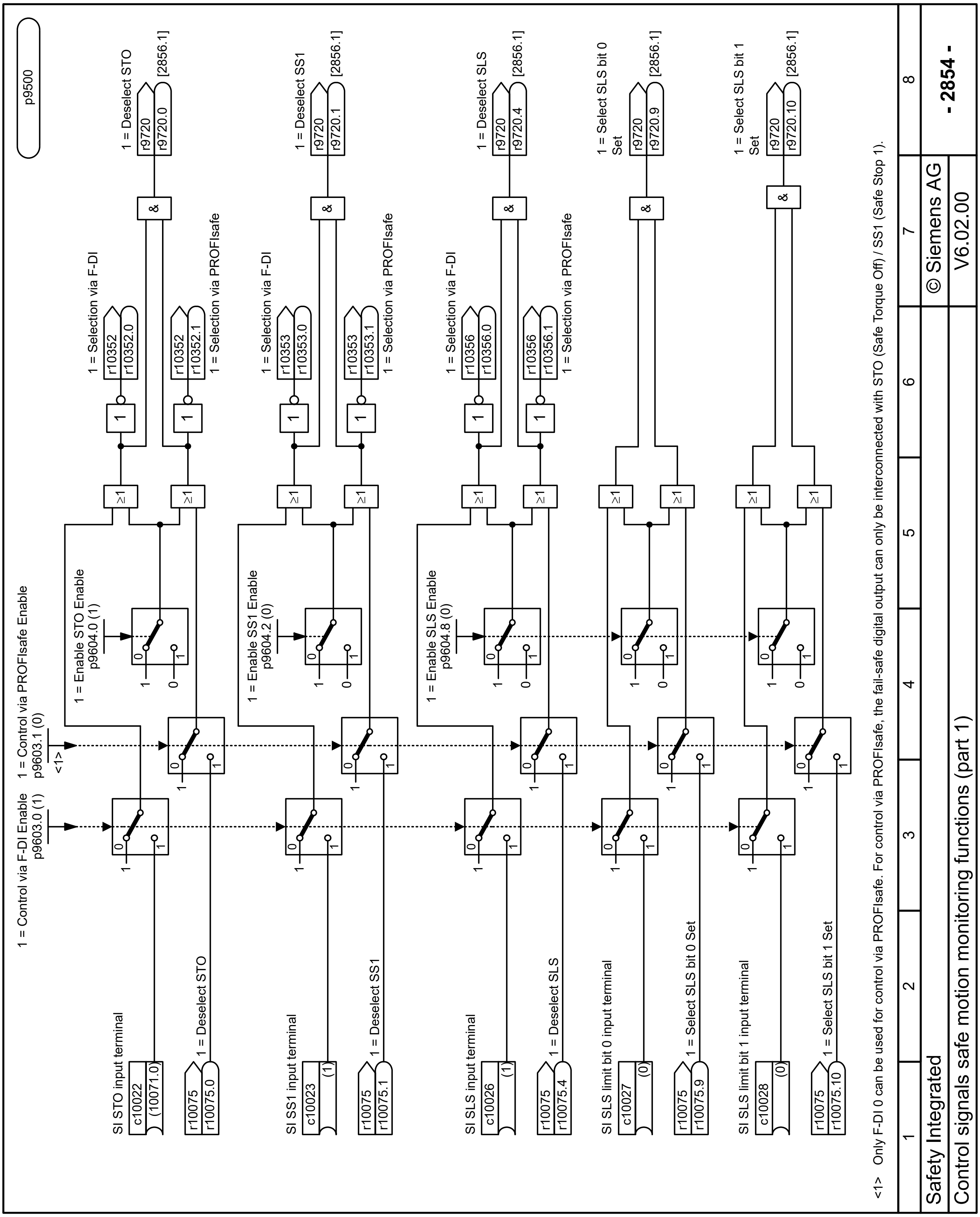


Figure 14-256 2854 – Control signals safe motion monitoring function (part 1)

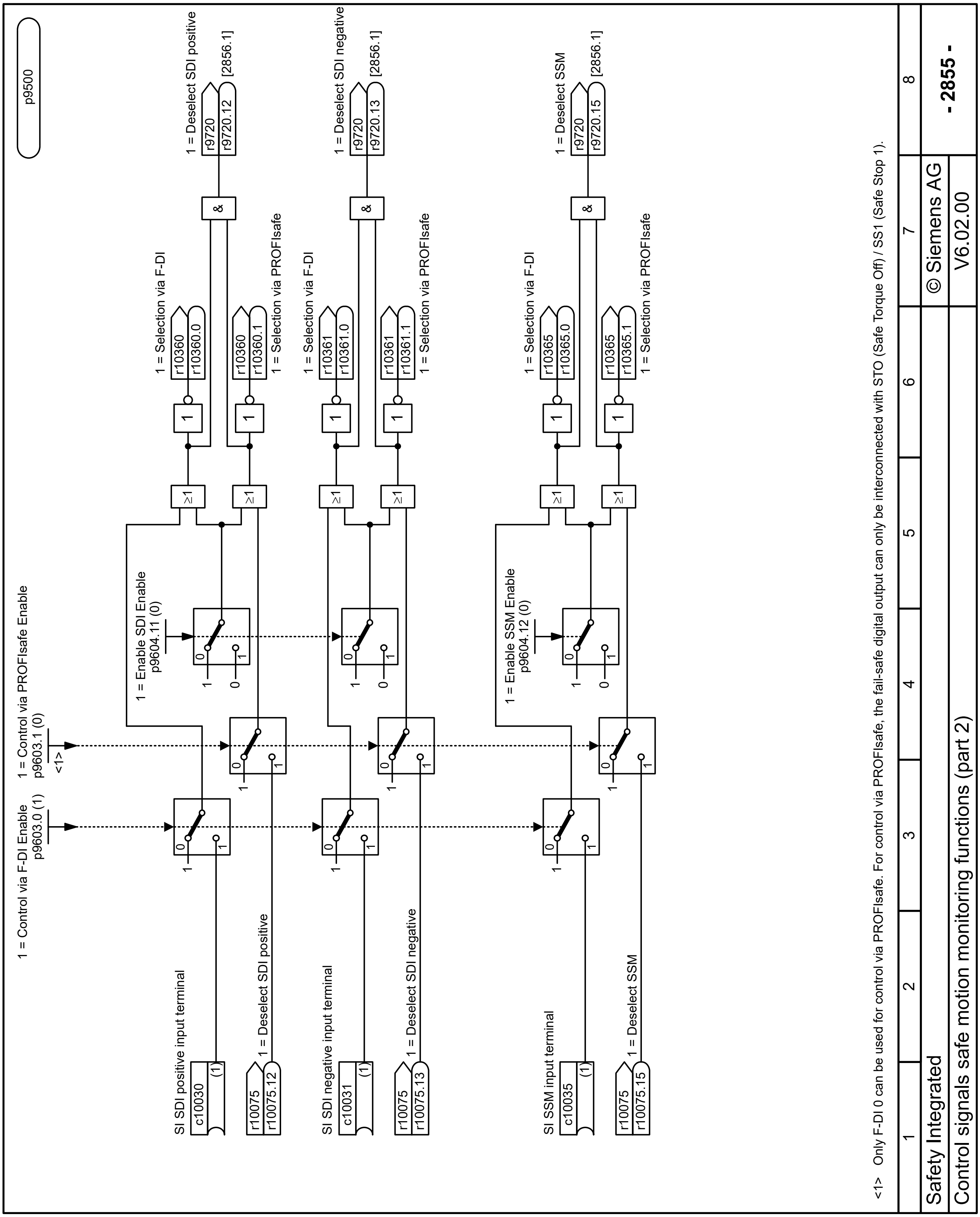

p9500
1 = Control via F-DI Enable
p9603.0 (1)
1 = Control via PROFIsafe Enable
p9603.1 (0)
<1>
1 = Enable SDI Enable
p9604.11 (0)
1 = Enable SSM Enable
p9604.12 (0)
SI SDI positive input terminal
c10030 (1)
1 = Deselect SDI positive
r10075
r10075.12
SI SDI negative input terminal
c10031 (1)
1 = Deselect SDI negative
r10075
r10075.13
SI SSM input terminal
c10035 (1)
1 = Deselect SSM
r10075
r10075.15
1 = Selection via F-DI
r10360
r10360.0
1 = Selection via PROFIsafe
r10360
r10360.1
1 = Selection via F-DI
r10361
r10361.0
1 = Selection via PROFIsafe
r10361
r10361.1
1 = Selection via F-DI
r10365
r10365.0
1 = Selection via PROFIsafe
r10365
r10365.1
1 = Deselect SDI positive
r9720
r9720.12
[2856.1]
1 = Deselect SDI negative
r9720
r9720.13
[2856.1]
1 = Deselect SSM
r9720
r9720.15
[2856.1]
<1> Only F-DI 0 can be used for control via PROFIsafe. For control via PROFIsafe, the fail-safe digital output can only be interconnected with STO (Safe Torque Off) / SS1 (Safe Stop 1).
1
2
3
4
5
6
7
8
Safety Integrated
Control signals safe motion monitoring functions (part 2)
© Siemens AG
V6.02.00
- 2855 -

Figure 14-257 2855 - Control signals of safe motion monitoring function (part 2)

14.12.11.12 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...15	SI status signals	
r10038	SI Safe State status	
p10039.0...10	SI Safe State signal selection	
c10042[0...5]	SI F-DO 0 signals of the AND logic operation	

14.12.11.13 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.

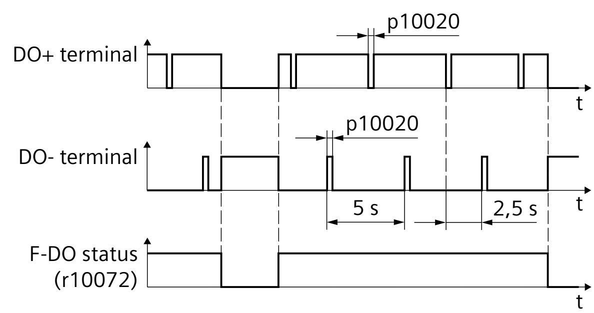


Figure 14-258 Dark pulses

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	

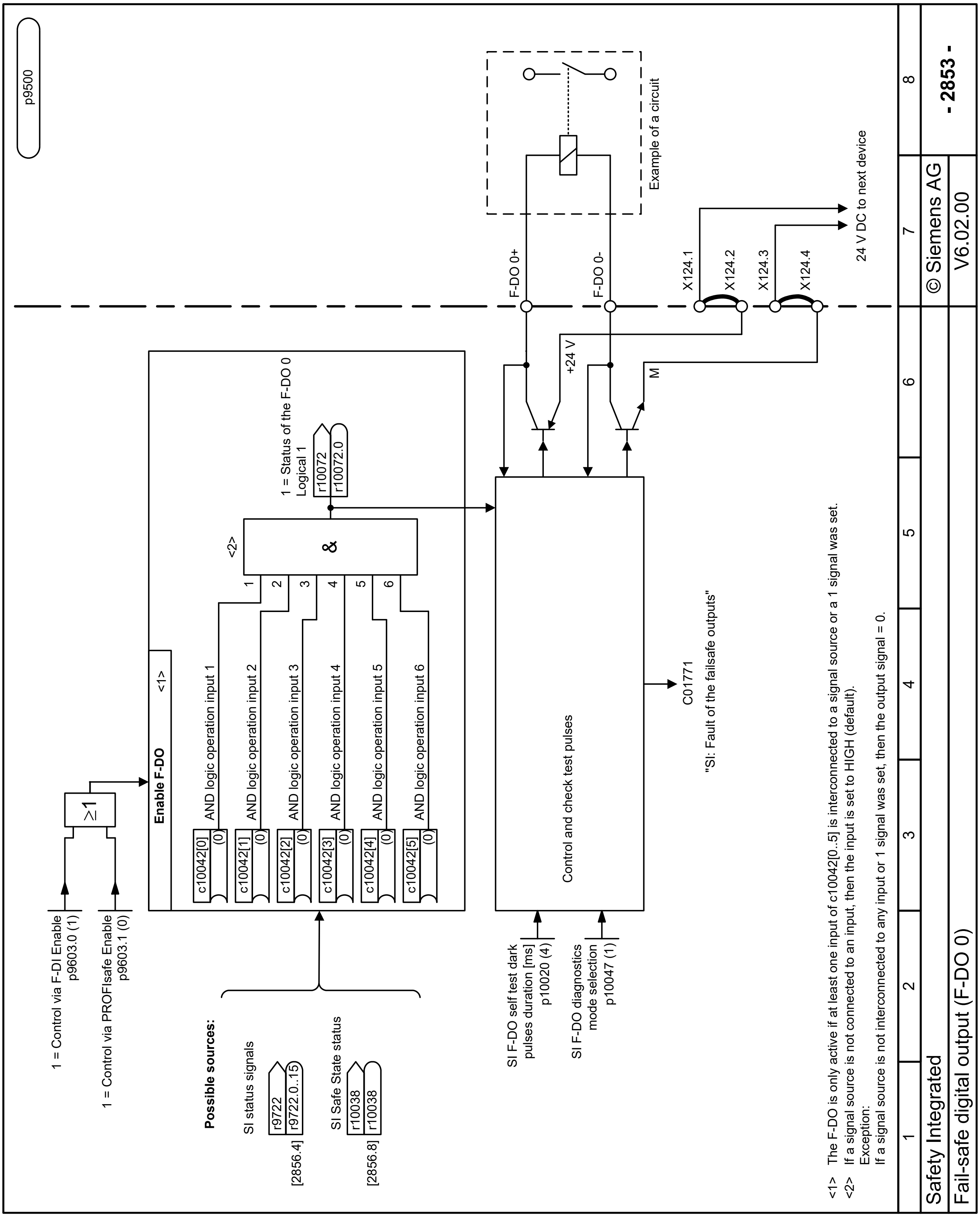


Figure 14-259 2853 - Fail-safe digital output (F-DO 0)

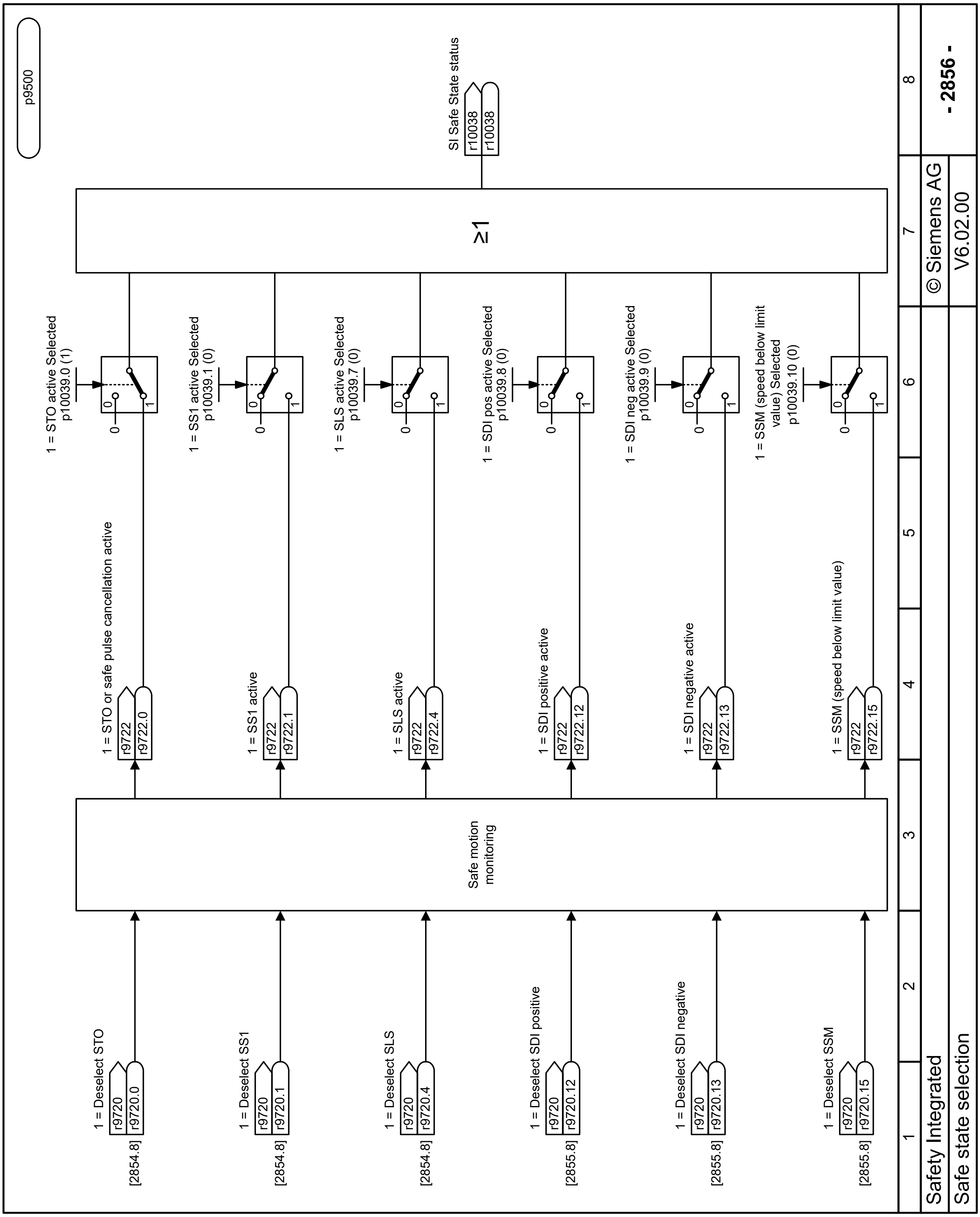


Figure 14-260 2856 - Safe State selection

14.12.12 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.

The parameterization can be transferred to several devices by separating the checksums for function and communication. When transferring the parameterization to several devices, you must check whether the device is correctly assigned in the communication group.

Parameters

The following list contains the parameters for "Function status/diagnostics".

Number	Name	Unit
r9722.0...15	SI status signals	
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	

14.12.13 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.

More information on validation is given for example in EN ISO 13849-1. 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

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.

14.12.14 Responses to safety messages

14.12.14.1 Stop responses

Description of function

The converter triggers a fault reaction in response to certain events:

- Stop response SCF
  The converter detects a discrepancy in the Safety Integrated monitoring channels, e.g. an error in the result and data comparison.
  If at least one safety function is selected, then the stop response SS1 or SS1E takes place after time p9555.
  From V6.3 and higher, parameter p9561 "SI SCF stop response", is available, with which the user can set whether an SS1 or a SS1E should be initiated after SCF. Time p9555 therefore delays the transition to the stop response SS1 or SS1E.
- 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.

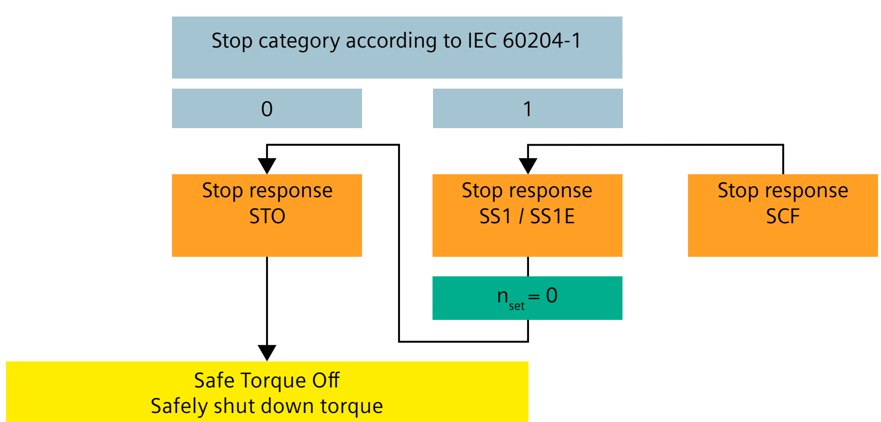


Figure 14-261 Stop responses

14.12.14.2 Priority of stop responses and stop functions

Overview

If multiple Safety Integrated Functions or stop responses are active at the same time, the priority of each function determines the behavior of the motor.

Description of function

The priority determines whether a stop response or a stop function influences another active Safety Integrated Function.

The stop responses and stop functions have a higher priority than all other Safety Integrated Functions.

Amongst themselves, the stop responses and stop functions have different priorities.

Table 14-97 Priority of stop responses and stop functions

Priority	Stop response or stop function
High	Safe Torque Off (STO)
Low	Safe Stop 1 (SS1)

A stop response or stop function with a higher priority influences an active stop response or stop function with a lower priority.

A stop response or stop function with a lower priority has no influence on an active stop response or stop function with a higher priority.

Example

Examples of the behavior of the motor if a stop response is active or if a stop function is selected:

- Safely-Limited Speed (SLS) is active and Safe Stop 1 (SS1) is selected.
  Result: The converter brakes the motor because the stop function Safe Stop 1 (SS1) has a higher priority than Safely-Limited Speed (SLS).
- Safely-Limited Speed (SLS) is active and the converter detects a limit value violation.
  Safe Torque Off (STO) is set as the stop response to a limit value valuation.
  During the stop response, the stop function Safe Stop 1 (SS1) is selected.
  Result: The selection of Safe Stop 1 (SS1) has no influence on the behavior of the motor. The motor coasts down because Safe Torque Off (STO) has a higher priority than Safe Stop 1 (SS1).

14.12.14.3 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.

Requirement

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
- Selection and deselection of STO or SS1
  Select the Safety Integrated Function STO or SS1 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.

14.13 Technology functions

14.13.1 PID technology controller

Overview

The technology controller controls process variables, e.g. pressure, temperature, level or flow.

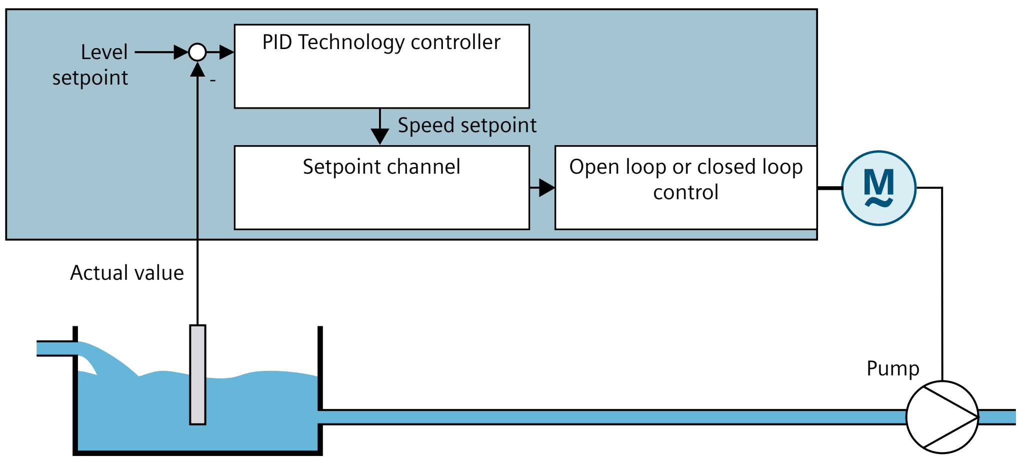
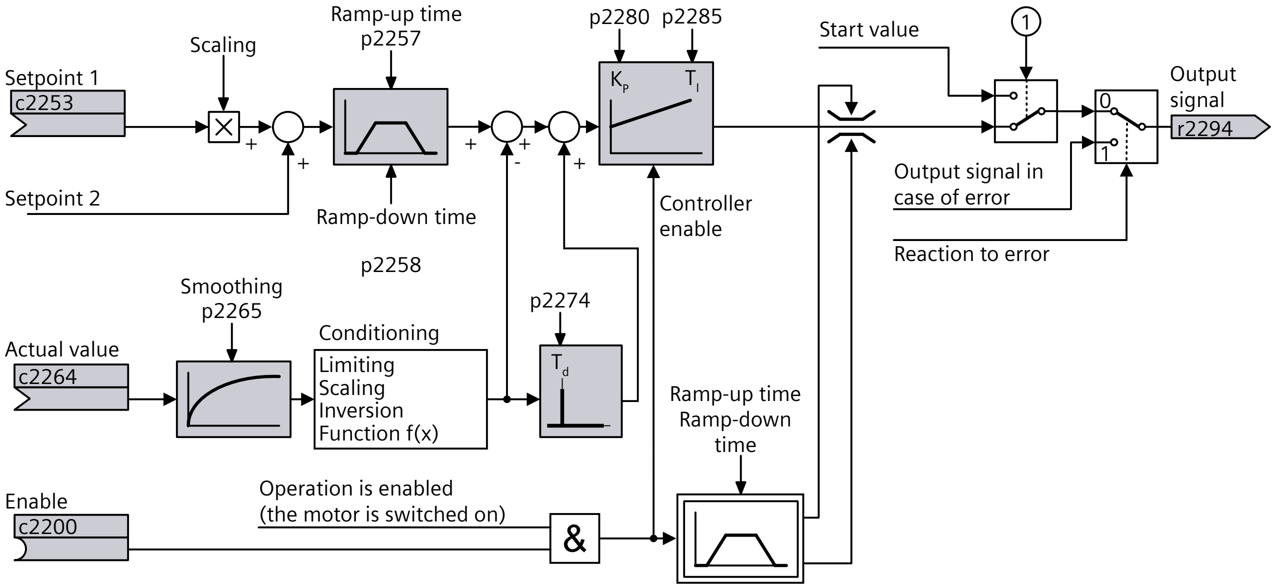


Figure 14-262 Example: Technology controller as a level controller

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 14-263 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 signal	
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	
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	
r2273	Technology controller system deviation	[%]
p2274	Technology controller differentiation time constant	[s]
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	
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...13	Technology controller status word	

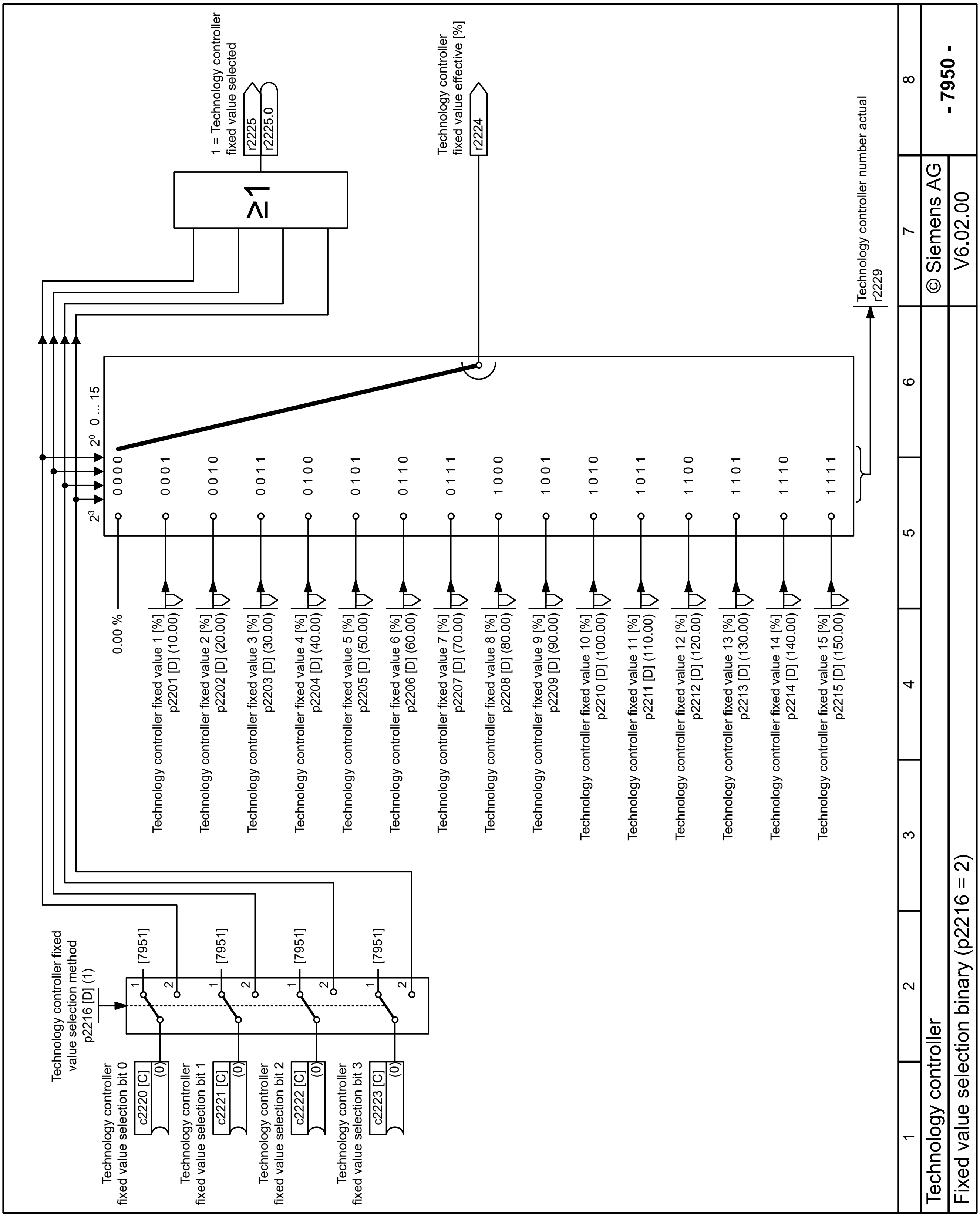


Figure 14-264 7950 - Fixed values, binary selection

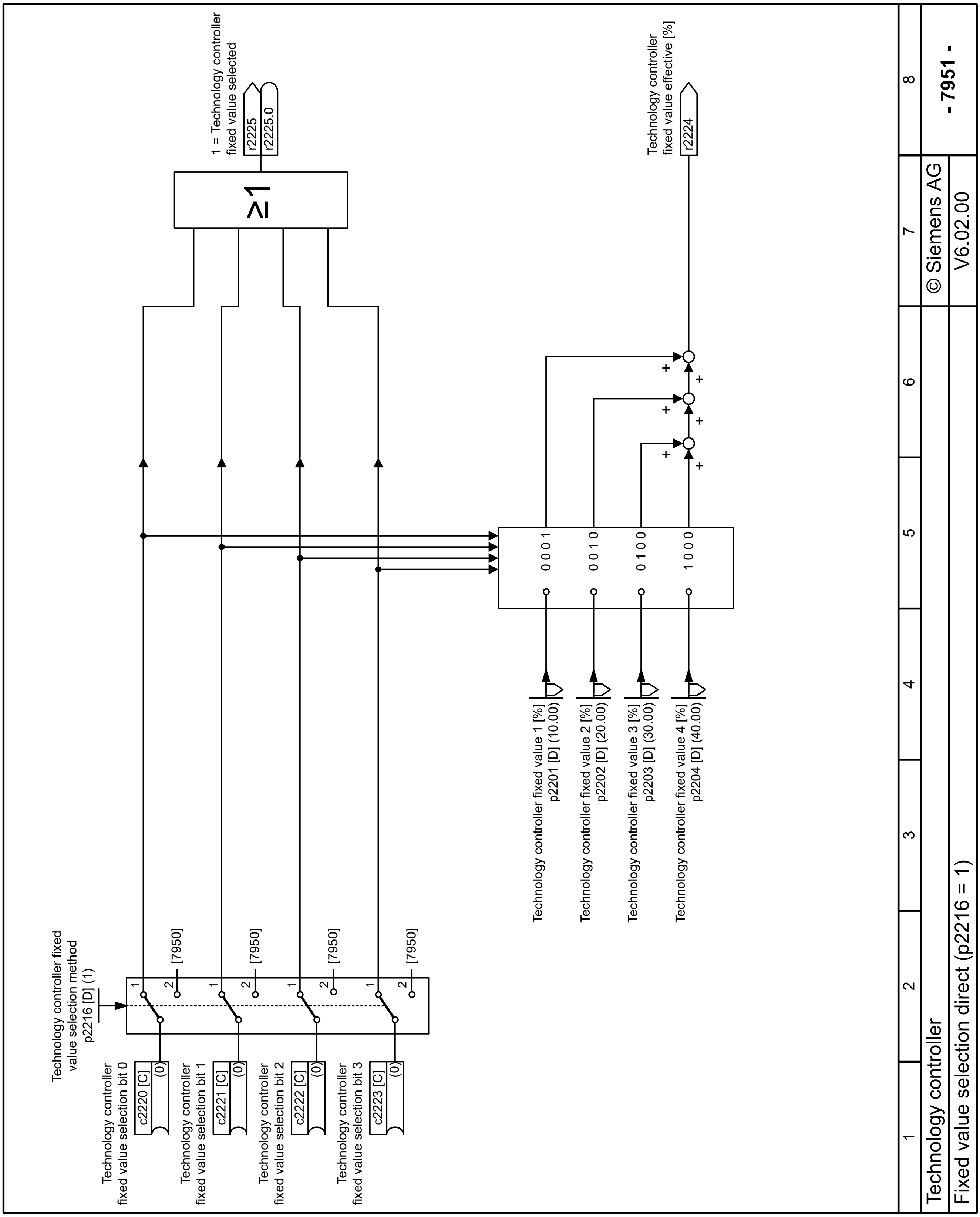


Figure 14-265 7951 - Fixed values, direct selection

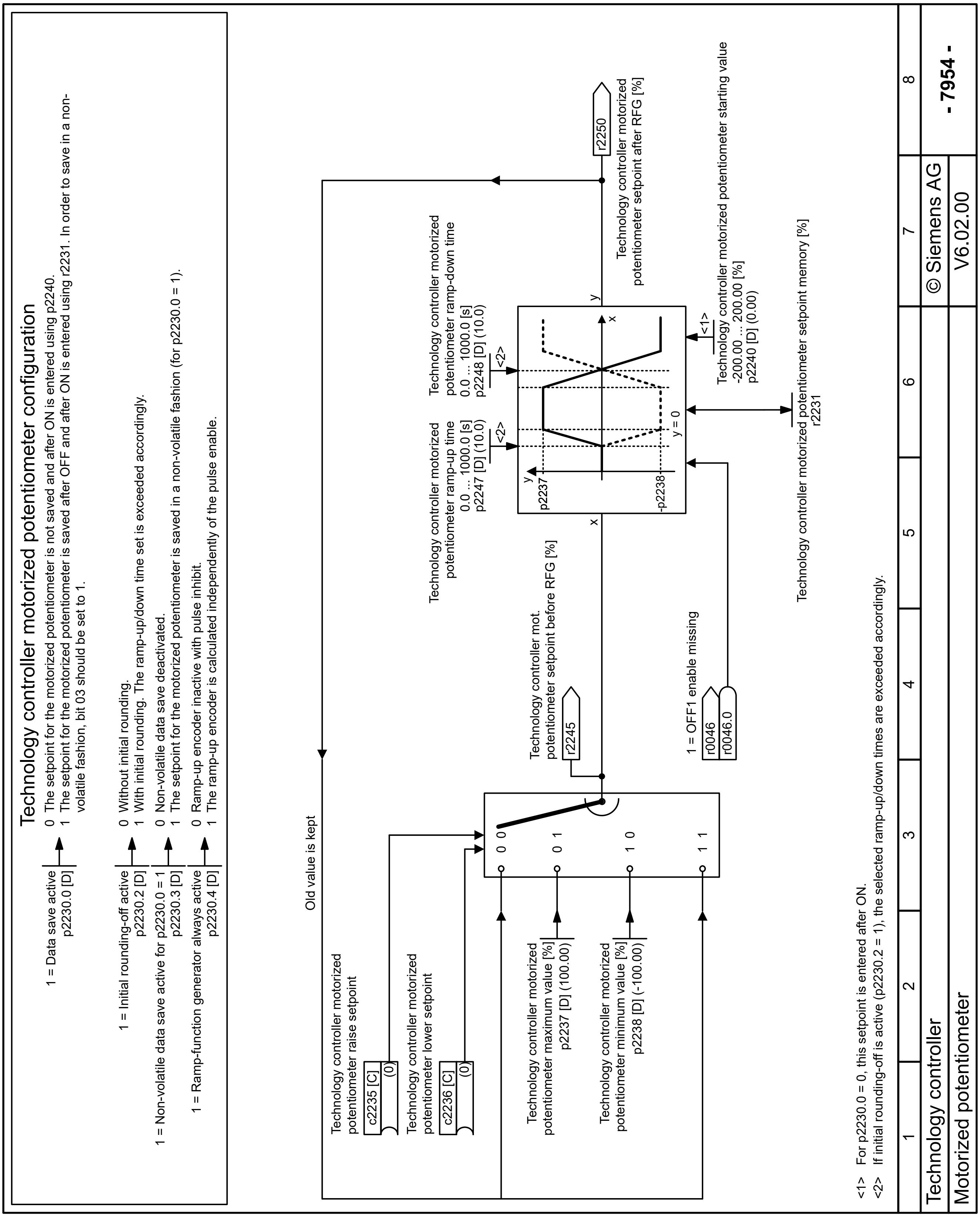


Figure 14-266 7954 - Motorized potentiometer

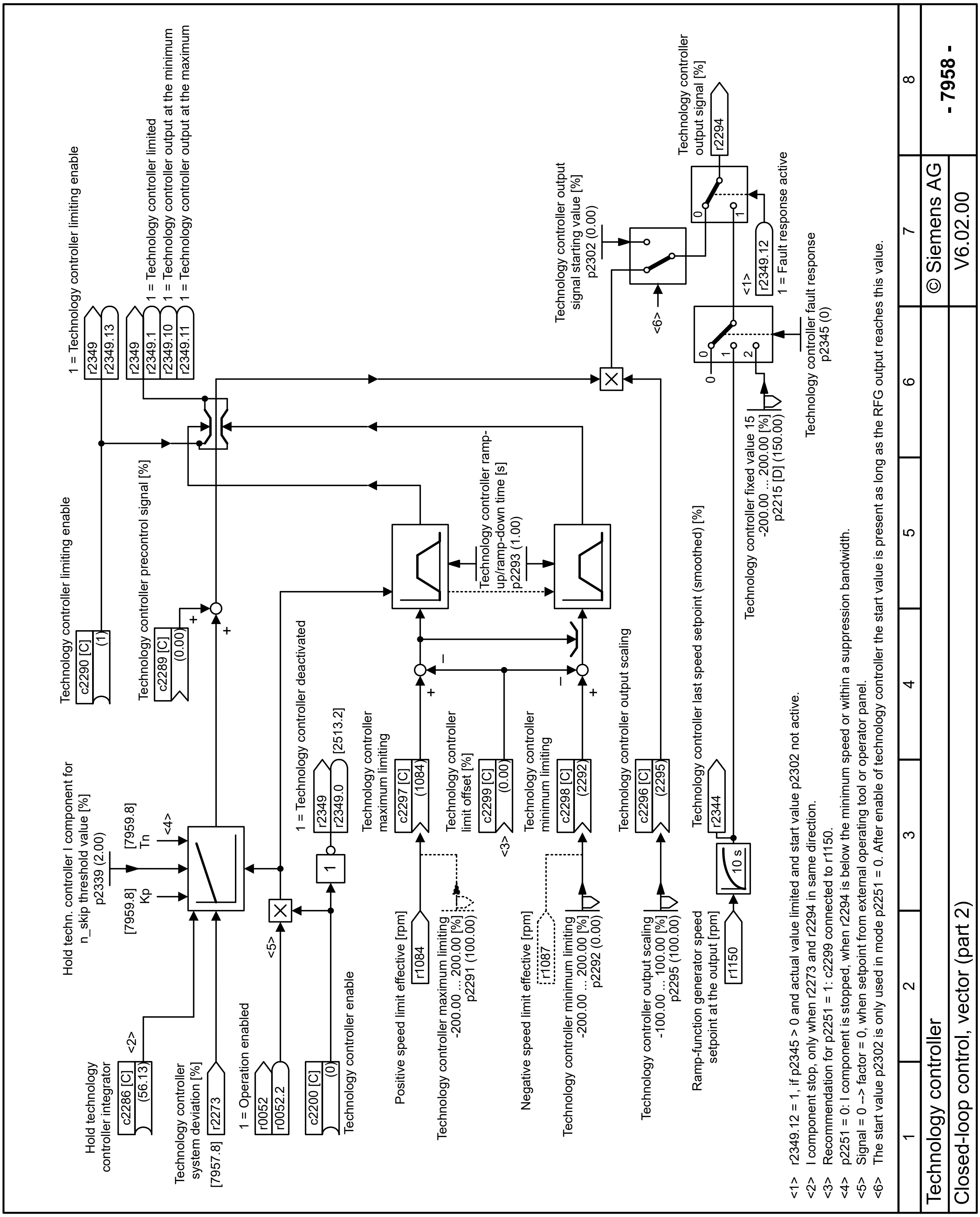


Figure 14-267 7958 – Closed-loop control, vector (part 2)

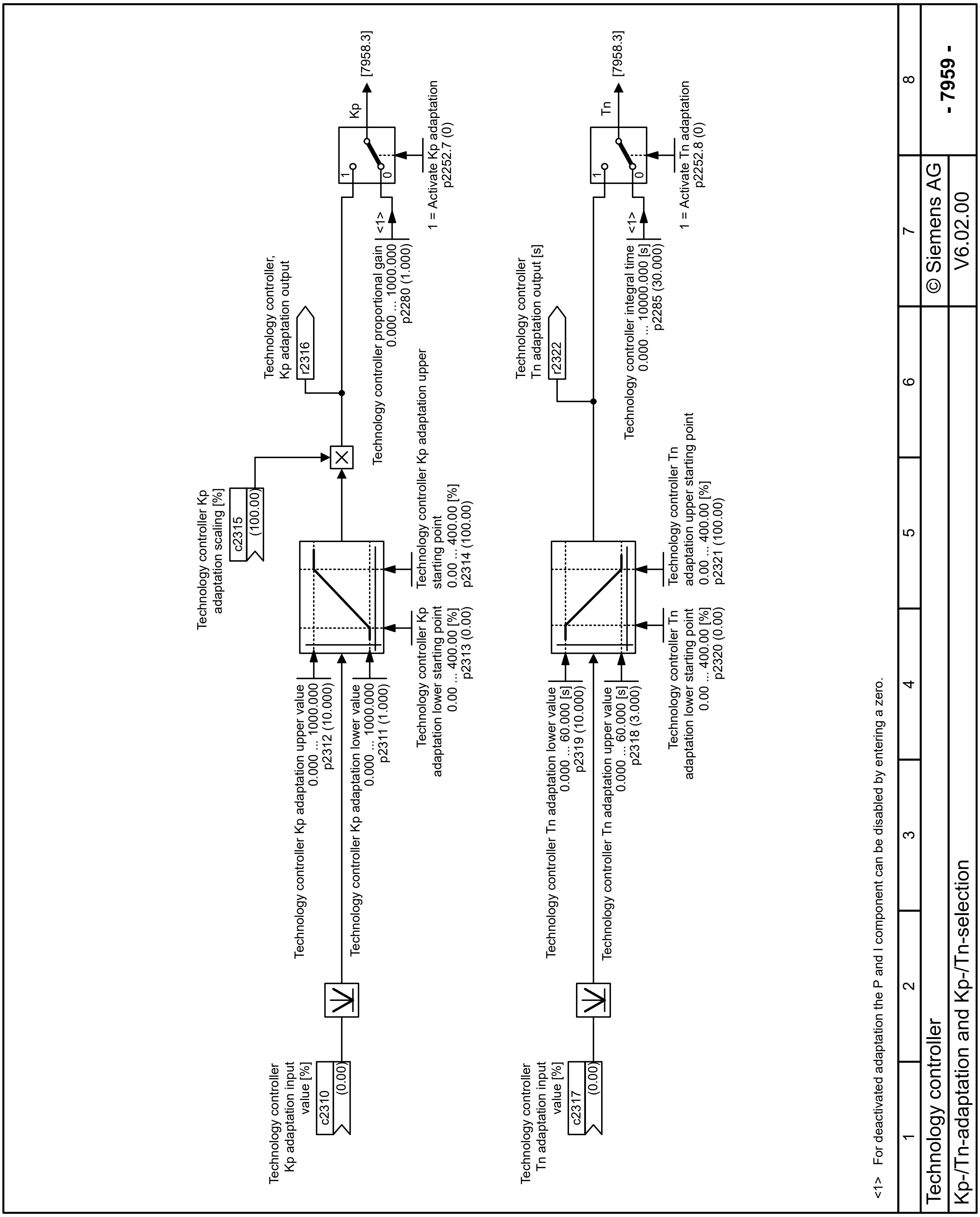


Figure 14-268 7959 – Kp/Tn adaptation and Kp/Tn selection

14.13.2 Manually setting the controller parameters of the PID technology controller

Overview

The controller parameters K_P, T_I and T_d of the PID technology controller are adjustable.

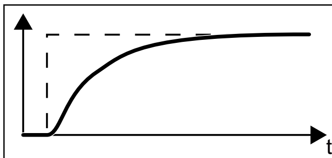
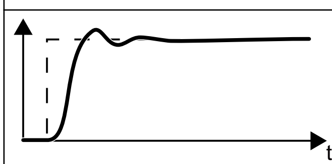
Requirement

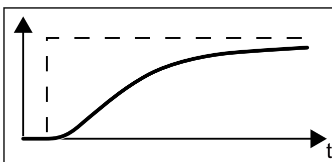
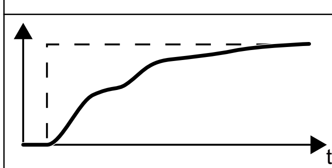
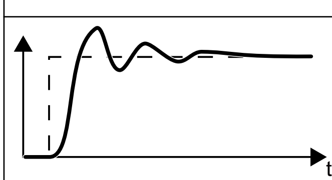
U/f control or closed-loop speed control is set.

Procedure

Proceed as follows to set the 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 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.

	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).

14.13.3 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.

Requirement

CAUTION

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.

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).
- Even for line (DOL) operation of the motor, the converter remains connected to the line supply.

Description of function

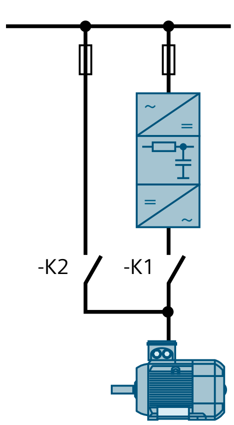


Figure 14-269 Converter bypassed by the motor - line supply breaker (K2)

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.

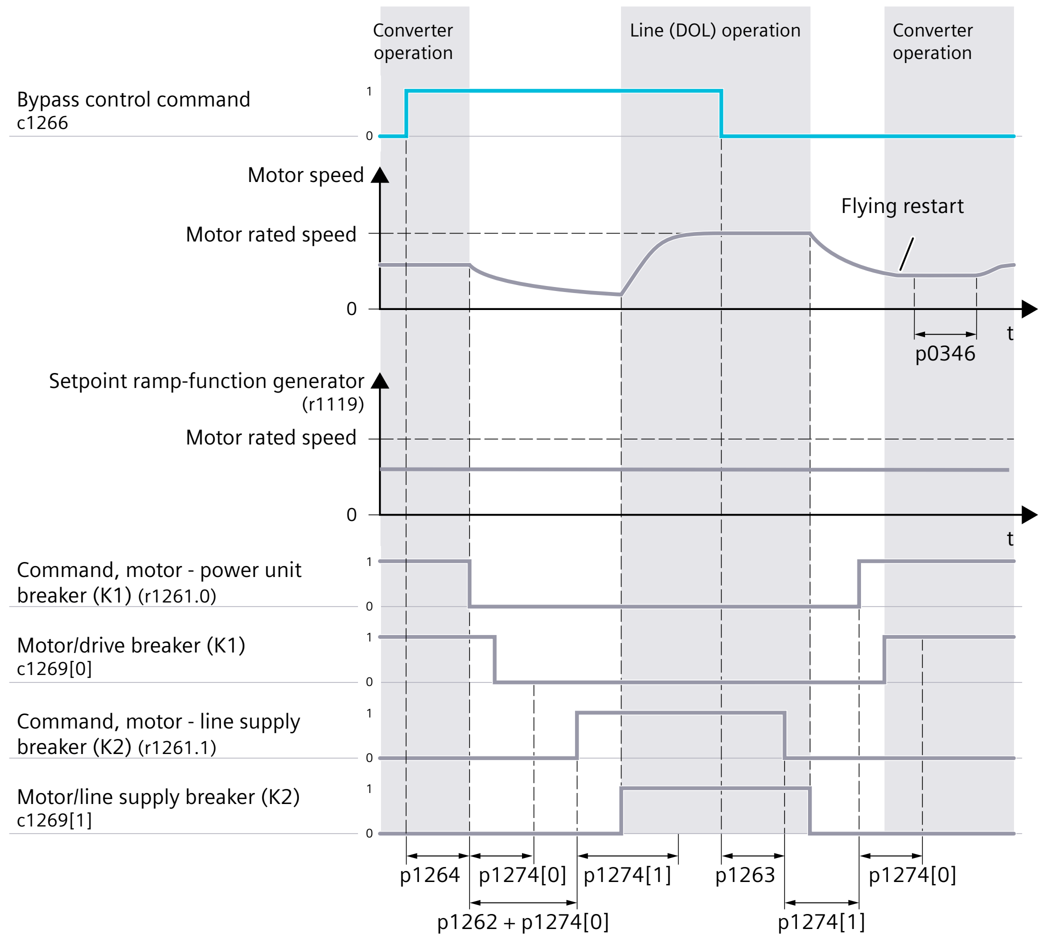


Figure 14-270 Switching over using the "Bypass control command" (p1267.0 = 1)

- 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.

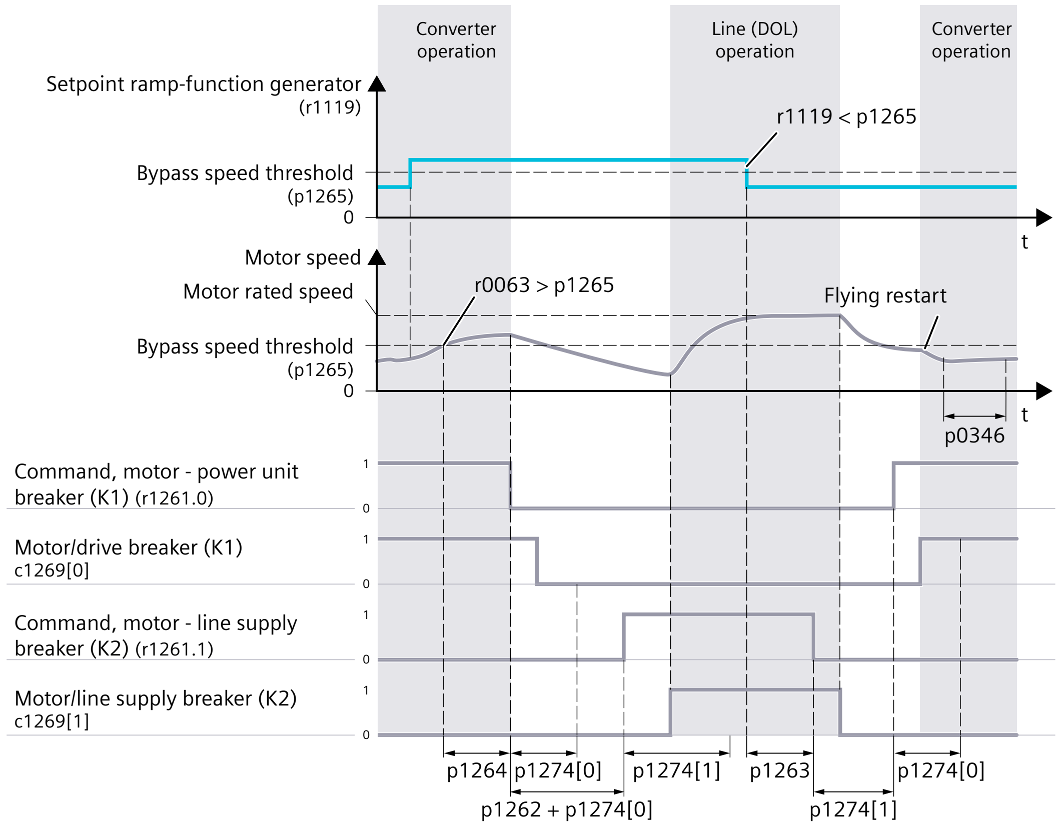


Figure 14-271 Switching over using the "Bypass speed threshold" (p1267.1 = 1)

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.

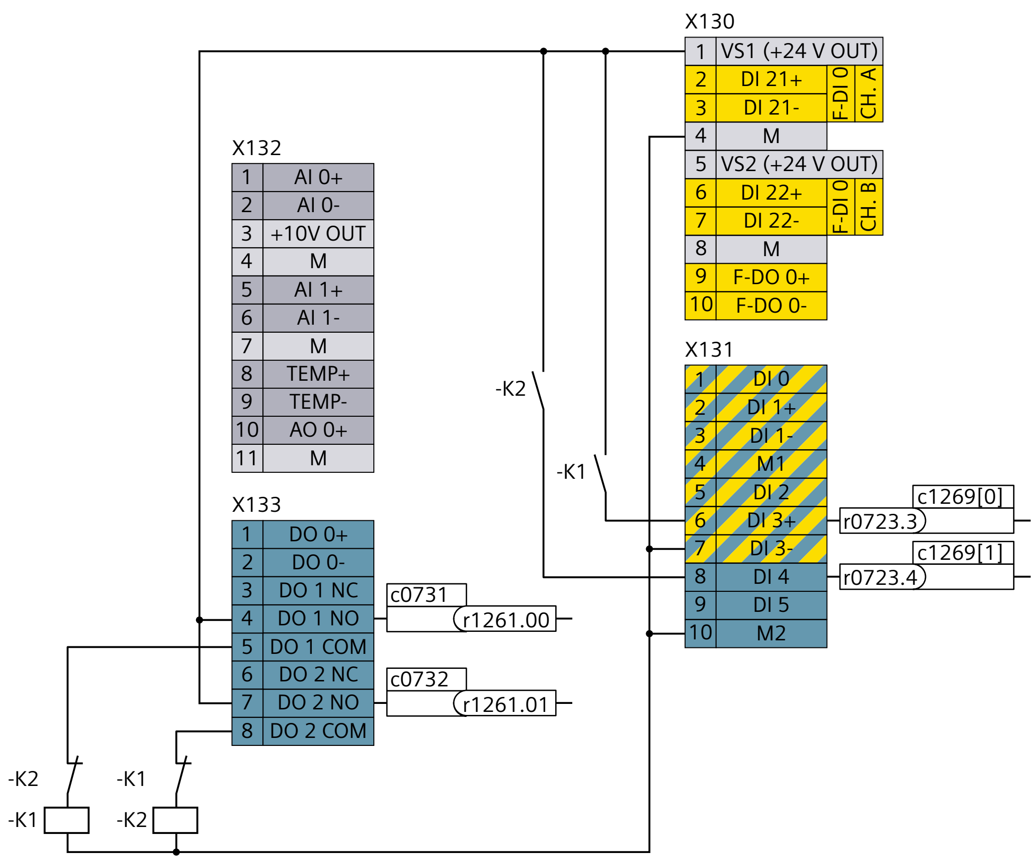
Switchover phase from line (DOL) operation to converter operation:

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 p0247.5 = 1, the converter waits for the time p1274[1]. If voltage measurement is deselected with p0247.5 = 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 14-272 Wiring for the "Bypass without line synchronization " function

Parameters

The following list contains the parameters of the "Bypass" function.

Number	Name	Unit
p1260	Bypass configuration	

r1261.0...14	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	
c1269[0...1]	Bypass switch feedback signal	
p1274[0...1]	Bypass switch monitoring time	[ms]

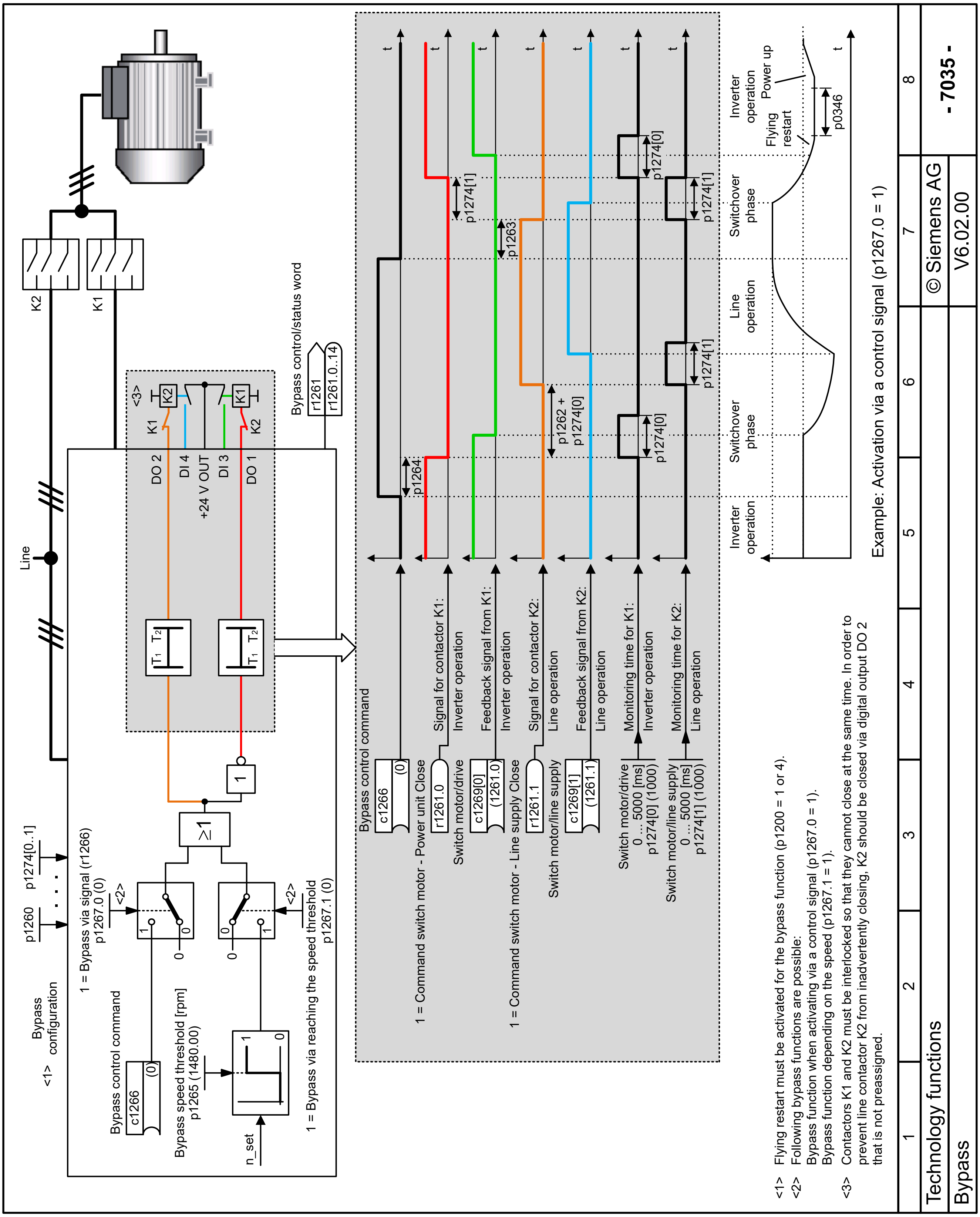


Figure 14-273 7035 - Bypass

14.14 Functions that require licensing

14.14.1 Using functions that require a license

Overview

The firmware functions that are included when the converter is supplied can be expanded using functions that require a license.

Requirement

A Siemens memory card with the appropriate license file must be inserted in the converter to operate the converter with a function that requires a license.

Description

For some functions that require a license, operation in the Trial License mode without a memory card is possible for a limited time. The Trial License mode is only permissible while commissioning and in the case of service.

Functions that require a license can be accessed in the following ways:

- Memory card with license as Z option
  The memory card can be ordered from the factory with licenses pre-installed.
  - The license file is permanently assigned to the memory card. The license file is provided as a ZIP file.
  - The certificates of license (eCoL) are stored with the license file on the memory card.
- Allocate a license to an existing Siemens memory card
  Use "Web License Manager" to assign an additional license to a particular memory card and create a new license file for the memory card.
  - The license file is created in the Web License Manager using the certificates of license, assigned to an existing memory card, and made available to download as a ZIP file.
    Use the commissioning tool to upload the license file to the memory card.
  - The certificates of license (eCoL) can be transferred to the memory card manually if necessary.

Certificates of license and license files differ as follows:

Type	Description
Certificate of license (eCoL)	• Provided as a PDF for each license purchased. • Contains the delivery note number and license number. • Necessary in order to create the license file in the Web License Manager. • It is not contained in the license file.
License file	• Provided as a ZIP file. • Contains serial number of the memory card in the file name. Cannot be transferred to other memory cards. • Necessary in order to activate licenses for functions that require licensing in the commissioning tool. • Contains a signature file. The converter uses the signature file to verify the authenticity of the licenses.

More information

Web License Manager can be found on the Internet:

Web License Manager (http://www.siemens.com/automation/license)

14.14.2 Creating and downloading the license file

Requirement

The following information is required to create a license file in the Web License Manager:

- License number and delivery note number of the license
- Product designation
- Serial number of the memory card
  The serial number is on the memory card.
  Alternative: Copy the serial number from the license overview in the commissioning tool you are using, and then paste the number in the Web License Manager.

Procedure

1. Call the following link: Web License Manager (http://www.siemens.com/automation/license).
2. Click on "Direct access".
   The progress indicator shows the "Login" step.
3. Enter the license number and delivery note number of your license. Then click "Next".
   The progress indicator shows the "Identify product" step.
4. Enter the serial number of the memory card.

5. Select the product you are using. Then click "Next".
   The progress indicator shows the "Select licenses" step.
   In the "Already assigned licenses" column, you can see which licenses of a particular memory card have already been assigned and how often.
   In the "Additional licenses to be assigned" column, activate the licenses you want and specify how many additional licenses you require.
6. Activate the additionally required licenses. Then click "Next".
   The progress indicator shows the "Assign licenses" step.
   This page shows a summary of the selected licenses for checking.
7. To start the assignment, click "Assign".
   The progress indicator shows the "Generate license key" step.
   The licenses are assigned to the specified memory card.
   The license file is displayed and is available to download.
8. Download the license file to the KEYS/SINAMICS directory of your operating unit.

Result

The license file is stored in the KEYS/SINAMICS directory of your operating unit.

14.14.3 Downloading the license file at a later time

Requirement

The license file has already been created in the Web License Manager.

Procedure

To display the license file so you can download it, proceed as follows:

1. Call the following link: Web License Manager (http://www.siemens.com/automation/license).
2. In the navigation, click the "Display license key" option in the "User menu".
3. Enter the serial number of the memory card you are using in the "Hardware serial number" field.
   OR
   In the "License number" field, enter your license number.
4. Click the "Display license key" button.
   The license file is displayed and is available to download.
5. Download the license file to the KEYS/SINAMICS directory of your operating unit.

Result

The license file is stored in the KEYS/SINAMICS directory of your operating unit.

14.14.4 Transferring the license file to the converter and activating it

Overview

Check the license status for the converter at the license overview page. All functions that require licensing for the converter are listed in a table. The table also shows which functions are enabled and whether licenses are missing for individual functions.

You can call the license overview page from the web server or the Startdrive project of the converter.

The procedure is described below using Startdrive as an example.

Requirement

- A memory card is plugged into the converter.
- The license file is in the KEYS/SINAMICS directory of your operating unit.
- The data in the converter and in the Startdrive project is consistent.
- There is an online connection between the operating unit and the drive.

Procedure

1. Call the license overview page.
2. Click the "Activate the license key file" button.
   A corresponding dialog opens.
3. Select the license file in the file system of your operating unit.
4. Close the load dialog.
   The licenses are checked.
   After a check has been successfully completed, dialog "Licensing" opens.
5. Click on the "Activate " button.
   The dialog closes.

Alternatively, you can also directly copy the license file and eCoLs to the memory card, directory "KEYS/SINAMICS" or "KEYS/SINAMICS/eCoL".

Result

The licenses are active. The license status for the converter is updated.

14.14.5 Restoring licensing after the memory card is removed

Overview

When a license file is loaded into the converter, the license file is stored retentively on the memory card.

If you remove the memory card from the converter and perform a restart, the function requiring licensing is blocked after ramp-up.

Requirement

The license file has been loaded into the converter.

Procedure

Proceed as follows to start using blocked functions again:

1. Reinsert the memory card into the converter.
2. Perform a restart.
3. Check the license status on the license overview page.

14.14.6 Loading certificates of license (eCoL) into the file directory of the operating unit

Overview

Use this function to back up the certificates of license (eCoL) contained on the memory card to your operating unit.

Requirement

- The memory card contains certificates of license.

Procedure

1. Click on the "Save eCoL archive" button.
2. Select directory KEYS/SINAMICS in your operating unit and then confirm the selection.

Result

The license certificates are stored in the KEYS/SINAMICS directory of your operating unit.

15 System messages

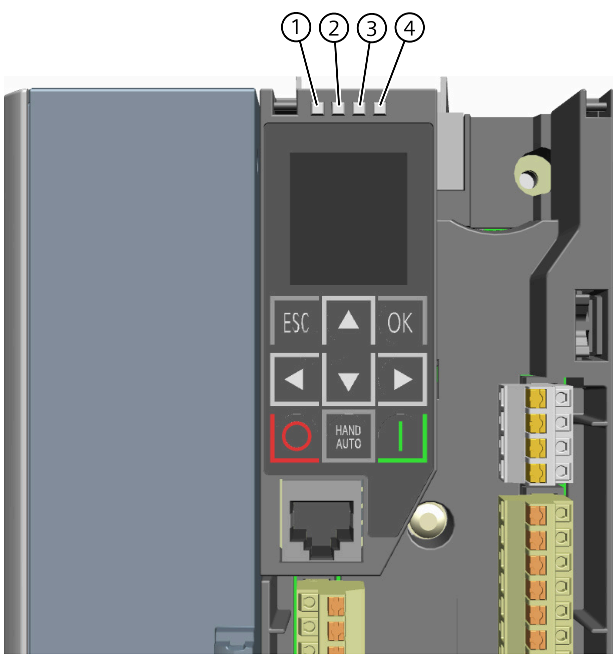
15.1 LEDs

15.1.1 LEDs on the converter

Overview

The LEDs at the front provide information about the operating state of the converter.

Description



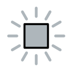
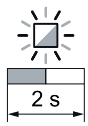
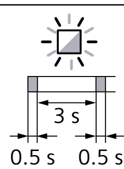
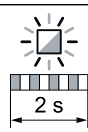
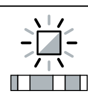
① RDY
② BF
③ LNK1
④ LNK2

Figure 15-1 LED on the front panel

15.1.2 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

15.1.3 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 devices

15.1.4 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		Converter detection via DCP flashing.	

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 setpoints (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.

15.1.5 LED RDY of the option modules

Behavior of the LEDs

Table 15-1 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.	

15.1.6 LED COM of option module OM-IIoT

Behavior of the LEDs

Table 15-2 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	

15.2 Identification & Maintenance (I&M) data

Technical data

The converter supports the following identification and maintenance (I&M) data.

Table 15-3 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 15-4 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

15.3 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.

Description of function

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.

The hardware real-time clock buffers power supply interruptions for up to 20 days.

15.4 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 delivery state (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)

15.5 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.

15.6 Alarm buffer

Overview

The converter stores the most recent alarms in an alarm buffer.

Description of function

An alarm includes an alarm code, an alarm value, and 2 alarm times (for parameters, see the following diagram).
The alarm code and the alarm value describe the alarm cause. The alarm value provides additional and more detailed information about the alarm.

Alarm times indicate when the alarm occurred and when the alarm was resolved.

Alarm buffer

The converter saves up to 8 active alarms in the alarm buffer.

In the alarm buffer, the alarms are sorted according to "Alarm time received". If the alarm buffer is completely filled and an additional alarm occurs, the converter overwrites the values with index [7]. Resolved alarms are moved to the alarm history.

Once the cause of the alarm has been eliminated, the converter writes the time to "Alarm time resolved". The "Alarm time resolved" value for unresolved faults remains at 0.

	Alarm code	Alarm value		Alarm time received			Alarm time removed		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 15-2 Alarm buffer

Alarm history

The alarm history saves up to 56 past alarms.

In the alarm history, alarms are sorted according to the "Alarm time resolved". The last alarm that was resolved has index[8].

The converter moves resolved alarms from the alarm buffer to the alarm history as follows:

1. To create space after position [8] in the alarm history, the converter shifts the alarms already stored in the alarm history "down" by one or more positions.
   If the alarm history is completely full, the converter will delete the oldest alarms.
2. The converter moves the removed alarms from the alarm buffer to the now freed up positions of the alarm history.
   Alarms that have not been resolved remain in the alarm buffer.
3. Gaps can appear in the alarm buffer as a result of resolved alarms being moved to the alarm history. The converter closes these gaps by moving unresolved alarms up. If there are more than 8 active alarms, active alarms not previously visible are added to the alarm buffer. The alarm buffer is resorted.

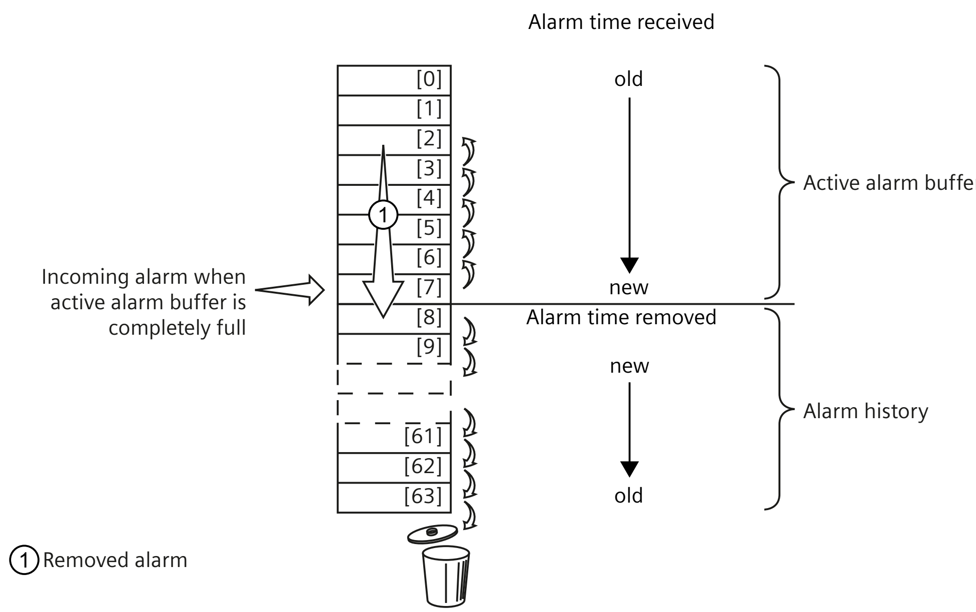


Figure 15-3 Alarm history

Parameters

The following list contains the parameters of the "Alarm buffer and alarm history" function.

Number	Name	Unit
r2111	Alarm counter	
p2118[0...19]	Change message type message number	
p2119[0...19]	Change message type type	
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	

r3121[0...63]	Component alarm
r3123[0...63].0...20	Diagnostic attribute alarm

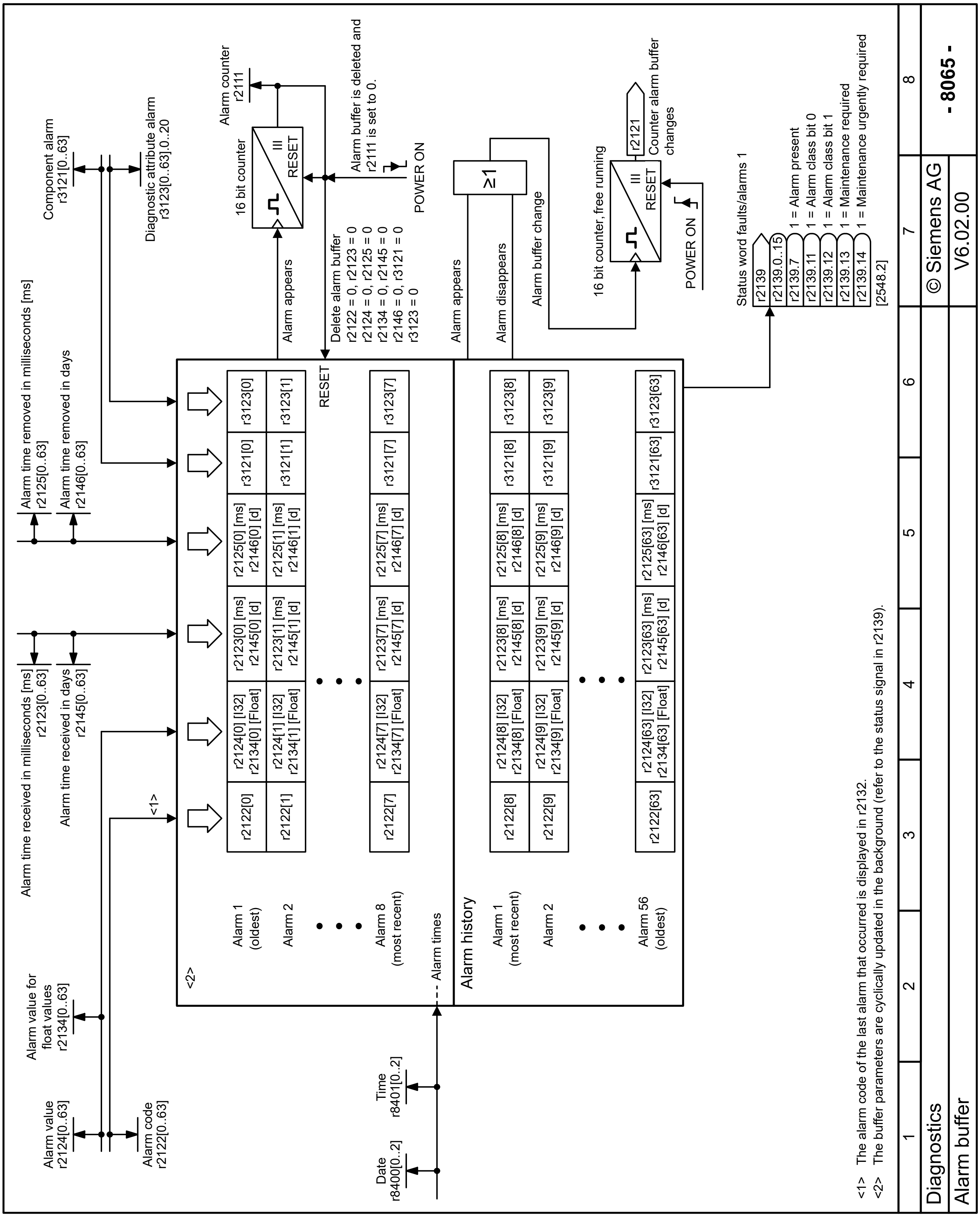


Figure 15-4 8065 - Alarm buffer

15.7 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

15.8 Fault buffer

Overview

The converter stores a limited number of faults as incidents in a fault buffer. As a consequence, acknowledged faults are kept for diagnostic purposes.

Description of function

A fault includes a fault code, a fault value and 2 fault times. The associated parameters are shown in the following diagram.

The fault code and fault value describe the cause of the fault. The fault value provides additional and more detailed information about the fault.

The fault times indicate when the fault occurred and when the fault was eliminated.

Fault buffer

The converter stores up to 8 incidents in the fault buffer. The fault buffer comprises the current incident and the fault history.

The fault buffer is kept when the converter supply voltage is switched off.

		Fault code	Fault value		Fault time received		Fault time removed		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 15-5 Structure of the fault buffer

Current incident

The current incident contains up to 8 active faults.

The faults are sorted by "Fault time received". If the current incident is full and an additional fault occurs, then the converter overwrites the values with Index [7].

	Fault code	Fault value		Fault time received			Fault time removed	
		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 15-6 Current incident

Acknowledging faults

Once the cause of the fault has been eliminated and the fault has been acknowledged, the converter writes the time to "Fault time resolved". The "Fault time resolved" of the faults that have not been resolved remains at 0. To acknowledge a fault, the converter offers the following options:

- Acknowledge via PROFIdrive control signal (STW1 bit 7): r2090.7 = change from 0 signal to 1 signal.
- Acknowledge via binary signal sink:
  r2103 (signal 1 for acknowledging faults)
  r2104 (signal 2 for acknowledging faults)
  r2103 and r2104 are equivalent interconnection options for acknowledging faults.
- Acknowledgement via a digital input

- Acknowledgement via an operating unit or via the commissioning tool
- Acknowledging by switching off/switching on the converter power supply
  The faults active before switch-off are automatically moved to the history when the converter runs up.

Faults detected during converter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again.

Resolved and acknowledged faults are cleared from the active incident. Unresolved faults remain stored in the active incident.

If more than 8 faults are active, then these faults are added to the active incident.

Fault history

Up to 7 incidents, each with 8 already acknowledged faults, are stored in the fault history.

The converter moves the acknowledged faults from the current incident to the fault history as follows:

1. The converter shifts the values previously saved in the fault history by 8 indices.
   The converter deletes the faults that were saved in the indexes [56 ... 63] before acknowledgement.
2. The converter copies the actual incident together with the acknowledged faults to the fault history. The fault history can include acknowledged faults that have still not been resolved (fault time resolved = 0). These faults remain as active faults until they are resolved.

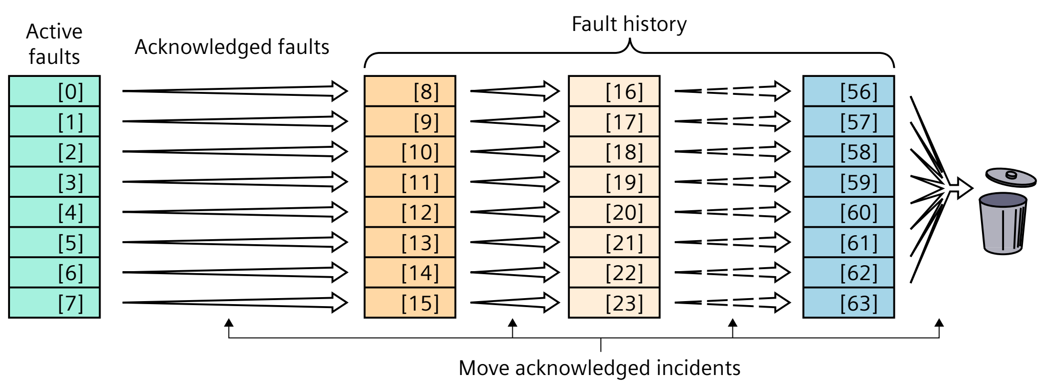


Figure 15-7 Movement of acknowledged faults to the fault history

Parameters

The following list contains the parameters of the "Fault buffer and fault history" function.

Number	Name	Unit
r0945[0...63]	Fault code	
r0948[0...63]	Fault time received in milliseconds	[ms]
r0949[0...63]	Fault value	
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
r3120[0...63]	Component fault
r3122[0...63].0...20	Diagnostic attribute fault

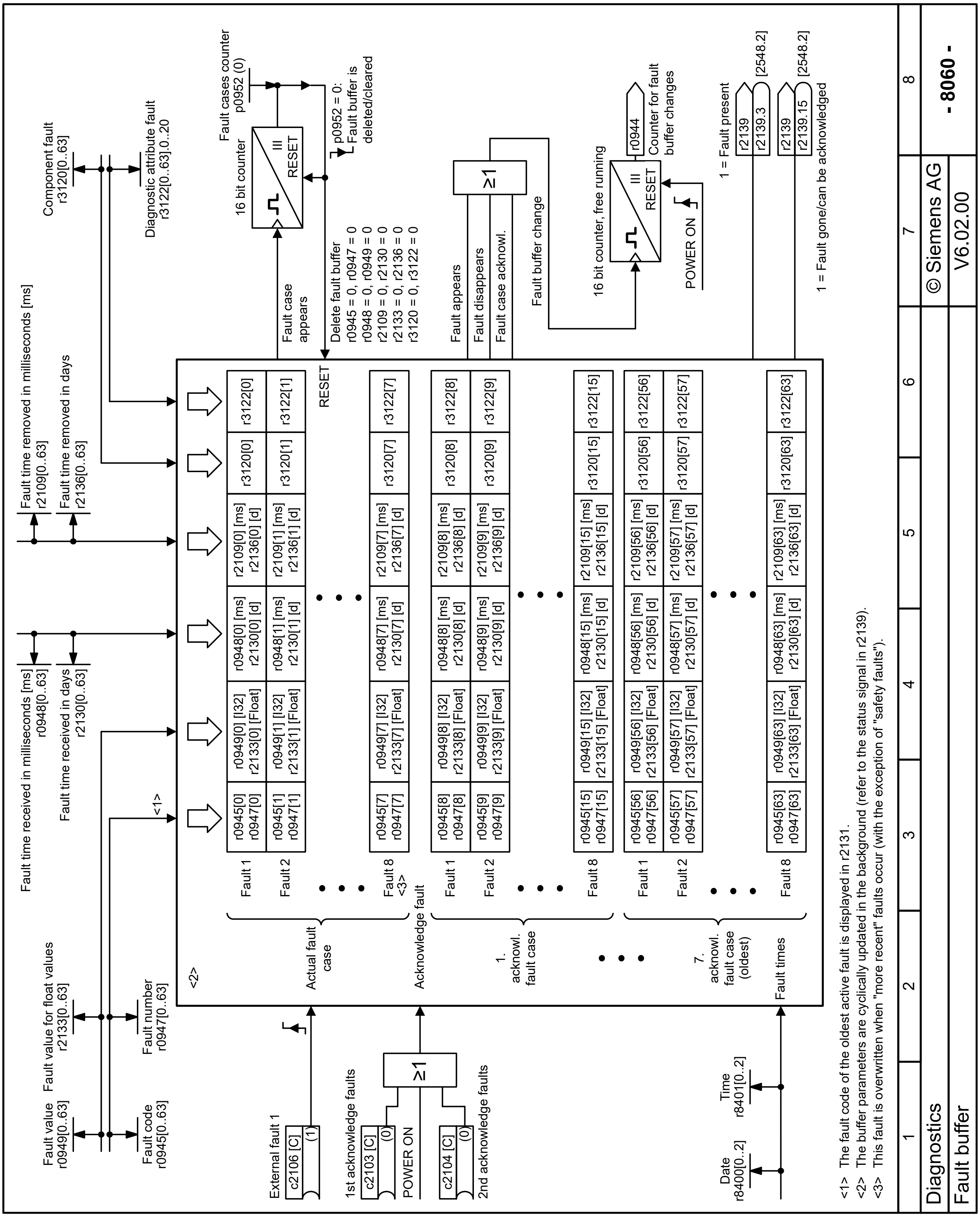


Figure 15-8 8060 - Fault buffer

15.9 Safety message buffer

Overview

The converter stores a limited number of safety messages in a safety message buffer. As a consequence, acknowledged messages are kept for diagnostic purposes.

Description of function

A safety message includes message code, message value and 2 message times. The associated parameters are shown in the following diagram.

In the delivery state (p3117 = 0), safety messages have 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 fault buffer or the alarm buffer.

The message code and the message value describe the message cause. The message value provides additional and more detailed information about the safety message. The message times indicate when the message occurred and when the message was resolved.

Safety message buffer

The entry into the safety message buffer takes place with a delay. Reading out the safety message buffer only makes sense when the converter signals "Safety message active" (r2139.5) and detects a changed safety message buffer (r60044).

The converter stores up to 8 message cases in the safety message buffer. The safety message buffer comprises the current message case and the message history.

The safety message buffer is kept when the converter supply voltage is switched off.

The current message case before the supply voltage is switched off is acknowledged when the supply voltage is switched on again, and it is then in the message history.

		Message code	Message value		Message time received		Message time acknowledged		Component	Diagnostic attributes
			I32	float	Days	ms	Days	ms		
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 15-9 Structure of the safety message buffer

Current message case

The current message case contains up to 8 active messages.

The safety messages are sorted by "Message time received". If the current message case is full and an additional safety message is received, then the converter overwrites the values with Index [7]. Resolved messages are moved to the safety message history.

	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 15-10 Current message case

Acknowledgment of safety messages

Once the cause of the safety message has been eliminated, the converter writes the time to "Message time resolved". The "Message time resolved" of the unresolved safety messages retains the value 0.

Safety messages are acknowledged via a fail-safe digital input (F-DI) or via PROFIsafe.

Resolved and acknowledged safety messages are cleared from the current message case. Unresolved safety messages remain stored in the current message case. If more than 8 messages are active, then these messages are added to the actual message case.

Safety message history

Up to 7 message cases each with 8 already acknowledged safety messages are saved in the safety message history.

The converter moves the acknowledged safety messages from the current message case to the safety message history as follows:

1. The converter shifts the values previously saved in the safety message history by 8 indices. The converter deletes the safety messages that were saved in the indices [56 ... 63] before acknowledgement.
2. The converter copies the actual message case with the acknowledged messages to the safety message history.
   The safety message history can include acknowledged messages that have still not been resolved (fault time resolved = 0) These messages remain as active message until they are resolved.

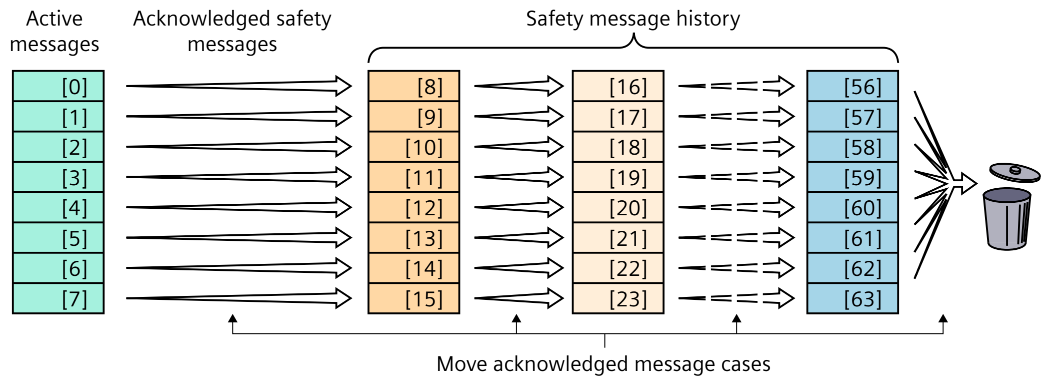


Figure 15-11 Movement of the acknowledged safety messages to the safety message history

Parameters

The following list contains the parameters of the "Safety message buffer and safety message history" function.

Number	Name	Unit
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	

15.10 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

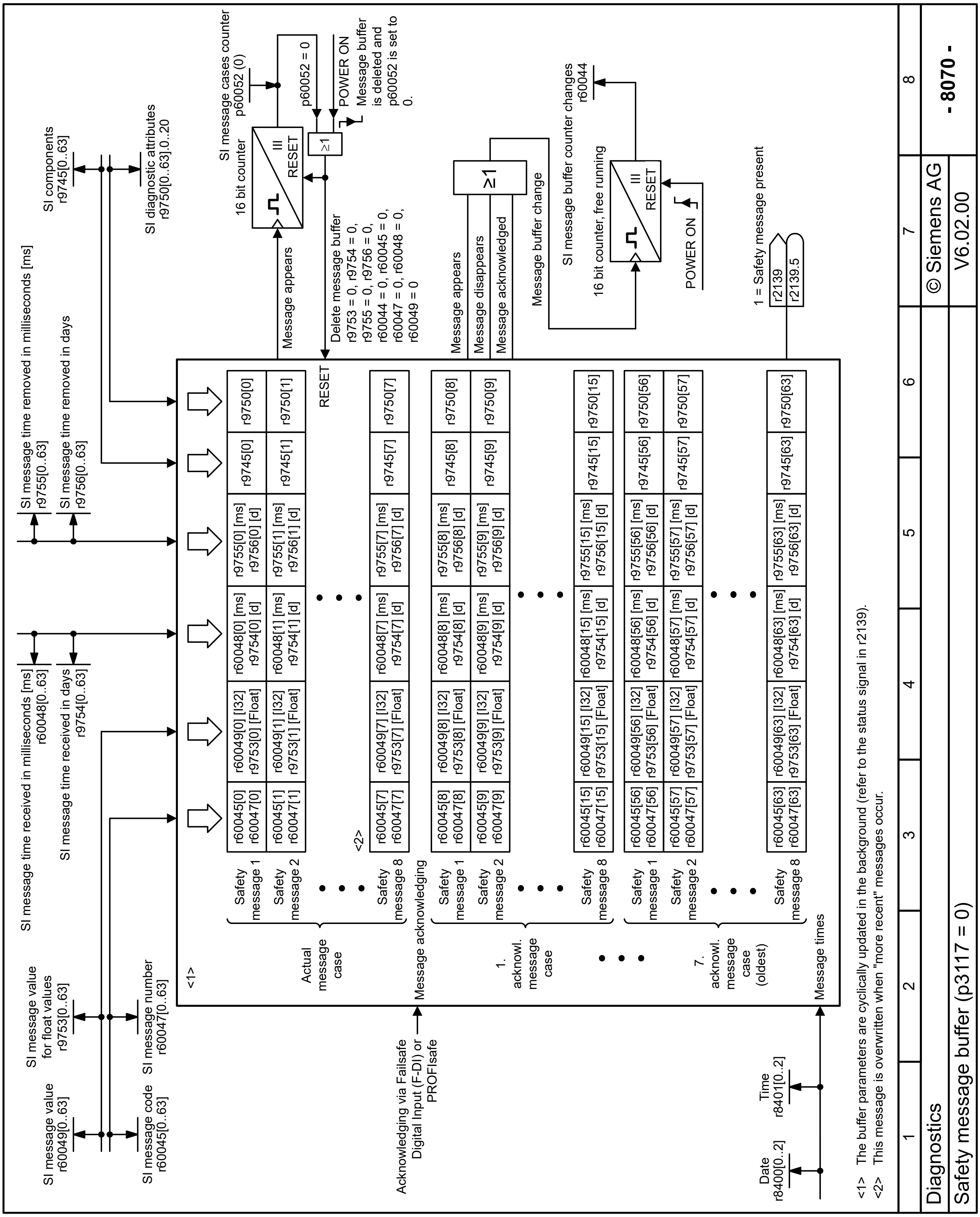


Figure 15-12 8070 - Safety message buffer

Corrective maintenance 16

16.1 Replacing a converter

16.1.1 Replacing a converter

Overview

You may only replace a converter with another converter if certain requirements are adhered to.

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. • Back up the settings of the converter to be replaced by uploading them to an external storage medium, e.g. a memory card. • Transfer the settings of the converter to be replaced by downloading them to the new converter. • If you do not have a backup of the converter settings, recommission the new converter. • Check the new converter for proper functioning.

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 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 power rating, commission the converter as a new converter.

16.1.2 Replacing the converter without memory card

16.1.2.1 Restoring the drive data via the web server

Requirement

- The converter is operated without a memory card.
- You have a backup file of the source converter on your operating unit.
  In the description below, a distinction is made between restoring drive data from an encrypted backup file or from an unencrypted backup file.
- The rated power of the target converter is the same as the rated power of the converter from which the backed-up data and settings originate.
- Ideally, the target converter is in the factory setting.
  It either involves a brand-new target converter or a target converter where all user-defined settings have been restored to the factory setting. You can find more information in Chapter "Full reset of all device settings (Page 768)".

Procedure

1. Switch off the supply voltage of the source converter.
2. Release all of the connections at the source converter, replace the converter and re-establish the connections at the target converter.
3. Switch on the supply voltage of the target converter.
4. Enter the IP address of the target converter, e.g. https://169.254.11.22, in the web browser.
   The web server is started. The "Basic settings" page is displayed.

   Note

   Determining the IP address of the target converter

   You determine the IP address of the target converter, e.g. using the integrated SINAMICS SDI Standard. You can find more information in Chapter "Scanning the IP address (Page 311)".

5. Make the basic settings for the converter.
   You can find more information in Chapter "Basic settings (Page 215)".

6. Click "Next".
   The "Welcome to the Security Wizard" page is displayed.
7. Select the option "Exit the Security Wizard and continue with low security settings".
8. Call the "Backup and restore" menu.
9. Click the "Click to select file, or drag and drop file here" button to select the backup file.
10. To restore the drive data, proceed as described below depending on the specific application.

- **Scenario 1:** The target converter has the same or a higher firmware version.
  - If the drive data are restored from an encrypted backup file, then proceed as follows, see Chapter "Restoring data from an encrypted backup file (Page 764)".
  - If the drive data are restored from an unencrypted backup file, then proceed as follows, see Chapter "Restoring data from an unencrypted backup file (Page 762)".
- **Scenario 2:** The target converter has an older firmware version.
  - The operation is canceled.
  - Restore the firmware to the version of the source converter. The firmware version can be ≥ firmware version of the source converter.

    Note

    Determining the firmware version of the source converter

    Review the machine documentation. Alternatively: Check which firmware version is installed on the other converters of the same type in the machine.

  - Proceed as described in scenario 1.

Result

When running up, the converter retrieves the settings from the backup file. Commissioning has been completed once the converter has run up.

More information

- Update the connected components:
  When the converter runs up after being restored, the connected components are updated. The converter must then be switched off and switched on.

16.1.2.2 Restoring data from an unencrypted backup file

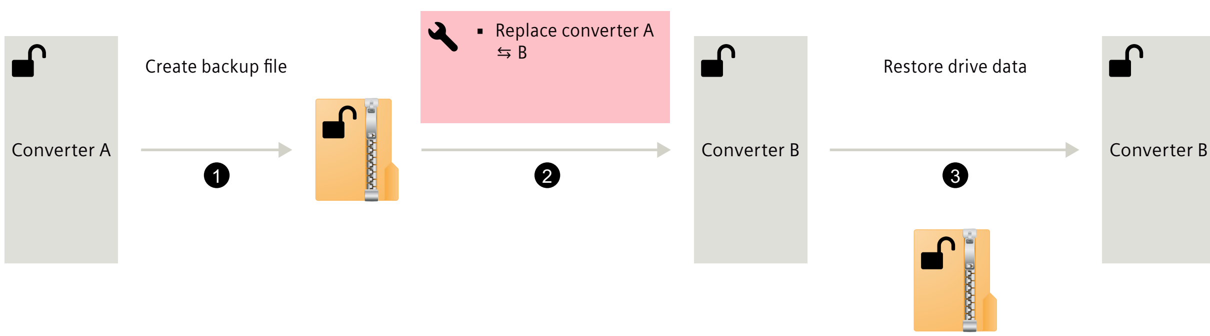
Requirement

- You have an unencrypted backup file of the source converter on your operating unit.
- Rights required for active user management (UMAC):
  - "Create backup or load drive data to Startdrive"
  - If Safety Integrated is contained in the backup file, the "Edit Safety Integrated application" right is required.

Procedure

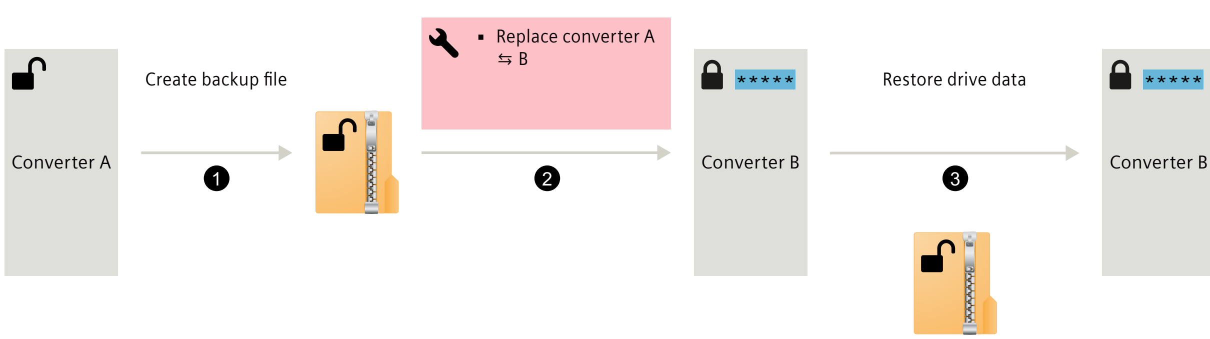
1. Call menu "Backup and restore" in the web server.
2. Navigate to the "Restore drive data from backup file" area.
3. Use the "Click to select file, or drag and drop file here" button to select the backup file.
4. To restore the drive data, proceed as described below depending on the specific application. This step is included in the following diagrams as step 3.

- **Scenario 1:** No drive password is configured in the source and target converters.



  – Click on "Restore".
    The drive data are loaded into the converter from the backup file.
    As a consequence, the status of the settings at the instant of the backup are restored.

- **Scenario 2:** No drive password is configured in the source converter. On the other hand, in the target converter function "Drive data encryption" had been previously activated and a drive password configured.



*****: Drive password for converter B

  – Click on "Restore".
    The drive data are loaded into the converter from the backup file.
    As a consequence, the status of the settings at the instant of the backup are restored.
    Function "Drive data encryption" is activated. The configured drive password is still effective in the target converter after data has been restored.

16.1.2.3 Restoring data from an encrypted backup file

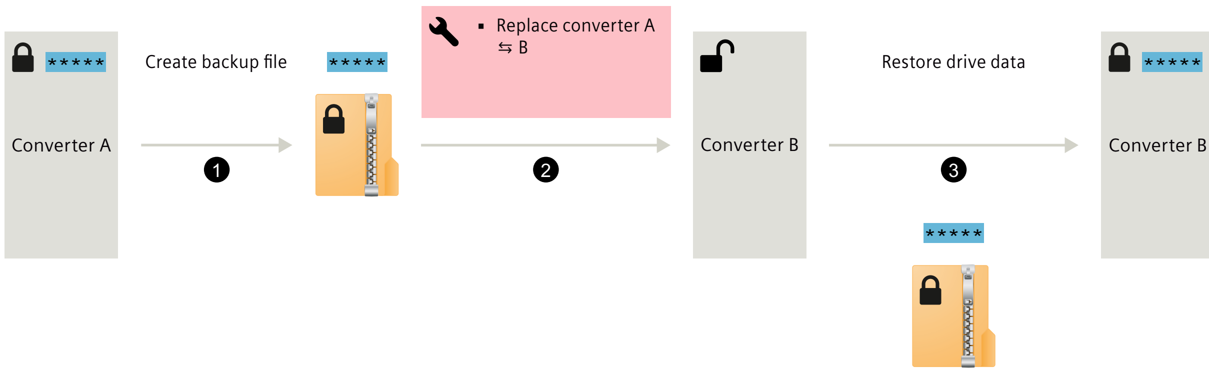
Requirement

- You have an encrypted backup file of the source converter on your operating unit.
- Configured drive password:
  – You know the drive password of the source converter with which the drive data in the backup file were encrypted.
  – You know the drive password of the target converter.
  Only applicable if the drive password of the target converter deviates from the drive password of the source converter.
- Rights required for active user management (UMAC):
  – "Create backup or load drive data to Startdrive"
  – If Safety Integrated is contained in the backup file, the "Edit Safety Integrated application" right is required.

Procedure

1. Call menu "Backup and restore" in the web server.
2. Navigate to the "Restore drive data from backup file" area.
3. Use the "Click to select file, or drag and drop file here" button to select the backup file.
4. To restore the drive data, proceed as described below depending on the specific application.
   This step is included in the following diagrams as step 3.

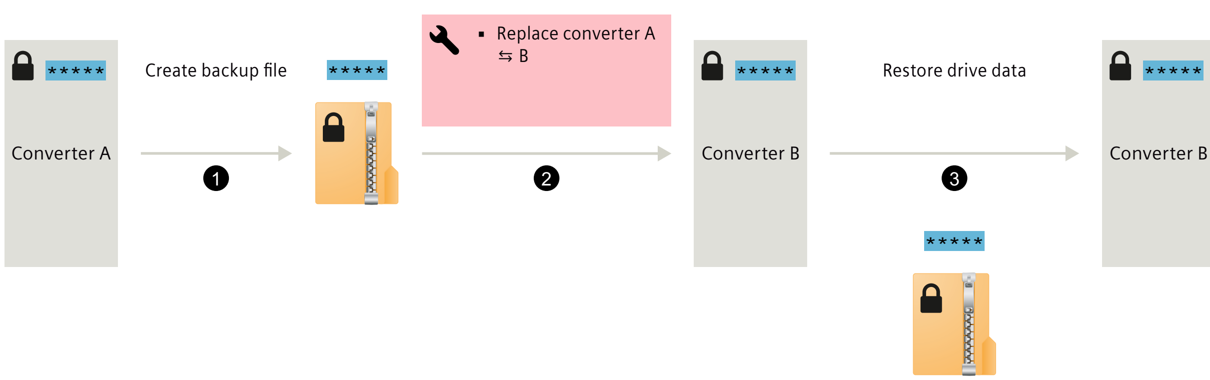
- **Scenario 1:** A drive password is configured in the source converter. On the other hand, function "Drive data encryption" had been previously de-activated in the target converter.



*****: Drive password for converter A

  – Click on "Restore".
    A dialog to enter the password opens.
  – Enter the drive password of the source converter.
    The drive data are loaded into the converter from the backup file.
    As a consequence, the status of the settings at the instant of the backup are restored.
    Function "Drive data encryption" is activated. The drive password of the source converter is transferred to the target converter.

- **Scenario 2:** The same drive password is configured in the source and target converters.

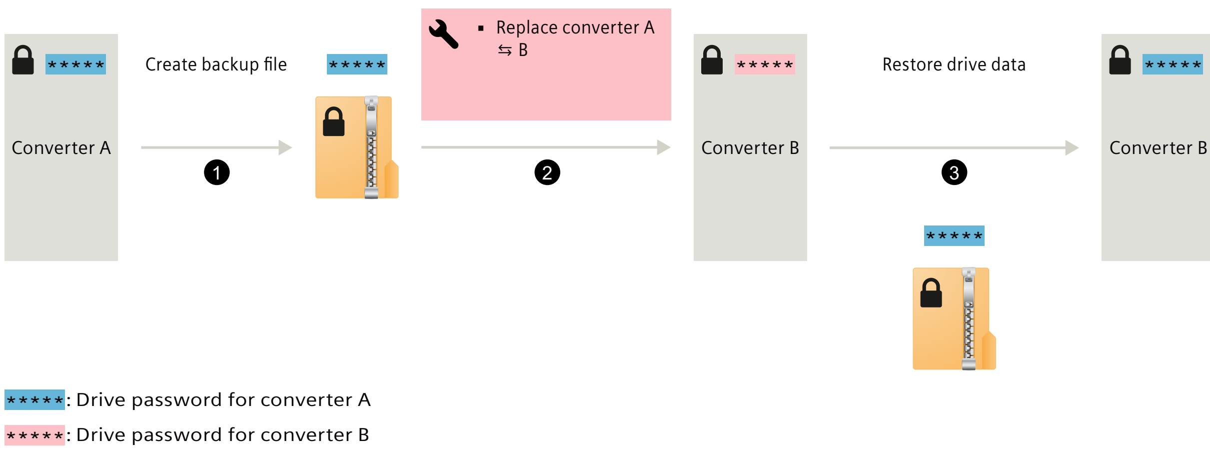


*****: Drive password for converters A and B

  – Click on "Restore".
    A dialog to enter the password opens.
  – Enter the drive password of the target converter.
    A dialog to enter the password opens.

   – Enter the drive password of the source converter.
     The drive data are loaded into the converter from the backup file.
     As a consequence, the status of the settings at the instant of the backup are restored.
     Function "Drive data encryption" is activated. The drive password of the source converter is transferred to the target converter.

- **Scenario 3:** A different drive password is configured in the target converter and the source converter.



   – Click on "Restore".
     A dialog to enter the password opens.
   – Enter the drive password of the target converter.
     A dialog to enter the password opens.
   – Enter the drive password of the source converter.
     The drive data are loaded into the converter from the backup file.
     As a consequence, the status of the settings at the instant of the backup are restored.
     Function "Drive data encryption" is activated. The drive password of the source converter is transferred to the target converter. When doing this, the drive password of the target converter is overwritten.

16.2 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
  - Interface X128 to the edge device if option module OM-IIoT is inserted
- Installed firmware on the converter
- Date and time
- Language setting

16.3 Restore Safety Integrated to factory settings

Overview

It is not always necessary to reset all of the converter settings. A separate reset 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

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 ready for operation and the "RDY" and "BF" LEDs light up green.

Result

The Safety Integrated settings for the converter have been reset.

16.4 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

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:

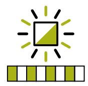
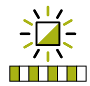
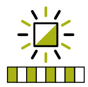
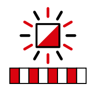
- You can access the converter manually.
- All electrical connections from the converter to the motor are disconnected.
- The PROFINET connection to the control system and other devices is disconnected.
- You have an empty writable SD card with max. 32 GB; e.g. 6SL5970-0AA00-0AA0.

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.
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 user-defined converter settings are deleted with the exception of the communication settings "IP configuration" and "Device name".

The converter firmware is unchanged.

After the manual reset to the factory setting, 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 interface X128 to the edge device are deleted.

16.5 Firmware update via memory card

Overview

The converter firmware can also be updated using a memory card.

Requirement

You have downloaded the corresponding firmware update file from the Internet and saved onto an empty memory card.

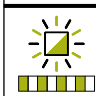
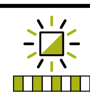
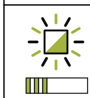
Alternatively, the firmware can be ordered on a memory card.

Procedure

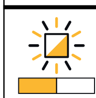
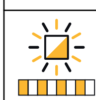
Proceed as follows to update the firmware using a memory card:

1. Switch off the converter supply voltage.
2. Insert the memory card with the appropriate firmware into the converter.

3. Switch on the converter supply voltage.
4. The new firmware is installed. The process requires approx. 2 minutes.

RDY	BF	Explanation of LED displays
		The firmware is being updated. Do not switch off the converter supply voltage.
	-	Firmware update completed

5. Switch off the converter supply voltage.
6. Remove the memory card.
7. Switch on the converter supply voltage.
   If required, the firmware of the 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.

8. Check whether the new version has been installed. The converter firmware version is displayed in a commissioning tool.

More information

You can find information about the firmware versions on the Internet:

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

16.6 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

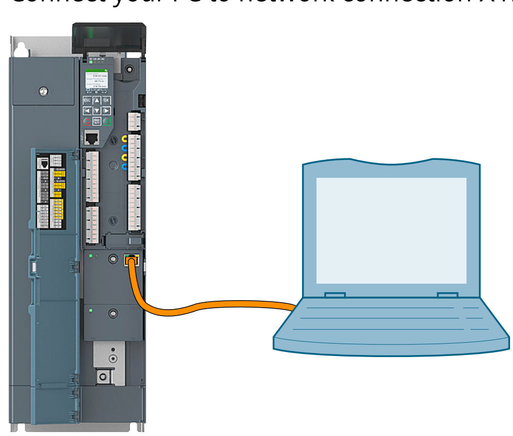
As example, the following data are used in the procedure:

- 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

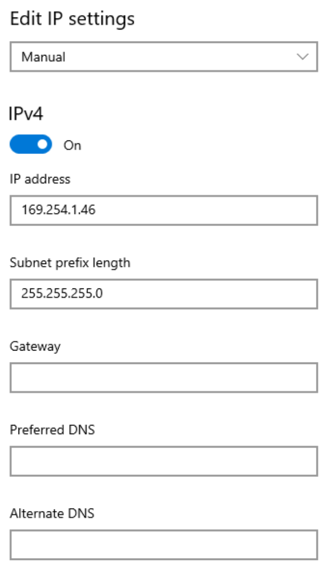
Proceed as follows to update the firmware of option module OM-IIoT:

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 network connection X128 of the OM-IIoT via a network cable.



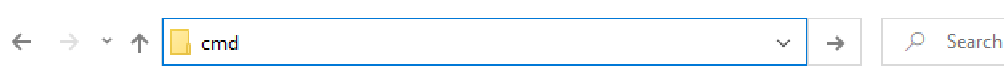
3. Switch on the converter power supply.
4. Wait until LED COM on the OM-IIoT lights up green.

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> _
```

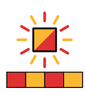
9. Enter command "ping xxx.xxx.xxx.xxx" with the IP address of the OM-IIoT:

```
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:

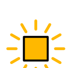
```
Pinging 169.254.1.42 with 32 bytes of data:
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Reply from 169.254.1.42: bytes=32 time=22ms TTL=64
Ping statistics for 169.254.1.42:
    Packets: Sent = 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:

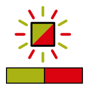


17. Wait until the converter has completely loaded the file for the firmware update:
```
sftp> put -f SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
Uploading SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip to /p4/
SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
SINAMICS_IIoT_Module_firmware_V01_00_013_000.zip
                100% 1170MB 10.2MB/s  01:54
sftp> _
```
After loading, LED COM on the OM-IIoT lights up green:

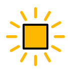
18. Enter command "bye":
```
sftp> bye
D:\IIOT\IIoT_upgrade> _
```
19. Switch off the converter supply voltage.
20. Wait until all LEDs on the converter are dark.
21. Switch on the converter supply voltage again.
22. The LED COM on the OM-IIoT temporarily lights up orange:



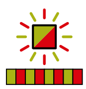
23. If the firmware versions in the OM-IIoT and in the loaded file differ, then the OM-IIoT updates the firmware.
    It takes approximately 5 minutes to update the firmware.
    When updating the firmware, LED COM on the OM-IIoT flashes red and green alternating:

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.

16.7 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

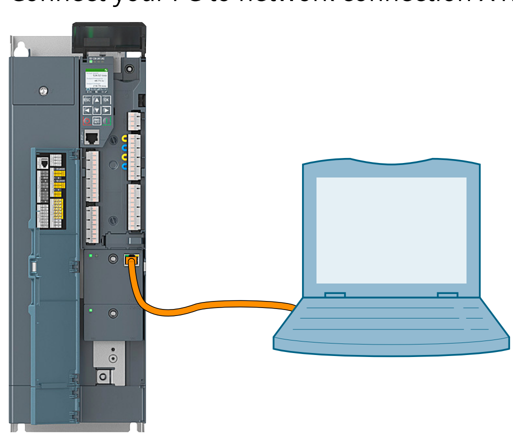
As example, the following data are used in the procedure:

- 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

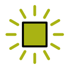
Proceed as follows when deleting the Public Key in option module OM-IIoT:

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 network connection X128 of the OM-IIoT via a network cable.

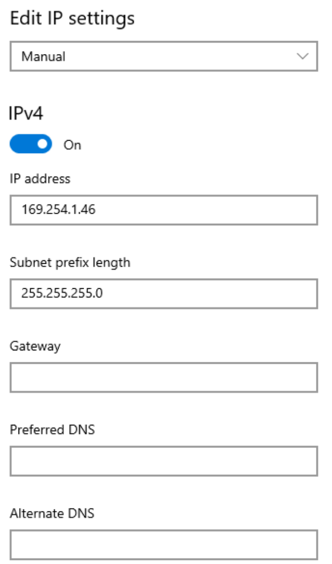


4. Switch on the converter power supply.

5. Wait until LED COM on the OM-IIoT lights up green.

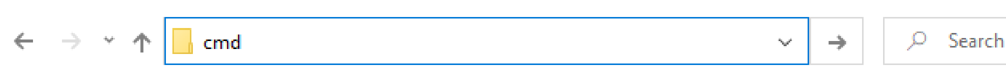


6. Configure the IP address and the subnet mask of your PC.



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.

16.8 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:

<table>
<tr><th rowspan="2">Measure</th><th rowspan="2">Converter warning after component replacement</th><th colspan="2">Reduced acceptance test</th></tr>
<tr><th>Acceptance test</th><th>Documentation</th></tr>
<tr><td>Converter replacement</td><td>No [1)]</td><td rowspan="4">• 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</td><td rowspan="2">• Supplement converter data
• Supplement hardware version and firmware version in the converter data.
• Log new checksums
• Countersignature</td></tr>
<tr><td>Encoder replacement</td><td>Yes</td></tr>
<tr><td>Motor replacement</td><td>No</td><td rowspan="2">No change</td></tr>
<tr><td>Gearbox replacement</td><td>No</td></tr>
<tr><td>Replacement of the OM-SMT option module</td><td>Yes</td><td>Test of the SMT function
• Short-circuit, test sensor cable
• Test wire break</td><td>• Supplement converter data
• Log new checksums
• Countersignature</td></tr>
<tr><td>Replacing safety-related I/O devices (e.g. Emergency Stop switch).</td><td>No</td><td>Check the control of the safety functions affected by the components that have been replaced.</td><td>No change</td></tr>
<tr><td>Converter firmware update</td><td>No</td><td>No</td><td>• Supplement firmware version in the converter data
• Log new checksums
• Countersignature</td></tr>
</table>

[1)] After the converter has been replaced and the backed up settings have been transferred, the converter is ready to use.

16.9 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.

16.10 Spare parts

Spare parts can be ordered on the Internet via the spare parts service Spares on Web (https://www.sow.siemens.com).

Spares on Web also gives you the option of determining the article numbers of spare parts.

16.11 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 cause 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).

16.12 Replacing fans

16.12.1 Replace fan unit, converter with IP20 degree of protection

Overview

The fan unit at the top of the converter must be replaced if a fan is defective or if the fan has reached its maximum operating period.

Requirement

⚠ WARNING

Electric shock when live parts are touched

After the fan unit is 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.
- Check that the fan unit is de-energized before removing it.
- Wait until the discharge time specified on the warning labels has elapsed.

The following requirements apply when the fan unit is replaced:

- Comply with ESD regulations.
- Only qualified personnel may replace the fan unit.
- 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

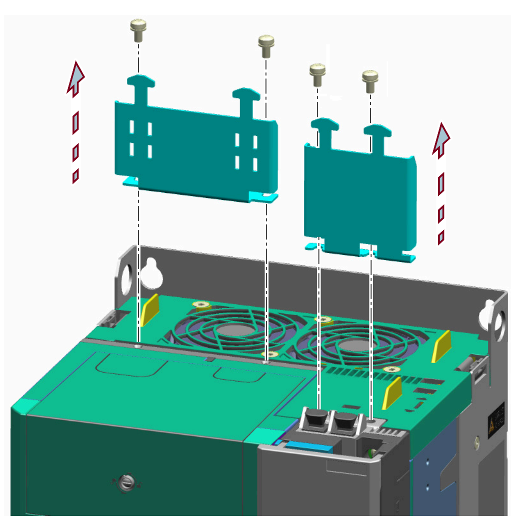
Procedure

The procedure to remove and install the fan unit is identical for all converter sizes. The fan unit differs in terms of the size and the number of fans contained.

The following procedure describes removing and installing the fan unit using a converter, frame size FSE as example.

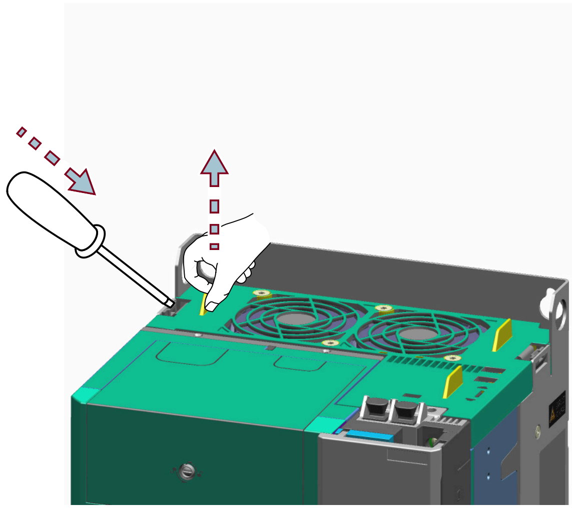
Proceed as follows to remove the fan unit:

1. Remove the shield connection plate by undoing the 2 screws using a torx screwdriver.

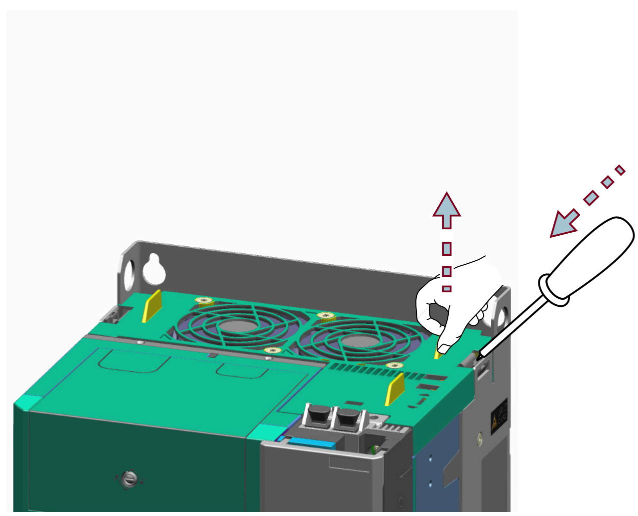


2. For converters, frame sizes FSA ... FSC, withdraw the connector for the braking resistor.

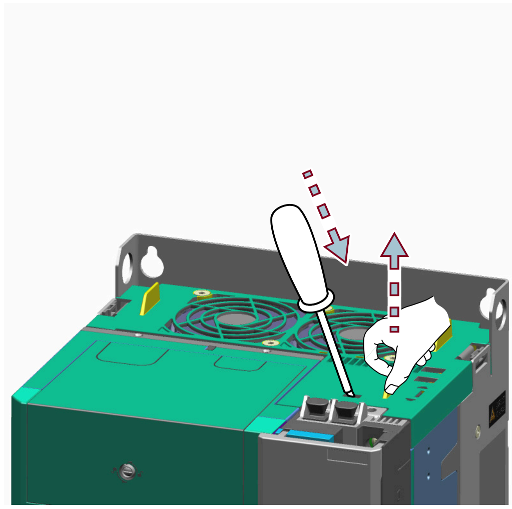
3. Press a slotted screwdriver against one of the two rear catches and at the same time pull the corresponding side of the fan unit out of the housing using the lug.



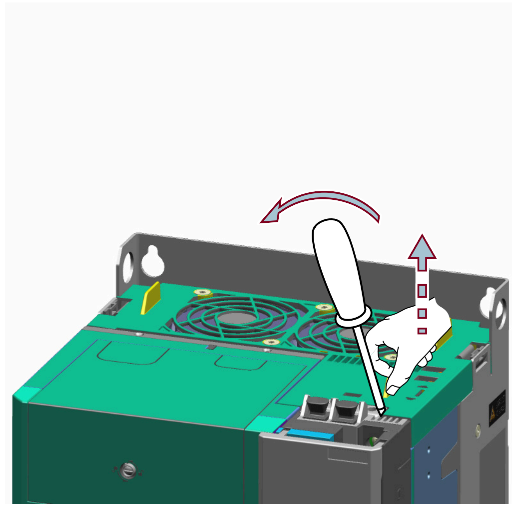
4. Press a slotted screwdriver against the other of the two rear catches and at the same time pull the corresponding side of the fan unit out of the housing using the lug.



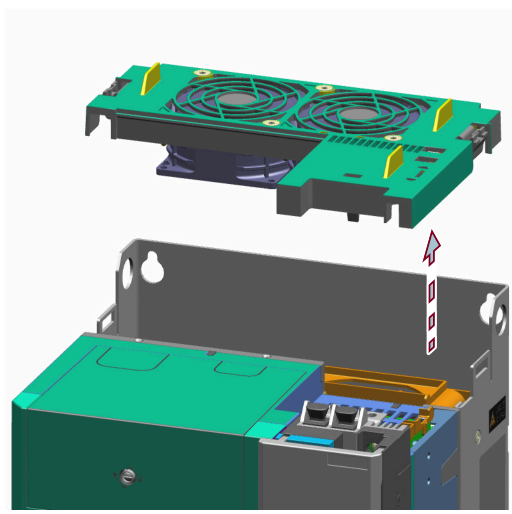
5. Press a slotted screwdriver against the front catch and at the same time pull the corresponding side of the fan unit out of the housing using the lug.



6. Using the slotted screwdriver, lever the fan unit out of the plug-in connection at the front.



7. Withdraw the fan unit vertically upward out of the housing.



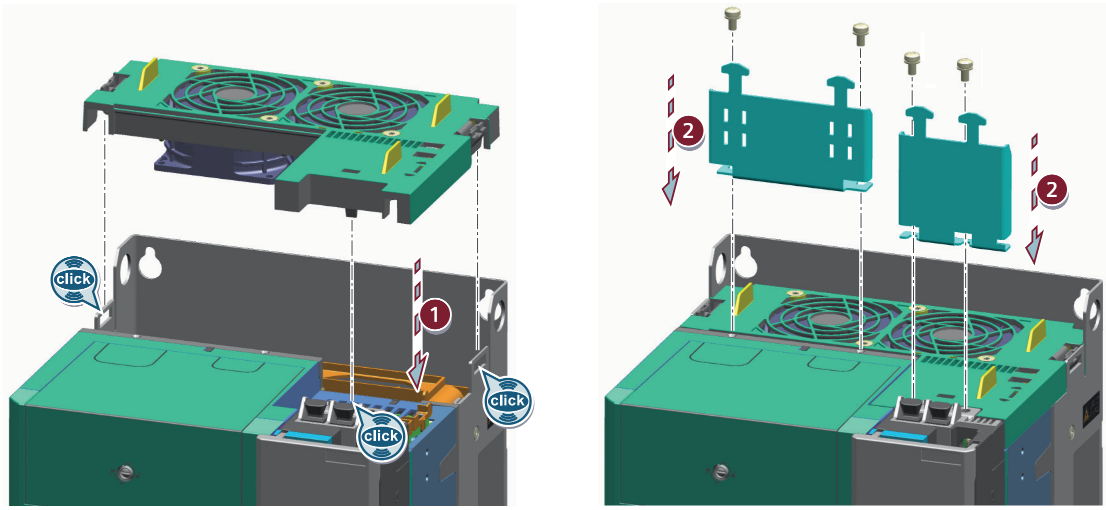


Figure 16-1 IP20 fan mounting, installation

Proceed as follows to install the new fan unit:

1. Place the new fan unit in the converter housing.
   Press the fan subassembly 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.

16.12.2 Replace fan unit, converter with IP55 degree of protection, frame sizes FSB-FSC

Overview

The fan unit at the top of the converter must be replaced if a fan is defective or if the fan has reached its maximum operating period.

Requirement

⚠ WARNING
Electric shock when live parts are touched
After the fan unit is 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. • Check that the fan unit is de-energized before removing it. • 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 fan unit is removed incorrectly. • Detach the fan unit connection plug before completely removing the fan unit from the converter.

The following requirements apply when the fan unit is replaced:

- Comply with ESD regulations.
- Only qualified personnel may replace the fan unit.
- Required tools:
  - Torx screwdriver TX 20

Procedure

The procedure for removing and installing the main fan subassemblies is identical for frame sizes FSB and FSC.

The following procedure describes removing and installing the main fan using a converter, frame size FSC as example.

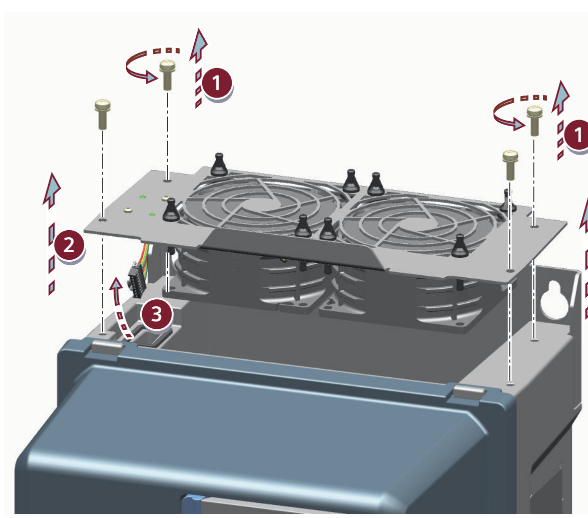


Figure 16-2 IP55 main fan, removal FSC

Proceed as follows to remove the fan unit:

1. Using a torx screwdriver, release the 4 fixing screws of the fan unit and remove it.
2. Slightly raise the fan unit.
3. Release the catch of the connection plug and withdraw the plug upwards. Remove the fan unit.

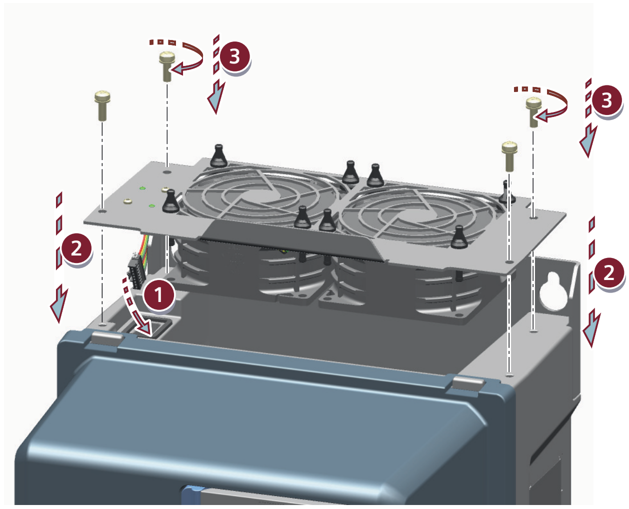


Figure 16-3 IP55 main fan, installation FSC

Proceed as follows to install the new fan unit:

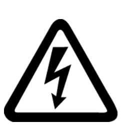
1. Insert the connector for the electrical connection of the fan unit into the socket in the converter housing. Carefully ensure that the connector audibly snaps into place. The power supply for the fan is therefore established.
2. Place the fan unit in the converter housing.
3. Using a torx screwdriver, tighten the 4 fixing screws of the fan unit. Tightening torque: 2 Nm.

16.12.3 Replace fan unit, converter with IP55 degree of protection, frame sizes FSD1-FSE

Overview

The fan unit at the top of the converter must be replaced if a fan is defective or if the fan has reached its maximum operating period.

Requirement



⚠ WARNING

Electric shock when live parts are touched

After the fan unit is 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.
- Check that the fan unit is de-energized before removing it.
- 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 fan unit is removed incorrectly. • Detach the fan unit connection plug before completely removing the fan unit from the converter.

The following requirements apply when the fan unit is replaced:

- Comply with ESD regulations.
- Only qualified personnel may replace the fan unit.
- The converter housing cover has been removed.
- Required tools:
  - Torx screwdriver TX 20

Procedure

The procedure for removing and installing the main fan is identical for frame sizes FSD1, FSD2 and FSE. The fan unit differs in terms of the size, the number of fans contained and the number of fixing screws.

The following procedure describes removing and installing the main fan using a converter, frame size FSD2 as example.

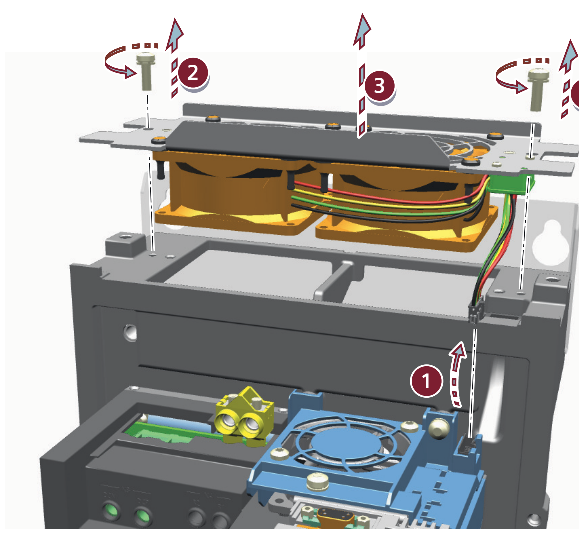


Figure 16-4 IP55 main fan, removal

Proceed as follows to remove the fan unit:

1. Release the catch of the connection plug and withdraw the plug upwards.
2. Using a torx screwdriver, release the fixing screws of the fan unit and remove the fixing screws.
3. Pull the connection plug through its opening as you slowly lift the fan unit upwards.

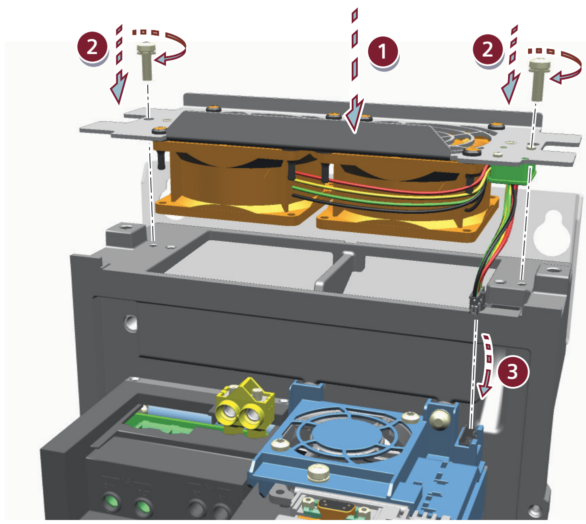


Figure 16-5 IP55 main fan, installation

Proceed as follows to install the new fan unit:

1. Push the connection plug through its opening as you slowly move the fan unit downwards to insert it.
2. Using a torx screwdriver, tighten the fixing screws of the fan unit. Tightening torque: 3 Nm.
3. Insert the connector for the electrical connection of the fan unit into the socket in the converter housing. Carefully ensure that the connector audibly snaps into place.

16.12.4 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.

Removing and installing the housing cover is identical for all converter frame sizes.

The following procedure describes removing and installing the housing cover using a converter, frame size FSC as example.

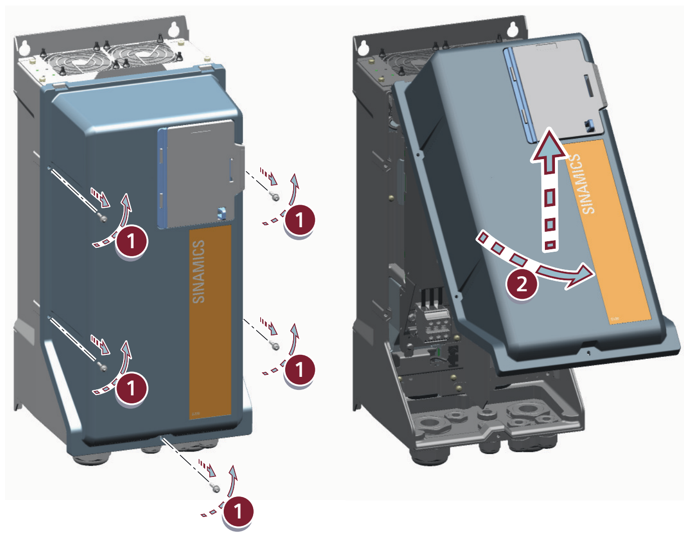
Requirement

The following requirements apply when the housing cover is removed:

- Comply with ESD regulations.
- Required tools:
  - Torx screwdriver TX 20

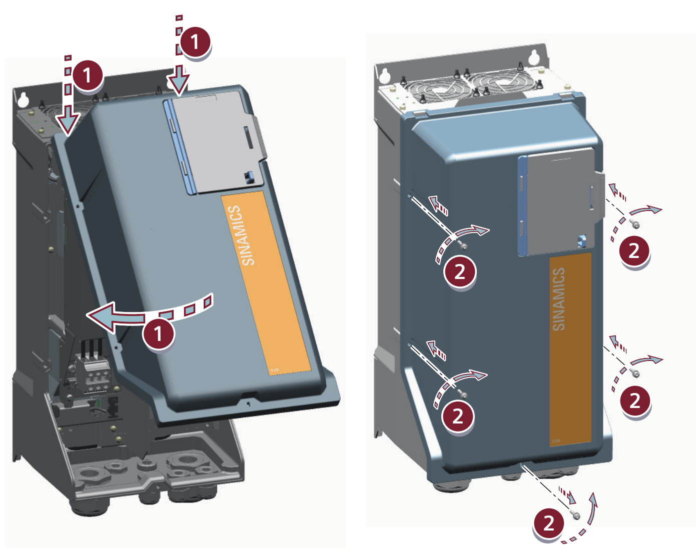
Procedure

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. Tightening torque: 2 Nm

16.12.5 Replace interior fan, converter with IP55 degree of protection, frame sizes FSB-FSC

Overview

The internal fan must be replaced if a fan is defective or if the fan has reached its maximum operating period.

Requirement

WARNING

Electric shock when live parts are touched

After the internal fan is 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.
- Check that the internal fan is de-energized before removing it.
- Wait until the discharge time specified on the warning labels has elapsed.

The following requirements apply when the internal fan is replaced:

- 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 procedure for removing and installing the internal fan is identical for frame sizes FSB and FSC. The internal fan differs in terms of the position and number of the fixing screws.

The following procedure describes removing and installing the internal fan for frame sizes FSB and FSC using a converter of frame size FSC as example.

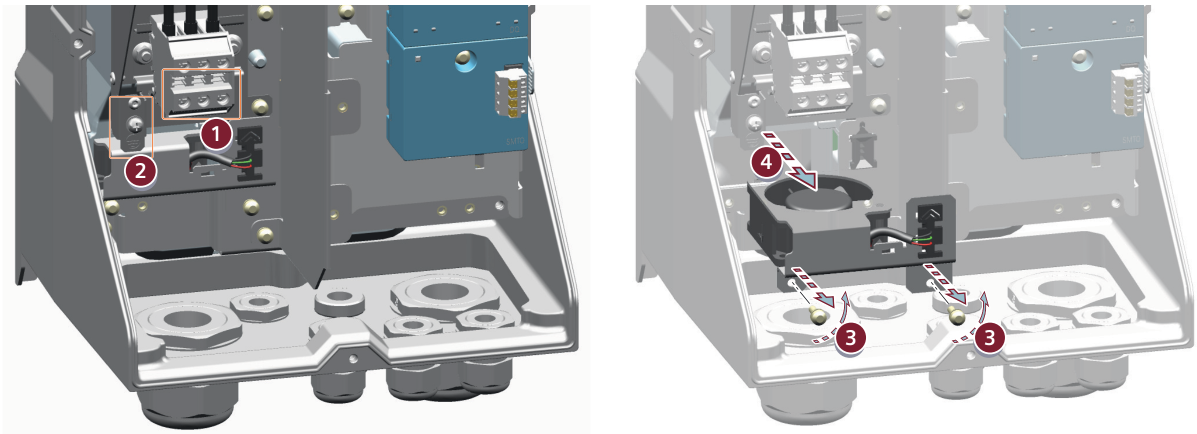


Figure 16-6 IP55 internal fan, removal FSC

Proceed as follows to remove the internal 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 internal fan and remove the fixing screws.
4. Pull the internal fan forwards and out of the converter. Carefully ensure that the plug-in connection of the electrical connection does not skew when it is pulled out.

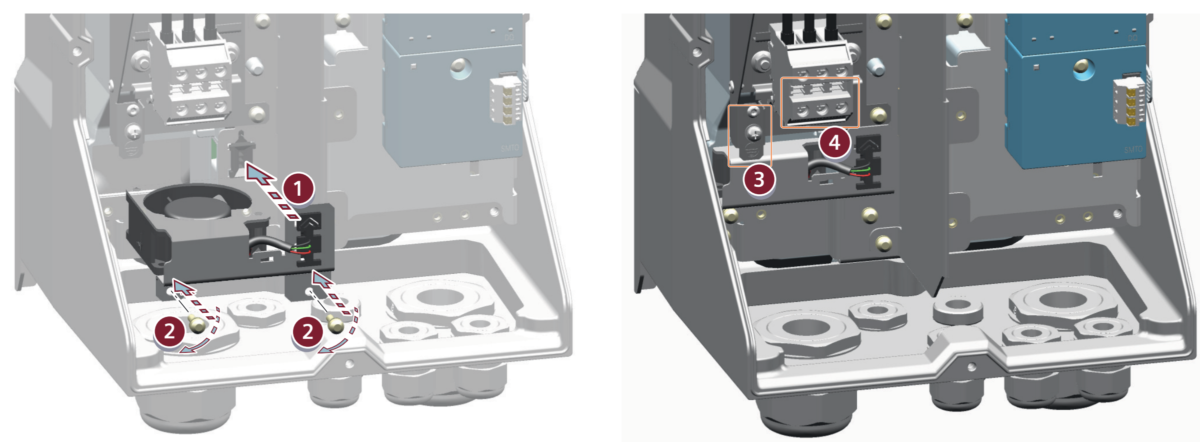


Figure 16-7 IP55 internal fan, installation FSC

Proceed as follows to install the internal fan:

1. Insert the internal fan into the converter.
2. Using a torx screwdriver, tighten the fixing screws of the internal fan (depending on the size, 1 or 2x). Tightening torque: 2 Nm.
3. Connect the protective conductor.
4. Connect the power supply cable.

16.12.6 Replace interior fan, converter with IP55 degree of protection, frame sizes FSD1-FSE

Overview

The internal fan must be replaced if a fan is defective or if the fan has reached its maximum operating period.

Requirement

WARNING

Electric shock when live parts are touched

After the internal fan is 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.

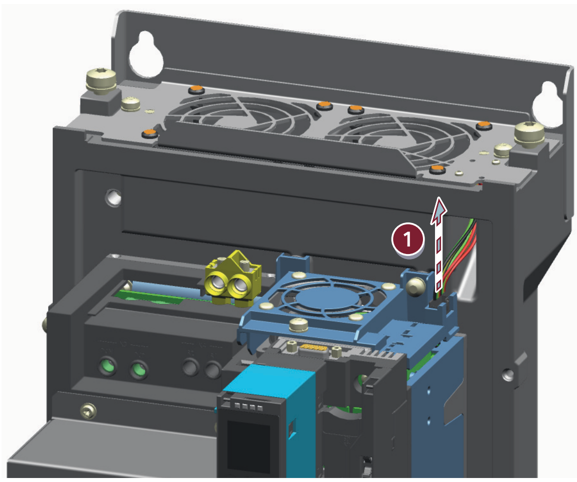
- Before replacing the fan, switch off the power supply at terminals X1:L1, L2, L3.
- Check that the internal fan is de-energized before removing it.
- Wait until the discharge time specified on the warning labels has elapsed.

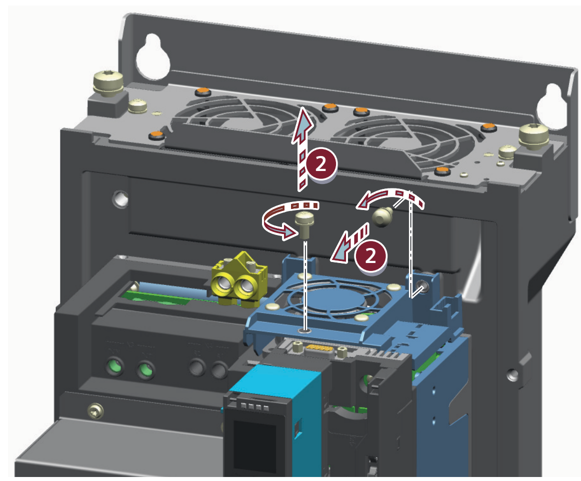
The following requirements apply when the internal fan is replaced:

- 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 procedure for removing and installing the internal fan is identical for frame sizes FSD1, FSD2 and FSE. The internal fan differs in terms of the position of the fixing screws.





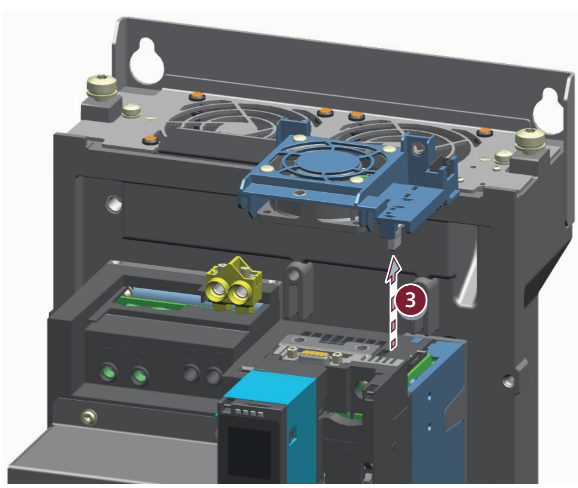


Figure 16-8 IP55 internal fan, removal FSD2

The following procedure describes removing and installing the internal fan for frame sizes FSD1, FSD2 and FSE using a converter of frame size FSD2 as example.

Proceed as follows to remove the internal fan:

1. Release the plug-in connection of the fan unit connection cable.
2. Using a torx screwdriver, release the fixing screws of the internal fan and remove the fixing screws.
3. Pull the internal fan upwards and out of the converter. Carefully ensure that the internal fan connector does not skew when it is removed.

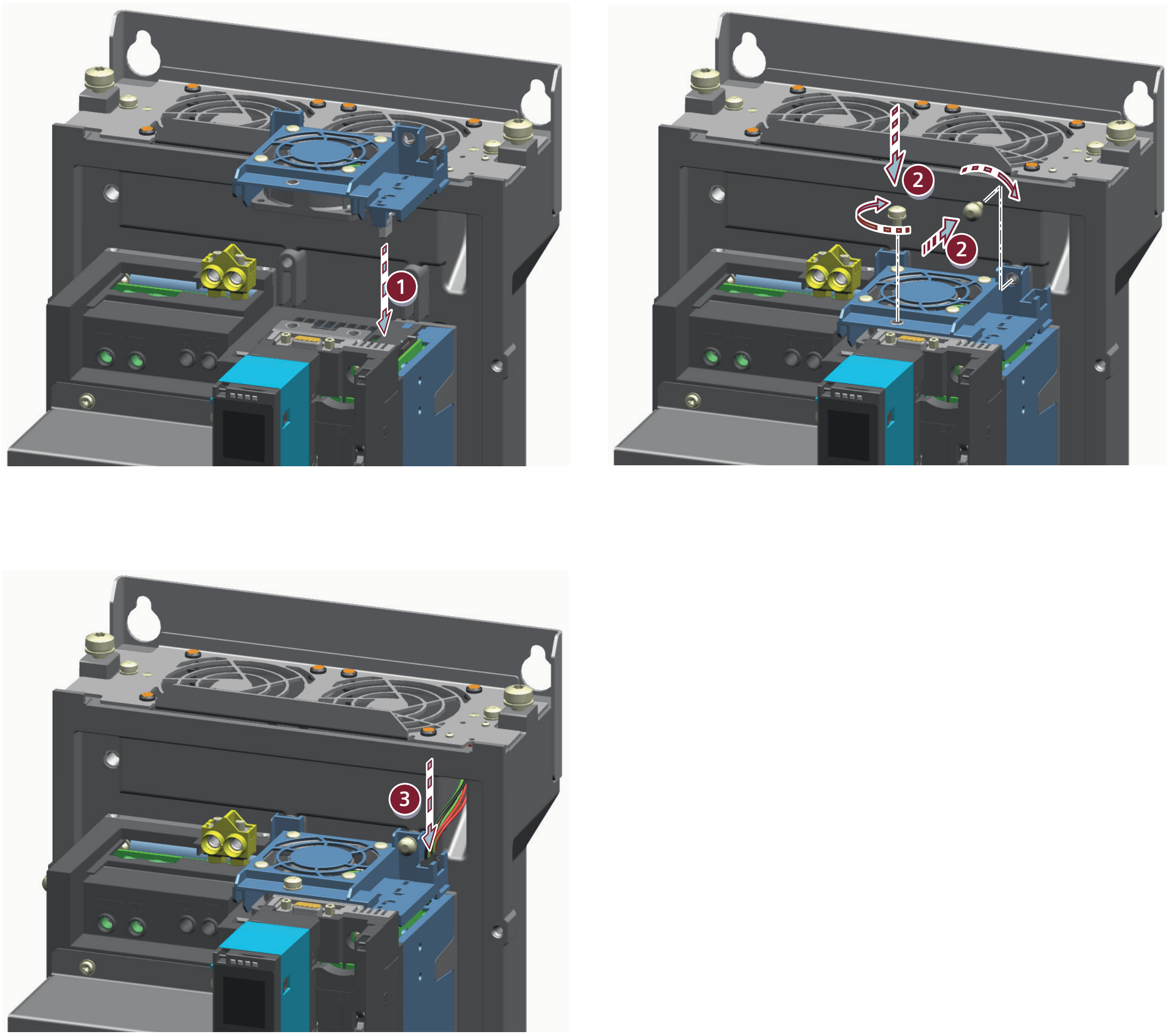


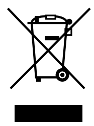
Figure 16-9 IP55 internal fan, installation FSD2

Proceed as follows to install the internal fan:

1. Insert the internal fan from above into the converter housing.
2. Using a torx screwdriver, tighten the fixing screws of the internal fan. Tightening torque: 3 Nm.
3. Push the fan unit connector into the converter socket until the connector engages with a click.

16.13 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.

17 Technical data

17.1 General technical specifications

Technical specifications

Table 17-1 General data of the converter

Property	Value
Line voltage	3 AC 200 V ... 240 V + 10 % - 20 % 3 AC 380 V ... 415 V + 10 % - 20 % 3 AC 440 V ... 500 V + 10 % - 20 %
Input frequency	50/60 Hz (47 ... 63 Hz)
R_{SC} 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
Pulse frequency	4 kHz (factory setting) The pulse frequency can be set in the range 2 ... 16 kHz.
Type of cooling	Air cooling using an integrated fan
Service life of the fan	40000 h
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 the connected converters

17.2 Environmental conditions

17.2.1 Mechanical environmental conditions

Technical data

Table 17-2 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 according to IEC 60721-3-3:2002	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 direction
		Shock test according to IEC 60068-2-27 test Ea (half-sine) • Peak acceleration: 5 g • Duration: 30 ms • 3 shocks per direction

Table 17-3 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.

17.2.2 Chemical environmental conditions

Technical specifications

Table 17-4 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	

17.2.3 Biological environmental conditions

Technical data

Table 17-5 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.

17.2.4 Climatic conditions

Technical data

Table 17-6 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 • Humidity 5 ... 95 % • Storage altitude ≤ 4000 m • Condensation, splash water, icing, salt spray not permissible
Transport	Class 2K4 according to IEC 60721-3-2:1997	• In the transport packaging • Temperature -40 ... +70 °C • Humidity 5 ... 95 %
Operation	Class 3K3 in accordance with IEC 60721-3-3 Ed. 2.2: 2002	• With increased ruggedness with respect to relative humidity • Temperature -20 ... +60 °C for IP20 degree of protection • Temperature -20 ... +50 °C for IP55 degree of protection • Relative humidity 5 ... 95 % no condensation (better than Class 3K3) • Ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted.

17.3 Power, input current, output current

17.3.1 200 ... 240 V 3 AC

Technical specifications

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 17-7 Power and currents

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	1.5 0	2.20	3.00	4.00
	With High Overload	kW	0.37	0.55	0.75	1.10	1.50	2.20	3.00
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 at 230 V	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	6.0	8.6	10.9	14.8
Output current at 230 V	Without Overload	A	4.1	4.9	6.7	8.8	11.3	14.9	19.5
	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
Input current at 240 V	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	3.9	6.2	7.2	10.1	13.2
Output current at 240 V	Without Overload	A	3.3	4.4	6.2	7.0	9.9	12.8	15.6
	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

Table 17-8 Power and currents

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
Rated power at 240 V	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 at 230 V	With Low Overload	A	21.7	29.5	41.8	53.9	66.5	76.0	103.2
	With High Overload	A	16.8	25.7	39.9	43.2	61.3	69.5	91.1
Output current at 230 V	Without Overload	A	27.7	34.9	47.2	64.7	77.0	92.4	114.9
	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
Input current at 240 V	With Low Overload	A	20.1	26.6	39.5	49.7	62.5	72.1	96.1
	With High Overload	A	15.2	22.9	28.9	42.4	54.5	67.3	81.1
Output current at 240 V	Without Overload	A	22.6	28.8	43.1	55.4	69.8	82.1	106.7
	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

17.3.2 380 V ... 415 V 3 AC / 440 V ... 500 V 3 AC

Technical specifications

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 17-9 Power and currents

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
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 at 400 V	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	3.7	4.4	6.1	8.1	10.7	14.5 12.7[1)]
Output current at 400 V	Without Overload	A	4.1	4.9	6.7	8.8	11.3	14.9	19.5
	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
Input current at 480 V	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	2.3	3.6	3.8	5.2	6.5	8.3	12.1 10.6[1)]
Output current at 480 V	Without Overload	A	3.1	3.5	5.0	6.4	7.8	11.3	14.4
	With Low Overload	A	3.0	3.4	4.8	6.2	7.6	11.0	14.0
	With High Overload	A	2.10	3.0	3.4	4.8	6.2	7.6	11.0
Output current for synchronous reluctance motors for 400 V		A	3.9	4.7	6.5	8.5	11.0	14.5	19.0

1) The data apply to Clean Power converters

Table 17-10 Power and currents

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
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 at 400 V	With Low Overload	A	23.3 20.6 [1]	31.3 28.0 [1]	37.8 33.5 [1]	44.9 40.1 [1]	59.9 52.9 [1]	72.6 65.3 [1]	86.7 77.5 [1]	105.9 95.1 [1]
	With High Overload	A	18.0 15.9 [1]	27.3 24.4 [1]	35 31.3 [1]	43 38.3 [1]	48 42.4 [1]	67 60.2 [1]	79 70.9 [1]	93 83.9 [1]
Output current at 400 V	Without Overload	A	27.7	34.9	41.1	47.2	64.7	77.0	92.4	114.9
	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
Input current at 480 V	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 12.8 [1]	21.7 19.8 [1]	27.5 24.8 [1]	35.0 32.1 [1]	42.0 37.6 [1]	52.6 48.9 [1]	66.1 60.8 [1]	77.7 72.2 [1]
Output current at 480 V	Without Overload	A	21.6	27.7	34.9	41.1	53.4	66.7	79.0	98.5
	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
Output current for synchronous reluctance motors for 400 V		A	27.0	35.0	43.0	50.0	69.0	85.0	103.0	123.0

[1] The data apply to Clean Power converters

17.3.3 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)

17.3.4 "Low Overload" and "High Overload" duty cycles

Technical data

The following diagrams show the overload capability of the converter when operating a standard induction motor.

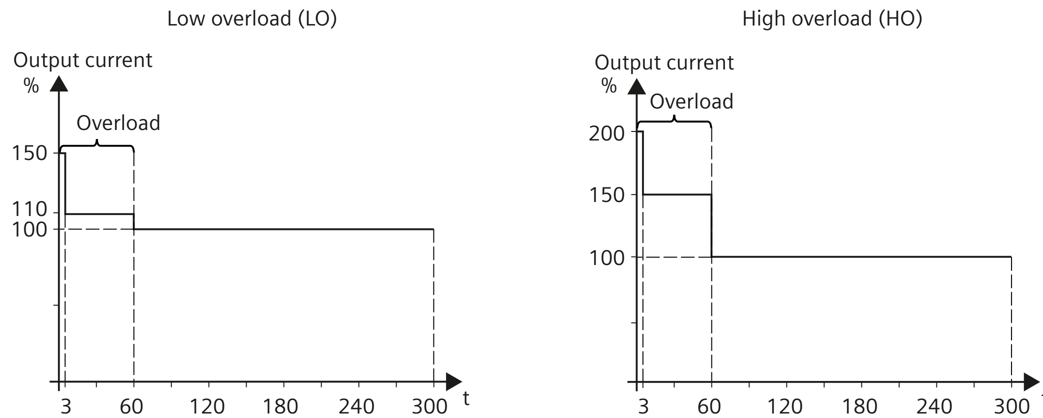


Table 17-11 "Low Overload" and "High Overload" duty cycles

Duty cycle	Duration without overload	Overload as a %	Overload duration	Overload as a %	Overload duration
Low Overload	240 s	150%	3 s	110%	57 s
High Overload	240 s	200%	3 s	150%	57 s

17.3.5 Duty cycle for synchronous reluctance motors

Technical data

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

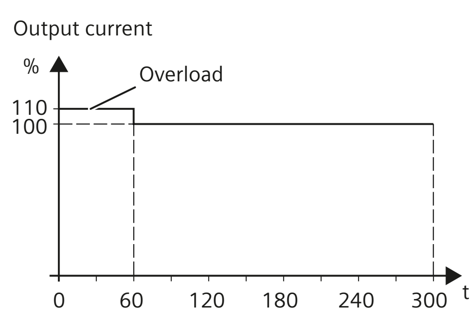


Table 17-12 Duty cycle with a synchronous reluctance motor

Duration without overload	Overload as a %	Overload duration
240 s	110 %	60 s

17.3.6 Braking resistor connections

Technical data

Table 17-13 Data of the braking chopper integrated in the converter

Property	Data		
Maximum braking power	100 % of the converter rated power with Low Overload		
Maximum load time	Frame sizes FSA ... FSC	240 s	
	Frame sizes FSD1 ... FSE	120 s	
Cycle time	240 s		Cycle time = load time + cooling time
Overcurrent protection	Yes		

17.4 Permissible output current depending on 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.

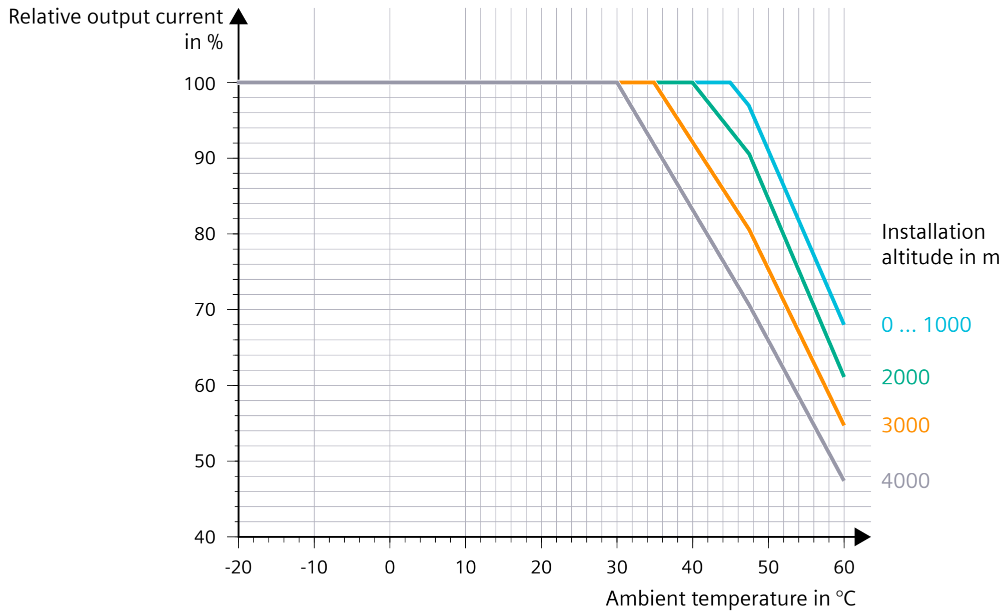


Figure 17-1 Current reduction according to "Low Overload" duty cycle

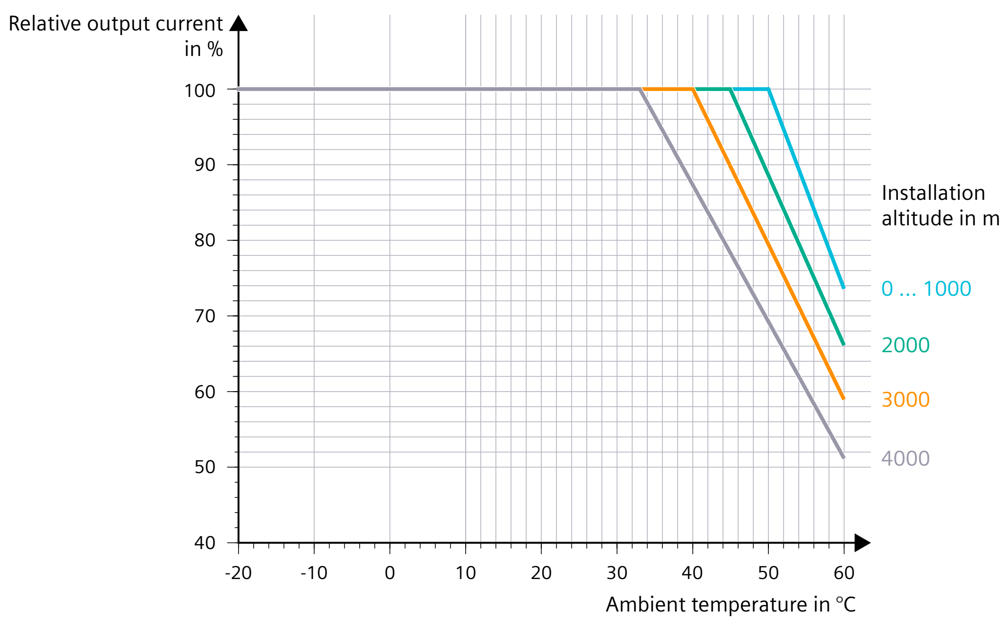


Figure 17-2 Current reduction according to "High Overload" duty cycle

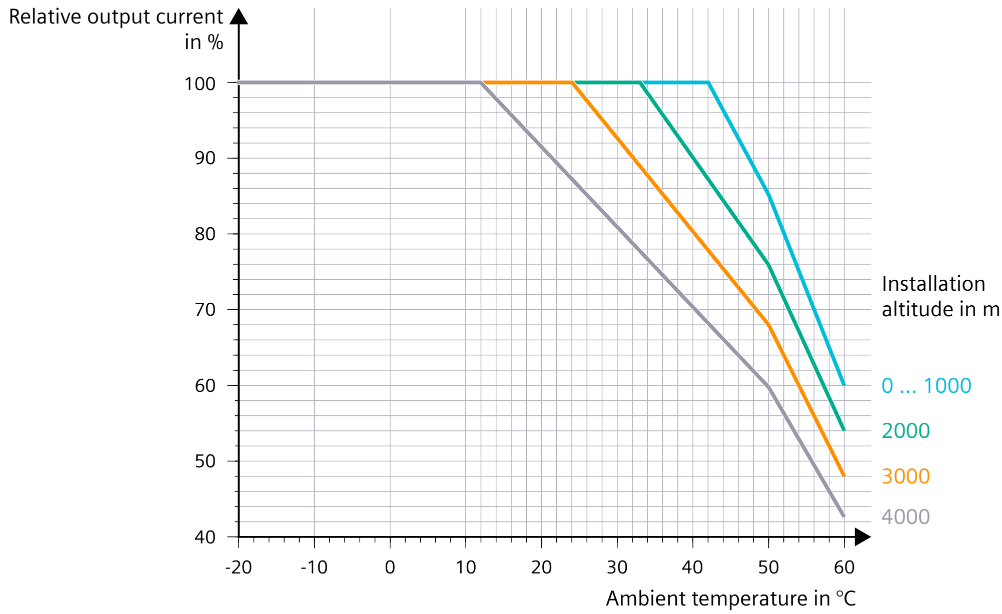


Figure 17-3 Current reduction with a synchronous reluctance motor

The relative output current is the quotient of the permissible output current and the rated output current.

17.5 Permissible output current depending on 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.

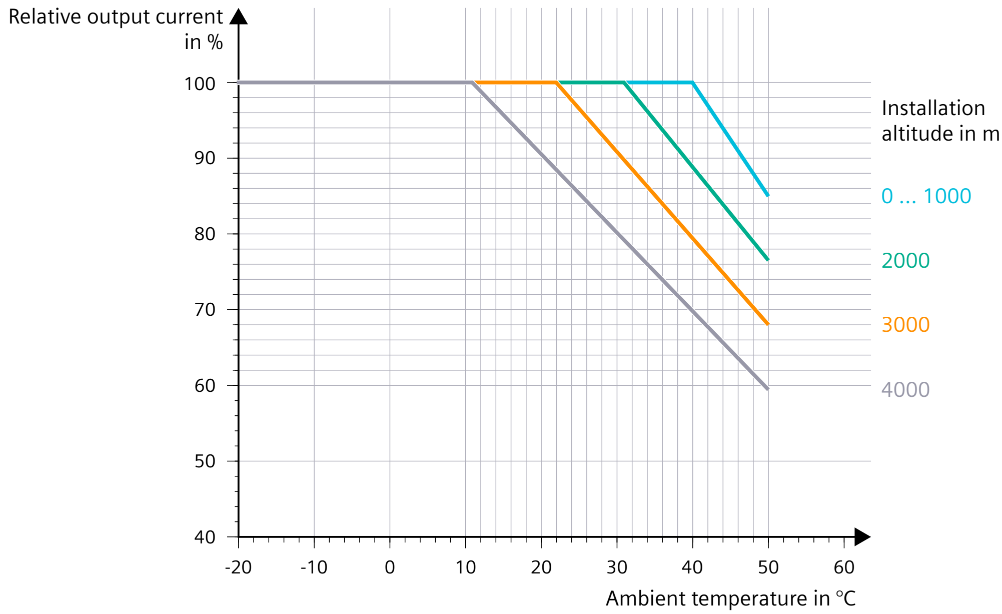


Figure 17-4 Current reduction according to "Low Overload" duty cycle

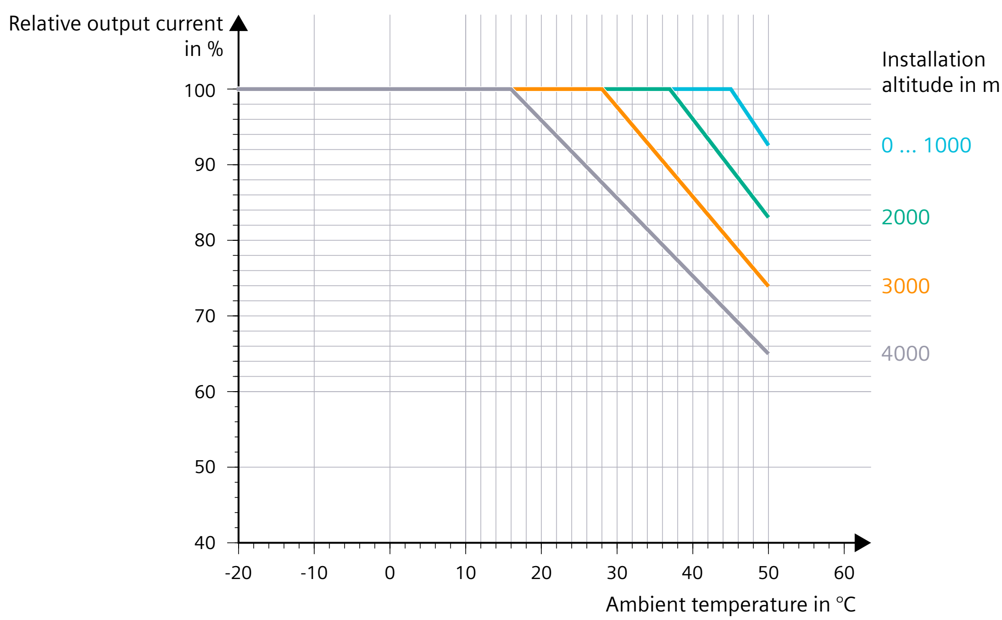


Figure 17-5 Current reduction according to "High Overload" duty cycle

The relative output current is the quotient of the permissible output current and the rated output current.

17.6 Permissible motor cable length as a function of the pulse frequency

Technical data

Table 17-14 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 17-15 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.

17.7 Current derating depending on the pulse frequency

Technical data

The following diagram shows 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.

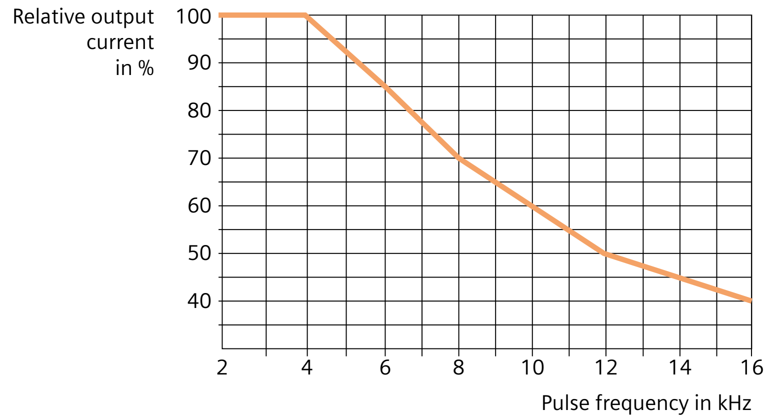


Figure 17-6 Current reduction based on Low Overload

17.8 Permitted output current at low speeds

Technical data

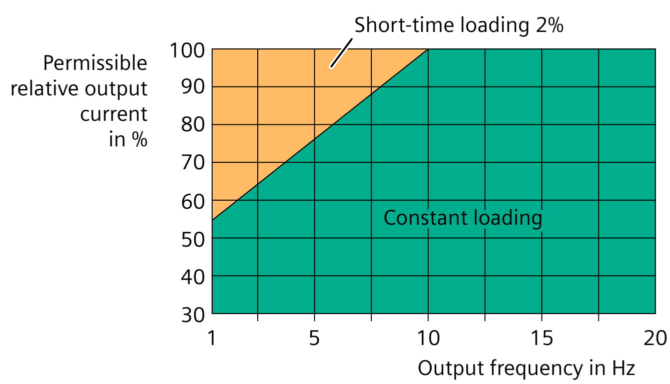


Figure 17-7 Permitted output current at low speeds

The permissible relative output current is the quotient of the permissible output current and the rated output current.

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.

17.9 Power loss

17.9.1 3 AC 200 V ... 240 V, IP20 degree of protection

Technical specifications

Table 17-16 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]	Absolute power loss according to NEC in W at operating point (90/100)[1]	Absolute power loss in W in standby[2]
6SL4112-0..☐☐-0..0		**@ 230 V, 50 Hz**	**@ 240 V, 60 Hz**	
05	0.55 kW	66.9	58.1	15.6
06	0.75 kW	78.6	71.5	15.6
08	1.1 kW	107	98.6	15.6
10	1.5 kW	144	112	15.6
11	2.2 kW	191	166	15.6
12	3 kW	202	174	19.2
13	4 kW	277	213	19.2
15	5.5 kW	373	296	21.6
16	7.5 kW	498	392	21.6
17	11 kW	566	511	28.8
18	15 kW	842	694	30.0
20	18.5 kW	1060	935	30.0
21	22 kW	1150	1000	34.8
23	30 kW	1530	1390	34.8

[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.

Power loss was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.2 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP20

Technical specifications

Table 17-17 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]		Absolute power loss according to NEC in W at operating point (90/100)[1]		Absolute power loss in W in standby [2]
6SL4113-0..☐☐-0..0		@ 400 V, 50 Hz		@ 480 V, 60 Hz		
		Unfiltered	Filtered	Unfiltered	Filtered	
08	1.1 kW	77.2	78.3	72.2	72.8	14.3
10	1.5 kW	90.6	92.2	77.3	78.1	14.3
11	2.2 kW	123	126	103	104	14.3
12	3 kW	165	170	131	133	14.3
13	4 kW	216	224	161	165	14.3
15	5.5 kW	238	244	206	210	17.6
16	7.5 kW	314	324	255	261	17.6
17	11 kW	406	420	340	348	19.8
18	15 kW	534	555	441	455	19.8
20	18.5 kW	562	564	508	510	25.3
21	22 kW	662	665	608	610	25.3
23	30 kW	888	899	765	772	27.5
24	37 kW	1110	1120	992	1000	27.5
26	45 kW	1230	1250	1100	1120	31.9
27	55 kW	1600	1630	1430	1450	31.9

[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.

Power loss was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.3 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, Clean Power, IP20 degree of protection

Technical data

Table 17-18 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]	Absolute power loss according to NEC in W at operating point (90/100)[1]	Absolute power loss in W in standby[2]
6SL4113-2..☐☐-2..0		**@ 400 V, 50 Hz**	**@ 480 V, 60 Hz**	
16	7.5 kW	456	367	32.2
17	11 kW	590	499	32.2
18	15 kW	781	640	32.2
20	18.5 kW	794	717	32.2
21	22 kW	936	859	32.2
23	30 kW	1157	994	37.6
24	37 kW	1441	1291	37.6
26	45 kW	1624	1457	39.2
27	55 kW	2130	1891	39.2

[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.

The power loss at operating point (90/100) was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.4 3 AC 200 V ... 240 V, IP55 degree of protection

Technical specifications

Table 17-19 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]	Absolute power loss according to NEC in W at operating point (90/100)[1]	Absolute power loss in W in standby[2]
6SL4112-0..☐☐-...0		**@ 230 V, 50 Hz**	**@ 240 V, 60 Hz**	
08	1.1 kW	108	101	25.2
10	1.5 kW	135	112	25.2
11	2.2 kW	166	150	25.2
12	3 kW	214	186	25.2
13	4 kW	290	225	25.2

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1)	Absolute power loss according to NEC in W at operating point (90/100)[1)	Absolute power loss in W in standby [2)
6SL4112-0..☐☐-...0		@ 230 V, 50 Hz	@ 240 V, 60 Hz	
15	5.5 kW	409	328	31.2
16	7.5 kW	540	429	31.2
17	11 kW	566	522	38.4
18	15 kW	840	692	38.4
20	18.5 kW	1060	933	38.4
21	22 kW	1160	1010	44.4
23	30 kW	1540	1400	44.4

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.

Power loss was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.5 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, degree of protection IP55

Technical specifications

Table 17-20 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1)		Absolute power loss according to NEC in W at operating point (90/100)[1)		Absolute power loss in W in standby [2)
6SL4113-0..☐☐-...0		@ 400 V, 50 Hz		@ 480 V, 60 Hz		
		Unfiltered	Filtered	Unfiltered	Filtered	
08	1.1 kW	85.5	85.8	82.2	82.4	23.1
10	1.5 kW	96.8	97.3	86.5	86.8	23.1
11	2.2 kW	123	124	108	109	23.1
12	3 kW	156	158	131	132	23.1
13	4 kW	193	196	156	157	23.1
15	5.5 kW	249	254	217	220	23.1
16	7.5 kW	325	334	266	271	23.1
17	11 kW	440	448	371	375	28.6
18	15 kW	573	585	476	483	28.6
20	18.5 kW	557	560	505	507	29.7
21	22 kW	655	660	603	607	29.7
23	30 kW	887	895	764	770	35.2
24	37 kW	1100	1120	990	1000	35.2

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]		Absolute power loss according to NEC in W at operating point (90/100)[1]		Absolute power loss in W in standby[2]
6SL4113-0..☐☐-...0		@ 400 V, 50 Hz		@ 480 V, 60 Hz		
		Unfiltered	Filtered	Unfiltered	Filtered	
26	45 kW	1240	1240	1110	1120	40.7
27	55 kW	1620	1630	1440	1450	40.7

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.

Power loss was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.6 3 AC 380 V ... 415 V / 3 AC 440 V ... 500 V, Clean Power, IP55 degree of protection

Technical data

Table 17-21 Power loss

Article number	Rated power	Absolute power loss according to IEC in W at operating point (90/100)[1]	Absolute power loss according to NEC in W at operating point (90/100)[1]	Absolute power loss in W in standby[2]
6SL4113-2..☐☐-2..0		@ 400 V, 50 Hz	@ 480 V, 60 Hz	
16	7.5 kW	461	372	37.2
17	11 kW	596	495	37.2
18	15 kW	786	645	37.2
20	18.5 kW	799	722	37.2
21	22 kW	941	864	37.2
23	30 kW	1163	1000	43.6
24	37 kW	1447	1297	43.6
26	45 kW	1632	1465	47.2
27	55 kW	2137	1899	47.2

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.

The power loss at operating point (90/100) was measured at a pulse frequency of 4 kHz and with space-vector modulation.

17.9.7 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)

17.10 Inputs and outputs

Technical specifications

Table 17-22 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. • 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 measuring probe input 0.01 ms

<table>
<tr><th>Property</th><th colspan="5">Data</th></tr>
<tr><td>Analog input</td><td colspan="5">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</td></tr>
<tr><td>Digital output/relay output</td><td colspan="5">Transistor output DO 0: Reverse polarity protection
Relay outputs DO 1 and DO 2
Response time 3 ms
30 V DC / ≤ 0.5 A for a resistive load</td></tr>
<tr><td>Analog output AO 0</td><td colspan="5">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%</td></tr>
<tr><td rowspan="10">Temperature sensor</td><td colspan="5">Measuring current 2 mA</td></tr>
<tr><td></td><td>Short-circuit monitoring</td><td>Overtemperature</td><td>Wire-break monitoring</td><td>Remark</td></tr>
<tr><td>Bimetal</td><td>-</td><td>-</td><td>-</td><td>For an overtemperature condition, the contact must open</td></tr>
<tr><td rowspan="2">PTC</td><td>< 20 Ω</td><td>> 1650 Ω</td><td>-</td><td>Rated value</td></tr>
<tr><td>< 35 Ω</td><td>> 1620 Ω</td><td>-</td><td>Rated value incl. maximum tolerance</td></tr>
<tr><td rowspan="2">KTY84</td><td>< 50 Ω</td><td>-</td><td>> 1630 Ω</td><td>Rated value</td></tr>
<tr><td>< 65 Ω</td><td>-</td><td>> 1600 Ω</td><td>Rated value incl. maximum tolerance</td></tr>
<tr><td rowspan="2">Pt1000</td><td>< 603 Ω</td><td>-</td><td>> 1720 Ω</td><td>Rated value</td></tr>
<tr><td>< 620 Ω</td><td>-</td><td>> 1690 Ω</td><td>Rated value incl. maximum tolerance</td></tr>
<tr><td>Pt100</td><td>< 300 Ω</td><td>-</td><td>> 375 Ω</td><td>Rated value</td></tr>
<tr><td>Failsafe
digital input F-DI 0</td><td colspan="5">Type 3 according to IEC 61131-2
Input voltage ≤ 30 V
Minimum response time 1 ms</td></tr>
<tr><td>Failsafe
digital output F-DO</td><td colspan="5">Minimum load resistance 48 Ω
Maximum load resistance 130000 Ω
Short-circuit protection
Overload protection
Minimum response time 1 ms</td></tr>
</table>

17.11 Safety Integrated Functions

17.11.1 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.

17.11.2 Response times - independent of the control type

Technical data

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) and Safely-Limited Speed (SLS): 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 the SSM limit being exceeded and an output at the bus (PS) or terminals (F-DO).

The specified response times are applicable for a fault-free drive system as well as when a fault is active in the system.

Table 17-23 Technical data - Response times

<table>
<tr><th colspan="2">Function</th><th>Unit</th><th>Worst case delay time</th></tr>
<tr><td colspan="2">SDI and SLS</td><td>ms</td><td>(3 · p9500) + t_R</td></tr>
<tr><td colspan="2">SSM (output to the bus)</td><td>ms</td><td>(3 · p9500) + p9545 + t_K_2</td></tr>
<tr><td colspan="2">SSM (output at terminals)</td><td>ms</td><td>(2 · p9500) + p9545 + 1.5</td></tr>
<tr><td rowspan="2">SMT</td><td>Motor overtemperature or internal error</td><td>ms</td><td>300</td></tr>
<tr><td>Short-circuit or wire break</td><td>s</td><td>1</td></tr>
</table>

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: 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

17.11.3 Response times when controlling via PROFIsafe

Technical data

The response times are converter-internal response times. Program runtimes in the F-host and the transmission time via PROFINET are not 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.

Notes regarding understanding the following table

The specified response times are applicable for a fault-free drive system as well as when a fault is active in the system.

- Worst Case Delay Time (WCDT): Maximum response time between a PROFIsafe telegram being received and a stop function being initiated when there is no fault
- One Fault Delay Time (OFDT): Maximum response time between a PROFIsafe telegram being received and a stop function being initiated when a fault is active
- Watchdog Time (WDTime): Time between receiving the last valid PROFIsafe telegram and the initiation of a stop function after the PROFIsafe monitoring time elapses
- 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-PLC

Table 17-24 Technical data - Response times

Property	Function	Unit	Value
WCDT / OFDT	STO / SS1	ms	$(2 \cdot p9500) + t\_K_1$
WDTime	STO / SS1	ms	$F\_WD\_Time + (2 \cdot p9500) + t\_K_1$
DAT		ms	$(2 \cdot p9500) + t\_K_1 + t\_K_2$
State change F-DI		ms	$p10017 + (2 \cdot p9500) + 3.5\ ms + t\_K_2$

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-PLC receives one PROFIsafe telegram per cycle from the converter, and the converter receives one PROFIsafe telegram per cycle from the F-PLC.

p10017: Debounce time of the F-DI (factory setting: 4 ms)

F_WD_Time: PROFIsafe monitoring time

Take the F_WD_Time from your PROFIsafe configuration.

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

17.11.4 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.

The specified response times are applicable for a fault-free drive system as well as when a fault is active in the system.

Table 17-25 Technical data - Response times

Function	Unit	Worst case delay time
STO / SS1	ms	p10017 + (2 · p9500) + 3.5 ms

p10017: Debounce time des F-DI (factory setting: 4 ms)

p9500: Monitoring cycle (factory setting: 4 ms)

17.12 SINAMICS SDI Standard

Technical data

Table 17-26 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

17.13 Option modules

17.13.1 Option module OM-SMT

Technical data

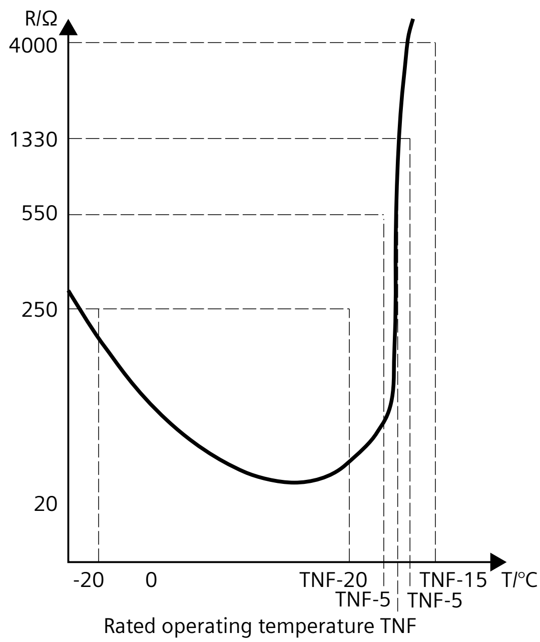


Figure 17-8 PTC characteristic

Table 17-27 Technical data option module OM-SMT

Property	Value
Overtemperature message	
1 Sensor[1)]	
• No overtemperature	T ≤ TNF - 5 K
• Overtemperature	T ≥ TNF + 15 K
3 Sensors[1)]	
• No overtemperature	T ≤ TNF - 20 K
• Overtemperature	T ≥ TNF + 5 K
Short-circuit detection	
• No short-circuit	R > 20 Ω + 20 %
• Short-circuit	R < 10 Ω - 20 %
Max. delay time[2)]	
Motor temperature or internal error	300 ms
Short-circuit or wire break	1 s
Max. current consumption (at 24 V DC)	0.15 A

1) Switching thresholds for overtemperature and switching back are dependent on the number of sensors connected in series based on the TNF (nominal response temperature) of the sensors.
Sensors = PTC Type A according to IEC 60947-8; DIN VDE V 0898-1-401

2) Response time of a type A PTC sensor:
Response time according to DIN VDE V 0898-1-401 basis version ≤ 10 s, small version ≤ 5 s

17.13.2 Option module OM-IIoT

Technical data

Table 17-28 Technical data option module OM-IIoT

Property	Value
Maximum transmission rate	100 Mbit/s
Max. current consumption (at 24 V DC)	0.30 A

17.13.3 Option module OM-DQ

Technical data

Table 17-29 Technical data option module OM-DQ

Property	Value
Max. current consumption (at 24 V DC)	0.75 A
Transfer rate	100 Mbit/s

17.13.4 Climatic conditions

Technical data

Table 17-30 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 • Humidity 5 ... 95 % • Storage altitude ≤ 4000 m • Condensation, splash water, icing, salt spray not permissible
Transport	Class 2K4 according to IEC 60721-3-2:1997	• In the transport packaging • Temperature -40 ... +70 °C • Humidity 5 ... 95 %
Operation	Class 3K3 in accordance with IEC 60721-3-3 Ed. 2.2: 2002	• With increased ruggedness with respect to relative humidity • Temperature -20 ... +60 °C for IP20 degree of protection • Temperature -20 ... +50 °C for IP55 degree of protection • Relative humidity 5 ... 95 % no condensation (better than Class 3K3) • Ice formation, condensation, dripping water, spraying water, splashing water and water jets are not permitted.

17.14 Braking resistor

17.14.1 Electrical data for braking resistor, degree of protection IP21

Technical data

Table 17-31 Electrical data for braking resistor, line voltage 3 AC 200 ... 240 V

Property	Unit	Article number				
		JJY:02315172 0007	JJY:02316372 0018	JJY:02343372 0001	JJY:02342262 0002	JJY:02342332 0001
Resistance	Ω	68	37	20	7.5	4.5
Maximum braking power P_{max}	kW	2.2	4.0	7.5	18.5	30
Rated braking power	kW	0.11	0.2	0.375	0.93	1.5

Table 17-32 Electrical data for braking resistor, line voltage 3 AC 380 ... 480 V/500 V

Property	Unit	Article number			
		6SL3201-0BE14-3 AA0	6SL3201-0BE21-0 AA0	6SL3201-0BE21-8 AA0	6SL3201-0BE23-8 AA0
Resistance	Ω	370	140	75	30
Maximum braking power P_{max}	kW	1.5	4.0	7.5	18.5
Rated braking power	kW	0.075	0.2	0.375	0.925

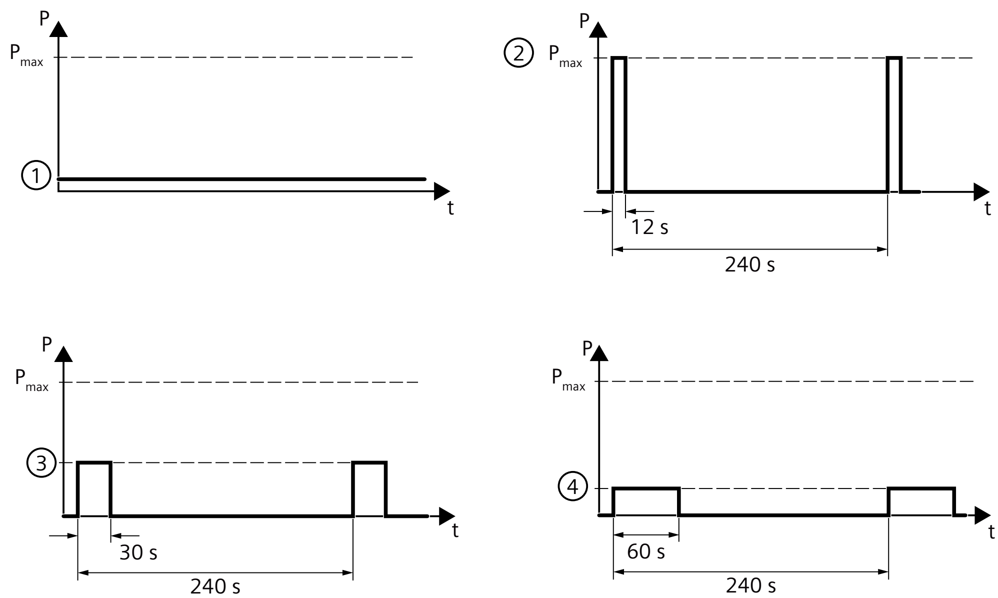
Table 17-33 Electrical data for braking resistor, line voltage 3 AC 380 ... 480 V/500 V

Property	Unit	Article number		
		JJY:023422620001	JJY:023424020001	JJY:023434020001
Resistance	Ω	25	15	10.5
Maximum braking power P_{max}	kW	22	37	55
Rated braking power	kW	1.1	1.85	2.75

17.14.2 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 17-9 Load rating of the braking resistor with different braking powers

Get more information

SINAMICS:
www.siemens.com/sinamics

Industry Mall:
www.siemens.com/industrymall

Industry Online Support:
www.siemens.com/online-support