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Frequency Converter ET 200S FC

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Product Information ET 200S FC Frequency Converter IPM25 / ICU24(F)

Issue 10/2006

Overview

This product information sheet describes counter-measures/asures to resolve faults that occur when operating an ET 200S FC frequency converter, firmware release 1.03 – and that are not described in the associated documentation (Operating Instructions Edition 10/2006, Parameter Manual Edition 03/2005).

Prerequisites for operating an ET 200S FC frequency converter

Note

The ET 200S FC frequency converter can only function in an ET 200S station that is completely mounted/installed and is connected to the appropriate power supply.

Restrictions for operation with certain interface modules

Note

- The FB100 requires the SFC14 and SFC15 system functions for communications with the control. Therefore, interface modules that do not support these functions cannot be used with the ET 200S FC frequency converter.

For example:

- | | |
|--------------------|--|
| – IM151-7 CPU V1.0 | Machine-readable product code [MLFB]:
6ES7 151-7AA00-0AB0 |
| – IM151-7 CPU V1.0 | Machine-readable product code [MLFB]:
6ES7 151-7AB00-0AB0 |
-

Exceeding the maximum frequency (p1082)

**Warning**

The maximum frequency (p1082) can be exceeded if all of the following conditions are fulfilled:

- The drive is in regenerative operation
 - The setpoint frequency is close to the maximum frequency
 - The drive is running with V/f control
-

Different default values in STARTER and in the frequency converter

Caution

The default, minimum and maximum values in the starter are not identical to those in the control unit ICU24(F). Offline parameterization only makes sense and is only practical if the default values have first been transferred from the control unit ICU24(F) into STARTER and saved.

Error when transferring parameters to MMC-PS

Caution

When transferring parameters to MMC-PS (p0010 = 30, p0802 = 2), the parameter value p0010 = 30 is permanently saved in the EEPROM. After the power supply voltage of the control unit ICU24(F) is powered on/powered off, this value is again accepted and the frequency converter is not ready to run.

Remedy: After transferring the parameter to the MMC-PS, the parameter value p0010 = 0 should be saved in the EEPROM (p0971 = 1).

Priority of OFF commands and safety functions

Note

Generally, a safety function can only be terminated by another safety function. Exception: OFF2.

The following priority assignments apply for the OFF commands and the safety functions:

1. Safe standstill (SH) = Safe torque off (STO)
2. OFF2
3. Safe braking ramp (SBR) = Safe stop1 (SS1)
4. Safely reduced speed (SG) = Safely limited speed (SLS)
5. OFF3
6. OFF1

This means, for instance, that if “safely reduced speed” is selected when the motor is at standstill and an ON command is issued after that, the frequency converter will ignore this command.

Replacing/exchanging the control unit ICU24(F)

Caution

When replacing the control unit, the connection between the ICU24(F) and IPM25 is interrupted. This means that the frequency converter is briefly in an undefined state. The following faults can, for example, be displayed:

- F0001, F0004, F0005, F0025, F0052, F0060, F0100, F1601, F1611, F1625
- Under certain circumstances, an incorrect frequency converter temperature is also displayed in r0037

If the connection is re-established, these fault messages can be acknowledged (depending on the setting of p1210, these faults are automatically acknowledged)

Loss of data telegrams after replacing or commissioning the ICU24(F)

Caution

When automatically downloading parameters from the MMC-PS into an ICU24(F) in conjunction with the IM151 HF interface module, under certain circumstances, data telegrams from the control (PLC) can be lost.

After this, the ICU24(F) unit remains in the wait state.

For an ICU24, this is displayed by a flashing RY LED and for an ICU24F, in addition, by the flashing LED of the parameterized shutdown groups.

This wait state can be terminated by powering down/powering up or withdrawing/inserting the control unit. The prerequisite is that there is a connection to the control (PLC).

Download via MMC-PS

Note

IM151: During a parameter download (e.g., MMC-PS → EEPROM), for a certain time the frequency converter cannot be accessed without a fault being displayed.

IM151-CPU: During a parameter download (MMC-PS → EEPROM), for a certain time the frequency converter cannot be accessed and the following fault messages are output:

- SFC_ERR = 1 SFC_ERR_RD = 80A0
 SFC_ERR_WR = 80A1
-

Fault message when ramping up with IM151-CPU and ICU24(F) with MMC-PS

Note

When automatically downloading parameters from the MMC-PS into an ICU24(F) in conjunction with the interface module IM151-CPU, under certain circumstances, the interface module may signal a parameterizing error.

The following modules are involved:

- IM151-7 CPU Machine-readable product code [MLFB]:
6ES7 151-7AA10-0AB0
- IM151-7 F-CPU Machine-readable product code [MLFB]:
6ES7 151-7FA01-0AB0
- IM151-7 F-CPU Machine-readable product code [MLFB]:
6ES7 151-7FA00-0AB0

The fault can be bypassed by parameterizing the ramp-up time of the CPU in the interface module so that it exceeds the time for the parameter download from the MMC-PS (max. 65 s).

Copying command and drive data sets (CDS, DDS)

Note

Command or drive data sets can be copied by selecting parameters p0809 and p0819. When this function is called, fault messages F0100, F0051, F1601 can occur if the setting "Write into EEPROM" (p0014 = 1) is activated.

Command and drive data sets may only be copied if p0014 = 0 ("Write to RAM"). After copying has been completed, an alignment - RAM to EEPROM – can be carried out (p0971 = 1).

Delayed drive starting when an ON command is present

Note

If control word 1 (r0054), bit 0 is set to 1 while p0010 ≠ 0, then an ON command is detected; however, the frequency converter is only powered up if p0010 is again reset to 0.

Fault message after a manual parameter transfer from MMC-PS

Note

After a manually initiated parameter transfer from the MMC-PS to EEPROM (p0803 = 2), the drive is initially ready. Before an ON command, in this case, the control unit must be re-initialized. This avoids fault messages being issued when the drive starts.

The control unit is initialized by withdrawing/inserting the module or by switching off the power supply and switching it back on again.

Significance of Alarm A0565

Note

Alarm A0565 means that the content of the EEPROM has changed. On the basis of this alarm, it can neither be concluded that the content of the MMC-PS differs from that of the EEPROM nor that the content matches.

Commissioning the frequency converter without communication with the control (PLC)

Note

The ET 200S FC frequency converter can be commissioned with STARTER without communications having been established with the higher-level control (PLC).

Disadvantage: Although master control can, in this case, be transferred to STARTER – it cannot be returned to the control (PLC).

Remedy: After saving the parameters in the EEPROM, the power supply of the control unit must be temporarily interrupted.

Changing the module ID (p8455 and p8456)

Note

The IDs of the control unit

- SPICPU (p8455) and
- PMMC (p8456)

can only be changed, if p0010 = 0.

Automatic restart after a power failure

Note

The automatic restart (p1210) does not function if the entire ET 200S station is de-energized when the power fails.

Saving p8457 = 1 on MMC-PS

Caution

When saving the parameter value p8457 = 1 on the MMC-PS, the functions for monitoring the correct slot ID (ID SPICPU) p8455 are permanently de-activated if an MMC-PS is required.

Normally, this situation cannot occur as parameter p8457 is automatically set to the value 0 as soon as any parameter in the frequency converter is changed.

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ET 200S FC Frequency Converter

Operating Instructions

Software-Version V1.03

This documentation belongs
to the documentation packages:
6SL3298-0CA12-0BP0 and
6SL3298-0CA12-1BP0

This documentation is also available on CD:
6SL3298-0CA11-1MG0

Issue 10/2006

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Safety-related information and instructions

These Operating Instructions include information and instructions that you should carefully observe to ensure your own personal safety and to avoid material damage. The information and instructions have a warning triangle that represents the degree of the potential hazard as follows:

The equipment may only be used for the applications specified in these Operating Instructions and only in conjunction with other devices and components that Siemens has recommended and certified.



Danger

indicates that death, severe personal injury and/or substantial material damage **will result** if proper precautions are not taken.



Warning

indicates that severe personal injury or material damage **can result** if proper precautions are not taken.



Caution

with a warning triangle, indicates that minor personal injury or material damage can result if proper precautions are not taken.

Caution

without a warning triangle, indicates that material damage can result if proper precautions are not taken.

Notice

indicates that an undesirable result or state may occur if the proper information and instructions are not observed.

Note

signifies important information about the product or highlights a part of the documentation to which special notice should be given.

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Exclusion of liability

Additional functions may be available that are not described in this document. However, this fact does not represent a responsibility to provide such functions with a new control or when providing service. We have checked the contents of this document with the described hardware and software.

However, deviations cannot be completely ruled-out so that we cannot guarantee complete conformance. However, the information in this document is regularly checked and the necessary corrections included in subsequent editions. We are thankful for any recommendations or suggestions.

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Safety information and instructions

The following warnings, precautionary measures and information and instructions are intended for your personal safety and to avoid damage to the product or the components associated with the equipment. Warnings, information and instructions are provided that are generally valid when handling the frequency converter ET 200S FC.

Specific warnings, information and instructions, that apply to specific activities, are provided at the beginning of each individual Chapter and are repeated or supplemented within this Chapter at critical points.

Please carefully read all of this information as it is intended to ensure your own personal safety and to ensure a long lifetime of the frequency converter and the equipment used with it.

It is also important to carefully observe all of the warning labels on the equipment itself. Please ensure that all of the warning labels are kept in a condition so that they can be easily read and replace missing or damaged labels.



Warning

- When electrical equipment is operated, certain parts and components of the equipment are at hazardous voltage levels.
 - This equipment has hazardous voltage levels and controls rotating mechanical parts and components that are also potentially hazardous. Certain parameter settings can mean that the frequency converter automatically restarts after the power supply voltage fails (e.g. automatic restart function).
 - Danger due to electric shock. After the power supply voltage has been disconnected and the equipment powered-down the DC link remains charged for 5 minutes. This is the reason that the power connector can be at a **hazardous voltage level for 5 minutes** - even if the frequency converter is not operational or has been withdrawn.
 - Emergency Stop devices in compliance with EN 60204 IEC 204 must remain in a fully functional state in all operating modes of the control unit. If the Emergency Stop device is reset, this may not result in an uncontrolled or undefined restart.
 - For cases where faults, e.g. short-circuits in the control unit, can result in significant material damage or even severe bodily injury (i.e. potentially hazardous short-circuits), additional external measures or devices must be provided. These measures and devices must either guarantee or bring the equipment into a non-hazardous state, even if a short-circuit occurs (e.g. independent limit switches, mechanical interlocks etc.).
-

Information regarding safety-relevant functions

Shutting down from the safely reduced speed operating state

Note

If "safely-reduced speed" is selected, the drive can be shutdown using "safe standstill".

It is not possible to shutdown using the non-safety relevant commands OFF1 / OFF3. However, the frequency converter can also be shut down using the non-safety relevant OFF2 (pulse inhibit).

De-selecting "safely reduced speed" and "safe braking ramp"

Note

The "safely reduced speed" and "safe braking ramp" states can be withdrawn by removing the safety-relevant signal. The frequency converter then returns to the setpoints that are present unless it already reached the state "safe standstill" via the "safe braking ramp" function.

The "safe standstill" state is **not** withdrawn by just withdrawing the safety-relevant signal. A new on command is always required in order to initiate the "safe standstill" state.

Notice

When configuring the drive, the centrifugal mass and torque of the drive must be taken into account for the purpose of setting the braking ramp.

Important information and instructions

Validity

These Operating Instructions are valid for the ET 200S FC frequency converter. These Instructions provide a description of the components that are valid at the time that the Operating Instructions were issued. We reserve the right to provide product information with up-to-date information about new components and components with a new version.

Qualified personnel

For the purpose of the safety-related information and instructions in these Operating Instructions, qualified personnel are those personnel who are authorized to commission, ground and tag equipment, devices, systems and circuits in accordance with the Standards of safety technology.

Only appropriately qualified personnel may work with or on this equipment. This personnel must have in-depth knowledge about all of the safety information/instructions, installation, commissioning, operation and service/maintenance measures.

Correct use of the equipment

The equipment is suitable for connection to power circuits that provide a symmetrical current of maximum 10,000 A (RMS) for a maximum voltage of 480 V if it is protected by either a Type H or K fuse, a circuit-breaker or fused motor feeder.

Please note the following when using the ET 200S FC frequency converter:

- The equipment may only be used for those applications listed in the Catalog and the Technical Description and only in conjunction with the third-party devices and components that have either been recommended or certified by the manufacturer. Modifications and the use of spare parts and accessories, that are either not marketed nor recommended by the manufacturer of the equipment, are forbidden.
- The perfect and safe operation of the product assumes that it has been correctly transported, correctly stored, professionally installed and mounted as well as careful operator control and service/maintenance (also refer to the Section "Technical data").

Exclusion of liability

The products described in these Operating Instructions have been developed to handle safety-related functions as part of a complete plant or machine. A complete safety-related system generally includes sensors, evaluation units, signaling devices and concepts for safe shutdown operations. It is the responsibility of the manufacturer/constructor of a plant or machine to ensure the overall correct function. Siemens AG, its regional offices and representative companies (known as "Siemens" in the following) is not in a position to guarantee all of the features of a complete plant or machine that was not designed by Siemens.

Siemens accepts no liability for recommendations that are either provided or implied in the following description. As a result of the subsequent description, no new guarantee, warranty or liability claims can be derived that extend beyond the general Siemens conditions of sale and delivery.

Repairs

The units may only be repaired by Siemens service, repair workshops that Siemens has certified or by authorized personnel that are trained in depth regarding all warnings and operating techniques.

If unauthorized personnel carry-out repairs, then all liability and warranty claims no longer apply and the safety-related functions are no longer certified.

Protective measures

The equipment provides an internal motor overload protection in compliance with UL508C.

- The i²t monitoring is activated as part of the factory setting.
- The motor parameters must be precisely configured in order to ensure perfect motor overload protection.
- Motor overload protection can also be implemented using an external temperature sensor (KTY84 or PTC). This must be activated using parameter p0601 (factory setting: De-activated).

Working on live parts and components

Caution

If measurements or tests have to be carried-out on the equipment when it is in a live condition (under voltage), the regulations of BGV A2 must be carefully observed, especially Paragraph 8 "Permissible deviations when working on live parts and components". Only suitable electronic equipment may be used.

Disassembly and disposal

The frequency converter packaging can be re-used. Please store the packaging so that it can be used at a later date.

The equipment can be disassembled into individual components thanks to the easy to release screw and snap-type connections. These individual parts and components can be input into a recycling system. Please dispose of the equipment in-line with the applicable local regulations.

Standards and certificates

The Standards and certificates valid for the ET 200S FC frequency converter are provided in the Manual "ET 200S Distributed I/O System" Chapter 7. The deviations that apply for the ET 200S FC are also described there.

Purpose of these Operating Instructions

The following Operating Instructions represent a supplement to the following Manuals:

- *SIMATIC ET 200S Distributed I/O System*
- *ET 200S FC Parameter Manual*

It describes the components and functions that are required to configure a ET 200S FC frequency converter. These Operating Instructions do not include any information regarding the functions that are generally applicable for the SIMATIC ET 200S distributed I/O system. These are provided in the Manual *SIMATIC ET 200S Distributed I/O System*.

Position in the information environment











In addition to these Operating Instructions, you will require the Manual for the DP master used.

Note

A list of the contents of the SIMATIC ET 200S Manuals is provided in these Operating Instructions in the Chapter "Overview" under Section "Navigator through the ET 200S Manuals"

We would like to recommend that you orientate yourself initially in this Chapter as to which contents in which Manual are important for your particular application.

The following list provides an overview of the contents of the documentation packages and manuals for ET 200S.

<p>ET 200S distributed I/O system</p>  <ul style="list-style-type: none"> • Installing and wiring the ET 200S • Commissioning and diagnostics for the ET 200S • Technical specifications of IM151-1, digital and analog electronic • Order numbers for the ET 200S 	<p>SIMATIC ET 200S motor starter fail-safe motor starter SIGUARD safety equipment 6ES7151-1AA10-8xA0¹⁾</p>  <ul style="list-style-type: none"> • Installing and wiring motor starters • Commissioning and diagnostics for motor starters • Technical specifications of motor starters • Fail-safe motor starter • Safety-integrated SIGUARD • Order numbers for motor starters 	<p>PROFINET System-Description</p>  <ul style="list-style-type: none"> • Basics of PROFINET • Network components and structures • Data interchange and communication • PROFINET-Engineering 	<p>From PROFIBUS DP to PROFINET IO</p>  <ul style="list-style-type: none"> • Differences • Blocks • System status lists • Diagnostics
<p>ET 200S IM151-7 CPU Interface module and operation list 6ES7151-1AB00-8xA0¹⁾</p>  <ul style="list-style-type: none"> • Addressing of the IM151-7 CPU • ET 200S with IM151-7 CPU in the PROFIBUS network • Commissioning and diagnostics for the IM151-7 CPU • Technical specifications of the IM151-7 CPU 	<p>ET 200S FC frequency converter Operating instructions 6SL3298-0CA12-0xP0^{1) 2)}</p>  <ul style="list-style-type: none"> • Installation • Commissioning • Open- and closed-loop control • Protection and monitoring functions • Technical specifications 		<p>ET 200S FC frequency converter Parameter Manual</p>  <ul style="list-style-type: none"> • Parameter list • Funktion diagrams • Faults and alarms
<p>ET 200S Positioning 6ES7151-1AD00-8xA0¹⁾</p>  <ul style="list-style-type: none"> • 1STEP 5V/204kHz • 1POS INC/Digital • 1POS SSI/Digital • 1POS INC/Analog • 1POS SSI/Analog 	<p>Process-related functions ET 200S 6ES7151-1AC00-8xA0¹⁾</p>  <ul style="list-style-type: none"> • 1COUNT 24V/100kHz • 1COUNT 5V/500kHz • 1SSI • 2PULSE 	<p>ET 200S serial interfaces and modules 6ES7151-1AE00-8xA0¹⁾</p>  <ul style="list-style-type: none"> • 1SI 3964/ASCII • 1SI MODBUS/USS 	
<p>1) x = Language ID for Order Nos. x stands for: A = German, B = English</p> <p>2) If you also require the "ET200S Distributed I/O System" manual then you can order this – including the Operating Instructions and the Parameter Manual for the ET 200S FC - under Order No. 6SL3298-0CA12-1xP0</p> <p>The documentation packages and the manuals can only be ordered in German and English. Documentation in French, Spanish and Italian is available through the Internet (refer to Service & Support in the Internet, http://support.automation.siemens.com/WWW/view/de/12834637/133300 or http://support.automation.siemens.com/WWW/view/de/18687280/133300).</p>			

A CD-ROM with user documentation (Operating Instructions and Parameter Manual, multi-lingual) for the ET 200S FC is available under Order No. 6SL3298-0CA11-1MG0.

The commissioning (start-up) STARTER software is available as CD-ROM under the following Order No. 6SL3072-0AA00-0AG0.

Fast access

In order to allow you to quickly access specific information, these Operating Instructions include the following fast access aids:

- A list of contents is provided at the beginning of the Operating Instructions.
- Sub-headings are provided in the individual Chapters that provide you with an overview of the contents of the particular Section.
- A detailed index is provided at the end of these Operating Instructions that allows you to quickly access the information you require.

Continuously updated information

Your local partner for communications-capable low-voltage switchgear in your region is available if you have any questions regarding the ET 200S FC.

You can access information on the following subjects through the Internet:

- Contact partners: <http://siemens.com/automation/partners>
- Operating Instructions:
 - <http://support.automation.siemens.com/WW/view/de/12834637/133300>
 - <http://support.automation.siemens.com/WW/view/de/18687280/133300>
- STARTER commissioning software
 - <http://support.automation.siemens.com/WW/view/de/10804985/133100>
- Function block FB 100:
 - <http://support.automation.siemens.com/WW/view/de/18686824/133100>

Target group

These Operating Instructions describe the components and functions of the ET 200S FC frequency converter. These Instructions address engineers, commissioning and machine operators as well as service and maintenance personnel.

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1

Overview

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1.1 The ET 200S FC frequency converter

1.1 The ET 200S FC frequency converter

Description

The ET 200S FC is a modular frequency converter that is completely embedded in the ET 200S distributed I/O system. The individual components must be configured/engineered in HW Config from STEP 7. The frequency converter itself comprises a control unit and a power module.

The control units are available in the following versions:

- ICU24 standard
- ICU24F as fail-safe version

The power module is available in the following versions:

- IPM25 FSA 750 W
- IPM25 FSB 2.2 kW
- IPM25 FSB 4 kW

The ET 200S FC operates with an input voltage of 3-ph. 400 V AC 50/60 Hz.

Note

No special power modules are required for the fail-safe ET 200S FC frequency converters.

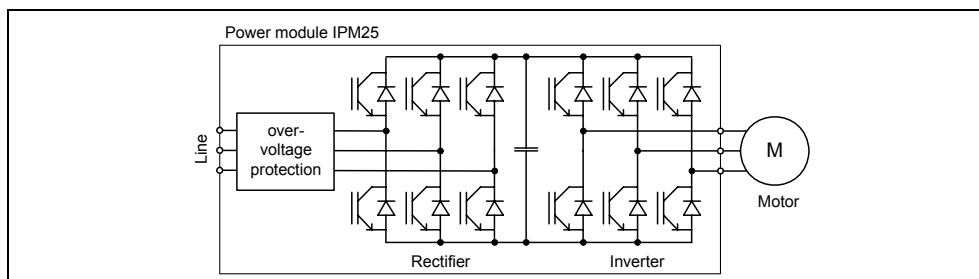


Fig. 1-1 Schematic diagram

1.1 The ET 200S FC frequency converter

Special features of the ET 200S FC

The ET 200S FC is a direct frequency converter. This means that it operates without a DC link and when the connected motor is in the regenerative mode, it feeds power back into the mains supply. Contrary to classic frequency converters, a braking resistor is not required that converts the regenerative power into heat.

The ET 200S FC does not require a line commutating reactor in operation. The harmonics fed back into the line supply lie well below the values of classic DC link converters.

Commissioning and operation

The PC-based "STARTER" tool is used to commission the frequency converter. The frequency converter parameters for operation can either be downloaded from the EEPROM of the control unit or from an MMC parameter memory (MMC = Micro Memory Card) that is inserted in the control unit. The frequency converter is controlled (open-loop) by the program in a higher-level control system (e.g. SIMATIC S7).

1.1 The ET 200S FC frequency converter

Features Description

- Modular frequency converter embedded in the ET 200S system
- Simple to install
- Simple to commission
- Signals are interconnected using BICO technology
- Data sets can be toggled between
- Fast current limiting (FCL) for trip-free operation
- Regenerative feedback into the line supply
- A braking resistor is not required
- The power module or control unit can be simply exchanged in operation (hot swapping)
- Rugged EMC design
- Can be configured for a wide range of applications
- Parameter settings can be saved in a non-volatile fashion - either in an EEPROM or on the MMC parameter memory (MMC-PS)
- Open-loop control and diagnostics via a higher-level control (e.g. SIMATIC S7)
- Diagnostics interface on the control unit
- Diagnostics using an LED on the control unit
- High pulse frequencies for low noise motor operation
8 kHz factory setting, can be set from 2 kHz to 16 kHz
- RS232 interface with USS protocol for commissioning with STARTER

Commissioning functions

- Quick commissioning
- Motor / control data are calculated
- Motor data identification routine
- Application commissioning
- Series commissioning
- Parameter reset to the factory setting

Operating functions

- Selectable setpoint channel
- Selectable ramp-function generator (RFG)
- Jog mode
- Freely-assignable function blocks (FFB)
- Positioning down ramp
- Automatic restart
- Flying restart
- Current limiting
- Slip compensation
- Motor holding brake (MHB)
- Regenerative braking

Fail-safe frequency converters:

- Safe standstill (SH)
- Safe braking ramp (SBR)
- Safely-reduced speed (SG)

Closed-loop control functions

- Closed-loop Vector control (closed-loop speed and torque control) with and without encoder
- V/f control with different characteristics

Protective functions

- Motor protective functions
- Frequency converter protective functions
- Plant/system protective functions

Interfaces

- Profibus via the backplane bus
- MMC-parameter memory (MMC-PS)
- RS232 interface with the USS protocol
- Motor temperature sensor, KTY84 or PTC
- Encoder interface
- Diagnostics interface

Fail-safe frequency converters:

- Fail-safe inputs to the shutdown groups G1 - G6

1.1 The ET 200S FC frequency converter

Block diagram

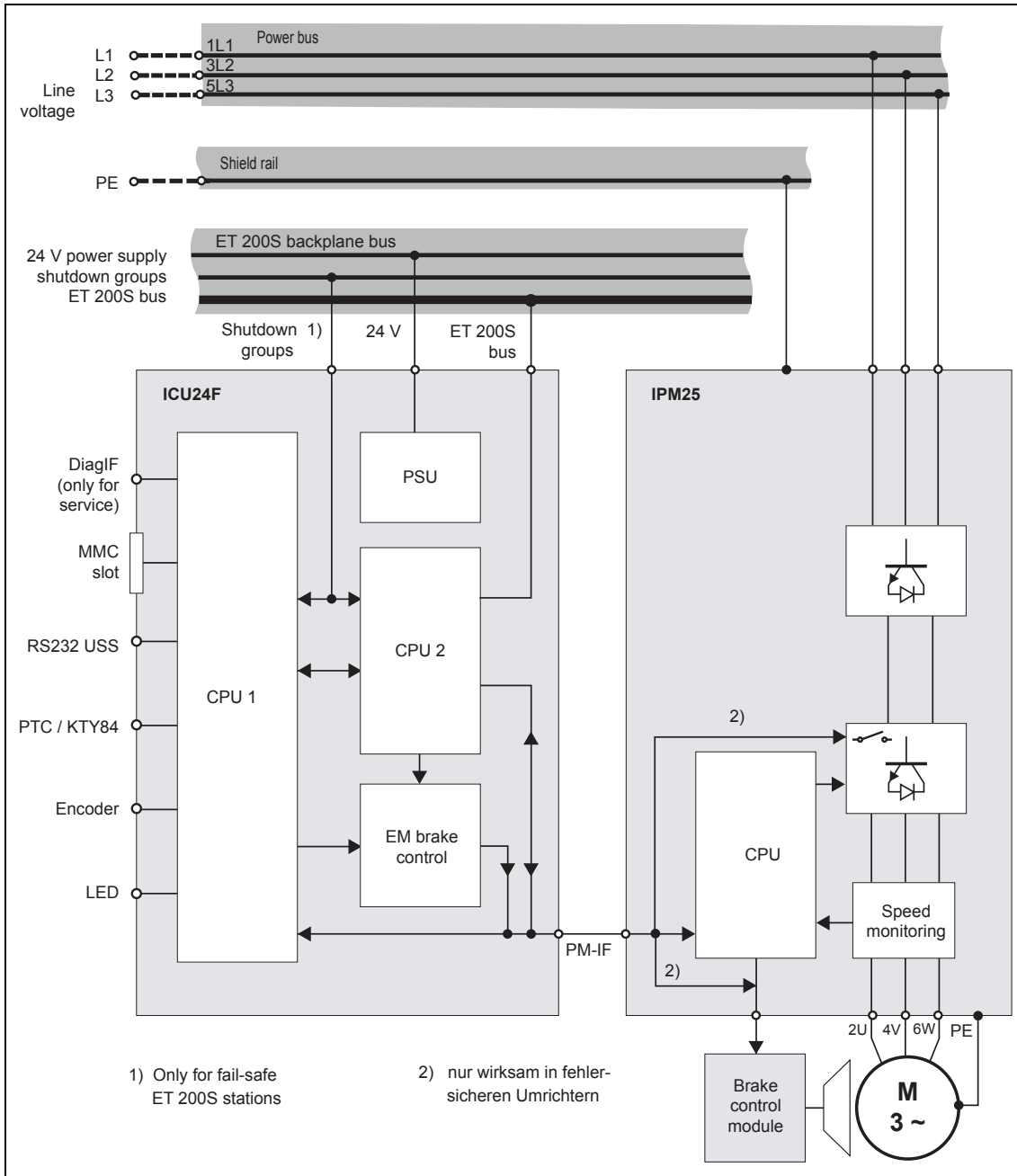


Fig. 1-2 Block diagram, fail-safe ET 200S FC

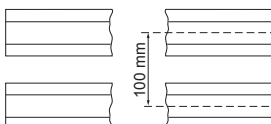
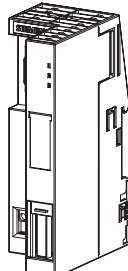
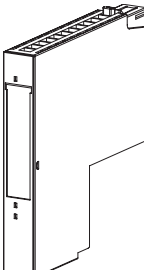
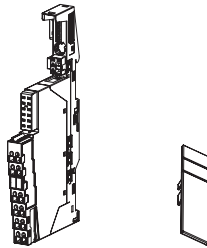
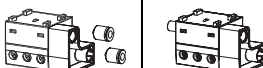
1.2 Components to assemble an ET 200S FC frequency converter

1.2 Components to assemble an ET 200S FC frequency converter


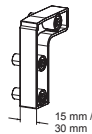

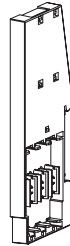
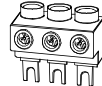
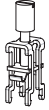


General ET 200S components

The following table indicates the general ET 200S components that are required to assemble an ET 200S FC frequency converter.

Table 1-1 ET 200S components

Components	Function	Diagram
Standard profile rails	These represent the mechanical system on which the ET 200S system terminal modules are snapped.	
Interface module IM 151	This connects the ET 200S system to the PROFIBUS-DP master and conditions the data for the electronic modules and frequency converter being used. (refer to the Manual <i>Distributed ET 200S I/O system</i>).	
Power module PM-D	This module monitors the electronics voltage for a group of frequency converters (= potential group) (refer to Section ET 200S stations with ET 200S FC frequency converters	
Terminal module TM-P15 S27-01	This supports the wiring and accepts the PM-D power module. The terminating cover is included in the scope of supply. It provides shock hazard protection for the shutdown groups G1 to G6 and also protects them against dirt.	
Terminal block PE/N M65-PEN	This extends the power bus by the protective ground (PE) and neutral conductor (N). It is used to connect (lefthand diagram) or route-through (righthand diagram) the protective and neutral conductors. It is snapped onto the terminal block L1/L2/L3 of the terminal module from below.	

1.2 Components to assemble an ET 200S FC frequency converter

Components	Function	Diagram
Distance module DM-V15	This is used for cooling. Distance modules may be required for high ambient temperatures. For more detailed information refer to the Chapter "Mounting", Section "Special ambient conditions". It does not have to be configured/engineered in HW Config.	
Jumper block L1/L2/L3	This is used to route through L1, L2, L3 and to close gaps in the power bus between two power modules when several ET 200S FC are used one after the other or when using expansion modules. Versions available which route-through L1/L2/L3 : <ul style="list-style-type: none"> • 15 mm • 30 mm 	
Jumper block PE/N	This extends the power bus by the neutral conductor (N) and the protective ground (PE) and is used to close gaps in the PE/N bus between two power modules when several ET 200S FC are used one after the other or when using expansion modules. Versions available which route-through PE/N: <ul style="list-style-type: none"> • 15 mm • 30 mm 	
Terminating module	This terminates the internal data bus of the ET 200S system electrically and simultaneously protects it against the ingress of dirt, refer to Chapter "Mounting", Section "Inserting the terminating module, terminating cover and caps" and the Manual <i>Distributed ET 200S I/O system</i> . The terminating module is included with the interface module in the scope of supply.	
3-phase infeed terminal	This is used to expand the connection cross-section for the power infeed – when required – to: <ul style="list-style-type: none"> • 2.5 to 25 mm²: Single-core (solid), multi-core or finely-stranded with conductor end sleeve • AWG 12 to 4: Single-core (solid) or multi-core: 	
Shield connection	Shield terminal (5 terminals) to attach the shield to the shield rail	
	Ground connection terminal to connect the cable to the common ground rail	
	Rail (1 m, 3 × 10 mm)	

1.2 Components to assemble an ET 200S FC frequency converter

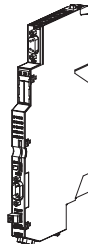
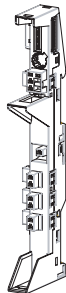
ET 200S FC components

The following table lists the frequency converter components that you require in order to assemble a frequency converter with the distributed ET 200S I/O system.

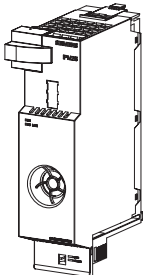
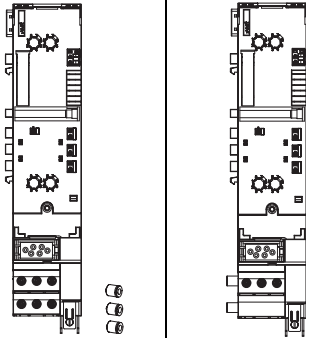
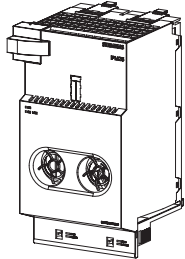
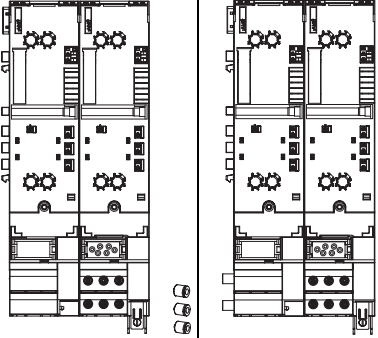
Table 1-2 Components to configure a frequency converter potential group

Component	ET 200S FC (refer to Table 1-3)	ET 200S FC Failsafe (refer to Table 1-5)
Terminal module TM-PFX30 or TM-PF30		X
Power / expansion module PM-D FX1 or PM-D F PROFIsafe		X
Terminal module TM-P15 S27-01	X	
Power module PM-D	X	
Terminal module TM-ICU15	X	X
Control unit ICU24	X	
Control unit ICU24F		X
Terminal module TM-IPM65 for FSA or TM-IPM130 for FSB	X	X
Converter power module IPM25 FSA or IPM25 FSB	X	X

Table 1-3 Components for an ET 200S FC frequency converter

Components	Function	Diagram
Control unit ICU24	The IPM25 power module of the ET 200S FC is controlled via the ICU24 control unit.	
Terminal module TM-ICU15	This accommodates the ICU24(F) control unit and establishes the connection to the 24 V power supply and the ET 200S backplane bus.	

1.2 Components to assemble an ET 200S FC frequency converter


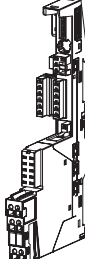
Components	Function	Diagram
<p>Power module IPM25 FSA for motors up to 750 W</p>	<p>This supplies current, voltage and frequency to the motor. For regenerative operation, power is fed back into the mains supply via this module.</p> <p>A brake control module can be connected to the power module.</p>	
<p>Terminal module TM-IPM65 for FSA</p>	<p>The terminal module accommodates a IPM25 FSA power module and supplies this with the mains voltages L1, L2, L3</p> <p>Versions:</p> <ul style="list-style-type: none"> • S32: With power bus infeed for a new load group (lefthand diagram) including 3 caps • S31: To route-through the power bus (righthand diagram), to expand a load group 	
<p>Power module IPM25 FSB for 2.2 kW and 4 kW motors</p>	<p>This supplies current, voltage and frequency to the motor. For regenerative operation, power is fed back into the mains supply via this module.</p> <p>A brake control module can be connected to the power module.</p>	
<p>Terminal module TM-IPM130 for FSB</p>	<p>The terminal module accommodates a IPM25 FSB power module and supplies this with the mains voltages L1, L2, L3</p> <p>Versions:</p> <ul style="list-style-type: none"> • S32: With power bus infeed for a new load group (lefthand diagram) including 3 caps • S31: To route-through power bus (righthand diagram), to expand a load group 	

1.2 Components to assemble an ET 200S FC frequency converter

Optional expansion modules for the ET 200S FC

The expansion modules to assemble an ET 200S FC frequency converter are listed in the following table.

Table 1-4 Optional ET 200S FC components

Components	Function	Diagram
Brake Control Module	The Brake Control Module can be used for all ET 200S FC frequency converters. The following versions are available: xB1: mechanical brakes (24 V DC / 4 A) xB2: mechanical brakes (500 V DC / 0.7 A)	
Terminal module TM-xB15 S24-01	This supports the wiring and accommodates a brake control module, xB1 or xB2.	

Fail-safe components

The frequency converter components and the general ET 200S components that you require in order to assemble a fail-safe ET 200S FC frequency converter are listed in the following table.

Note

The following fail-safe components are required in order to assemble a fail-safe ET 200S potential group with frequency converter:

- Fail-safe power module (PM-D F Profisafe or PM-D FX1) with the associated terminal module (TM-PF30 or TM-PFX30)
- Fail-safe control unit (ICU24F)

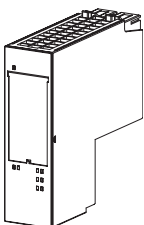
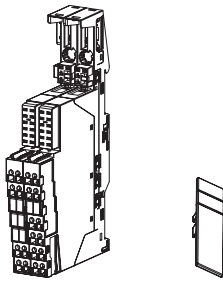
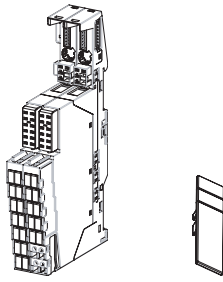
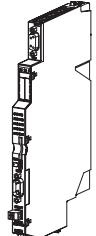
If additional ET 200S components are used, then the fail-safe versions must always be used.

It is not permissible to combine fail-safe components together with standard components in one potential group.

If fail-safe components and the functionality of Safety Integrated are used, the ET 200S system must be accommodated in an electrical cabinet with degree of protection IP54.

1.2 Components to assemble an ET 200S FC frequency converter

Table 1-5 Components to assemble a fail-safe ET 200S FC frequency converter

Components	Function	Diagram
Power / expansion module PM-D F PROFIsafe PM-D FX1	This monitors the electronics voltage for a group of frequency converters, is used to supply external safety-related devices and equipment and routes-through the signals of the shutdown groups G1 to G6. A detailed description of the power module PM-D F PROFIsafe is provided in the Manual 'Distributed ET 200S I/O System - Fail-Safe Modules'	
Terminal module TM-PFX30	This supports the wiring and accommodates a fail-safe power module PM-D FX1. Versions that are available: <ul style="list-style-type: none"> • With an infeed from the left to extend a load group for PM-D FX1 power modules • Without infeed from the left as power module for the start of a new potential group for the PM-D FX1 power modules The terminating cover is included with the module. It provides shock hazard protection for the shutdown groups, G1 to G6, and at the same time protects against the accumulation of dirt.	
Terminal module TM-PF30	It accepts a fail-safe PM-DF Profisafe power module. The terminating cover is included with the module. It provides shock hazard protection for the shutdown groups, G1 to G6, and at the same time protects against the accumulation of dirt.	
Control unit ICU24F	The ICU24F control unit evaluates, in addition to the ICU24 functions, the signals of the G1 to G6 shutdown groups and then implements the following safety functions: <ul style="list-style-type: none"> • STOP 0 acc. to EN60204 Part 1 (safe standstill) • STOP 1 acc. to EN60204 Part 1 (safe braking ramp) • Safely-reduced speed The TM-ICU15 terminal module is required for the ICU24F as well as for the ICU24 control units.	

1.3 Possibilities of configuring the ET 200S system

Information on the ET 200S

The following Section provides an overview of the possibilities of configuring the frequency converter in the distributed ET 200S I/O system.

Further, it also includes information and a description of the terminology to help understand how to assemble frequency converters in the distributed ET 200S I/O system.

Additional general information on the distributed ET 200S I/O system is provided in the Manual, "Distributed ET 200S I/O system".

We recommend that you use the "SIMATIC Configurator ET 200S" tool to select the appropriate components for a distributed ET 200S I/O system.

1.3.1 Terminology and definitions for ET 200S

Distributed ET 200S I/O system

The distributed ET 200S I/O system is a finely modular, highly flexible DP slave with degree of protection IP20.

An IM 151 interface module always forms the interface to PROFIBUS; the IM 151 interface module is available in different versions depending on the particular application.

Potential groups

A potential group involves a power module and all of the modules located to the right of the power module - up to an ET 200S terminating module or up to the next power module.

Note

Frequency converters and motor starters can be operated together in a potential group.

1.3 Possibilities of configuring the ET 200S system

Fail-safe potential groups

Fail-safe components are required for fail-safe potential groups. Every fail-safe potential group starts with a fail-safe power/expansion module. Fail-safe functions of the frequency converter can be initiated via the selected shutdown groups. An equipment/device fault is detected and a safe condition is established. Additional information is provided in the Chapter "Description of the components".

Note

- Both fail-safe as well as standard potential groups can be assembled in an ET 200S station.
 - It is not permissible to combine fail-safe components with standard components within a potential group.
-

Load groups

A frequency converter with power infeed and all of the frequency converters to the right up to the next converter/motor starter with power infeed belong to a load group.

All ET 200S FC frequency converters, that are supplied through **one** power bus infeed are known as a "load group". A load group does not have to be identical with a potential group. Within a group of frequency converters, that are supplied from the same power module, it may be necessary, for example, to have a new power bus infeed in order that the rated operating current (total current) of the terminal modules is not exceeded. The total current of the power bus may be a maximum of 50 A.

Note

It is not permissible to combine frequency converters and High Feature motor starters within a load group.

1.3.2 ET 200S stations with ET 200S FC frequency converters

General packaging guidelines

The ICU24 control units are located to the right of the power module and can be combined with all of the IPM25 power modules.

The IPM25 power module is always located to the right of the ICU24 control unit. The terminal modules are always located from the left to the right.

The power infeed for the IPM25 power modules of the ET 200S FC is realized either via the power bus (with jumper blocks) or directly for each individual power module.

Note

The following fail-safe components are required in order to assemble a fail-safe ET 200S FC frequency converter:

- Fail-safe power module (PM-D F Profisafe or PM-D FX1) with the associated terminal module (TM-PF30 or TM-PFX30)
- Fail-safe control unit (ICU24F)

Within a potential group it is not permissible to combine fail-safe components with standard components.

1.3 Possibilities of configuring the ET 200S system

ET 200S station with frequency converter – minimum configuration

The following example shows the layout and parts list for the minimum configuration of an ET 200S station with a frequency converter.

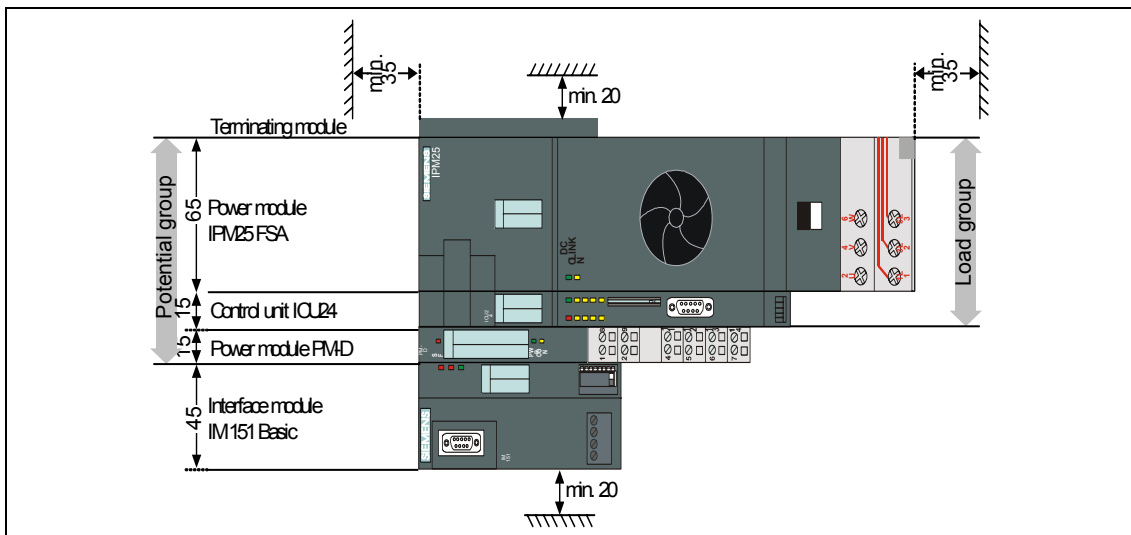


Fig. 1-3 ET 200S station with frequency converter - minimum configuration

Table 1-6 Parts list for the ET 200S station above

Order No.	Designation	Qty.
3RK1903-0AA00	Terminal module for the power module	1
3RK1903-0BA00	Power module PM-D for the motor starter	1
3RK1903-3EA10	Terminal module for the ICU24/ICU24F control unit	1
3RK1903-3EC00	Terminal module for IPM25 0.75 kW with feeder cable connection	1
6ES7151-1CA00-0AB0	IM 151 Basic to connect the ET200S to PROFIBUS DP	1
6SL3203-0BE22-5AA0	Frequency converter, EMC filter, Class A 25 A	1
6SL3225-0SE17-5UA0	Frequency converter, power module IPM25 0.75 kW	1
6SL3244-0SA00-1AA0	Frequency converter, ICU24 control unit	1

1.3 Possibilities of configuring the ET 200S system

ET 200S station with motor starters and frequency converters - with standard and fail-safe components

The following example shows the layout and parts list for an ET 200S station with standard and fail-safe frequency converters as well as with motor starter.

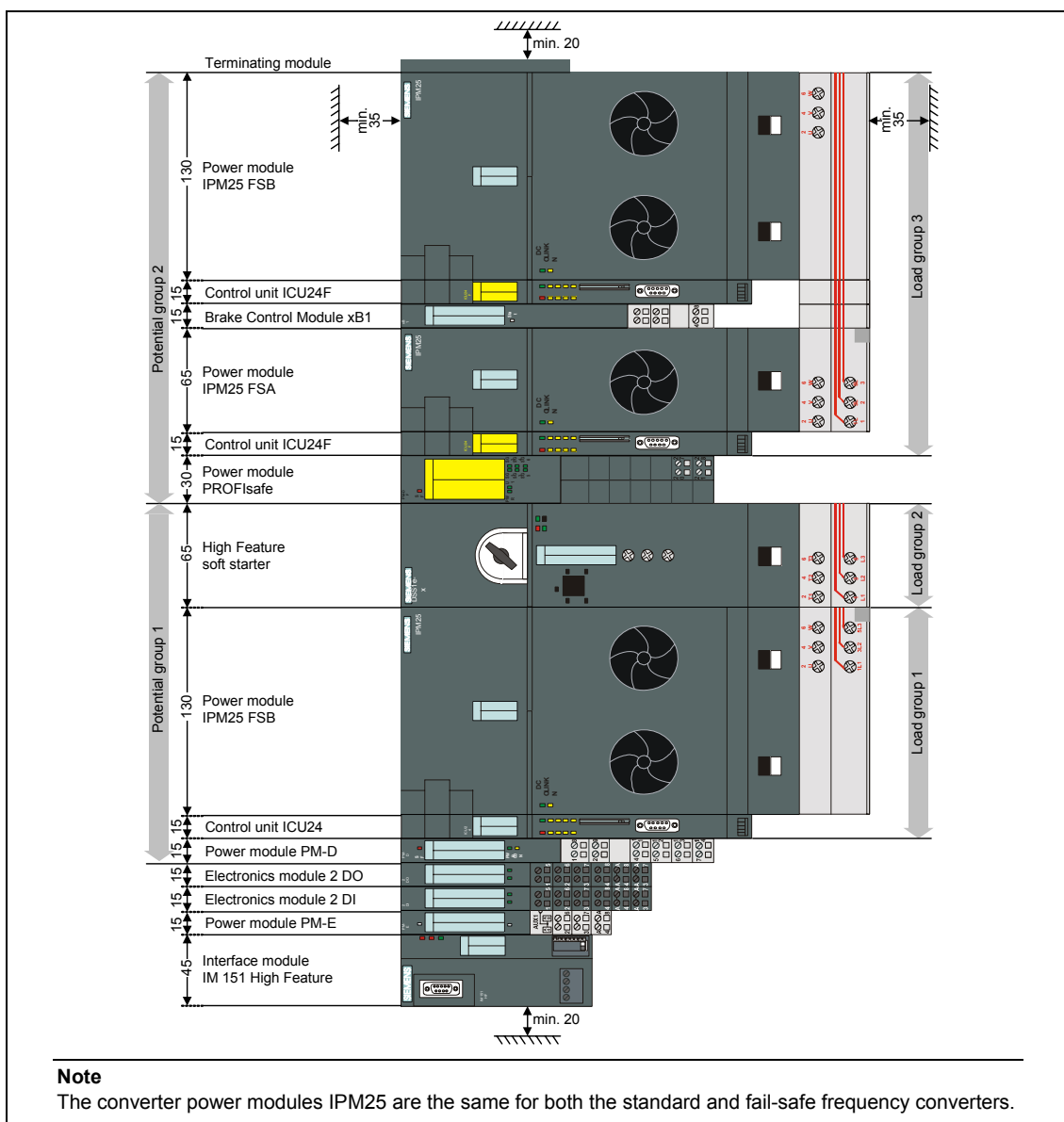


Fig. 1-4 Example for the layout of an ET 200S station

Table 1-7 Parts list for the above ET 200S station

Order No.	Designation	Qty.
3RK1301-0AB20-0AA3	High Feature soft starter with switch SST, 0.3 to 3 A	1
3RK1903-0AA00	Terminal module for the power module	1

1.3 Possibilities of configuring the ET 200S system

3RK1903-0AE00	15mm Jumper block L1/L2/L3	2
3RK1903-0AG00	Terminal module for an expansion modules xB1/2	1
3RK1903-0AK00	Terminal module for direct/soft starter with feeder cable connection	1
3RK1903-0BA00	PM-D power module for the motor starter	1
3RK1903-0CB00	Brake control module xB1 24V DC/4A	
3RK1903-3AA00	Terminal module for power module PM-D F	1
3RK1903-3BA00	PM-D F power module PROFIsafe	1
3RK1903-3EA10	Terminal module for the control unit ICU24/ICU24F	3
3RK1903-3EC00	Terminal module for IPM25 0.75 kW with feeder cable connection	1
3RK1903-3ED00	Terminal module for IPM25 2.2/4.0 kW with feeder cable connection	1
3RK1903-3ED10	Terminal module for IPM25 2.2/4.0 kW without feeder cable connection	1
6ES7131-4BB00-0AA0	Electronics module 2DI 24V DC standard (5 x)	0,2
6ES7132-4BB30-0AA0	Electronics module 2DO 24V DC/2A standard (5 x)	0,2
6ES7138-4CA00-0AA0	PM-E power module 24V DC for electronics module with diagnostics	1
6ES7151-1BA00-0AB0	IM 151 High Feature to connect the ET200S to PROFIBUS DP	1
6ES7193-4CA40-0AA0	Universal terminal module, screw connection (5 x)	0,4
6ES7193-4CD20-0AA0	Terminal module to AUX1 infeed, screw connection	1
6SL3203-0BE22-5AA0	Frequency converter, EMC filter, Class A 25 A	2
6SL3225-0SE17-5UA0	Frequency converter, power module IPM25 0.75 kW	1
6SL3225-0SE24-0UA0	Frequency converter, power module IPM25 4.0 kW	2
6SL3244-0SA00-1AA0	Frequency converter, control unit ICU24	1
6SL3244-0SA01-1AA0	Frequency converter, control unit ICU24F	2

1.4 Limit / maximum expansion of the ET 200S modules that can be connected

1.4 Limit / maximum expansion of the ET 200S modules that can be connected

Maximum expansion for each IM 151 interface module

When engineering the system, please observe the following:

- An ET 200S station can, for each IM 151 interface module, consist of a maximum of 63 modules to be configured. These include:
 - Power module, PM-D
 - Control units ICU24(F)
 - Electronics module
 - Motor starter
- The maximum width is 2 m.

Note

Power modules, EMC filter and brake control modules (xB1 and xB2) are integrated into the ET 200S system using the ICU24(F) control unit of the associated frequency converter.

These components are not configured in STEP 7 HW-Config.

The number of parameters of an ET 200S station – depending on the DP master – is a maximum of 244 bytes.

Parameter lengths of the ET 200S modules

The following table includes the parameter lengths (basic parameters) of the individual modules:

Table 1-8 Parameter lengths of the modules

ET 200S module	Parameter lengths [bytes]	ET 200S module	Parameter lengths [bytes]
PM-D	3	ICU24	8
PM-D F X1	3	ICU24F	8
PM-D F PROFIsafe	20		

1.4 Limit / maximum expansion of the ET 200S modules that can be connected

Current rating of the ET 200S power modules and the maximum number of control units that can be connected

The following table indicates the maximum current rating of the ET 200S power modules and the maximum number of control units ICU24(F).

Table 1-9 Current rating of the power modules and the maximum number of control units that can be connected

Power modules		Max. number of control units ICU24(F) that can be connected
Type	Max. current rating	
PM-D	10 A	12
PM-D F X1	6 A	7
PM-D F PROFIsafe	Inrush current: 10 A Continuous current: 5 A	5

The number of modules that can be connected depends on the total current of all of the modules of this potential group. This total may not exceed the maximum current rating.

Note

The current rating of a ICU24(F) control unit is max. 0.8 A, typically 0.4 A.

If additional components belong to a particular potential group - e.g. a motor starter - then the current consumption of this component must be separately taken into account.

Current rating of a load group

The total current rating of a load group (sum of the currents of all loads in a load group) is 50 A. If this value is exceeded, a new load group is required.

1.5 Navigator through the ET 200S Manuals

Overview

The components of the ET 200S are described in various Manuals. In the following examples you'll see possible ET 200S layouts and the required Manuals.

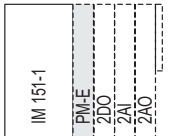
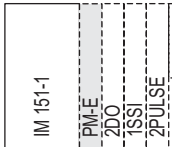
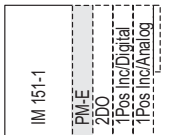
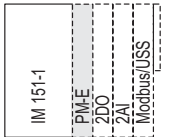
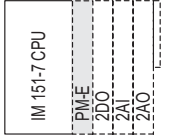
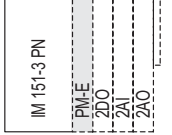
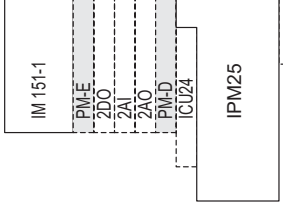
ET 200S comprises:	Manuals required	Order No..
	<ul style="list-style-type: none"> ET 200S distributed I/O system 	6ES7151-1AA10-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S technological functions 	6ES7151-1AA10-8xA0 6ES7151-1AC00-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S positioning 	6ES7151-1AA10-8xA0 6ES7151-1AD00-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S serial interface module 	6ES7151-1AA10-8xA0 6ES7151-1AE00-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system IM 151-7 CPU interface module 	6ES7151-1AA10-8xA0 6ES7151-1AB00-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system PROFINET System documentation 	6ES7151-1AA10-8xA0
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S FC frequency converter <ul style="list-style-type: none"> Operating Instructions Parameter Manual 	6SL3298-0CA12-1xP0 6SL3298-0CA12-0xP0

Fig. 1-5 ET 200S without fail-safe components

1.5 Navigator through the ET 200S Manuals

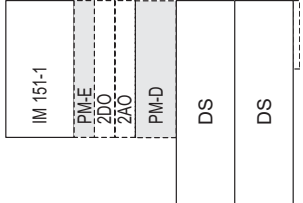
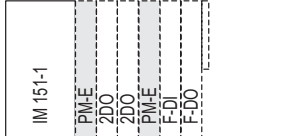
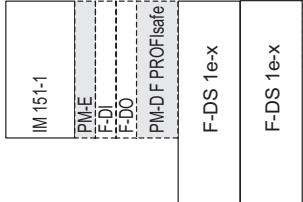
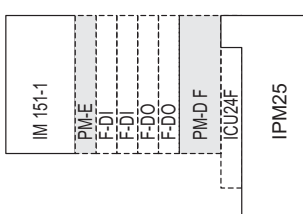
ET 200S comprises:	Manuals required	Order No..
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S motor starter Fail-safe motor starter SIGUARD safety technology 	<p>6ES7151-1AA10-8xA0</p>
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S distributed I/O system Fail-safe modules 	<p>6ES7151-1AA10-8xA0 Available through the Internet</p>
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S motor starter Fail-safe motor starter SIGUARD safety technology ET 200S distributed I/O system Fail-safe modules 	<p>6ES7151-1AA10-8xA0 Available through the Internet</p>
	<ul style="list-style-type: none"> ET 200S distributed I/O system ET 200S FC frequency converter <ul style="list-style-type: none"> Operating Instructions Parameter Manual 	<p>6SL3298-0CA12-1xP0 6SL3298-0CA12-0xP0</p>

Fig. 1-6 ET 200S with fail-safe components

1.5 Navigator through the ET 200S Manuals

Where do you find which information?

The following table should help you to quickly find the information that you are looking for. You can see to which Manual you must refer and which Chapter handles the topic you are interested in.

Table 1-10 Overview of the contents of the ET 200S Manuals

Topic	Manual, Chapter/Attachment										
	Operating Instructions ET 200S FC Frequency Converters	Parameter Manual ET 200S FC Frequency Converters	Distributed I/O system ET 200S	ET 200S motor starter Fail-safe motor starter	Interface Module IM 151-7 CPU	Technological Functions ET 200S	Positioning ET 200S	Serial Interface Module ET 200S	Distributed I/O System, ET 200S Fail-Safe Modules	Safety Technology in S7, System Description	S7 Distributed Safety - Configuring and Programming
ET 200S components	1/2		1	1	1				2	2	2
Configuration possibilities	1		3	1	4-5				3	3	1
Communications	4/5									4	
Configuring/engineering	1			4						7	3
Addressing	3		4		3				5		
Mounting	2		4	3					5		
Electrical architecture and wiring of ET 200S			5						6		
Programming and parameterization	6	1								8	5
Commissioning and diagnostics	6-8	3	6	4	7				7		
Functions	6-8				8						
Function charts		2									
General technical data	9		7	5					8		
Technical data	2				10	2-5	2	2-3			
Terminal modules	2		9	6-12							
Power modules			10	7-12							
Interface modules			8								
Electronic modules			11-12								
Positioning modules							3-6				
Expansion modules	2/3			11							
Fail-safe modules	2/3			12					9		
Monitoring, cycle and response times					9				12	9	
Dimension drawings	A1		B	B					10		
Applications			C-F	C							
Glossary			GI	GI	GI				13	10	9
Abbreviations	A2										
Index	A3										

1.5 Navigator through the ET 200S Manuals

2

Description of the Components

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2.1 Terminal modules for ET 200S FC

2.1 Terminal modules for ET 200S FC

Explanation

In the ET 200S distributed I/O system, the active components are connected-up through the terminal module. The active components such as electronic module, motor starter or frequency converter are plugged onto the terminal module and when required can be easily replaced.

The terminal modules required for the ET 200S FC frequency converters and their assignment to the particular components, are described in the following Sections.

2.1.1 Assignment of the terminal modules

Description

The following Tables list which different terminal modules you can use together with the power modules, control units, converter power modules, expansion modules and fail-safe modules.

Standard components

Table 2-1 Terminal module - power module

Terminal module		TM-P15 S27-01
		3RK1903-0AA00
PM-D	3RK1 903-0BA00	X

Table 2-2 Terminal module - ICU24 control unit

Terminal module		TM-ICU15
		3RK1903-3EA10
ICU24	6SL3244-0SA00-1AA0	X

2.1 Terminal modules for ET 200S FC

Table 2-3 Terminal modules - converter power modules IPM25

Terminal modules		TM-IPM65-S32	TM-IPM65-S31	TM-IPM130-S32	TM-IPM130-S31
		3RK1903-3EC00	3RK1903-3EC10	3RK1903-3ED00	3RK1903-3ED10
Converter power modules		with 400 V infeed	without 400 V - infeed	with 400 V - infeed	without 400 V - infeed
PM25 FSA	6SL3225-0SE17-5AA0	X	X		
PM25 FSB	6SL3225-0SE22-2AA0			X	X
PM25 FSB	6SL3225-0SE24-0AA0			X	X

Table 2-4 Terminal modules – brake control modules

Terminal modules		TM-xB15 S24-01
Brake control modules		3RK1903-0AG00
DS-XB1	3RK1903-0CB00	X
DS-XB2	3RK1903-0CC00	X

Fail-safe components

Table 2-5 Terminal modules - fail-safe power modules

Terminal modules		TM-PF30 S47-F0	TM-PFX30S47-G0	TM-PFX30S47-G1
		3RK1903-3AA00	3RK1903-3AE00	3RK1903-3AE10
Power modules			Infeed, left	Infeed, center
PM-DF Profisafe	3RK1 903-3BA00	X		
PM-D FX1	3RK1 903-3DA00		X	X

2.1 Terminal modules for ET 200S FC

2.1.2 Description of the terminal modules

Overview

These terminal modules are described in the following Section:

- TM-P15 S27-01 for power module PM-D
- TM-PF30 S47-F0 for power module PM-DF Profisafe
- TM-PFX30 S47 for power module PM-D FX1
- TM-ICU15 for control units ICU24
- TM-IPM65-S31 for converter power modules IPM25 FSA (without 400 V infeed)
- TM-IPM65-S32 for converter power modules IPM25 FSA (with 400 V infeed)
- TM-IPM130-S31 for converter power modules IPM25 FSB (without 400 V infeed)
- TM-IPM130-S32 for converter power modules IPM25 FSB (with 400 V infeed)
- TM-xB15 S24-01 for brake control modules

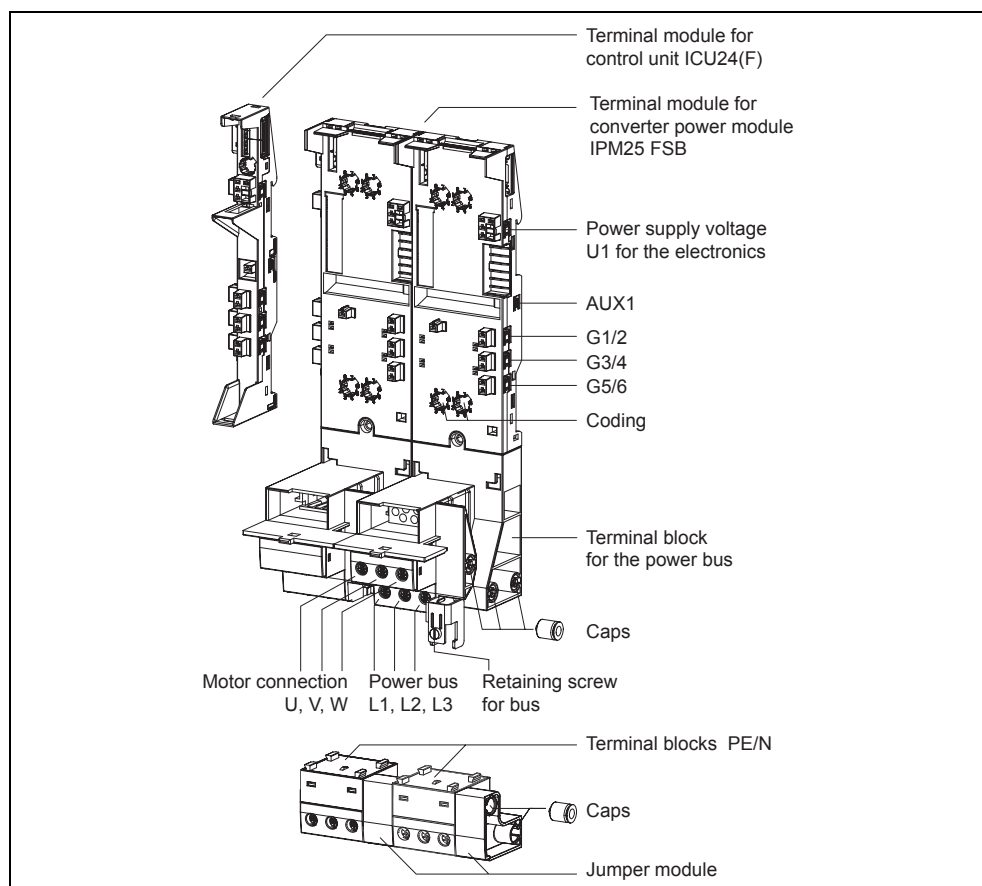


Fig. 2-1 Terminal modules for ET 200S FC

2.1.2.1 Terminal module TM-P15 S27-01 for power module PM-D

Features

The TM-P15 S27-01 terminal module is required for the PM-D power module. It comprises a support and a terminal block.

- Connection using screw terminals
- Pre-wiring of the terminal module

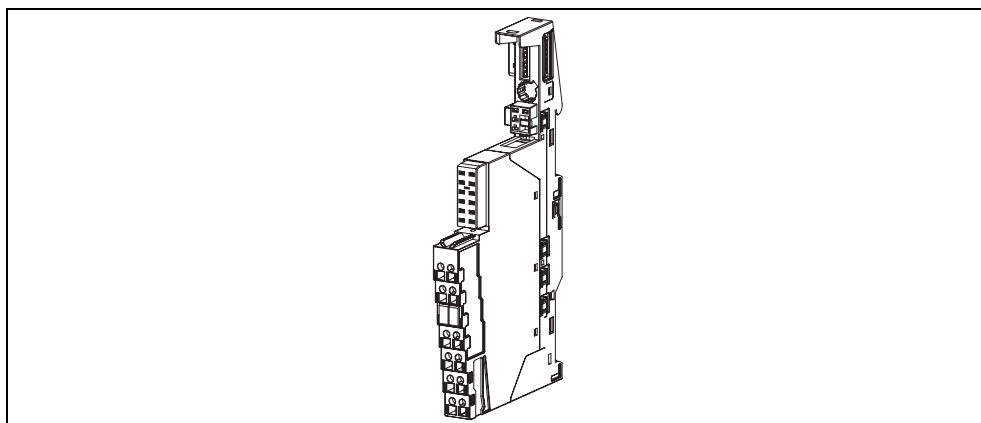


Fig. 2-2 Terminal module TM-P15 S27-01

Color coded labels

1. You can insert the color coded labels directly from the strips into the opening provided next to the terminal and remove.
2. Using your finger press the color coded label into the terminal module.

2.1 Terminal modules for ET 200S FC

Connection assignment

You'll find the connection assignment of the TM-P15 S27-01 terminal module in the following Table:

Table 2-6 Connection assignment TM-P15 S27-01

View	Terminal	Significance	
	1/8	L+	U1: Power supply for the electronics VRATED = 24 V DC
	2/9	M	
	4/11	A1	U2: Power supply for the contactor VRATED = 24 V DC
	5/12	A2-	
	6/13	AUX2	Not relevant Not relevant Not relevant
	7/14	AUX3	
-	AUX1		

Looping-through the voltages

Terminals 1/8, 2/9, 4/11, 5/12, 6/13 and 7/14 are jumpered in the terminal module and can be used to loop-through the voltages.

Technical data

Table 2-7 Technical data - TM-P15 S27-01

Dimensions and weight			
Mounting dimensions W x H x D	mm	15 x 196,5 x 102	
	inch	3.81 x 49.66 x 25.91	
Mounting depth with PM-D power module	mm	117,5	
	inch	29.84	
Weight	g	approx. 175	
	lbs	approx. 0.39	
Insulation voltages and rated currents			
Insulation voltage	V	500	
Rated operating voltage	V	DC 24	
Rated operating current	A	10	
Connection cross-sections			
Single-core	mm ²	1 x (0.14 to 2.5), acc. to IEC 60947 1 x 2.5	
Finely-stranded with connector sleeves	mm ²	1 x (0.14 to 1.5), acc. to IEC 60947	
AWG cables, single or multi-core	AWG	1 x (18 to 22)	
Wiring			
Tool required		Standard screwdriver, Size 1	
Tightening torque	Nm	0,4 to 0,7	
	lbf.in	3,5 to 6,2	

2.1.2.2 Terminal module TM-PFX30 S47 for power module PM-D F X1

Features

The TM-PFX30 S47 terminal module is required for the fail-safe PM-D F X1 power module. It comprises a support and a terminal block.

- Connected via screw terminals
- Pre-wiring of the terminal module
- The fail-safe modules are identified by yellow inscribed labels

The following versions are available:

- TM-PFX30 S47-G0 with infeed from the left to loop-through U1 and M as well as G1 to G6
- TM-PFX30 S47-G1 without infeed from the left to start a new group

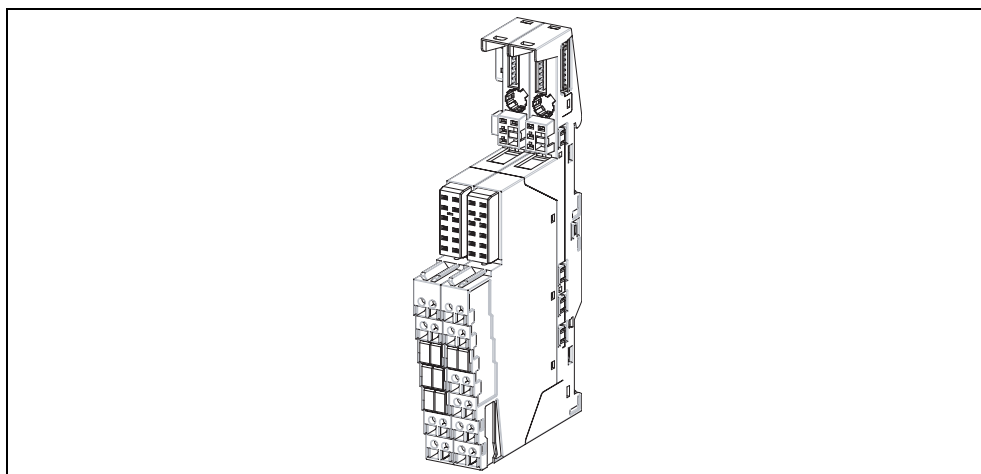


Fig. 2-3 Terminal module TM-PFX30 S47

Color coded labels

1. You can insert the color coded labels directly from the strips into the opening provided next to the terminal and remove.
2. Using your finger press the color coded label into the terminal module.

2.1 Terminal modules for ET 200S FC

Connection assignment

The connection assignment of the TM-PFX30 S47 terminal module is provided in the following Table:

Table 2-8 Connection assignment TM-PFX30 S47

Terminal	Significance	View	Terminal	Significance
1/8	+ IN/OUT		15/22	G1
2/9	M IN/OUT		16/23	G2
6/13	L+		18/25	G3
7/14	M		19/26	G4
-	AUX1		20/27	G5
			21/28	G6

Looping-through the voltages

Terminals 1/8, 2/9, 6/13, 7/14, 15/22, 16/23, 18/25, 19/26, 20/27 and 21/28 are jumpered in the terminal module and can be used to loop-through the voltages.

Technical data

Table 2-9 Technical data - TM- PFX30 S47

Dimensions and weight		
Mounting dimensions W x H x D	mm	30 x 196.5 x 102
	inch	7.62 x 49.66 x 25.91
Mounting depth with power module PM-D FX1	mm	117,5
	inch	29.84
Weight	g	approx. 375
	lbs	approx. 0.83
Insulation voltages and rated currents		
Insulation voltage	V	500
Rated operating voltage	V	DC 24
Rated operating current	A	10
Connection cross-sections		
Single-core	mm ²	1 x (0.14 to 2.5), acc. to IEC 60947 1 x 2.5
Finely-stranded with connector sleeves	mm ²	1 x (0.14 to 1.5), acc. to IEC 60947
AWG cables, single or multi-core	AWG	1 x (18 to 22)
Wiring		
Tool required		Standard screwdriver, Size 1
Tightening torque	Nm	0,4 to 0,7
	lbf.in	3,5 to 6,2

2.1.2.3 Terminal module TM-PF30 S47 F0 for power module PM-D F PROFIsafe

Features

The TM-PF30 S47 F0 terminal module is required for the fail-safe PM-D F PROFIsafe power module. It comprises a support and a terminal block.

- Connection using screw terminals
- Pre-wiring of the terminal module
- The fail-safe modules are identified by yellow inscribed labels

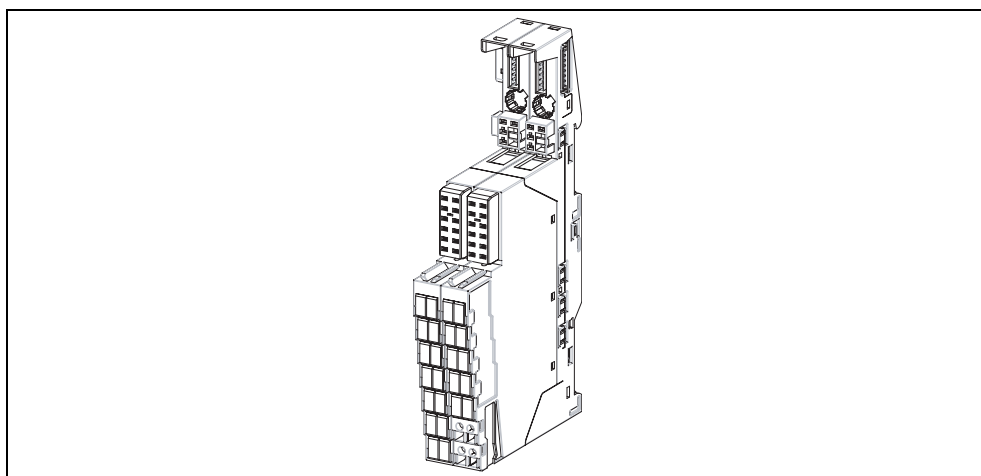


Fig. 2-4 Terminal module TM-PF30 S47 F0

Color coded labels

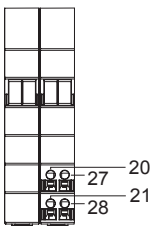
1. You can insert the color coded labels directly from the strips into the opening provided next to the terminal and remove.
2. Using your finger press the color coded label into the terminal module.

2.1 Terminal modules for ET 200S FC

Connection assignment

The connection assignment of the TM-PFX30 S47 F0 terminal module is provided in the following Table:

Table 2-10 Connection assignment TM-PFX30 S47 F0

Terminal	Significance		View
20/27 21/28	L+ M	Uin: To connect an external 24 V DC SELV/PELV power supply	

Looping-through the voltages

Terminals 20/27 and 21/28 are jumpered in the terminal module and can be used to loop-through the voltages.

Technical data

Table 2-11 Technical data - TM-PF30 S47 F0

Dimensions and weight			
Mounting dimensions W x H x D	mm	30 x 196.5 x 102	
	inch	7.62 x 49.66 x 25.91	
Mounting depth with power module	mm	117.5	
	inch	29.84	
Weight	g	approx. 350	
	lbs	approx. 0.77	
Insulation voltages and rated currents			
Insulation voltage	V	500	
Rated operating voltage	V	DC 24	
Rated operating current	A	10	
Connection cross-sections			
Single-core	mm ²	1 x (0.14 to 2.5), acc. to IEC 60947 1 x 2.5	
Finely-stranded with connector sleeves	mm ²	1 x (0.14 to 1.5), acc. to IEC 60947	
AWG cables, single or multi-core	AWG	1 x (18 to 22)	
Wiring			
Tool required		Standard screwdriver, Size 1	
Tightening torque	Nm	0,4 to 0,7	
	lbf.in	3,5 to 6,2	

2.1.2.4 Terminal module TM-ICU15 for control unit ICU24(F)

Features

The TM-ICU15 terminal module is required for the control unit ICU24(F).

- It does not have any input terminals.
- All of the required voltages and signals are transferred via connectors on the ICU24(F).

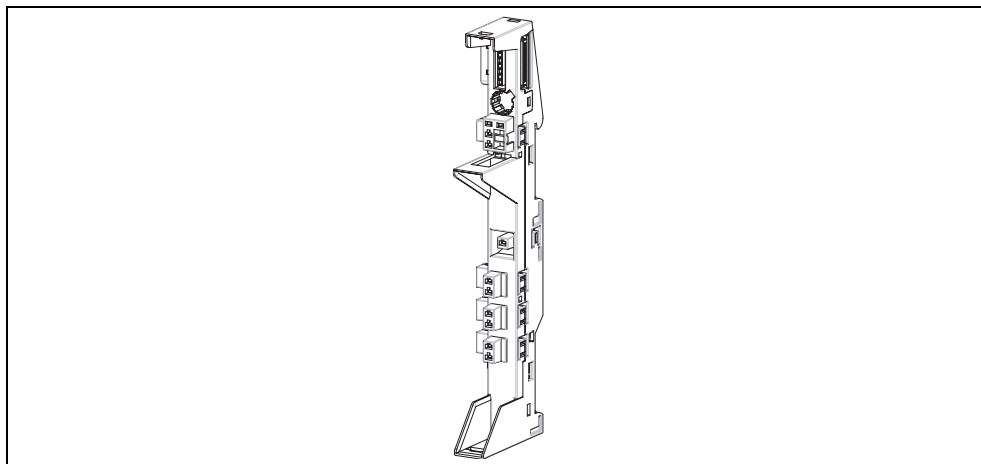


Fig. 2-5 Terminal module TM-ICU15

Technical data

Table 2-12 Technical data - TM-ICU15

Dimensions and weight		
Mounting dimensions W x H x D	mm	15 x 196.5 x 52
	inch	3.81 x 49.66 x 13.21
Mounting depth with control unit	mm	150
	inch	38.1
Weight	g	approx. 52
	lbs	approx. 0.11
Insulation voltages and rated currents		
Insulation voltage	V	500
Rated operating voltage	V	DC 24
Rated operating current	A	10

2.1 Terminal modules for ET 200S FC

2.1.2.5 Terminal modules TM-IPM for converter power modules IPM

Features

The TM-IPM terminal module is required for the converter power module of the ET 200S FC frequency converter. It comprises a support and a terminal block L1/L2/L3 for the power bus with screw to attach the shield connection to the bus.

- The power bus distributes the power within a load group
- The maximum current rating is 50 A at 60 °C
- The wiring is automatically established when mounting the terminal modules
- Power bus: 3 phase (L1, L2, L3), can be expanded to 5 phases using a PE/N terminal block
- There are 4 versions of the TM-IPM terminal module
 - TM-IPM65-S31 for converter power module IPM25 FSA (without power bus infeed)
 - TM-IPM65-S32 for converter power module IPM25 FSA (with power bus infeed)
 - TM-IPM130-S31 for converter power module IPM25 FSB (without power bus infeed)
 - TM-IPM130-S32 for converter power module IPM25 FSB (with power bus infeed)

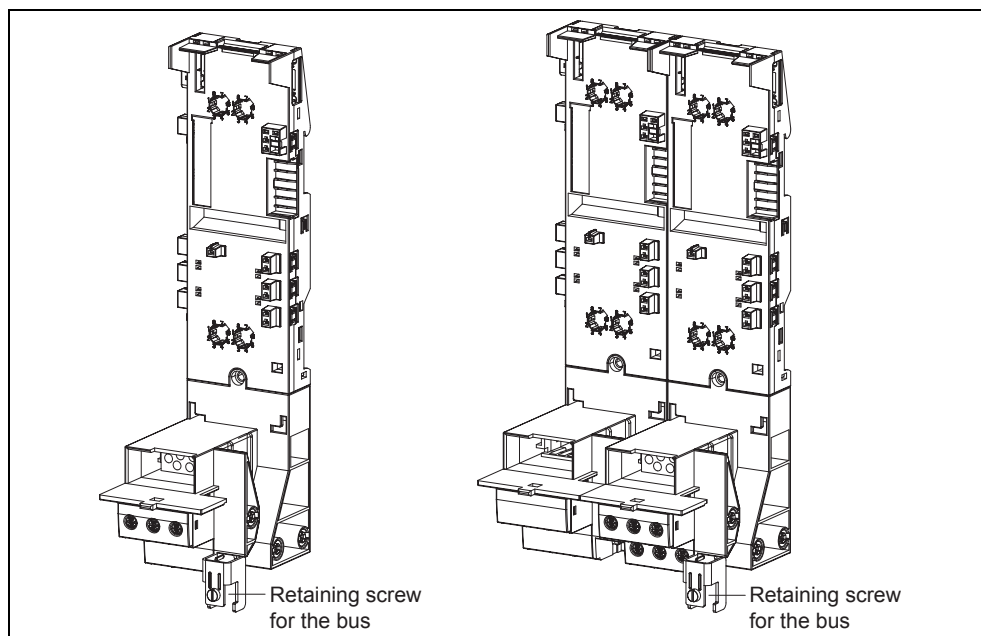


Fig. 2-6 TM-IPM65 and TM-IPM130 terminal modules

2.1 Terminal modules for ET 200S FC

The TP-IPM terminal modules have, in addition to the connections for the line and motor cables, a screw to attach a bus. Several frequency converters can be connected to ground potential via this bus. The shields of feeder cables (e.g. motor feeder cables) can be connected to the bus using shield terminals (refer to „Overview“).

Warning

At the last terminal module for the ET 200S FC converter power modules of a load group, before commissioning, the open contacts at the power bus (L1, L2, L3, N, PE) must be closed using the appropriate caps to ensure shock hazard protection (they must be firmly pressed-in). This prevents the contacts being touched and therefore provides the appropriate level of shock hazard protection (400 V AC).

Technical data

Table 2-13 Technical data - TM-IPM terminal modules

Dimensions and weight		TM-IPM65	TM-IPM130
Mounting dimensions W x H x D	mm	65 x 290 x 102	130 x 290 x 102
	inch	16,51 x 73,66 x 25,91	33,02 x 73,66 x 25,91
Mounting depth with converter power module	mm	151	151
	inch	38,35	38,35
Weight	g	approx. 455	approx. 728
	lbs	approx. 1	approx. 1,6
Rated voltages, currents and frequencies for the power bus			
Rated insulation voltage U_i	V	690	
Rated operating voltage U_e	V	500	
Rated withstand capability U_{imp}	kV	6	
Rated operating current I_e	A	50	
Rated frequency	Hz	50/60	
Connection cross-sections			
Single-core	mm ²	2 x (1 to 2.5) or 2 x (2.5 to 6)	
Finely-stranded with connector sleeve	mm ²	1 x 10 or 2 x (1 to 2.5) or 2 x (2.5 to 6) acc. to IEC 60947	
AWG cables, solid or multi-core	AWG	2 x (14 to 10)	
Wiring			
Tool required		Standard screwdriver, Size 2, Pozidrive 2	
Tightening torque	Nm	2,0 to 2,5	
	lbf.in	17,7 to 22,1	
Caution			
Degree of protection IP20 can only be achieved if insulated fork-type cable lugs are used to connect the power cables (e.g. Thomas & Betts KV10-10F-D or KV-14-10F-M)			

2.1 Terminal modules for ET 200S FC

2.1.2.6 Terminal blocks and jumper module

Terminal block PE/N (accessory)

The L1/L2/L3 terminal block belonging to the TM-IPM terminal module can be expanded by a PE/N terminal block.

The following versions are available:

- With an infeed at the start of a new load group, i.e. only connected at the righthand side. This terminal block is supplied with the appropriate caps for N and PE.
- With loop-through, i.e. contact is established at the righthand and lefthand sides.

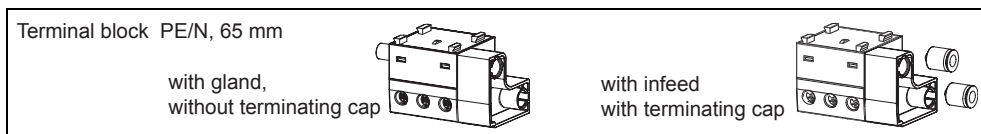


Fig. 2-7 Terminal block PE/N

Note

The PE/N terminal blocks should be mounted before assembling the terminal modules for the frequency converters.

Jumper module L1/L2/L3 and jumper module PE/N

The jumper module closes the gaps in the power bus for several converter power modules within a load group.

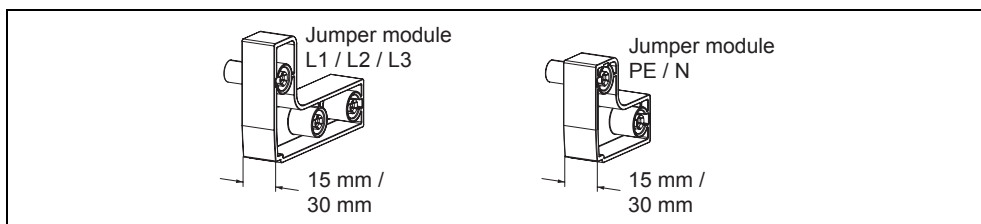


Fig. 2-8 Jumper modules

2.1.2.7 Terminal module TM-xB15 S24-01 for brake control modules

Features

The TM-xB15 S24-01 terminal module is required for the brake control module xB1 or xB2. It comprises a support and a terminal block. Screw terminals are used to establish the connections.

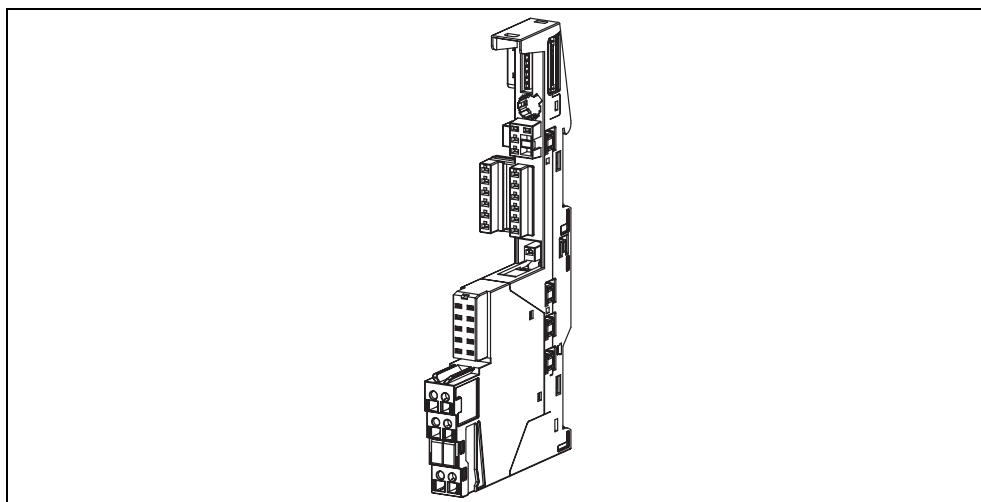


Fig. 2-9 TM-xB15 S24-01 terminal module

Connection assignment

The connection assignment of the TM-xB15 S24-01 terminal module is provided in the following Table:

Table 2-14 Connection assignment TM-xB15 S24-01

View	Terminal	Block diagram
	<p>4 8</p>	<p>Configurations</p> <p>P-switching</p> <p>Motor with brake Brake Control</p> <p>M-switching</p>

2.1 Terminal modules for ET 200S FC

Technical data

Table 2-15 Technical data - TM-xB15 S24-01

Dimensions and weight		
Mounting dimensions W x H x D	mm	15 x 196.5 x 95
	inch	3.81 x 49.66 x 25.91
Mounting depth with the brake control module	mm	117,5
	inch	29.84
Weight	g	approx. 120
	lbs	approx. 0.26
Rated currents		
Inputs (terminals 1 and 2, 5 and 6) - only for TM-xB215 S24-01 brake control (terminals 4 and 8)		
Connection cross-sections		
Single-core	mm ²	1 x (0.14 to 2.5), acc. to IEC 60947 1 x 2.5
Finely-stranded with connector sleeve	mm ²	1 x (0.14 to 1.5), acc. to IEC 60947
AWG cables, single or multi-core	AWG	1 x (18 to 22)
Wiring		
Tool required		Standard screwdriver, Size 1
Tightening torque	Nm	0,4 to 0,7
	lbf.in	3,5 to 6,2

2.2 Power modules for ET 200S FC

Overview

There are two types of power modules for the ET 200S FC frequency converter

- For standard applications - the PM-D power/expansion module
- For safety applications, the following power/expansion modules
 - PM-D F Profisafe
 - PM-D F X1

The power modules can be used in conjunction with motor starters and frequency converters.

2.2.1 Power module PM-D for ET 200S FC frequency converters

Features

- A new potential group starts with the power module - together with the associated terminal module. The ET 200S FC frequency converters of a potential group are located to the right of the power module.
- The power module transfers the voltages for the electronics power supply to the voltage buses of the terminal modules - and more precisely for all ET 200S FC frequency converters of a potential group.
- The PM-D monitors the voltages U₁ (PWR) - power supply for the electronics - and U₂ (CON) - power supply for the contactor. Power failures are displayed and signaled.

Caution

Power modules may neither be inserted nor withdrawn in operation.

2.2 Power modules for ET 200S FC

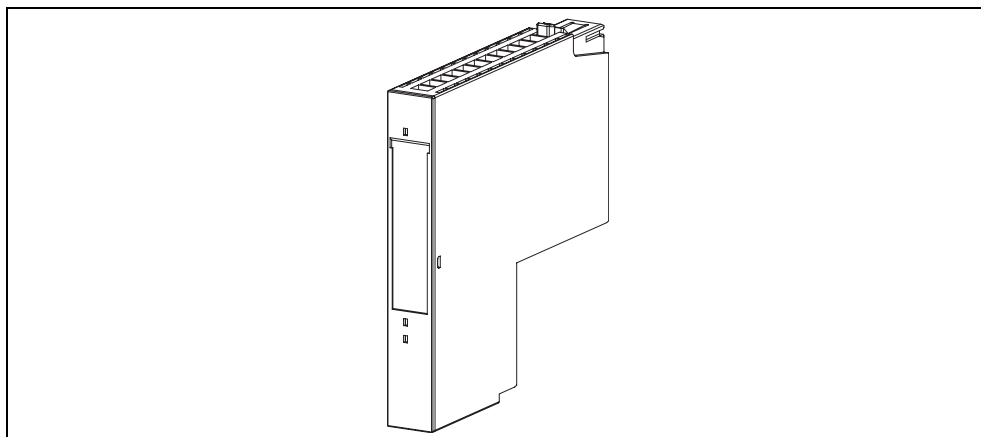


Fig. 2-10 Power module PM-D

Parameters

The Table describes the parameters that can be set for a PM-D power module.

Table 2-16 Parameters for the power module PM-D

Parameter	Action, value range	Basic factory setting	Range of effectiveness
Group diagnostics	<ul style="list-style-type: none"> • Inhibit • Enable 	Inhibit	Module

Group diagnostics

You enable the diagnostics message using this parameter (also refer to Chapter "Protective and monitoring functions").

Note

Using the "Inhibit group diagnostics" parameter, faults are no longer displayed on the LED displays.

Status displays

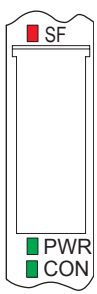
	SF (red)	PWR (green)	CON (green)	Significance
	Dark	Bright	Bright	Bright
Bright	Bright	Bright	Bright	Group fault
Bright	Bright	Bright	Dark	Power supply U2 for the contactors not available
Bright	Bright	Dark	Bright	Power supply U1 for the electronics not available
Bright	Bright	Dark	Dark	Power supply U1 and U2 not available

Fig. 2-11 LED status display for the PM-D power module

Technical data

Table 2-17 Technical data - power module PM-D

Dimensions and weight		
Mounting dimensions W x H x D with the terminal module	mm	15 x 196.5 x 117.5
	inch	3,81 x 49.66 x 29.84
Weight	g	approx. 65
	lbs	approx. 0.14
Voltages, currents, potentials		
Rated control supply voltage U_s	V	DC 20.4 to 28.8 up to 60 °C
Rated operating current I_e	A	10
Recommended upstream short-circuit protection:		
• fuse	A	gL/gG 10
• m.c.b.	A	10, release characteristic B
Insulation between U1 and U2 checked with	V	500
Current drain from the backplane bus	mA	≤ 10
Status, alarms, diagnostics		
Alarms		None
Diagnostic functions:		Yes
• group error/device fault		Red LED SF
• power supply voltage monitoring for the electronics U1 (PWR)		Green LED PWR
• power supply voltage monitoring for the contactors U2 (CON)		Green LED CON
• diagnostics data can be read-out		Yes

2.2 Power modules for ET 200S FC

2.2.2 Fail-safe power/expansion module PM-D F X1

General information about the fail-safe ET 200S modules

Caution

Fail-safe modules **cannot** be used in conjunction with the SIGUARD power modules PM-D F1/F2/F3/F4/F5.

Fail-safe means the following: The main current path/enable circuits are safely interrupted if an EMERGENCY STOP is requested via the mechanically selected SG bus. A device fault is detected and a safe condition is established.

Features

- A new fail-safe potential group starts with the power/expansion module - together with the associated terminal module. The fail-safe components of a fail-safe potential group are located directly to the right of the power/expansion module.
- The PM-D F X1 has a redundant overvoltage protection that triggers the internal protection/fuse above the SIMATIC voltage range. This means that the complete downstream system is brought into a no-voltage condition.
- The PM-D F X1 transfers the fused voltage (U1) for the electronics power supply as well as the shutdown groups G1 to G6 to the voltage buses of the terminal modules - and, more precisely, for all fail-safe components of a fail-safe potential group.
- External safety equipment and devices can be supplied from the fused voltage U1 from the PM-D F X1. This therefore guarantees that overvoltages cannot occur in the system (it must be ensured that there is no feedback path - reaction free).
- Supplies the 6 shutdown groups G1 to G6 as well as from U1 and M.
- The status of the shutdown groups G1 to G6 is displayed using an LED.
- Diagnostic messages/signals are transferred to the higher-level control.
- The fail-safe potential group can be switched in an additional ET 200S tier.
- The fail-safe modules are identified by yellow labeling strips.

Caution

Power/expansion modules may neither be inserted nor withdrawn in operation.

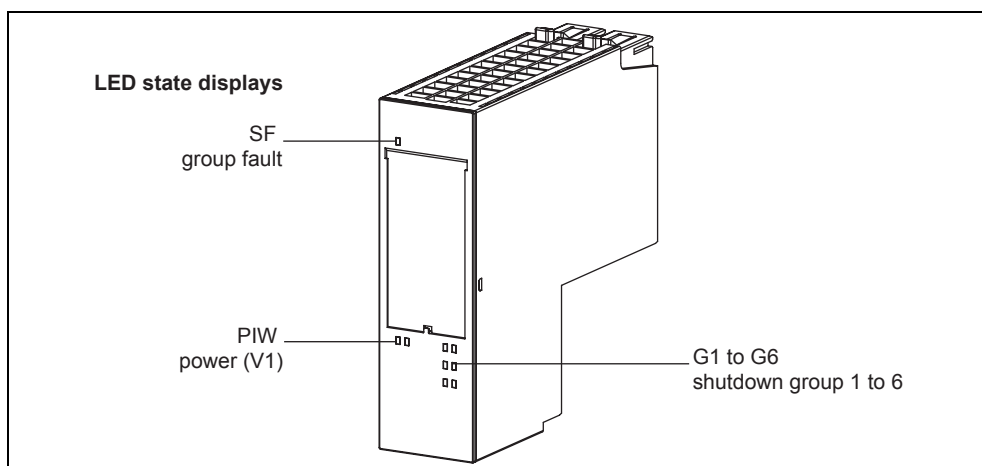


Fig. 2-12 Power/expansion module PM-D F X1

Parameters

The parameters for the power/ expansion module PM-D F X1 that can be set, are described in the following Table.

Table 2-18 Parameters for the PM-D F X1 power/expansion module

Parameter	Action, value range	Factory setting	Range of effectiveness
Group diagnostics	<ul style="list-style-type: none"> • Inhibit • Enable 	Inhibit	Module

Group diagnostics:

You enable the diagnostics message using this parameter (also refer to Chapter "Protective and monitoring functions").

Note

Using the "Inhibit group diagnostics" parameter, faults are no longer displayed on the LED displays.

Status displays

	SF (red)	PWR (green)	G1 - G6 (green)	Significance
	Dark	Bright	Bright	Normal operation
Bright	Bright	No signif.	Bus error	
Bright	Dark	No signif.	Power supply voltage U ₁ for the electronics not available	
No signif.	No signif.	Dark	EMERGENCY STOP on bus G _x , wire breakage at input G _x or bus not used	

G1 - G6 indicate the operation of the six safe buses.

Fig. 2-13 LED status display on the PM-D F X1

2.2 Power modules for ET 200S FC

Electrical structure

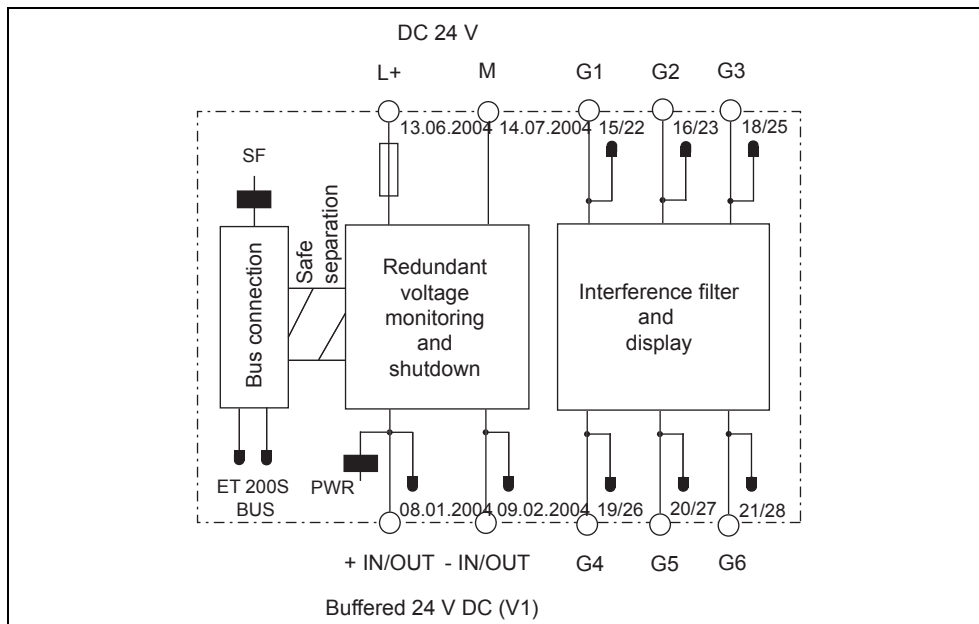


Fig. 2-14 Block circuit diagram, PM-D F X1

Explanation

The PM-D F X1 is mounted at the beginning of a potential group or a new line (TM-PFX30 S47-**G1**) or is inserted to loop-through a potential group (TM-PFX30 S47-**G0**).

You can connect a voltage (U_{in}) at the PM-D F X1 at terminals 6/13 and 7/14.

A fused voltage of 24 V DC (U_1) can be fed-in and fed-out at terminals 1/8 and 2/9.

The shutdown groups G1 to G6 can be fed-in and fed-out at terminals 15/22, 16/23, 18/25, 19/26, 20/27, 21/28.

The PM-D F X1 module comprises the following system components:

- Non safety-related system components:
 - bus coupling with communications
 - diagnostic messages via the BUS
 - display of switching and fault statuses
- Safety-related system components:
 - monitoring voltage V_1 for an overvoltage condition
 - shutting-down voltage V_1 for an overvoltage condition (<100 ms)

Caution

It is the responsibility of the user to monitor the shutdown groups for cross-circuit faults and short-circuit faults.

Regulations when routing cables

Caution

Using the appropriate measures when routing cables, the user must prevent a cross-circuit fault occurring between the individual shutdown groups G1 to G6 as well as U1 or U_{in} or other cables (refer to EN 60204-1 and EN 13849-2).

Safety regulations

Caution

If the PM-D F X1 power/expansion module is supplied through U_{in}, then a PELV power supply should be used that, also under fault conditions, outputs a maximum of 60 V DC.

An external protective circuit (surge filter) is required between the load power supply (power supply) and the load voltage input (U_{in}) of the terminal module in order to achieve the appropriate surge strength. For example, a Blitzductor VT (Order No. 918 402 from Dehn + Söhne).

Caution

PM-D F X1, F-CM and fail-safe ET 200S FC components that belong to a potential group, must be located in the same electrical cabinet. It is only permissible to route G1 to G6, U1, U_{in} within this electrical cabinet.

Caution

If external safety devices (not ET 200S, e.g. SIGUARD 3TK28, AS-i Safety monitor) are connected to the PM-D F X1, then it must be ensured that this is **reaction-free** regarding the potential group.

The external safety devices then switch VU₁₊ (terminal 1/8) to the SG buses (EMERGENCY STOP signal).

Depending on the required Category/SIL, an appropriate safety device should be selected.

Please observe the regulations for the particular safety device!

Replacing modules

If a PM-D F X1 module has to be replaced, then a test engineer does not have to re-accept it from an official safety perspective.

2.2 Power modules for ET 200S FC

Technical data

Table 2-19 Technical data - power/expansion module PM-D F X1

Dimensions and weight		
Mounting dimensions W x H x D	mm	30 x 196,5 x 102
	inch	7.62 x 49.66 x 25.91
Mounting depth with terminal module	mm	117.5
	inch	29.84
Weight	g	approx. 100
	lbs	approx. 0.22
Module-specific data		
Ambient temperature	°C	0 to 60
Degree of protection		IP20
Maximum safety Classes that can be achieved:		
IEC 61508		SIL 3
DIN V 19250		Shutdown Classes 5 and 6
EN 954-1		Category 4
Safety parameters:		
Low demand PFDAVG (10a)		2.5*10 ⁻⁶
High demand/continuous mode PFH 1/h		5.7*10 ⁻¹¹
Proof-test interval in years		10
Voltages, currents, potentials		
Rated control supply voltage Us	V	DC 21.6 to 26.4 V up to 60 °C
Rated operating current Ie	A	6
internal protection using a fuse	A	7 (fast)
Recommended upstream short-circuit protection:		
Fuse	A	gL/gG 6.3 ¹⁾
Current drain:		
From the backplane bus	mA	≤ 10
From U1	mA	≤ 35
From Gx	mA	≤ 15
Status, alarms, diagnostics		
Alarms		None
Diagnostic functions:		Yes
Group error/device fault		Red LED SF
Monitoring of the electronics power supply U1 (PWR)		Green LED PWR
Monitoring of the 6 shutdown groups		Green LED G1 to G6
Diagnostics information can be read-out		Yes
Standards, Approvals		
TÜV [German Technical Inspectorate]		Yes
UL, CSA certification		Yes

- 1) The fuse must be designed so that the connected power supply can provide the current required to rupture the fuse.

2.2.3 Fail-safe power/expansion module PM-D F Profisafe

General information on the fail-safe ET 200S modules

Caution

Fail-safe modules **cannot be used** in conjunction with the SIGUARD power modules PM-D F1/F2/F3/F4/F5.

Fail-safe means the following: The main current path/enable circuits are safely interrupted if an EMERGENCY STOP is requested via the mechanically selected SG bus. A device fault is detected and a safe condition is established.

Features

- A new fail-safe potential group starts with the power/expansion module - together with the associated terminal module. The fail-safe components of a fail-safe potential group are located directly to the right of the power/expansion module.
- The PM-D F PROFIsafe has a redundant overvoltage protection that triggers the internal protection/fuse above the SIMATIC voltage range. This means that the complete downstream system is brought into a no-voltage condition.
- The PM-D F PROFIsafe transfers the fused voltage (U₁) for the electronics power supply as well as the shutdown groups G1 to G6 to the voltage buses of the terminal modules - and, more precisely, for all fail-safe components of a fail-safe potential group.
- External safety equipment and devices can be supplied from the fused voltage U₁ from the PM-D F PROFIsafe . This therefore guarantees that overvoltages cannot occur in the system (it must be ensured that there is no feedback path - reaction-free).
- Supplies the 6 shutdown groups G1 to G6 as well as from U₁ and M.
- The status of the shutdown groups G1 to G6 is displayed using an LED.
- Diagnostic messages/signals are transferred to the higher-level control.
- The fail-safe potential group can be switched in an additional ET 200S tier.
- The fail-safe modules are identified using yellow inscribed labels.

Caution

Power/expansion modules may neither be inserted nor withdrawn in operation.

2.2 Power modules for ET 200S FC

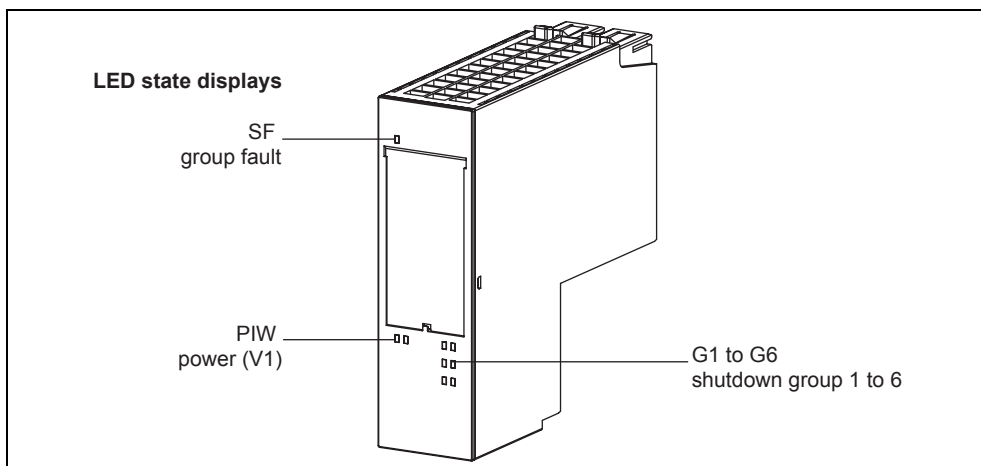


Fig. 2-15 Power/expansion module PM-D F PROFIsafe

Parameters

The parameters for the power/expansion module PM-D F PROFIsafe that can be set, are described in the following Table.

Table 2-20 Parameters for the PM-D F PROFIsafe power/expansion module

Parameter	Action, value range	Factory setting	Range of effectiveness
Group diagnostics	<ul style="list-style-type: none"> • Inhibit • Enable 	Inhibit	Module

Group diagnostics:

You enable the diagnostics message using this parameter (also refer to Chapter "Protective and monitoring functions").

Note

Using the "Inhibit group diagnostics" parameter, faults are no longer displayed on the LED displays.

Status displays

	SF (red)	PWR (green)	G1 - G6 (green)	Significance
	Dark	Bright	Bright	Normal operation
	Bright	Bright	No signif.	Bus error
	Bright	Dark	No signif.	Power supply voltage U ₁ for the electronics not available
	No signif.	No signif.	Dark	EMERGENCY STOP on bus G _x , wire breakage at input G _x or bus not used

G1 - G6 indicate the operation of the six safe buses.

Fig. 2-16 LED status display on the PM-D F PROFIsafe

Electrical structure

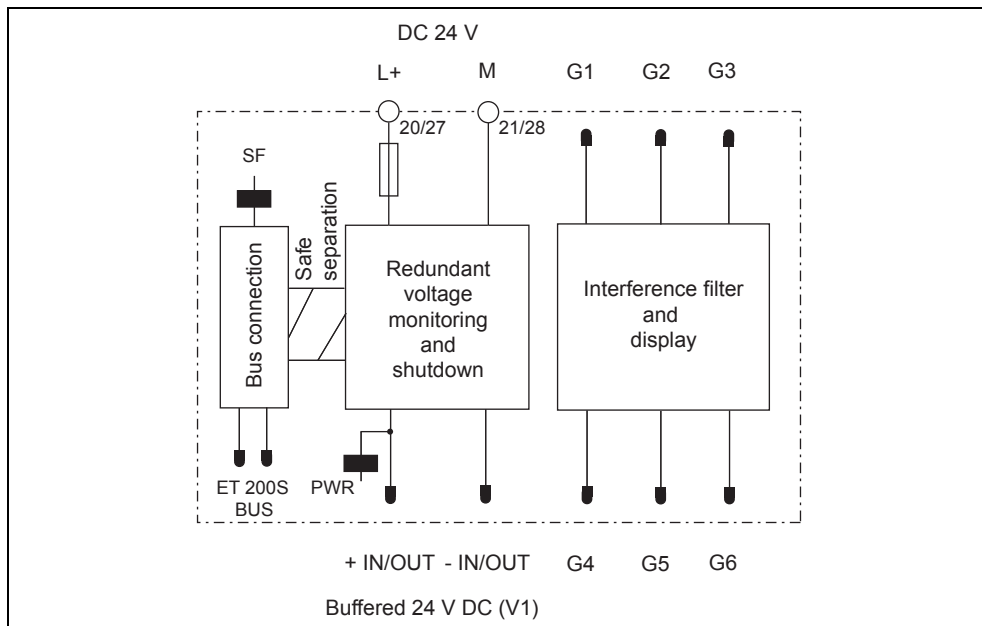


Fig. 2-17 Block circuit diagram PM-D F PROFIsafe

Explanation

The PM-D F PROFIsafe is mounted at the beginning of a potential group or a new line (TM-PFX30 S47-G1) or is inserted to loop-through a potential group (TM-PFX30 S47-G0).

You can connect a voltage (U_{in}) at the PM-D F PROFIsafe at terminals 20/27 and 21/28.

The PM-D F PROFIsafe module comprises the following system components:

- Non safety-related system components:
 - bus coupling with communications
 - diagnostic messages via the BUS
 - display of switching and fault statuses
- Safety-related system components:
 - monitoring voltage U_1 for an overvoltage condition
 - shutting-down voltage U_1 for an overvoltage condition (<100 ms)
 - monitoring the shutdown groups for cross-circuit fault and short-circuit fault

2.2 Power modules for ET 200S FC

Regulations when routing cables

Caution

Using the appropriate measures when routing cables, the user must prevent a cross-circuit fault occurring between U₁ or U_{in} and other cables (refer to EN 60204-1 and EN 13849-2)..

Safety regulations

Caution

If the PM-D F PROFIsafe power/expansion module is supplied through the U_{in}, then a PELV power supply should be used that, also under fault conditions, outputs a maximum of 60 V DC.

An external protective circuit (surge filter) is required between the load power supply (power supply) and the load voltage input (U_{in}) of the terminal module in order to achieve the appropriate surge strength. For example, a Blitzductor VT (Order No. 918 402 from Dehn + Söhne).

Caution

PM-D F PROFIsafe, F-CM and fail-safe ET 200S FC components that belong to a potential group, must be located in the same electrical cabinet. It is only permissible to route G1 to G6, U₁, U_{in} within this electrical cabinet.

Caution

If external safety devices (not ET 200S, e.g. SIGUARD 3TK28, AS-i safety monitor) are connected to the PM-D F PROFIsafe, then it must be ensured that this is **reaction-free** regarding the potential group.

The external safety devices then switch U₁₊ (terminal 20/27) to the SG buses (EMERGENCY STOP signal).

Depending on the required Category/SIL, an appropriate safety device should be selected.

Please observe the regulations for the particular safety device!

Replacing modules

If a PM-D F PROFIsafe module has to be replaced, then a test engineer does not have to re-accept it from an official safety perspective.

Technical data

Table 2-21 Technical data - PM-D F PROFIsafe

Dimensions and weight		
Mounting dimensions W x H x D	mm	30 x 196.5 x 102
	inch	7.62 x 49.66 x 25.91
Mounting depth with terminal module	mm	117.5
	inch	29.84
Weight	g	approx. 120
	lbs	approx. 0.26
Module-specific data		
Ambient temperature	°C	0 to 60
Degree of protection		IP20
Maximum safety Classes that can be achieved:		
IEC 61508		SIL 3
DIN V 19250		Shutdown Classe 6
EN 954-1		Category 4
Safety parameters:		
Low demand PFDAVG (10a)		2,5*10 ⁻⁶
High demand/continuous mode PFH 1/h		5,7*10 ⁻¹¹
Proof-test interval in years		10
Voltages, currents, potentials		
Rated control supply voltage Us	V	DC 21.6 to 26.4 up to 60 °C
Rated operating current Ie	A	4
Internal protection using a fuse	A	7 (fast)
Recommended upstream short-circuit protection:		
Fuse	A	gL/gG 6.3 ¹⁾
Current drain:		
From the backplane bus	mA	≤ 10
From U1	mA	≤ 35
From Gx	mA	≤ 15
Status, alarms, diagnostics		
Alarms		None
Diagnostic functions:		Yes
Group error/device fault		Red LED SF
Monitoring of the electronics power supply U1 (PWR)		Green LED PWR
Monitoring of the 6 shutdown groups		Green LED G1 to G6
Diagnostics information can be read-out		Yes
Standards, Approvals		
TÜV [German Technical Inspectorate]		Yes
UL, CSA certification		Yes

- 1) The fuse must be designed so that the connected power supply section can provide the current required to rupture the fuse.

2.3 Control units and converter power modules of the ET 200S FC

2.3 Control units and converter power modules of the ET 200S FC

Overview

The frequency converter comprises a control unit ICU24(F) and an IPM25 FSA or IPM25 FSB converter power module. The series of ET 200S FC converters covers the power range extending from 0.75 kW to 4 kW.

The individual versions, as shown in the following table, can be combined with one another as required.

Table 2-22 Possibilities of combining control units and power modules

Control unit Power module	ICU24	ICU24F
IPM25 FSA, 750 W	X	X
IPM25 FSB, 2.2 kW	X	X
IPM25 FSB, 4 kW	X	X

Note

The ET 200S FC drive converters are open-type devices corresponding to UL 50 and therefore may only be operated in the appropriate housings/cabinets to ensure protection against mechanical damage.

The fail-safe ET 200S FC frequency converters (with ICU24F control unit) are open-type units corresponding to UL 50 and in order to ensure protection against mechanical damage and accumulated dirt - they must be operated in the appropriate housings/cabinets with degree of protection IP54 according to EN 60529.

2.3 Control units and converter power modules of the ET 200S FC

2.3.1 Control units ICU24 and ICU24F

Description

The ICU24 control unit and the fail-safe ICU24F control unit are components of the ET 200S FC converter that are always required. All of the closed-loop control processes to control the IPM25 power module and the brake control module (option) run on this unit. They handle the communications with the higher-level control via the IM 151 interface module.

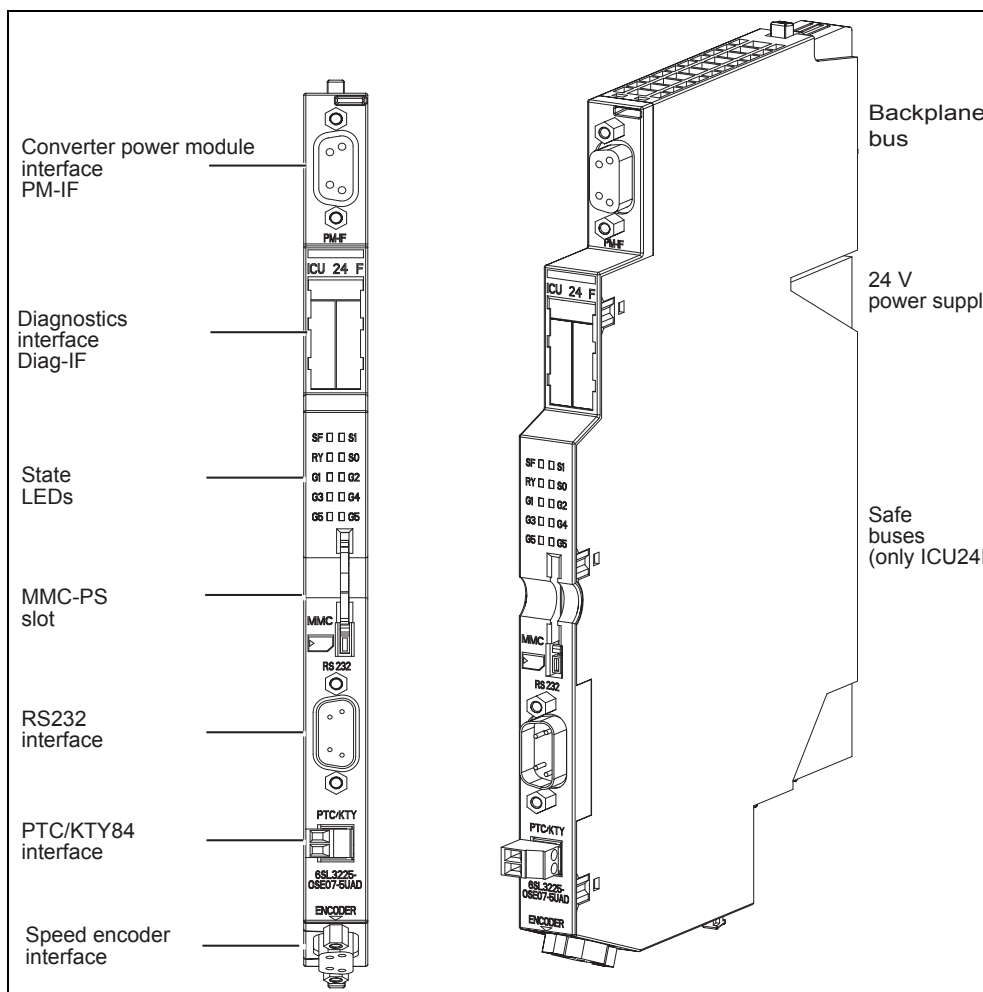


Fig. 0-18 Control unit ICU24(F) with its components

2.3 Control units and converter power modules of the ET 200S FC

Closed-loop control functions

V/f characteristic control (V/f characteristic) and the closed-loop field-orientated control (closed-loop vector control) are the most important techniques to control (closed-loop) the speed and torque of induction and synchronous motors. The ICU24(F) control unit supports the following techniques:

V/f characteristic

- Linear V/f control
- Linear V/f control with closed-loop flux current control (FCC)
- Parabolic V/f control
- Multi-point V/f control

Closed-loop Vector control

- Speed control with / without encoder
- Closed-loop torque control with / without encoder

Protective functions

A series of protective functions are implemented using the ICU24(F) where both the IPM25 power module of the ET 200S FC is protected as well as the associated motor and the system itself.

Frequency converter protection

- Ground fault
- Short-circuit
- Overcurrent
- Overvoltage
- Undervoltage
- Thermal monitoring
 - I^2t
 - heatsink temperature
 - chip temperature

Motor protection

- Stall protection
- Locked rotor protection
- Thermal monitoring
 - I^2t
 - temperature sensor

System protection

- Load torque monitoring

Braking functions

- Regenerative brake
- Control of an external mechanical motor holding brake

2.3 Control units and converter power modules of the ET 200S FC

Replacing the control unit

The control units can be simply installed and can also be replaced under voltage (hot swapping). However, an ICU24F control unit cannot be replaced by an ICU24.

Caution

When releasing the connection between the ICU24(F) and IPM25 (be withdrawing the PM-IF), the frequency converter is in a non-defined state and the following subsequently listed faults can be displayed.

- F0004, F0005, F0060.1, F0025, F0100.

Under certain circumstances, an incorrect temperature can be displayed in r0037
If the connection is re-established, these fault messages can be acknowledged (depending on the setting of p1210, the faults are automatically acknowledged).

Displays of the various states

ICU24 display of the various states

The state of the frequency converter is displayed on the front panel of the ICU24 of the ET 200S FC frequency converter using three LEDs (SF, RY and OL). For the ICU24, LEDs SH and G1 to G6 have no significance:

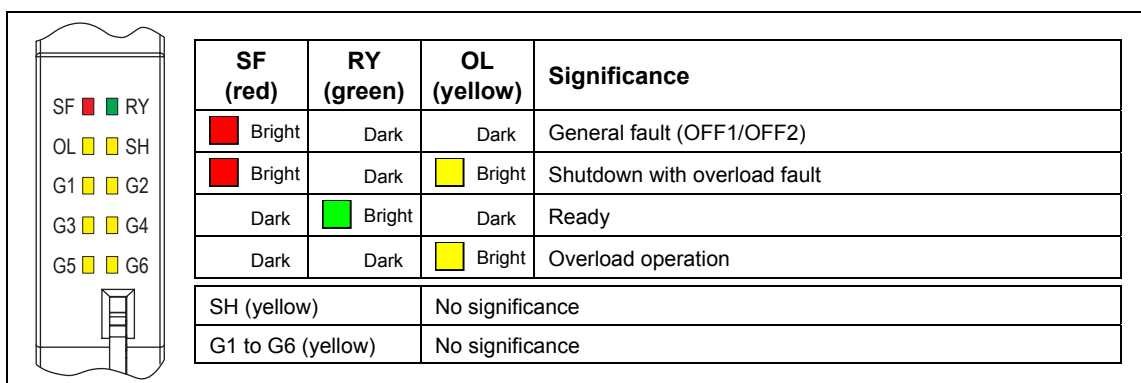


Fig. 2-19 LED state display on the front panel of the ICU24

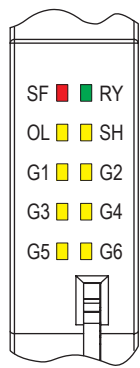
Additional state displays for the ICU24

- SF ■ Flashes (0,5 Hz) after the firmware has been successfully completed to indicate that a system test is required
- RY ■ Flashes while the frequency converter is being commissioned – Quick commissioning
- RY ■ Flashes if no frequency converter fault is present; if communications to a higher-level control have still not been established – but power is present at the ET 200 S station
- All LEDs Are bright (lit) while the firmware is being updated
- Dark while uploading and downloading parameters sets when the control unit is running-up ICU(F)

2.3 Control units and converter power modules of the ET 200S FC

ICU24F display of the various states

The state of the frequency converter is displayed on the front panel of the ICU24F of the ET 200S FC frequency converter using ten LEDs (SF, RY, SH, OL, G1 - G6).



SF (red)	RY (green)	SH (yellow)	OL (yellow)	Significance
Bright	Dark	Dark	Dark	General fault (OFF1/OFF2)
Bright	Dark	Dark	Bright	Shutdown with overload fault
Bright	Dark	Bright	Dark	Fault shutdown with safe operating stop
Dark	Bright	Dark	Dark	Ready
Dark	Dark	Dark	Bright	Overload operation
Dark	Dark	Bright	Dark	Safe operating stop state (SH) reached
Dark	Dark	Bright	Bright	State – safely-reduced speed has been reached
G1 to G6 (yellow) Flashes		Indicate the assigned safety group of the frequency converter Flashes for the time that the assigned safety function is activated		

Fig. 2-20 LED state display on the front panel of the ICU24F

Additional state displays for the ICU24F

SF	Flashes (0,5 Hz)	after the firmware has been successfully completed to indicate that a system test is required.
RY	Flashes	while the frequency converter is being commissioned – Quick commissioning
RY	Flashes	if no frequency converter fault is present; if communications to a higher-level control have still not been established – but power is present at the ET 200 S station. Gx is the selected shutdown group, x= 1 to 5
Gx and G6	Bright	
All LEDs	Dark	while uploading and downloading parameters set when the control unit is running-up ICU(F)
	are bright	(lit) while the firmware is being updated.
G1 to G6	Flash (2 Hz)	in synchronism while the safety functions are being commissioned.

Note

The ET 200S system diagnostics for ICU24(F) are provided in the Chapter "Connection to SIMATIC S7".

2.3 Control units and converter power modules of the ET 200S FC

Interfaces

The following interfaces are on the ICU24(F) control unit (refer to Fig. 0-1):

- Interface to the converter power module PM-IF.
- Backplane bus (at the rear) establishes the connection to the IM 151 interface module.
- MMC-PS slot
The ET 200S FC can be parameterized so that the parameter settings can either be read from the MMC parameter memory (MMC-PS) or from the EEPROM of the ICU24(F). Further, parameters can either be uploaded or downloaded via the MMC-PS. Details are provided in the Section "Options for the ET 200S FC".
- RS232 interface, serial interface to parameterize the ET 200S FC via PC using the "STARTER" commissioning (start-up) software.
- PTC/KTY84 interface to monitor the motor temperature.
- Speed encoder interface for HTL encoders (24 V output, max. 200 mA).
- Diagnostics interface (Diag-IF, only for service purposes).
- Shutdown groups G1 to G6 (only ICU24F).

Technical data

Table 2-23 Technical data of the control unit ICU24(F)

Dimensions and weight		
Mounting dimensions W x H x D	mm	15 x 220 x 156
(Mounting depth with terminal module)	inch	3.8 x 55.9 x 39.6
Weight	g	approx. 220 (ICU24F approx. 250)
	lbs	approx. 0.49 (ICU24F approx. 0.56)
Module-specific data		
Ambient temperature	°C	-10 – 60 for horizontal mounting -10 – 40 for vertical mounting
Degree of protection		IP20
Max. safety Classes that can be achieved (only ICU24F)		
IEC 61508		SIL 2
EN 954-1		Category 3
PFH value		$1.46 \cdot 10^{-7}$
Usage (operating) duration	Years	10
Electrical data		
Setpoint resolution		0.01 Hz digital, 0.01 Hz serial
Output frequency resolution		0.01 Hz digital, 0.01 Hz serial
Current drain	A	0.8 max. 0.4 typ.

2.3 Control units and converter power modules of the ET 200S FC

2.3.2 Converter power modules IPM25 FSA/FSB

Overview

The following converter power modules are available for the ET 200S FC frequency converter:

Table 2-24 Power modules for the ET 200S FC frequency converter

Designation	Order No. [MLFB]	Load capability	Design (width)
IPM25 FSA	6SL3225-0SE17-5UA0	0.75 kW	65 mm
IPM25 FSB	6SL3225-0SE22-2UA0	2.2 kW	130 mm
IPM25 FSB	6SL3225-0SE24-0UA0	4.0 kW	130 mm

Designs

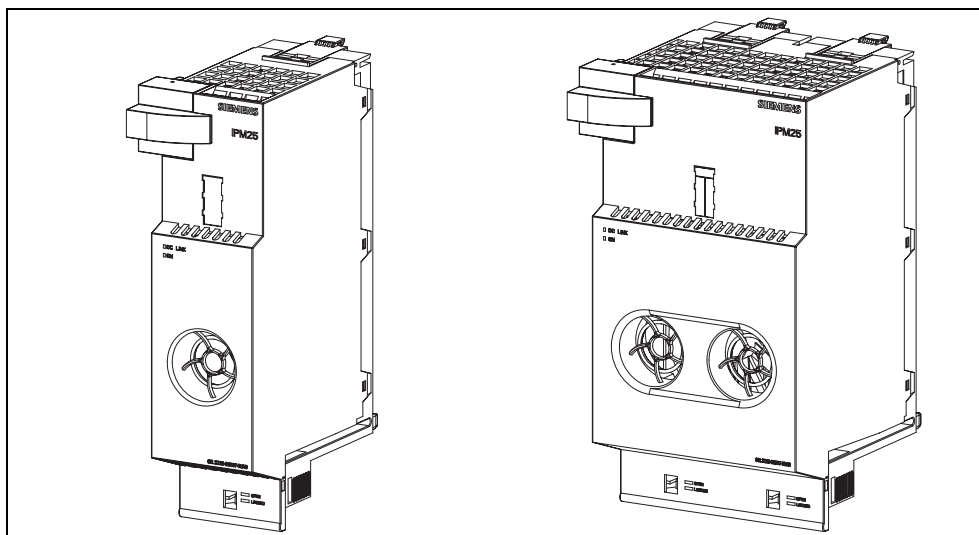


Fig. 2-21 Power module IPM25-FSA (left) and power module IPM25-FSB (right)

2.3 Control units and converter power modules of the ET 200S FC

Description

The IPM25 FSA and IPM25 FSB power modules are components belonging to the ET 200S FC frequency converter system. They operate with an input voltage of 3-ph. 400 V AC 50/60 Hz and cover the power range from 0.75 kW to 4 kW.

They have an AC-AC power stage with control (closed-loop) electronics and are connected to the ICU24(F) control unit via the PM-IF connector. The ICU24(F) control unit handles the closed-loop motor control with the necessary interfaces to the ET 200S.

The motor is connected to the terminal module of the power module through an electrical connection. A brake control module is connected via the terminal module of the brake control module.

A brake control module from the ET 200S system can be controlled via the power module to activate/de-activate a motor holding brake. The connection to the power module is established through the terminal module when the components are snapped-on.

2.3 Control units and converter power modules of the ET 200S FC

Features

The most important features of the power module include:

- They operate without any DC link and can regenerate into the line supply. An essential advantage of these frequency converters is that they do not require a braking resistor.
- They fulfill the requirements of EN 61000-3-12 without any additional measures. This means that line commutating reactors are not required.
- For low-noise motor operation they provide adjustable pulse frequencies (2 kHz to 16 kHz, factory setting, 8 kHz).
- They can be simply installed and replaced under voltage (hot swapping).

Caution

If, when replacing a converter power module (IPM25, 4,0 kW), a lower rating converter power module is inserted (IPM25, 2.2 kW), then parameter p0640 "current limit" (and possibly also p1520, 1521, 1530 and 1531) is automatically adapted to the lower power rating in order to protect the converter power module from being destroyed.

This parameter change is independent of the settings for a frequency converter replacement in p7840. This means that the parameter is always changed. This change also remains if the control unit subsequently does not accept the converter power module and an error is output.

If, when replacing a converter power module, a converter power module with a higher power rating is inserted, the value for the current limit in p0640 remains. The reason for this is that there are absolutely no restrictions regarding the maximum current limit being fallen below.

This self-protection mechanism of the frequency converter means that when a converter power module is replaced - from a lower rated power to a higher rated power - then parameter p0640 must, under certain circumstances, be adapted to the appropriate application (required current limit).

For the case that an MMC-“PS required“ is configured, this means that the values for the power module with the lower power rating can also be written to the MMC-PS. This means that as soon as higher rating converter power module is inserted, the data for the lower rating power module are written into the EEPROM.

In this particular case, data for the higher rating converter power module must be changed in the RAM and written to the MMC-PS with p0802. This can be done either before or after the converter power module is replaced.

- Some wiring is eliminated. The power and output to the motor is implemented via the terminal module.

2.3 Control units and converter power modules of the ET 200S FC

Displays of the various states

The state of the power module is displayed using two LEDs.

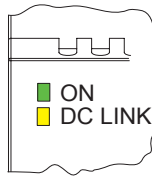
	LED	State	Significance
	ON (green)	Bright	Frequency converter output is active (pulse enable)
		Dark	Frequency converter output is not active (pulse enable)
	DC LINK (yellow)	Bright	DC voltage connection available
Dark		DC voltage connection not available	

Fig. 2-22 LED to display the states of the converter power module

Note

The ET 200S system diagnostics for IPM25 is provided in Chapter "Protection and monitoring functions".

Technical data

Table 2-25 Technical data of the IPM25 as a function of the power rating

Order No.		Power		Input current	Output current	Fuse ¹⁾
		kW	hp	A	A	A
6SL3225-0SE07-5UA0	(FSA)	0.75	1.0	1.9	2.1	3NA3003
6SL3225-0SE12-2UA0	(FSB)	2.2	3.0	5,7	5.9	3NA3005
6SL3225-0SE14-0UA0	(FSB)	4.0	5.0	9,6	10.2	3NA3007

Footnotes for Table **Error! No text of specified style in document.-2**

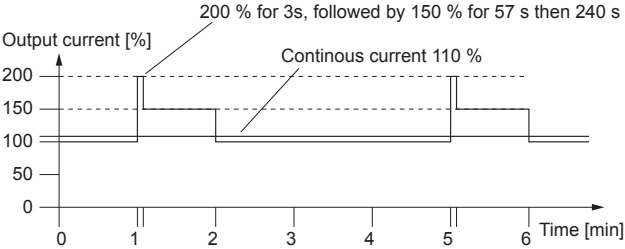
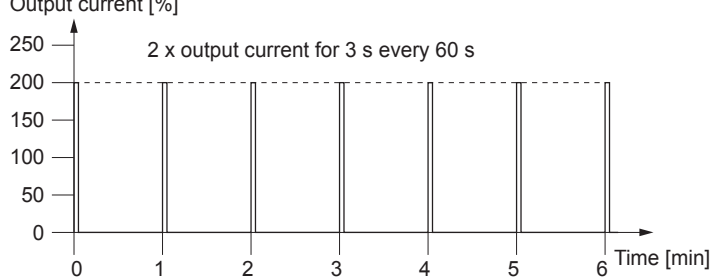
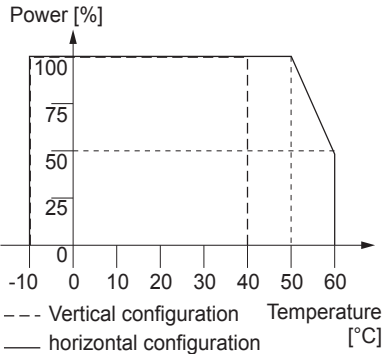
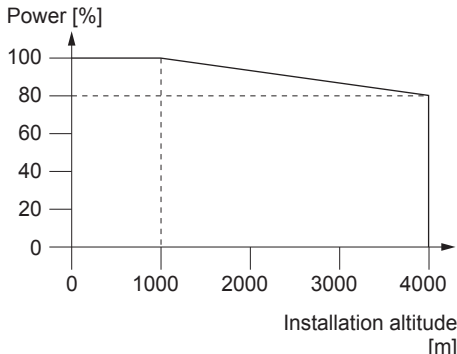
1) Fusing for the case that only one frequency converter is connected to the power bus. If several frequency converters are connected to the common power bus of the ET 200S, then a fuse must be selected to provide cable protection corresponding to the total input current of all frequency converters.

Note

For UL approval a suitable H or K class fuse should be used e.g., Bussman NOS series fuses.

2.3 Control units and converter power modules of the ET 200S FC

Table 2-26 General technical data of the IPM25 FSA/FSB power modules

Dimensions and weight			
		FSA	FSB
Mounting dimensions W x H x D (with terminal module)	mm	65 x 290 x 156	130 x 290 x 156
	inch	16,5 x 73,7 x 39,6	33,0 x 73,7 x 39,6
Weight	g	approx. 1000	approx. 1800
	lbs	approx. 2.2	approx. 4.0
Electrical data			
Rated voltage	V	3-ph. 380 – 480 AC, +10 % / -15 %	
Overvoltage category		2	
Line supply frequency	Hz	47– 63	
Power factor		≥ 0.7	
Efficiency	%	96 – 97	
Pulse frequency	kHz	2 – 16, can be adjusted in 2 kHz steps	
Inrush current	A	< rated current	
Overload capability (the adjacent diagrams only apply when the drive is motoring). The regenerative feedback power is limited to the rated power of the IPM25)		<p>200 % for 3s, followed by 150 % for 57 s then 240 s 100 %</p>  <p>Continuous current 110 %</p> <p>or</p>  <p>2 x output current for 3 s every 60 s</p>	
Module-specific data			
Degree of protection		IP20	
Electromagnetic compatibility		EMC filter acc. to EN 55 011, Class A (accessory)	
Maximum cable length (motor)	m	50 (shielded) 100 (unshielded)	
Ambient temperature [°C]		Installation altitude [m]	
 <p>--- Vertical configuration — horizontal configuration</p>			

2.4 Options for the ET 200S FC

Overview

The following essential options are available for the ET 200S FC frequency converters:

- **MMC parameter memory (MMC-PS)**
the MMC parameter memory can be configured as data medium for the operating data of the ET 200S FC. This means that the ICU24(F) control units of the frequency converter can be quickly and simply replaced.

Note

Only MMC-PS are permissible for the ET 200S FC frequency converters. If another memory card is used, an error message is output.

- **Brake control module**
the brake control module is available in two different versions - xB1 and xB2. It is a component of the ET 200S system and just like the other ET 200S components, it is snapped onto pre-wired terminal modules.
- **EMC filter**
The EMC filter is not a component of the ET 200S system and is externally mounted.

Detailed information regarding the options is provided in the following sections.

2.4 Options for the ET 200S FC

2.4.1 MMC parameter memory (MMC-PS)

Description

For ET 200S FC frequency converters, a special **Micro Memory Card** (MMC-PS) can be used as memory for parameter sets.

ICU24(F) control units can be extremely simply replaced without requiring that the system is re-commissioned by using an MMC-PS.

When required, an MMC-PS can also be used as medium for firmware upgrades.

Caution

Either a parameter set or firmware can be saved on an MMC-PS. It is not possible to simultaneously save firmware and parameter set.

The firmware update, in this case, has a higher priority than downloading parameter sets. This means that as long as a firmware update is saved on an MMC, a parameter set cannot be downloaded.

Note

In the HW Config of STEP 7 it must be configured as to whether an MMC-PS must be used or whether the frequency converter can be operated without MMC-PS.

Additional details for using the MMC-PS are provided in the Chapter "Interfaces", Section "MMC-PS slot".

2.4.2 Brake control modules xB1 and xB2

Description

The brake control modules have the task of controlling the integrated DC-spring-operated brake (motor holding brake) of a three-phase motor. The brake is actuated using a solenoid. When the circuit is closed, this solenoid keeps the brake open. When the current is interrupted, the solenoid drops-out and the brake is activated by the force of the spring therefore braking the motor.

An external actuator can be incorporated as additional application, e.g. DC valves. This is especially the case if this functionally depends on the motor.

The brake control module can be used in conjunction with motor starters and ET 200S FC frequency converters.

The brake control module is always mounted to the right of the power module of the ET 200S FC frequency converter. The electrical connection to the ET 200S FC is established when the power module is inserted on the terminal module.

Note

The brake control module must be inserted before the converter power module of the ET 200S FC frequency converter. Further, the converter power module must be withdrawn before the brake control module can be withdrawn.

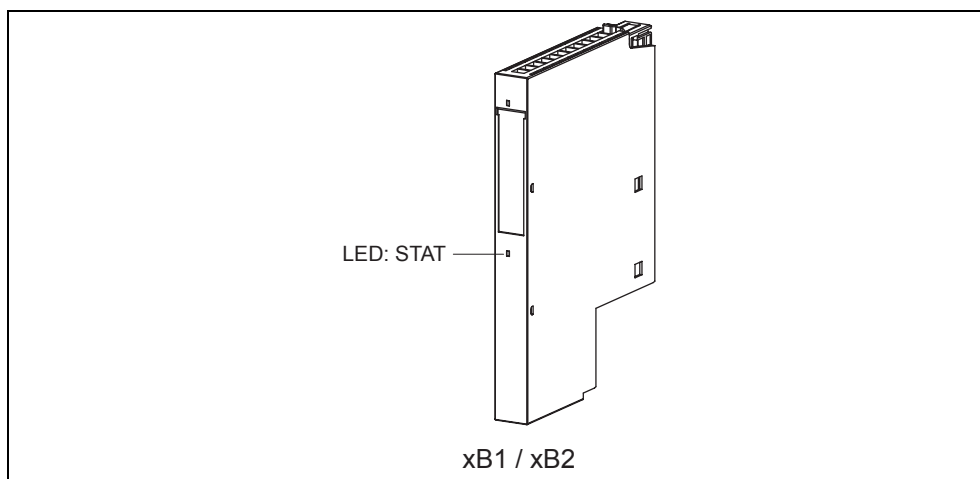


Fig. 2-23 Brake control module xB1 / xB2

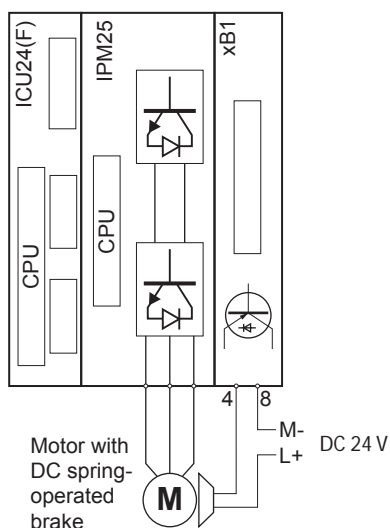
2.4 Options for the ET 200S FC

Common features of the xB1 and xB2

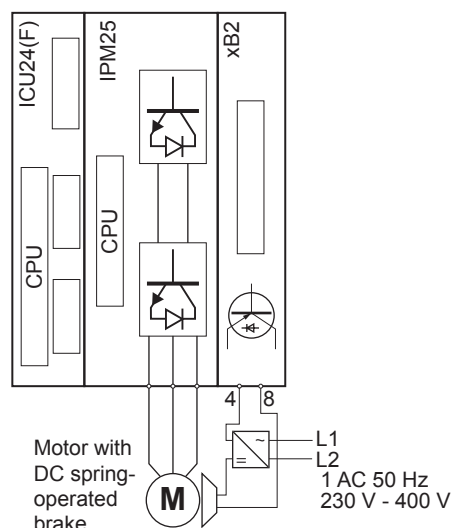
- The brake control module contains a single-pole electronic switch which can be used to control the DC-spring-operated brake integrated in the electric motors (motor holding brake).
- There is a lug located on the lefthand side of the brake control module that ensures that it can only be withdrawn or inserted if the associated drive converter power module is withdrawn. This means that the module cannot be removed or inserted under voltage (i.e. in a live condition).
- A coding element is mounted on the brake control module housing. This allows the modules to be differentiated from one another mechanically.
- The brake control module is controlled using the power module of the frequency converter. The ET 200S FC has an internal brake logic circuit that is enabled and set via parameters p1215 to p1217.
- The brake is released when voltage is connected to it.

Differentiating features between xB1 and xB2**Brake control module xB1**

- 3RK1903-0CB00
- An external 24 V DC power supply voltage is required.

**Brake control module xB2**

- 3RK1903-0CC00
- An external power supply voltage of 1-ph. 230 V to 400 V AC is required.

**Note**

In safety-relevant applications, the motor holding brake is always initiated via the configured bus as soon as a "safe standstill" signal is present. The initiation by "safe standstill" has a higher priority than the signal issued via the brake control module.


Warning

If a brake control module xB1 is being used and the motor holding brake is opened, and the motor voltage is interrupted, the motor holding brake remains open and only alarm message A0922 is output.

Displays of the various states

The following states are displayed via the LED on the brake control module:

Table 2-27 Status displays (LED) of the brake control module

LED	State	Significance
 yellow	Bright Dark	Brake released Brake active

Note

If the overload or short-circuit protection responds, this is not displayed.

2.4 Options for the ET 200S FC

Technical data

Table 2-28 Technical data - brake control modules xB1 and xB2

Dimensions and weight		xB1	XB2
Mounting dimensions W x H x D	mm	15 x 195.6 x 95	15 x 195.6 x 95
	inch	3.8 x 49.6 x 24.1	3.8 x 49.6 x 24.1
Mounting depth with terminal module	mm	117.5	117.5
	inch	29.82	29.8
Weight	g	approx. 120	approx. 120
	lbs	approx. 0.265	approx. 0.265
Module-specific data			
Ambient temperature			
In operation	°C	0 to 60	0 to 60
In storage	°C	-40 to 80	-40 to 80
Degree of protection		IP20	IP20
Isolation			
Between the control and brake circuit	V	AC 500	AC 500
Surge voltage strength	kV	8	8
Switching element of the brake control module (terminals 4 – 8)			
Rated operating voltage	V	DC 24	DC 500
Peak voltage (periodical)	V	< DC 35	< 710
Continuous current ¹⁾	A	≤ 4	≤ 0.7
Inrush current at t < 120 ms	A	≤ 8	≤ 5
Switch-off current DC 13, at 24 V (with ext. induction protection)	A	≤ 4	-
Switch-off current DC 13, at 220 V _{rms} ²⁾ (with ext. induction protection)	A	-	≤ 0.7
Residual current	mA	< 10	< 1
Voltage drop at I _{load} < 0.7 A	V	< 0.3	< 1.4
Permissible braking (examples) for single-phase rectification			
230 V AC results in 100 V _{rms} , T < 40 °C	W	-	≤ 70
400 V AC results in 170 V _{rms}	W	-	≤ 100
500 V AC results in 220 V _{rms}	W	-	≤ 135
Permissible power of the brake at 24 V	W	≤ 95	-
Fault message when the brake is not controlled		No	No
Protective measures			
Overload protection ³⁾		Integrated current limiting	Integrated current limiting
Short-circuit protection according to EN 60947-5-1 ³⁾		Yes, with 24 V/1 kA	Yes, with 230 V/1 kA
Incorrect polarity protection ⁴⁾		No	No
Induction protection (internal)		Protective diode	Varistor
External protective circuit for inductive loads ⁵⁾		≤ 40 W recommended > 40 W required	≤ 40 W recommended > 40 W required

Footnotes for Table Fehler! Kein Text mit angegebener Formatvorlage im Dokument.-2

- 1) When configuring the system, take careful note of the data regarding special ambient conditions in the "ET 200S Motor Starter / Fail-Safe Motor Starter" Manual.
- 2) For single-phase rectification of a 500 V AC line supply
- 3) Electronic trip (the frequency converter can only be powered-up again after shutdown via the frequency converter)
- 4) Module forms a short circuit without current limiting, the brake is released and the overload and short-circuit protection is not effective
- 5) RC element or protective diode connected to the brake coil (solenoid) or varistor connected to the brake rectifier

2.4.3 EMC filters

Description

ET 200S FC frequency converters can be equipped with Class A EMC filters. When using the optional group EMC filter and when mounted/installed in compliance with EMC guidelines, the EMC Directive according to EN 55011, Class A is fulfilled.

For the ET 200S FC, there are two EMC filters that are mounted externally

Rated current 25 A Order No. 6SL3203-0BE22-5AA0

Rated current 50 A Order No. 6SL3203-0BE25-0AA0

Caution

Operation with EMC filter is only permitted for TN line supplies.

Mounting guidelines for ET 200S FC frequency converters with EMC filter

- Operation with EMC filter is only permitted with TN line supplies.
- The EMC Class A filter is located directly in front of the power bus supply in the line feeder cable of the ET 200S FC frequency converter.
- The frequency converter must be mounted on a panel grounded through a large surface area.
- Only shielded cables are permissible after the EMC filter.
- For frequency converters with safety-relevant functions, shielded cables must always be used.
- The power bus for the frequency converter must be routed separately away from other power buses.
- The complete ET 200S system with frequency converters must be installed in a metallic electrical cabinet.
- The maximum length of the motor cables is 350 meters. In this case, all of the motor feeder cables of all of the drive converters that are connected to a common power bus must be added.
- The maximum length of shielded motor cable per frequency converter is 50 m.
- Connection cross-sections
 - 25 A : 4 mm² (AWG 11)
 - 50 A : 10 mm² (AWG 7)

2.4 Options for the ET 200S FC

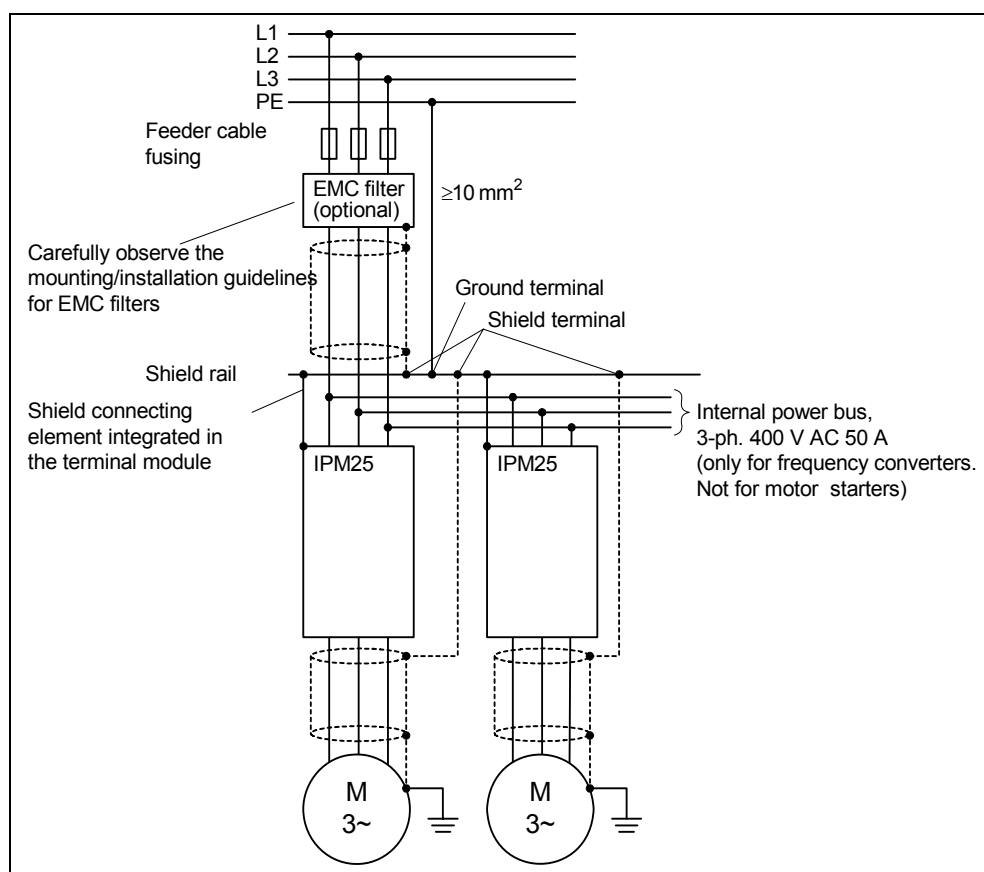


Fig. 2-24 ET 200S FC frequency converter with EMC filter

2.4.4 Other options

PC ↔ ICU24(F) communication cable

A PC ↔ ICU24(F) communication cable is required to commission the ET 200S FC frequency converter via the STARTER commissioning tool. It can be ordered under Order No. [MLFB] 6ES7901-1BF00-0XA0.

Mounting

Contents of Chapter 3

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3.1 Slot rules

Slot rules for ET 200S FC frequency converters

In order to ensure that an ET 200S system operates correctly and safely, the individual components must be inserted according to specific rules. The following Section provides an overview of the rules that must be carefully observed when configuring an ET 200S station with ET 200S FC frequency converters.

- A power module is always located to the right of an IM 151 module.
- Every potential group starts with a power module.
- A converter power module IPM25 must always be inserted to the right of an ICU24(F) control unit.
- A fail-safe ICU24F control unit may only be inserted in a potential group with a fail-safe power module (PM-D F PROFIsafe or PM-D FX1).
- An ICU24 control unit may only be inserted in a potential group with a standard power module (PM-D).
- ET 200S FC frequency converters and high-feature motor starters may not be operated in a common load group.

3.2 Mounting rules

Mounting rail

The ET 200S distributed I/O system is mounted on rails according to EN 50022 (35 mm x 7.5 mm or 35 mm x 15 mm). In order to configure an ET 200S station with ET 200S FC frequency converters, you require two mounting rails that are located with a center-to-center clearance of 100 mm.

Note

We recommend that the mounting rails are screwed to the mounting plane with a clearance of 200 mm.

Extremely simple mounting

The distributed ET 200S system has been designed so that it can be extremely simply mounted. When configuring an ET 200S station with ET 200S FC frequency converters, to start, the terminal modules are mounted. The power modules and frequency converter components are then inserted on the terminal modules.

Mounting rules for configuring an ET 200S station with ET 200S FC frequency converters

Please observe the following rules when mounting components (also refer to Chapter "Overview" Section "ET 200S stations with ET 200S FC frequency converters"):

- The system is mounted on a single tier in groups.
- Every tier starts with an IM 151 interface module at the left.
- A power module is mounted after the interface module or at the start of every potential group. The following power modules are permissible for the ET 200S FC frequency converters:
 - PM-D
 - PM-D F X1
 - PM-D F PROFIsafe
- The ET 200S distributed I/O system is terminated using a termination module; ET 200S FC frequency converters additionally have a termination cover and termination caps for the power bus.
- Each IM 151 interface module can be expanded up to a maximum of 63 modules to be configured.

3.2 *Mounting rules*

- 24 frequency converters can be connected to an ET 200S station. In this case, the maximum width of a station mounted on an ET 200S mounting rail may not exceed 2 m.

Mounting position

Components can be mounted either vertically or horizontally on the mounting rail. It maybe necessary to take into account a possible de-rating.

3.3 Mounting dimensions and clearances

Overview

The mounting dimensions and clearances when mechanically assembling an ET 200S FC are shown in the following table Montage (also refer to "Overview" Section "ET 200S stations with ET 200S FC frequency converters").

Table 3-1 Mounting dimensions and clearances for ET 200S FC components

	Module	Dimensions [mm]
Mounting width	• Power module PM-D	15
	• Distance module DM-V15	15
	• Power module PM-D F PROFIsafe	30
	• Power module PM-D F X1	30
	• ICU24	15
	• ICU24F	15
	• IPM25 FSA	65
	• IPM25 FSB	130
	• Brake control module	15
Mounting heights, including terminal modules	With three-phase power bus (L1, L2, L3)	290
	With five-phase power bus (including PE/N)	332
Minimum clearances for mounting and wiring	• Above and below the terminal modules	35
	• To the left of the interface module	20
	• To the right next to the ET 200S termination module	20
	• Below the shield rail	15
	• In front of the frequency converter (front plane of the freq. converter) to the cabinet door and/or panel	35

3.4 Special ambient conditions

Just what are the special ambient conditions?

The ET 200S FC frequency converters are designed for operation at an ambient temperature of 40 °C and an installation altitude up to 1000 m. The frequency converter can be operated within these limit values without having to apply any de-rating (reduced power output).

If the ambient operating conditions deviate from these values, then these are considered to be special ambient conditions and it is not permissible that the frequency converter is operated with its full power. In certain ranges, by using a distance module, it is possible to operate the frequency converter at its rated power.

De-rating factors

ET 200S FC frequency converters may have to be de-rated for the following reasons:

- Ambient temperature > 40 °C
- Pulse frequencies > 8 kHz can result in converter power module component temperatures of > 40 °C.
- Installation altitude > 1000 m
As a result of the low air pressure, the cooling air quantity provided by the fan is not sufficient to maintain the temperature of the power modules below 40 °C.

Distance module

The following statements refer exclusively to ET 200S FC frequency converters that are mounted in-line without any intermediate spacing on a mounting rail:

- If the ambient operating temperature exceeds 40 °C, if a DM-V15 distance module is used, the frequency converter can be operated within a specific temperature range with its rated power.
- The DM-V15 distance module is suitable for all ET 200S FC frequency converters. This is a purely passive module and does not have to be engineered.
- It is mounted to the right of the power module - or if available, to the right of the brake control module - and therefore to the left of the control unit of the following frequency converter.
- The backplane bus and the shutdown groups are looped-through for the following modules.
- The power bus must be routed via jumper modules.

3.5 Mounting terminal modules

Features

Terminal modules replace the control wiring in the electrical cabinet and are the mechanical support/carrier elements of the function modules - e.g. the power modules and the frequency converter components, control unit and converter power module.

Using the terminal modules, the electrical cabinet can be completely pre-wired without equipping the power modules and frequency converter. If an encoder cable and/or PTC/KTY are used, then they must be connected to a separate connector.

Prerequisites

The two mounting rails have been mounted (100 mm center-to-center clearance).

The space for the IM 151 interface module is taken into account.

Mechanically coding the modules

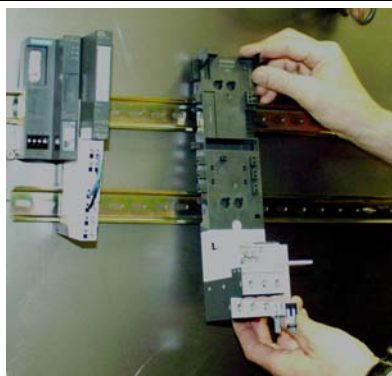
When the module is inserted for the first time, the terminal module is mechanically coded so that if a fault develops, then only a module with the same function can be used to replace it.

When mounting the modules carefully observe the configuration and designate the terminal modules using the ET 200S slot number labels.

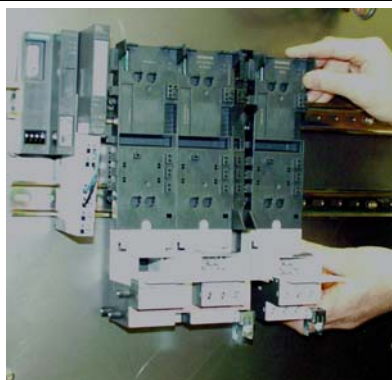
3.5 Mounting terminal modules

Mounting ET 200S FC terminal modules

The following example shows how a 65 mm wide terminal module is mounted.



Attach the terminal module to the upper mounting rail and move it downwards until it audibly latches into the lower mounting rail.



Using both hands shift the terminal module - without skewing it - to the left to the already mounted modules until it audibly latches into the adjacent module.

Fig. 3-1 Mounting a terminal module using as an example a TM-DS65

Removing ET 200S FC terminal modules



Warning

Before carrying-out any work, disconnect/switch-out all of the supply voltages!

You can only remove a terminal module if no other modules are connected at the righthand side. Otherwise, all of the modules to the righthand side must first be removed or pushed to one side.

The following example shows how a 65 mm wide terminal module is removed.

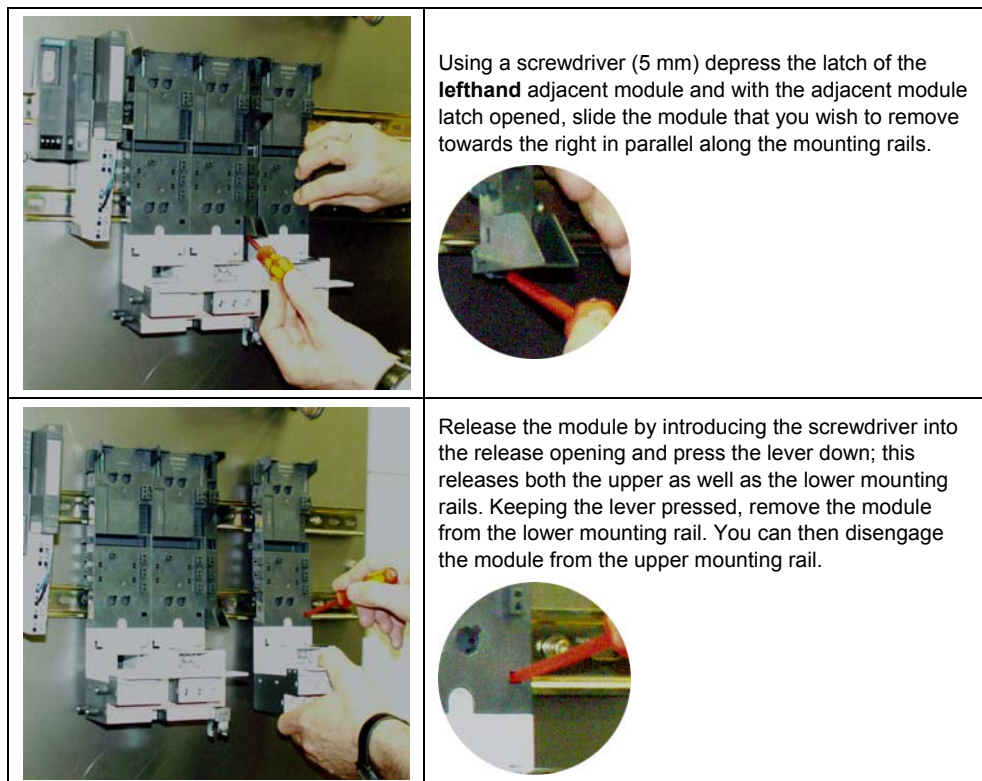


Fig. 3-2 Removing a terminal module using as an example a TM-IPM65

3.5 Mounting terminal modules

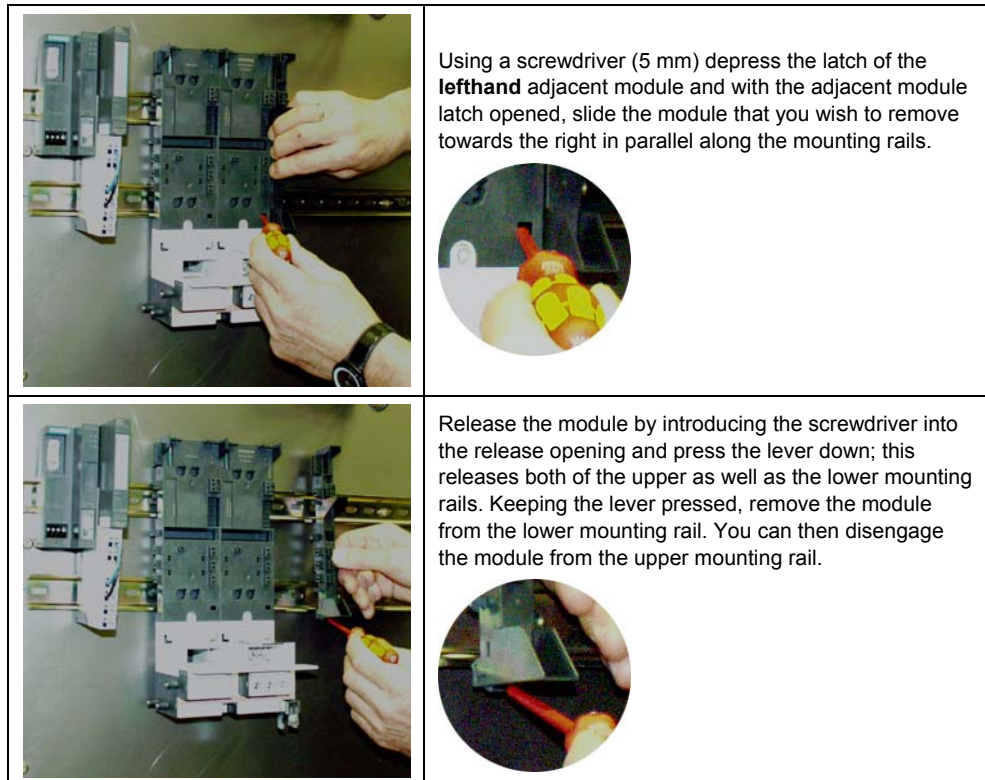


Fig. 3-3 Removing a terminal module using as an example a TM-ICU15

3.6 Mounting ET 200S FC frequency converter components

Prerequisites

- The mounting rails have been mounted.
- The terminal modules have been mounted.

Notes

When all of the modules are inserted, the associated terminal module is mechanically coded (two coding elements), so that when a module has to be replaced then only a module with the same function can be used.

When inserting the modules carefully ensure that the ET 200S configuration is maintained!

New modules shipped from the plant are supplied with the coding elements, both for the power module as well as also for the terminal module.

Before the new module from the factory can be inserted on an already coded terminal module, the coding element for the terminal module must be removed from the new module.

Incorrectly inserted coding elements can be removed from the terminal module using a 3 mm screwdriver.

Sequence when mounting the various components

1. Insert the power module
2. Insert the control unit ICU24 / ICU24(F)
3. Insert the brake control module (if a brake control module is being used)
4. Insert the converter power module
5. Insert the terminating module, terminating cover and caps

Caution

If a brake control module has been configured, then this must always be inserted before the converter power module.

If the converter power module has already been inserted, then it must be removed again before the brake control module can be inserted.

3.6 Mounting ET 200S FC frequency converter components

3.6.1 Power modules

Inserting power modules

Insert the power module into the mounted and pre-wired terminal module. Independent of the coding elements, power modules can only be inserted at the terminal modules used for this purpose.

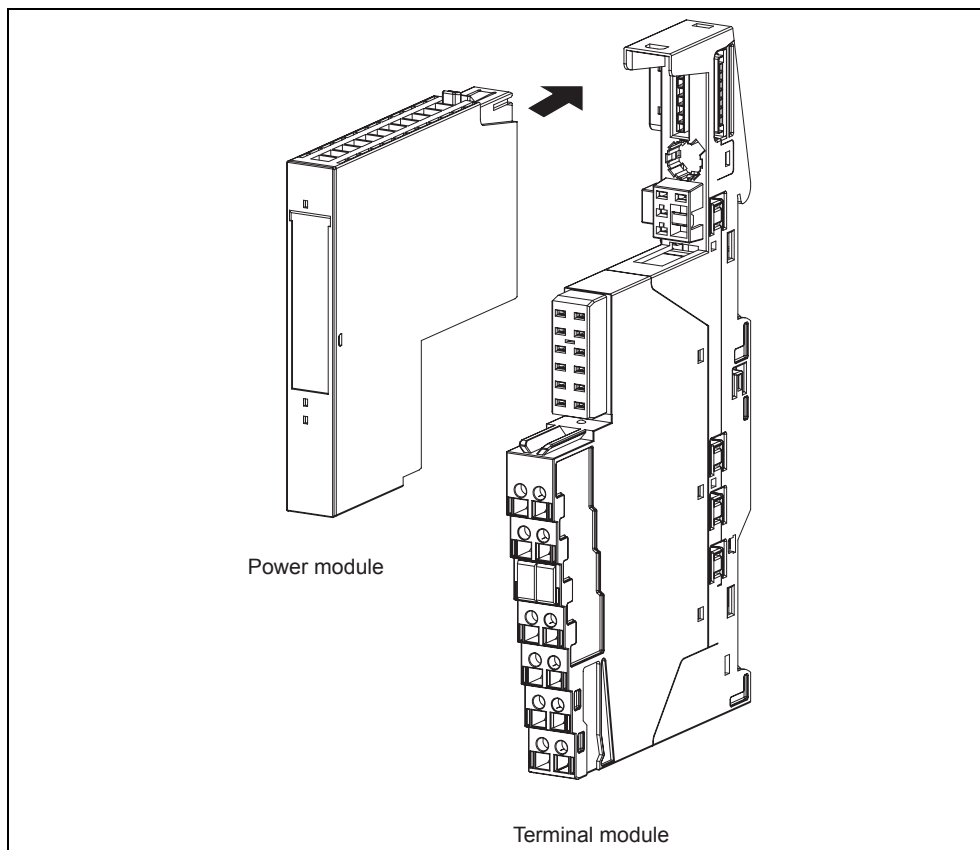


Fig. 3-4 Inserting a power module

3.6.2 Control unit ICU24(F)

Inserting control units

Notes

When inserting the control unit, the associated terminal module is mechanically coded (two coding elements), so that when a module has to be replaced then only a module with the same function can be used.

When inserting the modules carefully ensure that the ET 200S configuration is maintained!

New modules supplied from the factory are supplied with the coding elements, both for the ICU24(F) as well as for the terminal module.

Before the new module from the factory can be inserted on an already coded terminal module, the coding element for the terminal module must be removed from the new module.

Incorrectly inserted coding elements can be removed from the terminal module using a 3 mm screwdriver.

When inserting, carefully check that the retaining latches are correctly engaged.

Insert the ICU24(F) on the mounted terminal module. ICU24(F) control units can be inserted - independent of the coding element - only on the terminal modules intended for this purpose.

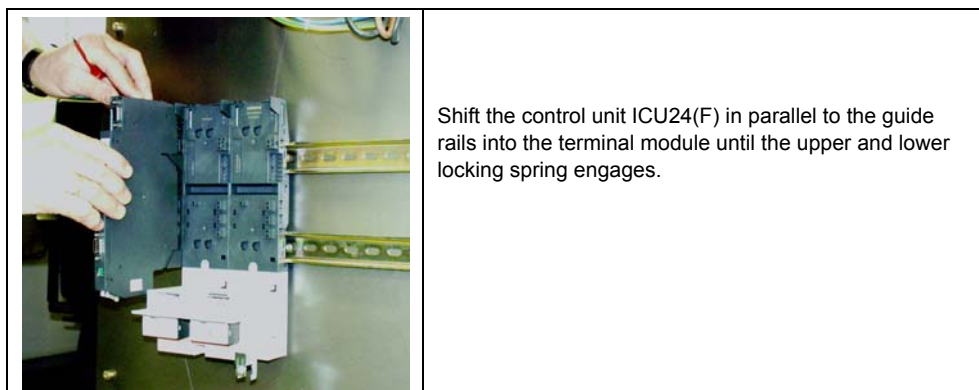


Fig. 3-5 Inserting a control unit

3.6 Mounting ET 200S FC frequency converter components

Removing control units

Before a control unit can be withdrawn, the converter power module must first be withdrawn.

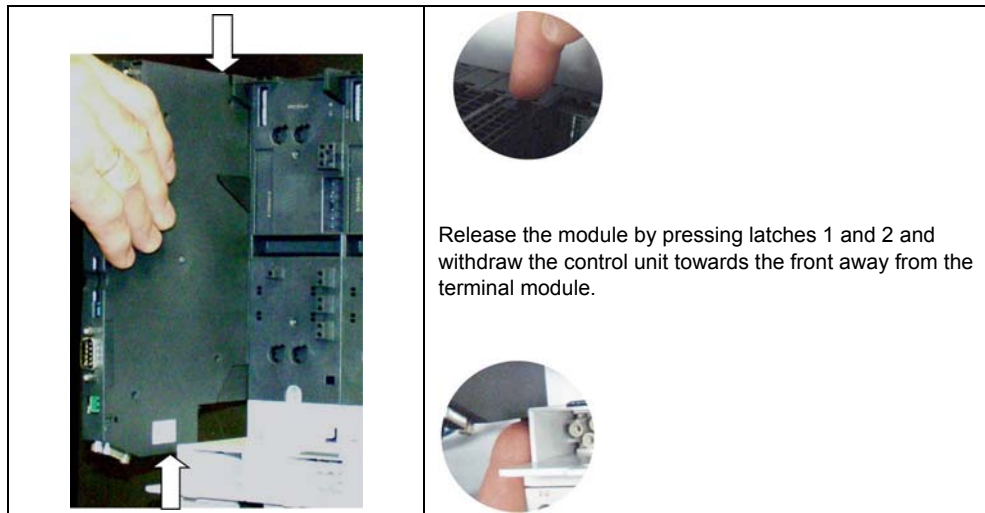


Fig. 3-6 Removing an ICU24(F)

3.6.3 IPM25 converter power module

Inserting converter power modules

Notes

When the converter power module is inserted, the associated terminal module is mechanically coded (two coding elements), so that when a module has to be replaced then only a module with the same function can be used.

When inserting the modules carefully ensure that the ET 200S configuration is maintained!

New modules shipped from the plant are supplied with the coding elements, both for the converter power module as well as also for the terminal module.

Before the new module from the factory can be inserted on an already coded terminal module, the coding element for the terminal module must be removed from the new module.

Incorrectly inserted coding elements can be removed from the terminal module using a 3 mm screwdriver.






When inserting, carefully check that the retaining latches are correctly engaged.

After the ICU24(F) – and if required, the brake control module – have been inserted, the converter power module is inserted into the mounted terminal modules. In so doing, two "engaged positions" must be noted. Depending on the particular position, electrical connections are established or are interrupted when removing.

3.6 Mounting ET 200S FC frequency converter components

The following table explains how the IPM25 is mounted.

Table 3-2 Mounting an IPM25 converter power module

 <p>Position 1 Position 2</p>	<p>Set connector IM-PF at the converter power module to position 2</p>
	<p>With the IPM25 converter power module slightly tilted, insert it (refer to diagram) into the terminal module from the front. Then firmly press on the lower section until a contact has been established to the power bus.</p> <ul style="list-style-type: none"> • The IPM25 converter power module remains slightly tilted; the latch has not engaged. • The IPM25 converter power module is, in this position, not mechanically secured and is only connected to the power bus. <div style="text-align: right;">  <p>Latch</p>  <p>Interlocking spring</p> </div>
	<p>Press the latch and move the converter power module towards the mounting rail until the latch engages twice.</p> <p>Set the connector IM-PF at the converter power module to position 1 so that you establish the connection between the control unit and the converter power module.</p> <p>Engage once: Parking position</p> <ul style="list-style-type: none"> • The connection to the ICU24(F) has still not established. This means that the electronics of the converter power module are still not supplied. • The connection to the energy bus has been established, frequency converter operation is still not possible. • The connection to the brake control module – if one is being used – has still not been established. <p>Engage twice: Operating position</p> <ul style="list-style-type: none"> • The connection to the backplane bus has been established via the ICU24(F). • The connection between the control unit and converter power module is established via the PM-IF connector. • The connection between the converter power module and brake control module – if one is being used – is established. • The interlocking spring is engaged.

3.6 Mounting ET 200S FC frequency converter components

Removing IPM25 converter power modules

The converter power module can be withdrawn under voltage.

- If a brake control module is not being used, then the motor coasts down as soon as the PM-IF connector has been withdrawn.
- If a brake control module is being used, the motor is braked as soon as the PM-IF connector is withdrawn therefore interrupting the brake control.

The other components of the ET 200S station continue to operate normally.

The following table describes how the IPM25 is removed.

Table 3-3 Removing the IPM25

	<ul style="list-style-type: none"> • Set the connector IM-PF at the converter power module to position 2 so that you interrupt the connection to the ICU24(F). • Press the latch(es) (one for the ET 200S FC FSA, two for the ET 200S FC FSB) downwards • Guide the latch beyond the first engaging position. The converter power module is now in the parking position; the module is (still) in a mechanically secured position (also refer to the previous table) <p>As soon as you have moved the latch beyond the second engaging position, then the converter power module is in the released position.</p> <p>If you now release the interlocking spring, then the converter power module is no longer mechanically secured.</p>
	<p>Using both hands, hold the converter module in the upper and lower grips and withdraw it.</p> <p>Withdraw the module, in an inclined position, from the terminal module in one continuous movement (approx. 30 N withdrawal force).</p>

Note

Before the drive system is handed over, we recommend that the service and maintenance personnel are informed in detail about how to correctly handle the ET 200S FC frequency converter so that if a component has to be replaced, the advantages of the ET 200S system can be utilized from the very beginning.

3.6 Mounting ET 200S FC frequency converter components

3.6.4 Inserting brake control modules

Prerequisite

The terminal module for the brake control module (optional) is mounted.

Notes

When the brake control module is inserted, the terminal modules are mechanically coded, so that when a module has to be replaced then only a module with the same function can be used.

When inserting the modules carefully ensure that the ET 200S configuration is maintained!

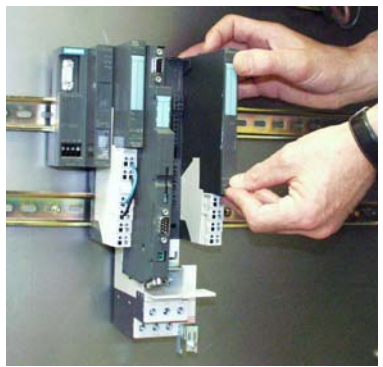
New modules shipped from the plant are supplied with coding elements both for the brake control module as well as also for the terminal module.

Before the new brake control module can be inserted on an already coded terminal module, the coding element for the terminal module must be removed from the new brake control module.

Incorrectly inserted coding elements can be removed from the terminal module using a 3 mm screwdriver.

Inserting a brake control module

Table 3-4 Inserting a brake control module

	<p>Insert the brake control module on the mounted and pre-wired terminal module; you might first have to change the coding.</p> <p>Independent of the coding element, brake control modules can only be inserted on the terminal modules intended for the purpose.</p> <p>Caution</p> <p>If a brake control module has been configured then this must always be inserted before the converter power module.</p> <p>If the converter power module has already been inserted, it must first be removed before the brake control module can be inserted.</p>
---	--

Removing the brake control module

The brake control module can only be removed if the associated converter power module was removed.

Release the module by pressing down on the latch at the top of the module; remove the module from the terminal module towards the front.

3.6.5 Inserting terminating modules, terminating covers and caps

Terminating module

For the distributed ET 200S I/O system, the terminating module must be mounted as the last module. The ET 200S is only ready for operation after the terminating module has been inserted. The terminating module is part of the scope of supply of the IM 151 interface module. Additional information is provided in the Manual, SIMATIC ET 200S distributed I/O system.

Terminating cover

For ET 200S FC frequency converters, a terminating cover must be inserted on the last terminal module of a potential group if this is followed by a PM-E or a terminating module. This protects the open contacts from dirt and terminates the ET 200S in a "finger-safe" fashion.

The terminating cover is included in the scope of supply of the TM-P15 S27-01, TM-PF30 S47-F0 and TM-PFX30 S47-G1 terminal modules for the power modules.

Caps



Warning

At the last terminal module for ET 200S FC frequency converters of a load group, before commissioning and connecting to the power bus (L1, L2, L3, N, PE), the open contacts must be closed with the appropriate caps to provide shock hazard protection (firmly insert the caps). This prevents the contacts from being touched and avoids the hazards of electric shock (400 V AC).

The caps must be removed when expanding the ET 200S station. To do this, use a 1 mm screwdriver. Then re-locate the caps back on the power bus of the now last ET 200S FC frequency converter.

The caps are included in the scope of supply of the terminal modules for the ET 200S FC frequency converter with power bus infeed and the terminal block with PE/N infeed.

Terminating the ET 200S configuration on a tier

Terminate the configuration of a distributed ET 200S I/O system with frequency converters by inserting the following components:

3.6 Mounting ET 200S FC frequency converter components

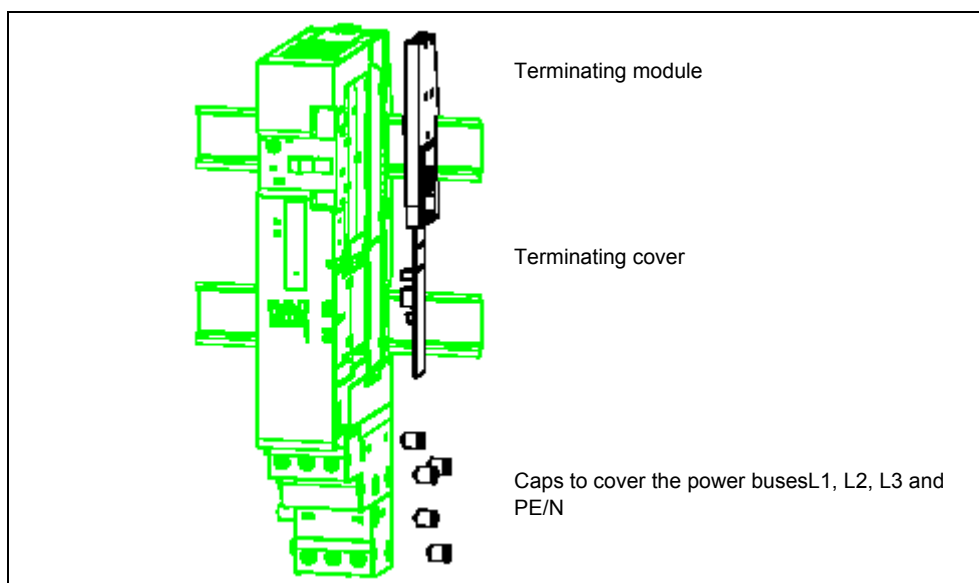


Fig. 3-7 Inserting the terminating cover with caps

Mounting a terminating module

1. Attach the terminating module to the upper mounting rail.
2. Locate the terminating module on the lower mounting rail until it audibly engages.
3. Shift the terminating module to the left until it audibly engages with the last terminal module.

Removing a terminating module

1. Using a screwdriver (5 mm) press the lever at the last terminal module downward to its endstop and shift the terminating module to the right.
2. Remove the terminating module from the mounting rail.

3.7 Wiring in the ET 200S system

Description

The converter power module IPM25 of the frequency converter ET 200S FC is designed to be directly connected to TN and TT line supplies with grounded neutral conductor with a rated voltage from 3-ph. 380 V to 3 AC 480 V AC.

For systems where the CE-EMC requirements must be fulfilled, the specified EMC filter and shielded cable must be used. In this case, standard SY cables are recommended. The shield must be grounded at both ends.

Mounting guidelines for ET 200S FC frequency converters with EMC filter

- Operation with EMC filter is only permitted with TN line supplies.
- The EMC Class A filter is located directly in front of the power bus supply in the line feeder cable of the ET 200S FC frequency converter.
- The frequency converter must be mounted on a panel grounded through a large surface area.
- Only shielded cables are permissible after the EMC filter.
- For frequency converters with safety-relevant functions, shielded cables must always be used.
- The power bus for the frequency converter must be routed separately away from other power buses.
- The complete ET 200S system with frequency converters must be installed in a metallic electrical cabinet.
- The maximum length of the motor cables is 350 meters. In this case, all of the motor feeder cables of all of the drive converters that are connected to a common power bus must be added.
- The maximum length of shielded motor cable per frequency converter is 50 m.
- Connection cross-sections
 - 25 A : 4 mm² (AWG 11)
 - 50 A : 10 mm² (AWG 7)

3.7 Wiring in the ET 200S system

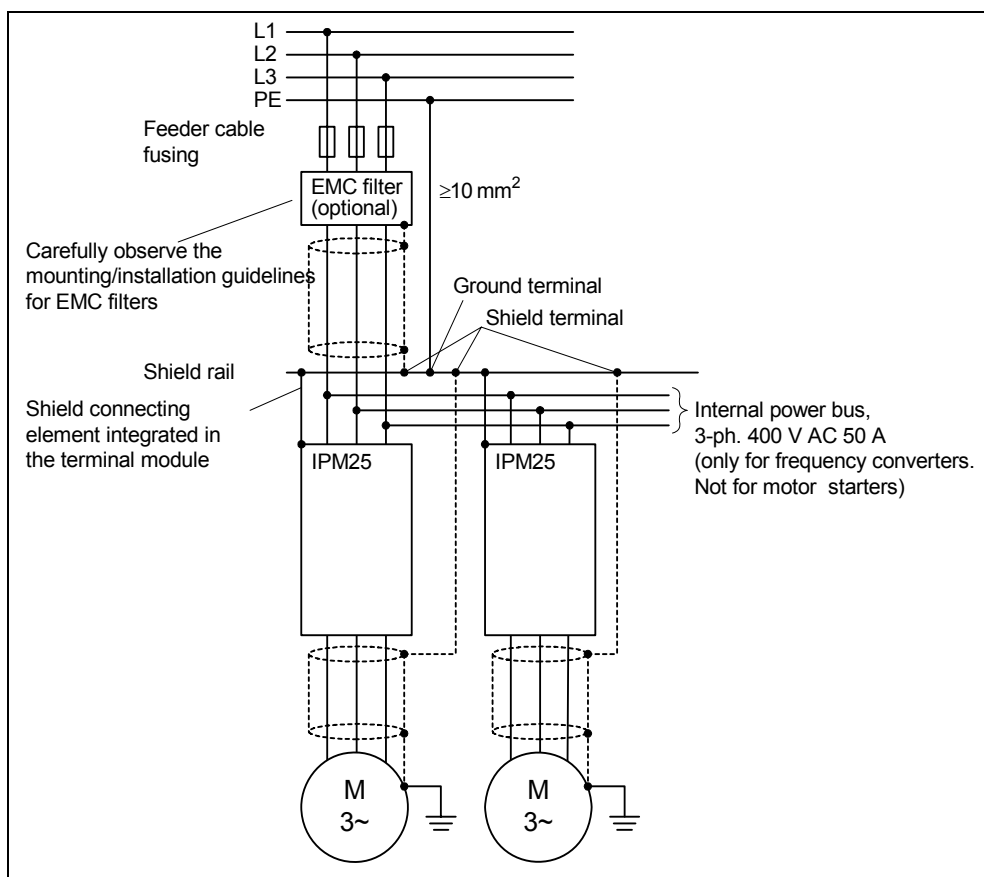


Fig. 3-8 ET 200S FC frequency converter with EMC filter

3.8 Shield connections

Description

There is a metal terminal with retaining screw for a busbar (Integrated screen support) below the terminal modules TM-IPM for ET 200S FC converter power modules. After the busbar has been mounted, it has the following functions for the frequency converter:

- Potential bonding between several frequency converters
- Connecting the shields of cables
- Connecting group (common) grounding cables

The following accessories are required:

Designation	Order No.
Shield terminal	6ES7 193-4GB00-0AA0 (5 shield terminals)
Ground connection terminal	8WA2 868
Busbar (1 m, 3 × 10 mm)	8WA2 842

Procedure

1. Cut-off an appropriate length of busbar
2. Locate the busbar in the metal terminal
3. Attach the shield terminal to the busbar
4. Attach the ground connection terminal to the busbar
5. Screw the busbar using the retaining screw (0.8 Nm)
6. Pull the cable through the shield terminal so that the shield is located between the busbar and the shield terminal screw
7. Tighten the shield terminal screw
8. Establish the connection to the group (common) grounding cable

3.8 Shield connections

4

Interfaces

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4.1 Communication interfaces

4.1 Communication interfaces

Overview

The control module of the ET 200S FC frequency converter has 3 communication interfaces (communication ports) that can be simultaneously used.

These interfaces are designed as follows:

- **RS232 interface**
The ET 200S FC is commissioned using a PC.
- **PROFIBUS DP coupling**
Via the ET 200S backplane bus for communication with a higher-level control.
- **MMC-PS slot**
Slot for a special Micro Memory Card (MMC-PS). The MMC-PS can be used to save parameters or to update the firmware.

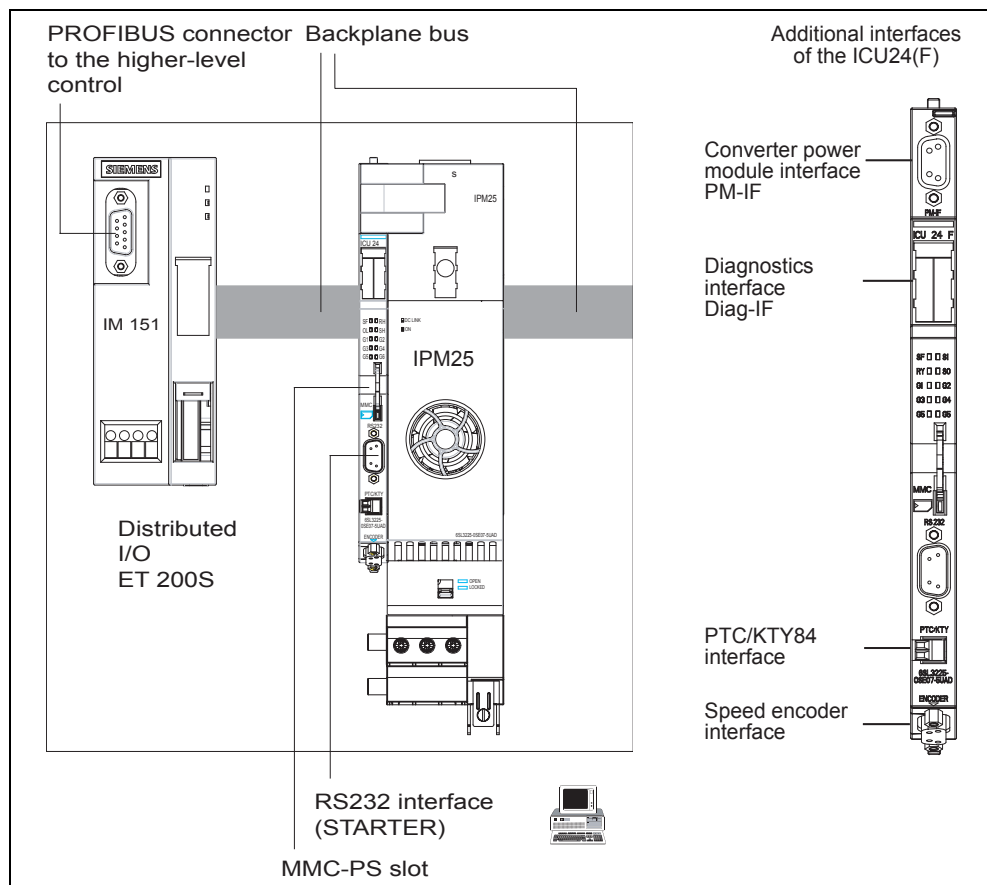


Fig. 4-1 Interfaces at the ET 200S FC

4.1.1 RS232 interface

Description

The ET 200S FC frequency converter has a serial RS232 communications interface with USS protocol. It used to commission the ET 200S FC using the "STARTER" commissioning tool. The following components are required:

- PC with Windows 2000 / NT4, SP6 / XP Professional
- "STARTER" commissioning tool.
- Null-modem cable (Order No. 6SE7901-1BF00-0XA0)

Prerequisites for commissioning the system via the RS232 interface

- ET 200S is powered-up
- ICU24(F) is connected to the PC using a zero-modem cable
- STARTER is installed on the PC

Commissioning the system via the RS232 interface

Note

The safety-related parameters can only be set and changed online using the "STARTER" commissioning tool via the RS232 interface.






- Start the commissioning (start-up) software STARTER
- At the control panel of your PC set the "PC COM-Port (USS)" as PG/PC interface with a baud rate of 38 400.

Note

If the baud rate is to be changed, then parameter p2010 must always be first changed and then the PG/PC interface.


- Set-up a new project or open an already existing project.

4.1 Communication interfaces

- Insert an ET 200S FC frequency converter:
 - Automatic mode:
via "Project/incorporate nodes that can be reached into the project"
STARTER searches for frequency converters connected via the zero-modem cable and sets all of the required settings to the correct value
 - Manual mode:
insert "Individual drive" using the Project Navigator 
You can select the ET 200S FC frequency converter from a screen form.
- You can now parameterize the ET 200S FC either online or offline.
 - Online:
Press the  button. All of the parameter changes are made directly in the RAM of the ET 200S FC. The changes are saved in the EEPROM using  (copy RAM to ROM).
 - Offline:
In this case it is necessary that a parameter set from the associated control unit is saved on the PC using an upload operation. The parameter changes are then made in this parameter set at the PC. After you have completed all of the parameter changes, bring the frequency converter into the online mode using . The changes are saved in the EEPROM using the button  (download into the target device).


Caution

This operation overwrites all of the parameter settings in the frequency converter!

- If you have completed all of the required parameter settings and saved these in the EEPROM you can exit the online mode using  and close the commissioning (start-up) tool STARTER.

Notes

There are two ways of parameterizing the system:

- Prompted using dialog boxes in the Project Navigator (STARTER V3.2 or higher)
- Using the Expert list ( ET_200S_FC/Expert/Expert list)

When commissioning the system, setpoints and commands can be entered through "STARTER" in order to move the drive. To do this the control panel in the detailed display of STARTER must be activated using the Project Navigator "ET_200S_FC / ET_200S_FC / control panel".

- Fetch master control: Click-on the button "Fetch master control" → The master control is transferred to STARTER- and the button changes to "... return".
- Return: Click-on the button "... return" → the master control is returned to the higher-level control – and the button changes to "Fetch master control".

4.1.2 PROFIBUS DP interface (backplane bus)

Description

Communications between an ET 200S-station and the associated higher-level control (e.g. SIMATIC S7) are established using the standardized PROFIBUS DP communications protocol.

Communications within the ET 200S-system are established via the ET 200S-backplane bus.

The ET 200S-interface IM 151 forms the interface between the two bus systems.

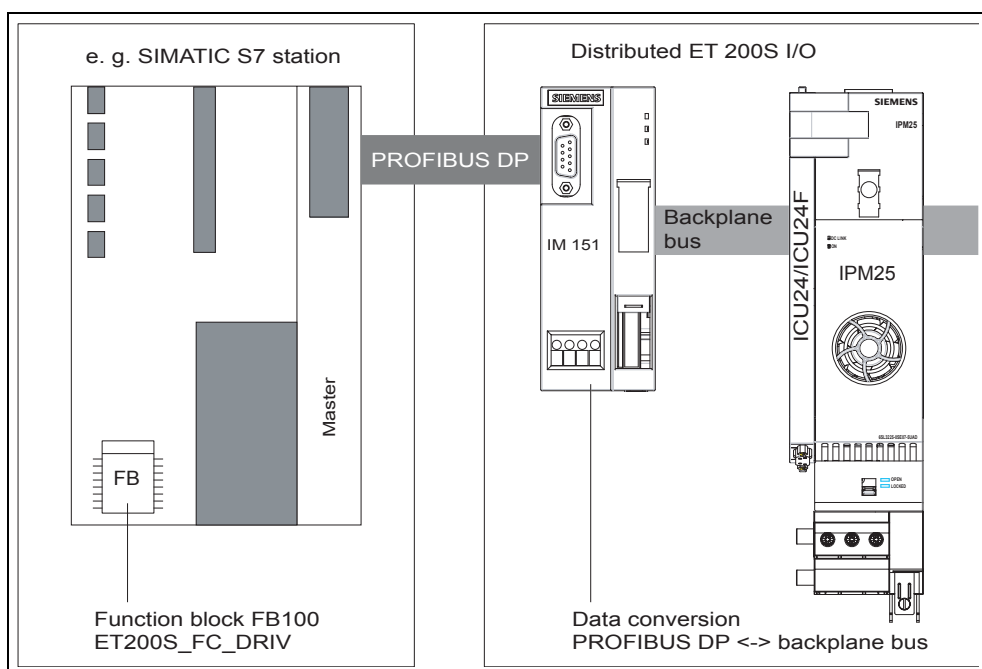


Fig. 4-2 PROFIBUS DP coupling for ET 200S

4.1 Communication interfaces

Communications data

In normal process operation, the ET 200S FC frequency converter is handled and controlled via the function block "FB100 ET200S_FC_DRIV".

It provides the following functionality:

- Sends control words and setpoints with a fixed length to the drive
- Receives status words and actual values with a fixed length from the drive
- Reads and writes individual parameter values of the ET 200S FC in cyclic data exchange
- Display drive faults
- Displays communication errors
- Displays parameterizing errors in cyclic data exchange

Note

In cyclic data exchange, individual parameter values can be changed via the function block while the frequency converter is operational.

Details regarding communications with the higher-level control ...

are provided in Chapter " SIMATIC S7 connection ".

4.1.3 MMC-PS slot

Uses

Frequency converter data can be saved in an external MMC parameter memory (MMC-PS) via this MMC-PS interface; when required, they can be re-loaded into the frequency converter.

The MMC-PS can be used for the following:

- MMC-PS as parameter memory
 - Transferring parameters from the MMC-PS when replacing the control unit
 - Transferring parameters from the MMC-PS when cloning
 - Transferring parameters from the MMC-PS after every OFF/ON of the power supply voltage for the control unit
- MMC-PS to upgrade the firmware

Note


Several parameter sets can be saved in an MMC-PS. For the standard setting, the file name clone00.bin is used. Other names can be set via p0804 (clone00 to clone99.bin).

Caution

Either parameter sets or a firmware can be saved in an MMC-PS.

The firmware update, in this case, has a higher priority than downloading parameter sets. This means that as long as a firmware update is saved on an MMC-PS, then after power-up, a firmware upgrade is always carried-out.

How to insert the MMC-PS

	<p>The label should point to the right so that the chamfered edge of the MMC-PS faces downwards.</p> <p>The MMC-PS must be pushed completely into the slot and should only be removed by first activating the eject button</p>
---	--

For further information about MMC-PS refer to Chapter "Commissioning and Operation", Sections "MMC-PS as parameter memory to upread, download and in operation" and "Firmware upgrade with MMC-PS".

4.2 Power Module Interface (PM-IF)

4.2 Power Module Interface (PM-IF)

Description

The PM-IF (Power Module Interface) connects the control module of the frequency converter with the frequency converter power module IPM25.

Via this interface all of the required open-loop and closed-loop control signals as well as monitoring and diagnostic messages, are transferred.

The sequence, described in Chapter "Installing" Section "Power module IPM25" must be maintained under all circumstances.

4.3 Diagnostics interface (Diag-IF)

Description

For special diagnostic purposes, the control module ICU24 has an 8-pin "Diag-IF" plug connector with the following pin assignment:

Table 4-1 Pin assignment, Diag-IF

Pin	Signal	Description	Activating parameters
1	Analog output 0	Non-isolated analog output, 0 - 3 V	p0771 - p0781
2	Analog output 1	Non-isolated analog output, 0 - 3 V	
3	0 V	0 V	-
4	0 V	0 V	-
5	Digital input 0	Non-isolated digital input, 24 V	p0701
6	Digital input 1	Non-isolated digital input, 24 V	p0702
7	Digital output 0	Non-isolated digital output 3.3 V	p0731
8	Digital output 1	Non-isolated digital output 3.3 V	p0732

The diagnostics interface is located behind the label of the control module ICU24(F).

Caution

The diagnostics interface may only be used for diagnostic purposes by personnel that have received the appropriate, specialized training. It is not permissible to operate the ET 200S FC via Diag-IF.

4.4 PTC/KTY84 interface

4.4 PTC/KTY84 interface


Data

Parameter range:	p0601, p0604, p0610
Alarms:	A0511, A0512
Errors:	F0011, F0015

Description

The ICU24(F) has a connector to connect a PTC or KTY84 sensor to monitor the motor temperature. This connector has the following assignment:

Table 4-2 Pin assignment of the PTC/KTY connector

	ICU24	Motor connection KTY84		Motor connection PTC
	Pin	Terminals	Signals	Terminals
	1	21 yellow	KTY + (anode)	3 blue
	2	22 green	KTY – (cathode)	4 black

Note

For KTY84 temperature sensors, the cathode **must** be connected at pin 2 of the connector.

The terminal designations at the motor only apply for Siemens motors.

Additional information ...

For additional information regarding the motor temperature monitoring with either PTC or KTY84 sensor, refer to Chapter "Protection and Monitoring Functions", Section "Motor protection and overload reactions".

4.5 Interface Brake Control Module

Data

Parameter range: p1215 – p1217

Description

An ET 200S brake control module can be controlled from the ET 200S FC.

The electrical connection between the brake control module and the frequency converter is established through the terminal module of the brake control module when the converter power module IPM25 is inserted.

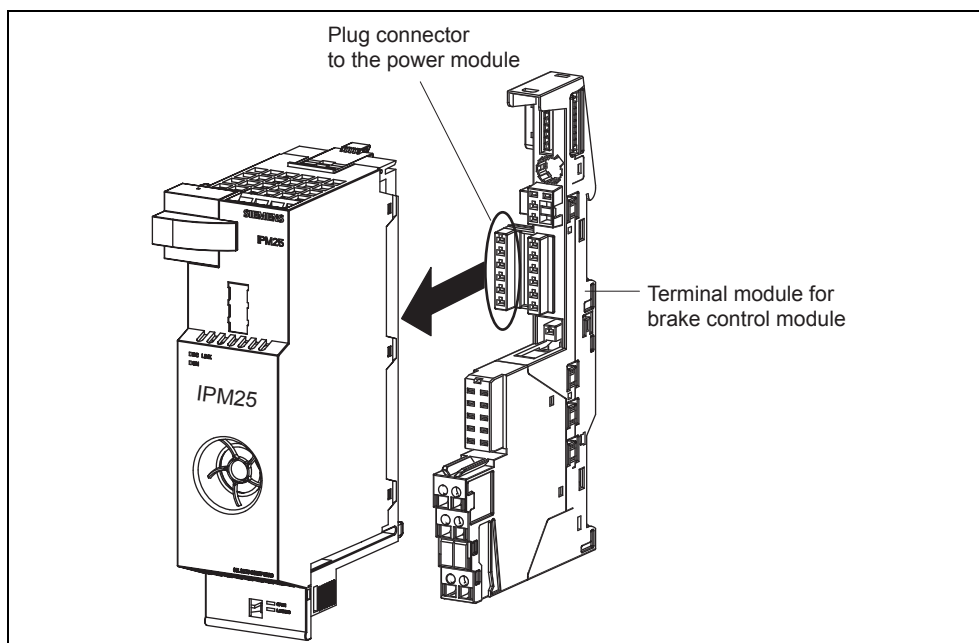


Fig. 4-3 Interface, brake control module – converter power module

Details regarding the brake control module ...

are provided in Chapter “Description of the components”, Section “Brake control module”.

4.6 Speed encoder interface

4.6 Speed encoder interface

Data

Parameter range:	p0400 - p0410, p0491 - p0494, p1300 r0061, r0090, r0403
Alarms:	A0590
Errors:	F0090

Description

A 9-pin sub-D socket represents the speed encoder interface on the control module ICU24(F). It is designed so that only HTL pulse encoders can be connected that are referred to ground (single-ended). Pulse encoders referred to ground (single-ended) only have one cable for each channel. This means that only the speed can be sensed with one channel. In order to sense both the speed and direction of rotation of a motor, a two-track speed encoder (channels A and B) must be used.

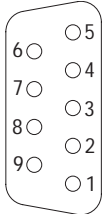
The ICU24(F) control module provides an unregulated 24 V power supply voltage for the speed encoder. Another external power supply voltage cannot be used.

When compared with sensorless Vector control (SLVC) - i.e. without using an encoder - and V/f operation, a speed encoder offers the following advantages:

- Zero speed with full-load torque
- Precise closed-loop speed control
- Higher dynamic response of the closed-loop speed and torque control

The pin assignment is described in the following table:

Table 4-3 Pin assignment of the speed encoder interface

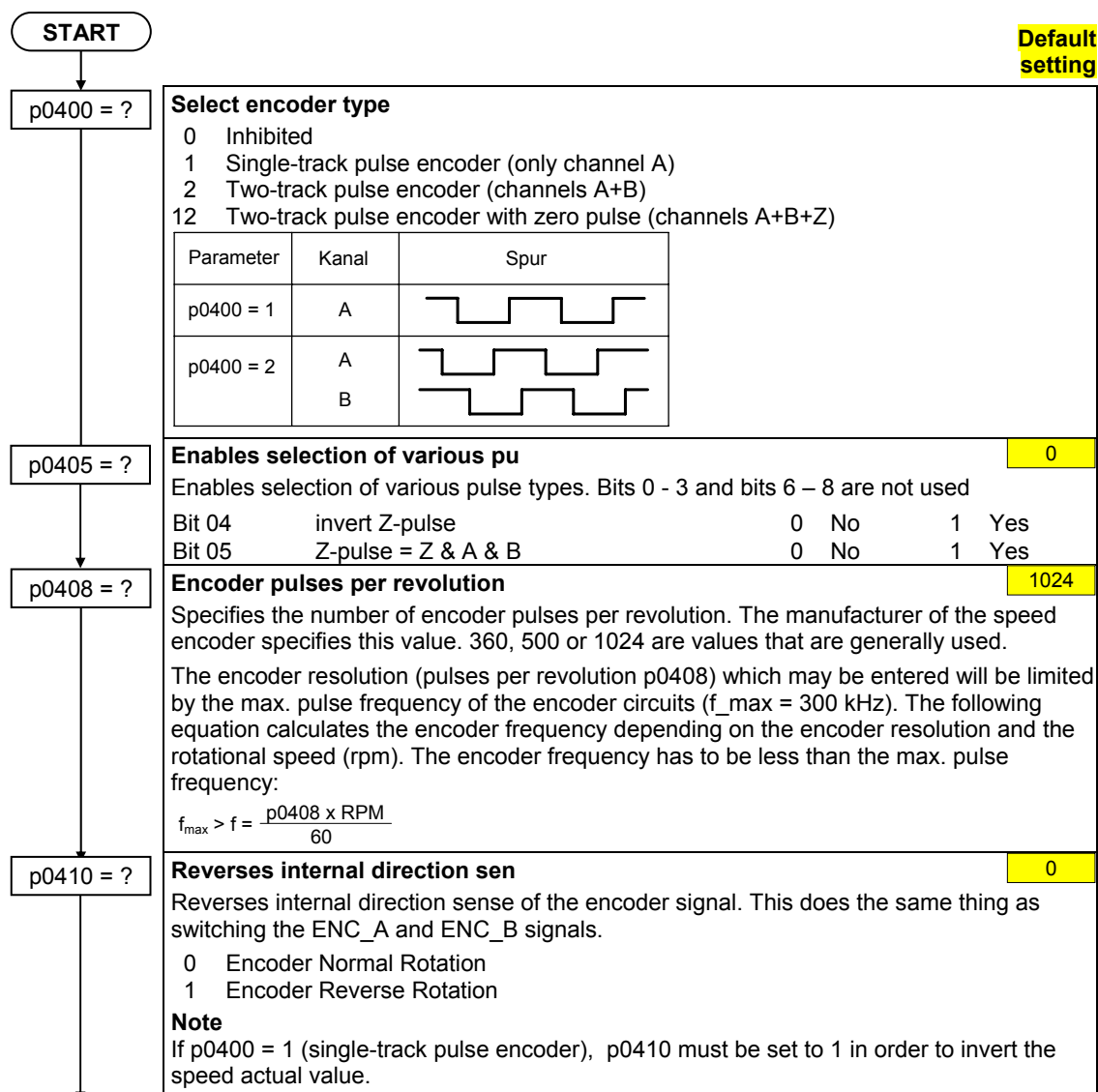
	Pin	Signal	Description
	1	A	Channel A, non-inverting input
	2	B	Channel B, non-inverting input
	3	Z	Channel Z, non-inverting input
	4	0 V	0 V power supply voltage for the speed encoder
	5	24 V	24 V power supply voltage for the speed encoder
	6, 7, 8, 9		Not used
	Shield	GND	Ground

Caution

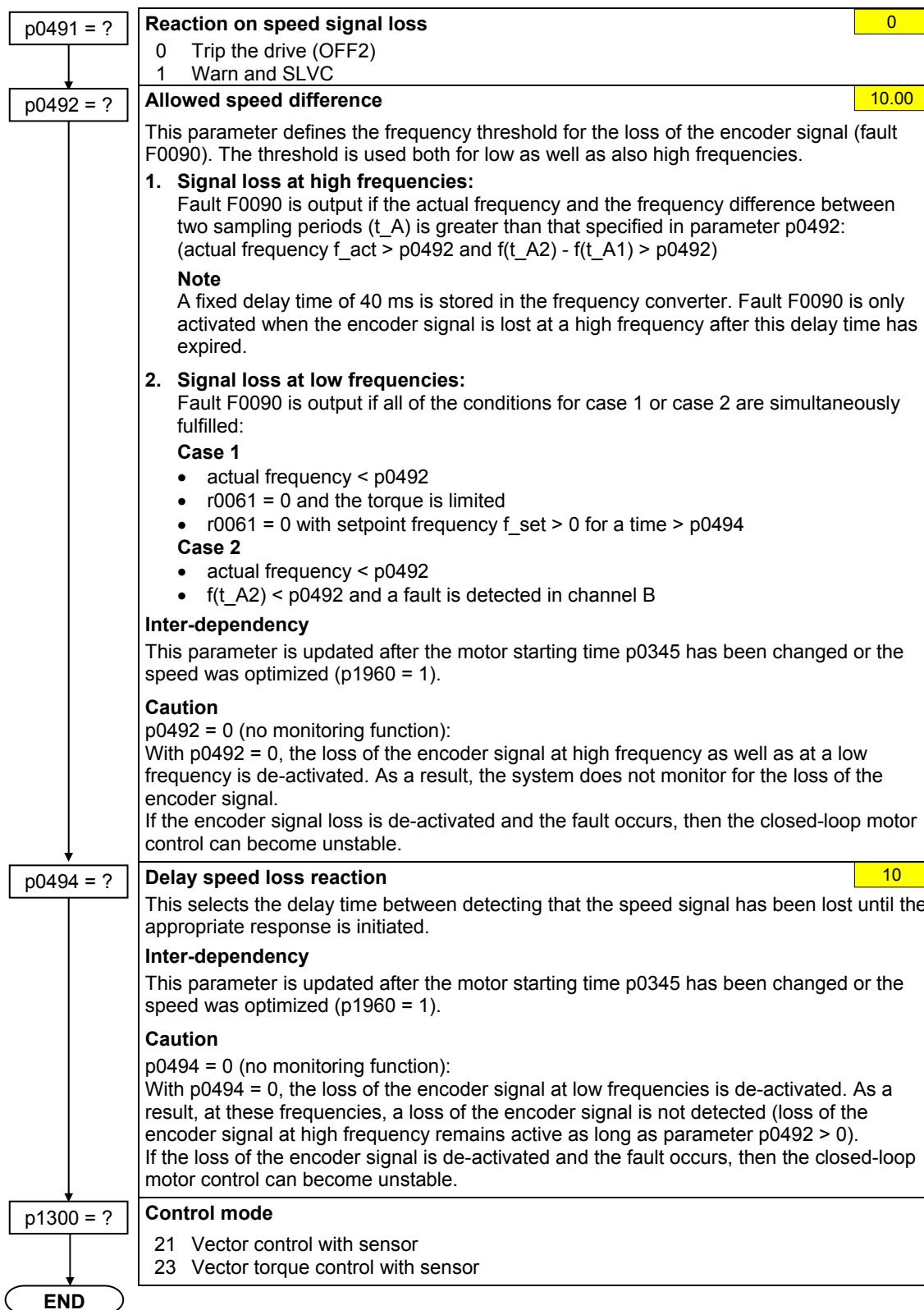
When using closed-loop vector control with an encoder the sense of direction of the motor and the speed encoder must match. If this rule is not carefully observed then a functioning vector control with encoder is not guaranteed. This is the reason that considerable care and attention should be taken when connecting the motor to the frequency converter and making the encoder connections (it is not permissible that the motor cables or the encoder signal cables are connected with the incorrect polarity!).

Parameterizing the speed encoder

The following parameters must be set so that the speed encoder can be perfectly adapted to the control module:



4.6 Speed encoder interface



4.6 Speed encoder interface

Monitoring parameters

Parameters r0061, r0090 and r0403 are available as monitoring parameters:

r0061	CO: Rotor speed Indicates the actual speed sensed by the speed encoder.																														
r0090	CO: Act. rotor angle Indicates the current angle of the rotor. This function is not available on single input channel encoders.																														
r0403	CO/BO: Encoder status word Indicates the status word of the speed encoder in the bit format. <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Bit 00</td> <td style="width: 55%;">Encoder active</td> <td style="width: 10%;">0</td> <td style="width: 10%;">No</td> <td style="width: 10%;">1</td> <td style="width: 5%;">Yes</td> </tr> <tr> <td>Bit 01</td> <td>Encoder fault</td> <td>0</td> <td>No</td> <td>1</td> <td>Yes</td> </tr> <tr> <td>Bit 02</td> <td>Signal OK</td> <td>0</td> <td>No</td> <td>1</td> <td>Yes</td> </tr> <tr> <td>Bit 03</td> <td>Encoder low signal loss</td> <td>0</td> <td>No</td> <td>1</td> <td>Yes</td> </tr> <tr> <td>Bit 04</td> <td>Using one encoder pulse edge</td> <td>0</td> <td>No</td> <td>1</td> <td>Yes</td> </tr> </table>	Bit 00	Encoder active	0	No	1	Yes	Bit 01	Encoder fault	0	No	1	Yes	Bit 02	Signal OK	0	No	1	Yes	Bit 03	Encoder low signal loss	0	No	1	Yes	Bit 04	Using one encoder pulse edge	0	No	1	Yes
Bit 00	Encoder active	0	No	1	Yes																										
Bit 01	Encoder fault	0	No	1	Yes																										
Bit 02	Signal OK	0	No	1	Yes																										
Bit 03	Encoder low signal loss	0	No	1	Yes																										
Bit 04	Using one encoder pulse edge	0	No	1	Yes																										

Note

When commissioning the closed-loop Vector control with sensor (VC) the frequency inverter should first be activated with V/f control (p1300 = 0). When the motor is spinning and the speed encoder connected (activated using p0400), parameters r0061 and r0021 must match one another as far as the following quantities are concerned:

- Sign
- Absolute value (a deviation of a few percent is permitted)

The closed-loop Vector control with sensor (encoder) (p1300 = 21 or 23) may only be activated if both conditions are fulfilled.

Caution

If the encoder is incorrectly connected, incorrect values will be displayed in r0061, r0063, r0021 and r0022.

4.6 Speed encoder interface

Connection to SIMATIC S7

Contents of Chapter 5

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5.1 Integrating ET 200S FC frequency converters into automation systems with STEP 7

5.1 Integrating ET 200S FC frequency converters into automation systems with STEP 7

General information on STEP 7

STEP 7 is the basis package to configure and program SIMATIC automation systems. It is part of the SIMATIC industrial software. The basis package STEP 7 is available in several versions.

"STEP 7 for applications running on SIMATIC S7-300/400" is required to integrate ET 200S FC frequency converters.

Additional information on STEP 7 is provided in the STEP 7 Manuals.

Integrating ET 200S FC frequency converters into SIMATIC S7

ET 200S FC frequency converters are integrated into a SIMATIC S7 control via STEP 7. Communications is realized using the standardized PROFIBUS-DP communications protocol whereby the SIMATIC automation device represents the master, the ET 200S system - with one or several ET 200S FC frequency converters as components and additional ET 200S modules - the slave.

Within the ET 200S distributed I/O system, the frequency converter is addressed via the ET 200S backplane bus.

Hardware components (SIMATIC and ET 200S)

- SIMATIC S7 300 or SIMATIC S7 400 with integrated PROFIBUS-DP interface
- ET 200S system with IM 151 interface module and PM-D power module for standard frequency converters or PM-D FX1 or PM-D F Profisafe for fail-safe frequency converters
- ET 200S FC frequency converters comprise a control unit, ICU24(F) and frequency converter power module (IPM25)

*5.1 Integrating ET 200S FC frequency converters into automation systems with STEP 7***Software components (SIMATIC and ET 200S)**

- STEP 7 from Version 5.2, Servicepack 1 or higher plus hardware support package (HSP).
The download is made from HW Config in STEP 7. The correct link is pre-set there.
- The ET200S FC library of blocks is available in the Internet under the following address:
<http://support.automation.siemens.com/WW/view/de/18686824/133100>
- The "S7 Distributed Safety V5.2" software package is required for PM-D F Profisafe.

5.2 Configuring the communications

Overview

The following configuring steps are required before PROFIBUS communications can be established:

- Create the hardware configuration of the ET 200S FC in the SIMATIC Manager
- Link-in function block FB100 for ET 200S FC in the user program; the name can be changed
- Commission the frequency converter

Note

This description requires STEP 7 know-how and the ability to handle and use the SIMATIC Manager.

Additional information on this is provided in the SIMATIC S7 Manuals.

5.2.1 Creating the hardware configuration in the SIMATIC Manager

Description

How the hardware configuration is created using HW Config in the SIMATIC Manager is explained using the following example involving an ET 200S FC frequency converter with an "IM 151-1 Standard" interface module. The explanation is split-up into three steps

- Parameterizing the PROFIBUS DP interface in SIMATIC S 7
- Equipping the ET200S station
- Settings for the ICU24(F)

Note

For information regarding the interface modules, please refer to the Manual "Distributed ET 200S I/O system", Chapter 9 "Interface modules".

Parameterizing the PROFIBUS DP interface in SIMATIC S 7

The PROFIBUS DP interface is parameterized when configuring the hardware. When selecting a CPU with integrated DP interface or a DP communications processor from the hardware catalog, a PROFIBUS-DP system is provided in the hardware configuration.

After setting the parameters for the master, the slave - in this particular case, the ET 200S station - must be selected from the hardware catalog and located at the PROFIBUS bus line. This is realized by inserting an IM 151. The Profibus address of the ET 200S station must also be defined in the IM 151.

Settings for the ICU24(F)

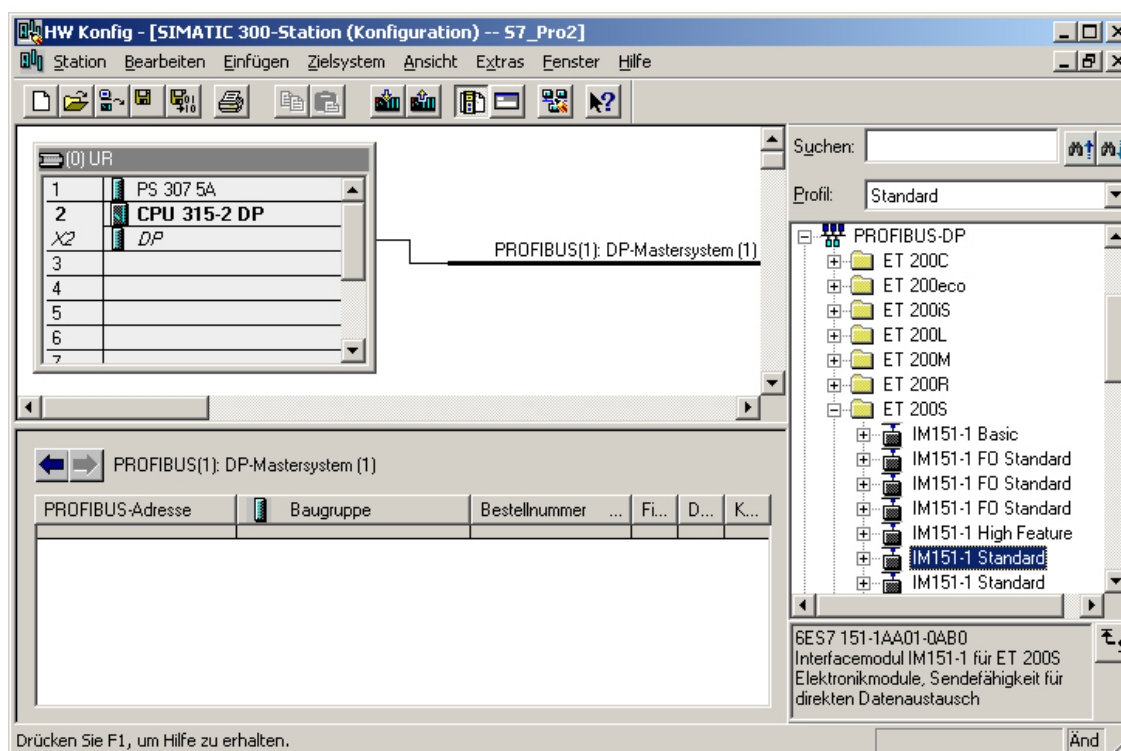


Fig. 5-1 Linking-in IM 151 in HW Config

5.2 Configuring the communications

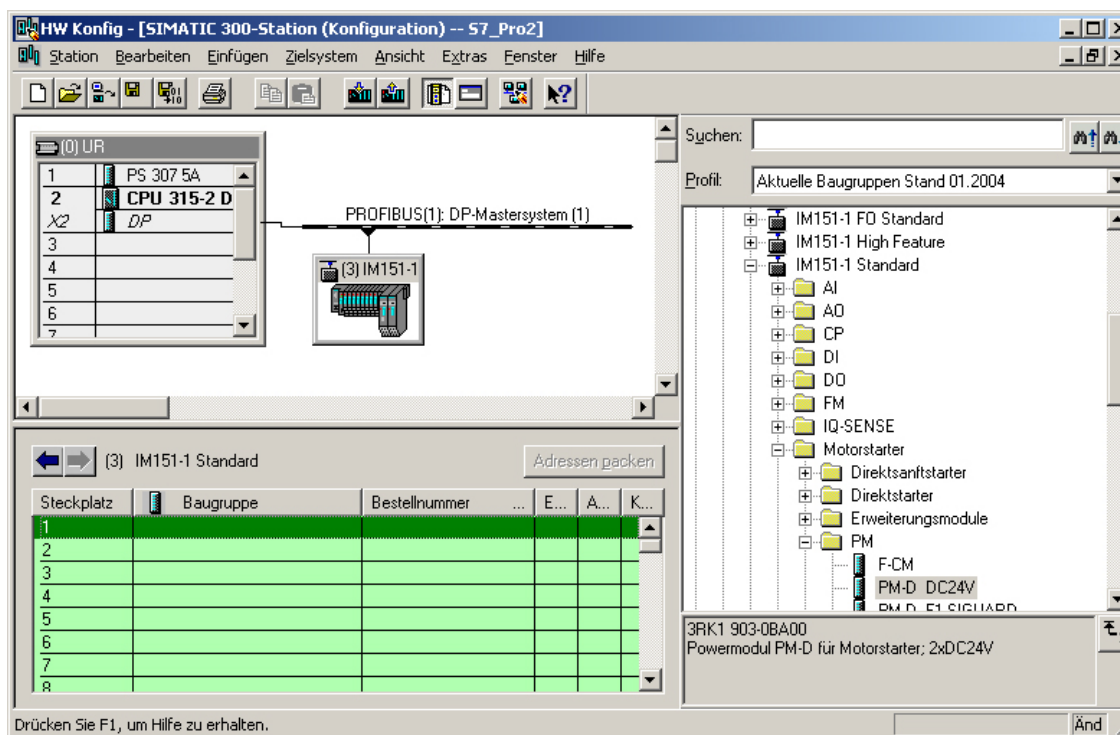


Fig. 5-2 Inserting the power module in HW Config

Notes

The PM-D and PM-D FX1 power modules are listed under the nodes Motorstarter / PM.

The "S7 Distributed Safety V5.2" software package is required in order to install PM-D F Profisafe.

5.2 Configuring the communications

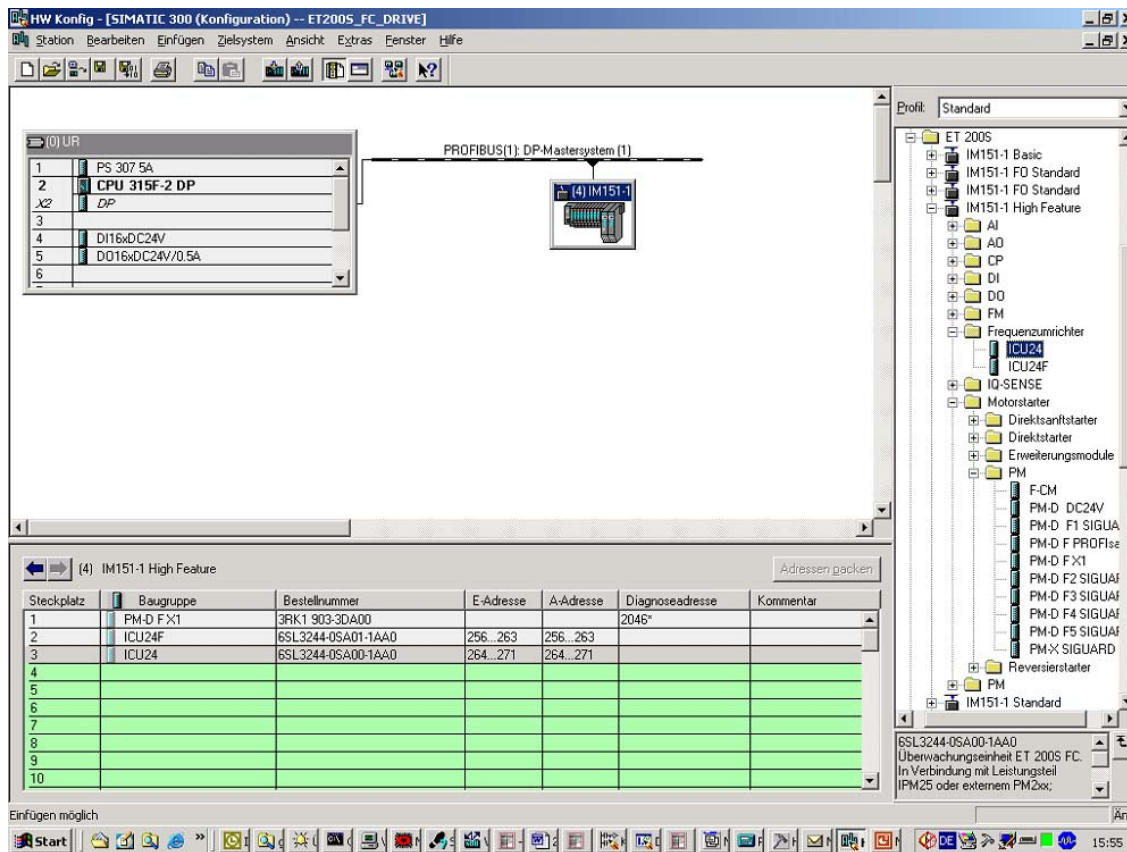


Fig. 5-3 Inserting an ICU24

5.2 Configuring the communications

Settings for the ICU24(F)

A double click on the ICU24(F) opens the properties window of the ICU24(F) with the tabs, General, Addresses and Parameters.

General

No settings are required.

Addresses

Set the addresses for the ICU24(F) (enter the configured starting address of the ICU24(F) into LADDR on the FB100 (refer to Section 5.2.2.1)).

Notes

- The address must be specified in the hexadecimal form; e.g. the starting address 256 signifies the following: LADDR:=W#16#100 (refer to Fig. 5-3)
- The input address range and output address range of the ICU24(F) must be identical.

Parameters

- ID (SPICPU) is protection against interchanging and can be freely allocated by the user (slot coding/ID).
- MMC-PS required (PMMC) is used for the hardware configuration (MMC parameter memory).
 - MMC-PS required (PMMC) = yes
means that when the frequency converter runs-up, an MMC parameter memory must be inserted
 - MMC-PS required (PMMC) = no
means that an MMC-PS is not required; and even if an MMC-PS is inserted, this is ignored when running-up (exception: parameter sets are manually uploaded/downloaded)
- Safety-Unit (PMMC), Konfiguration der Safety-Funktionalität
 - Safety-Unit (PMMC) = Safety activated
requires an ICU24F control unit on the frequency converter side with p9601 = p9801 = 1.
 - Safety-Unit (PMMC) = Safety not activated
can be configured on the frequency converter side with an ICU24F as well as an ICU24, p9601 = p9801 = 0

The required settings are listed in the following table:

Table 5-1 Parameter settings for ICU24 and ICU24F in the STEP 7 HW Config

Step 7 parameter	ICU24	ICU24F
ID (SPICPU)	Numerical value 0 ... 65535	Numerical value 0 ... 65535
MMC-PS required (PMMC)	yes / no	yes / no
Safety-Unit (PMMC)	--	Safety activated / Safety not activated

Note

If the same SPICPU address is entered for several ICU24, then the ICU24 can be interchanged with one another.

Caution

In fail-safe stations, each ICU24F must have its own dedicated SPICPU address. The user must ensure that this address is unique.

5.2.2 Function block to integrate ET 200S FC into user programs

The ET 200S FC function block

The following function block is available for the ET 200S FC.

- ET200S_FC_DRIV, FB100
Properties:
 - sending control words and setpoints with a fixed length to the drive
 - receiving status words and actual values with a fixed length from the drive
 - displaying drive faults
 - displaying communication faults
 - displaying parameterizing errors in cyclic data transfer
 - reading and writing individual parameter values of the ET 200S FC in cyclic data transfer
- The ET200S FC library of blocks is available in the Internet under the following address:
<http://support.automation.siemens.com/WWW/view/de/18686824/133100>
- The "S7 Distributed Safety V5.2" software package is required for PM-D F Profisafe.

5.2 Configuring the communications

5.2.2.1 Function block ET200S_FC_DRIV, FB100

Function description

This block cyclically transfers process data (control words, setpoints) from the SIMATIC control to the drive taking into account the conditions for consistency.

Precisely one frequency converter can be addressed at the LADDR input. If there are several frequency converters in an ET 200S station, a dedicated instance data block of ET200S_FC_DRIV must be created for every frequency converter.

After the start, the function block is in normal cyclic data transfer with the ET 200S FC frequency converter.

Calling OBs

Aligned with the generic STEP7 rules, the function block can be integrated into one of the following execution levels:

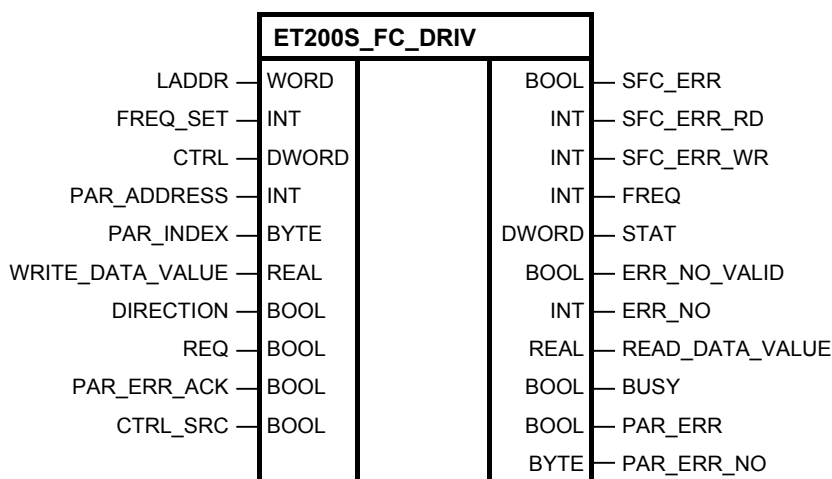
- cyclic: OB1
- time-controlled: e.g. OB35

Note

The processing time of the OB must be less than the value set in p8451 "TIME_OUT_CYCL".

A change made to p08451 only becomes effective after powering-down the ICU24(F) and powering-up again.

User interface (symbol)



5.2 Configuring the communications

Parameter description (I/O bar)

Table 5-2 Connections at the function block ET200S_FC_DRIV

Parameters	Declaration	Data type	Description
General FB parameters			
LADDR	INPUT	WORD	The address of the ET 200S FC, set in HW Config, for data transfer Format: Hexadecimal, Example: Configured starting (initial) address 256 means LADDR = W#16#100 (refer to Fig. 5-3)
SFC_ERR	OUTPUT	BOOL	This output is at true if there is a communications error in SFC 14/15.
SFC_ERR_RD	OUTPUT	INT	This output contains the error number of the SFC14 (refer to the following Table "SFC_ERR_RD Error Codes").
SFC_ERR_WR	OUTPUT	INT	This output contains the error number of the SFC15 (refer to the following Table "SFC_ERR_WR Error Codes").
Cyclic FB parameters			
FREQ_SET	INPUT	INT	Input for the required speed value Format: Hexadecimal, example: W#16#4000
CTRL 1)	INPUT	DWORD	Input for the control data Format: Hexadecimal, example: CTRL = DW#16#0000047E → DW#16#0000047F = Start frequency converter (positive edge) Note For bit 10 the FB100 always transfers the value 1.
FREQ	OUTPUT	INT	This output indicates the value of p2051.1 (default is speed actual value).
STAT 2)	OUTPUT	DWORD	This output indicates the status word of the frequency converter Format: Binary
ERR_NO_VALID	OUTPUT	BOOL	This output is at true if the function block had received a valid fault number of the ET 200S FC
ERR_NO	OUTPUT	INT	This output indicates the fault number of the ET 200S FC (value from r0947) in the decimal format. Example: ET 200S FC Fault F0090 → Edition 90. Refer to the ET 200S FC List Manual for details on the fault messages. . Note Fault memory r0947 is cleared by acknowledging twice. This means that if several faults are present, then they are all reset by acknowledging twice.

- 1) Bit 7 and bit 28 up to bit 31 must not be changed, refer to Section 5.2.4 "Cyclic data exchange between a higher-level control (FB100) and ICU24(F)"
Bit 10 must always be set to 1 (control from the PLC). From FB100, V2.2 onwards, this setting cannot be changed.
- 2) Bit 3 and bit 28 up to bit 31 must not be changed, refer to Section 5.2.4 "Cyclic data exchange between a higher-level control (FB100) and ICU24(F)"

5.2 Configuring the communications

Asynchronous FB parameters			
PAR_ADDRESS	INPUT	INT	Input for a write parameter of the ET 200S FC (refer to the parameter list of the ET 200S FC). Input example: For p1082 → Input 1082 Details, refer to the ET 200S FC List Manual.
PAR_INDEX	INPUT	BYTE	Input for the index of a parameter of the ET 200S FC Format: Hexadecimal, Example: Index 32 means PAR_INDEX = B#16#20
WRITE_DATA_VALUE	INPUT	REAL	Input for the parameter value
DIRECTION	INPUT	BOOL	1: Write parameter value 0: Read parameter value
REQ	INPUT	BOOL	Data request. A rising edge starts data transfer.
READ_DATA_VALUE	OUTPUT	REAL	Output of the data read from the ET 200S FC
BUSY	OUTPUT	BOOL	This output is at true if data is being transferred between the function block and the ET 200S FC (sending or receiving).
Signaling and monitoring parameter errors			
PAR_ERR_ACK	INPUT	BOOL	Acknowledging a parameter error = 1
PAR_ERR	OUTPUT	BOOL	This output is at true if there is a parameter error.
PAR_ERR_NO	OUTPUT	BYTE	This output indicates the error number in the decimal format. Example: PAR_ERR_NO = 106 Error numbers, refer to Table 5-5.
FB parameters with special functions			
CTRL_SRC	INPUT	BOOL	<ul style="list-style-type: none"> 0 to 1 edge sets p0810 to 1.0 (control data set 2 active) 1 to 0 edge sets p0810 to 0.0 (control data set 1 active) With the appropriate setting of p0700, the control priority can be changed-over from "USS on RS232" to "Fieldbus" (SIMATIC S7).

Note

Read and write access errors are displayed at FB100 via outputs SFC_ERR, SFC_ERR_RD and SFC_ER_WR (via SFC14 and SFC15). The function of these diagnostic outputs in FB100 depends on the type of the IM 151 head (main) module being used and the control (CPU) being used.

Parameter transfer to the frequency converter

The behavior when parameters are transferred to the frequency converter is shown in the following diagram.

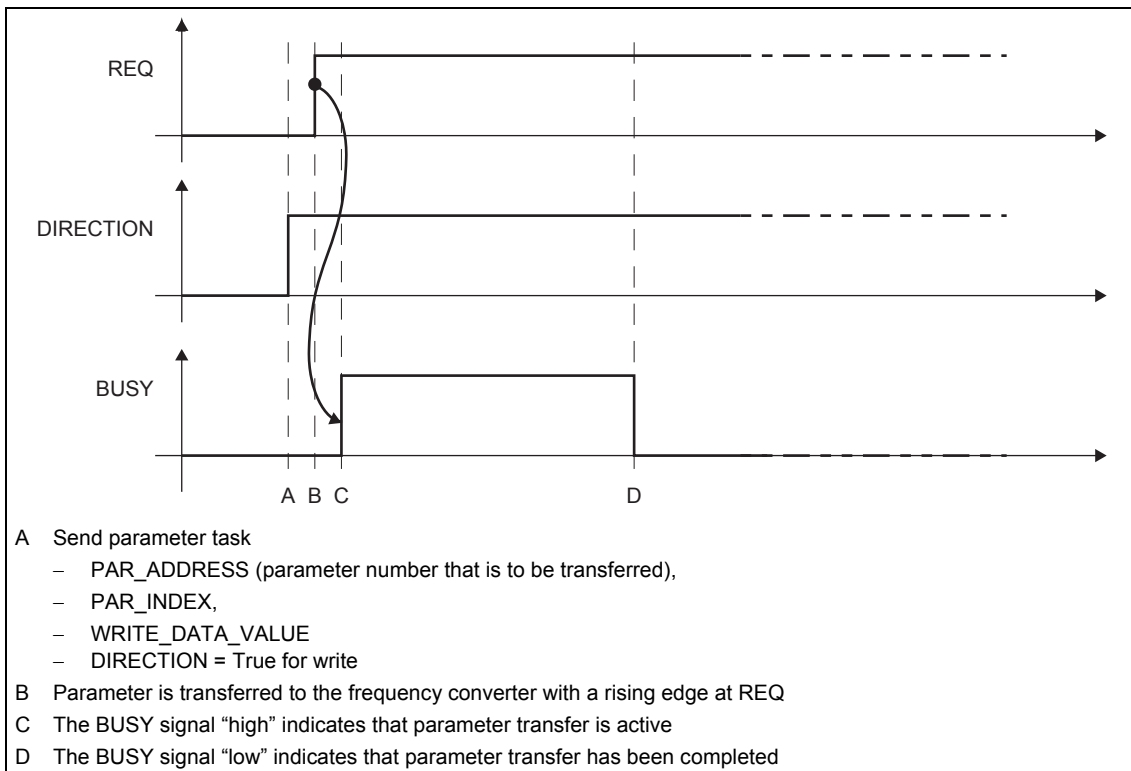


Fig. 5-4 Parameter transfer to the frequency converter

5.2 Configuring the communications

Parameter transfer from the frequency converter

The behavior when parameters are transferred from the frequency converter is shown in the following diagram.

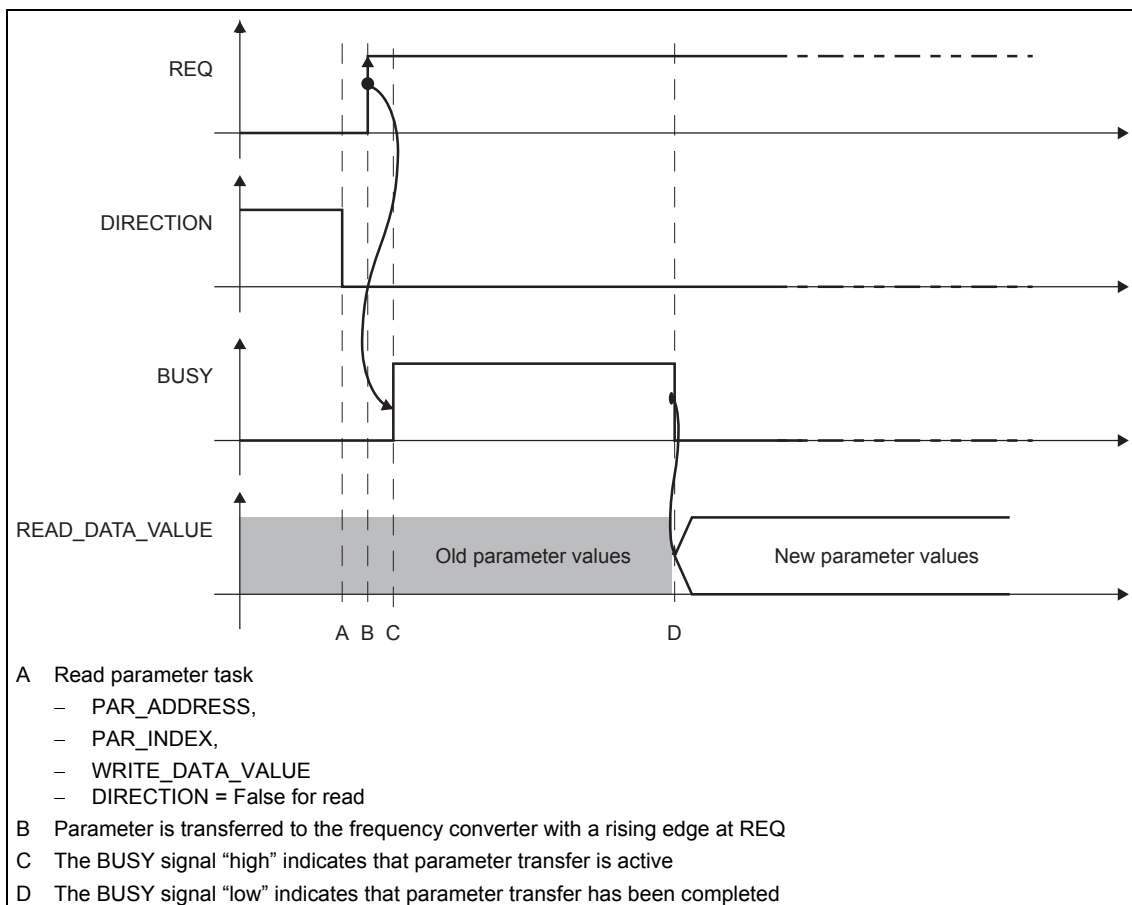


Fig. 5-5 Parameter transfer from the frequency converter

Parameterizing errors

A parameterizing error is signaled, if one of the following input errors is made:

- an incorrect parameter number
- an incorrect index
- an illegal value

The following diagram shows how parameterizing errors are handled.

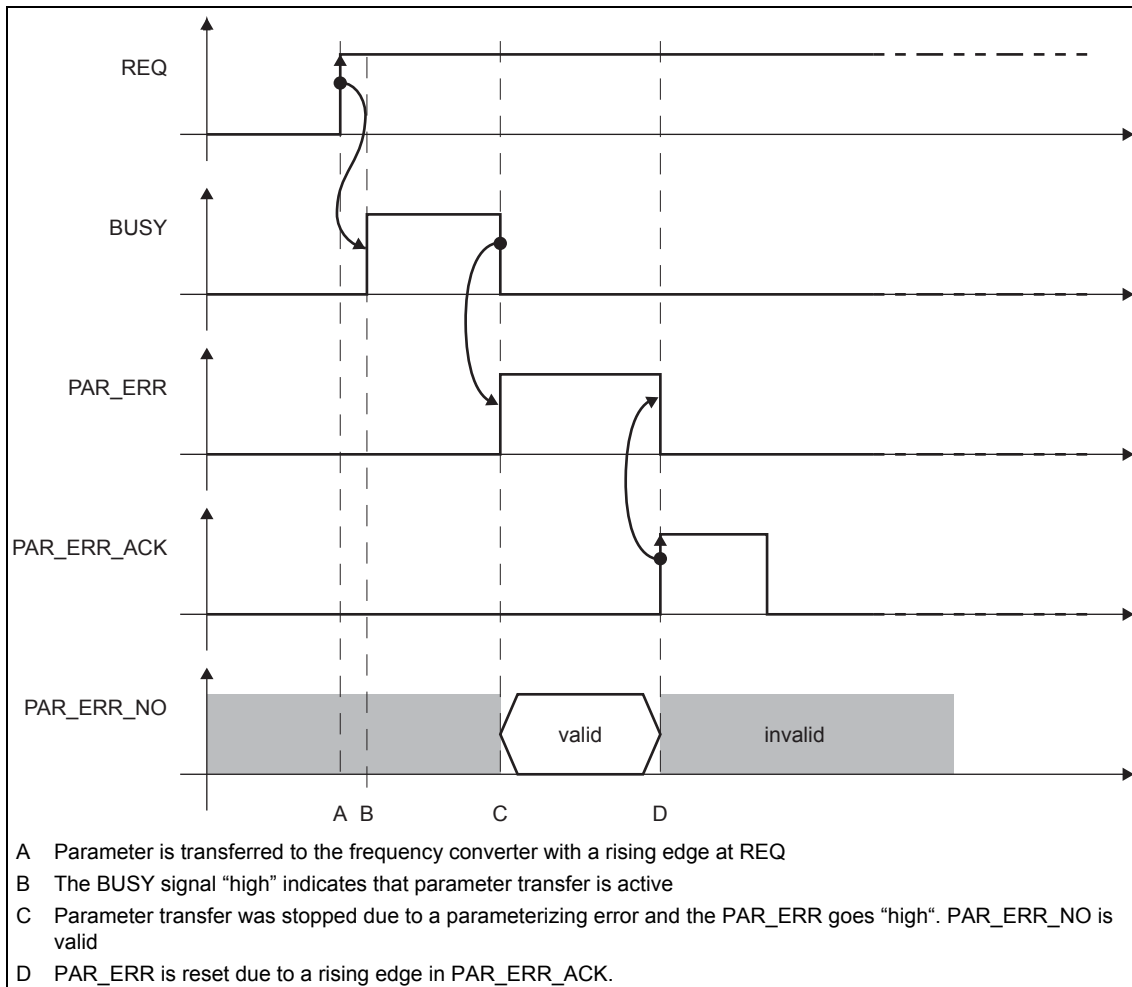


Fig. 5-6 Parameterizing error

5.2 Configuring the communications

Drive faults

The following diagram shows how drive faults are handled.

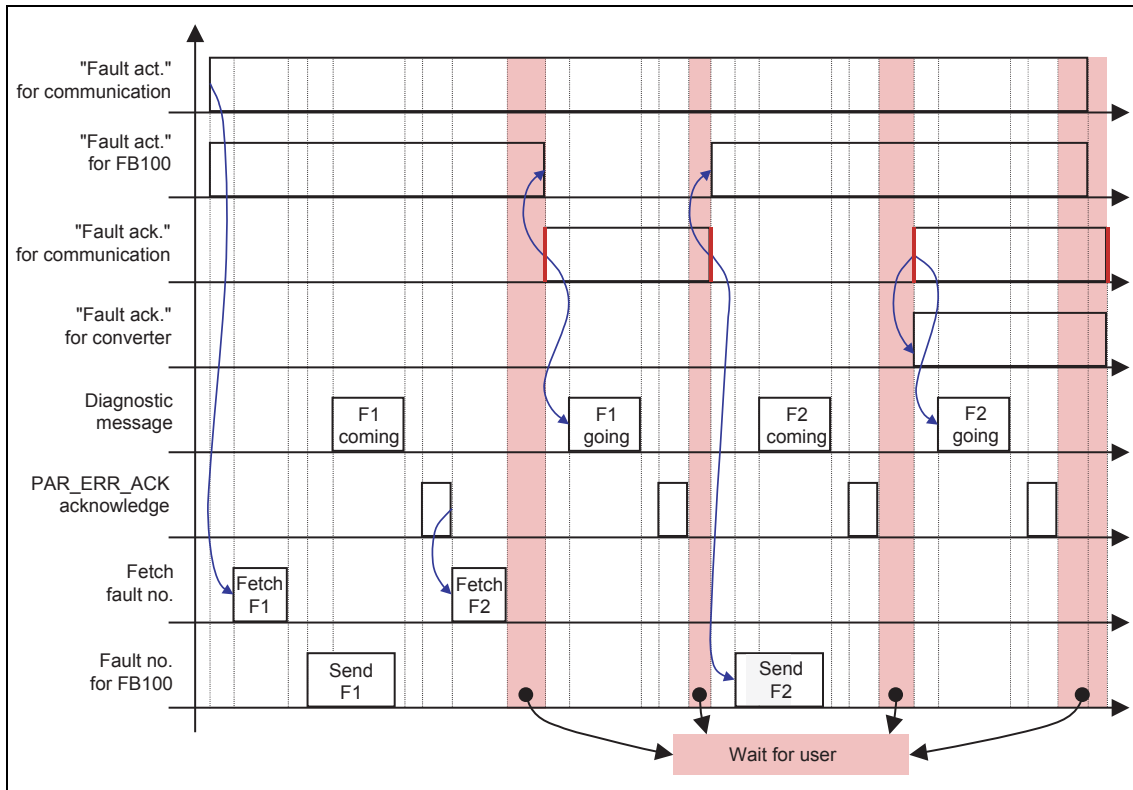


Fig. 5-7 Drive faults

Block call (STL source code)

```

CALL  "ET200S_FC_DRIV" , DB100
  LADDR      := "W#16#100"
  FREQ_SET   := "W#16#4000"
  CTRL       := "DW#16#0000047E → DW#16#0000047F"
              (ON signal, Start frequency converter)

  PAR_ADDRESS :=
  PAR_INDEX   :=
  WRITE_DATA_VALUE :=
  DIRECTION   :=
  REQ         :=
  PAR_ERR_ACK :=
  CTRL_SRC    :=
  SFC_ERR     :=
  SFC_ERR_RD  :=
  SFC_ERR_WR  :=
  FREQ        :=
  STAT        :=
  ERR_NO_VALID :=
  ERR_NO      :=
  READ_DATA_VALUE :=
  BUSY        :=
  PAR_ERR     :=
  PAR_ERR_NO  :=

```

Technical block data

Refer to the object properties of the FB100 in STEP 7.

Note

Parameters written into the frequency converter through FB100 should be subsequently verified by reading the back again (upload).

Caution

As a result of the special safety requirements placed on the input mechanisms, it is not possible to parameterize safety-relevant parameters using a function block (FB100).

The safety-relevant parameters may only be modified using the STARTER commissioning (start-up tool) or automatically downloaded from an optional MMC-PS.

5.2 Configuring the communications

5.2.3 Commissioning the frequency converter

Description

The parameterization of the ET 200S FC frequency converter is described in Chapters "Commissioning and operation", "Open-loop and closed-loop control technique" as well as "Protection and monitoring functions".

For more details please refer to the List Manual of the ET 200S FC frequency converter.

5.2.4 Cyclic data exchange between a higher-level control (FB100) and ICU24(F)

Sending

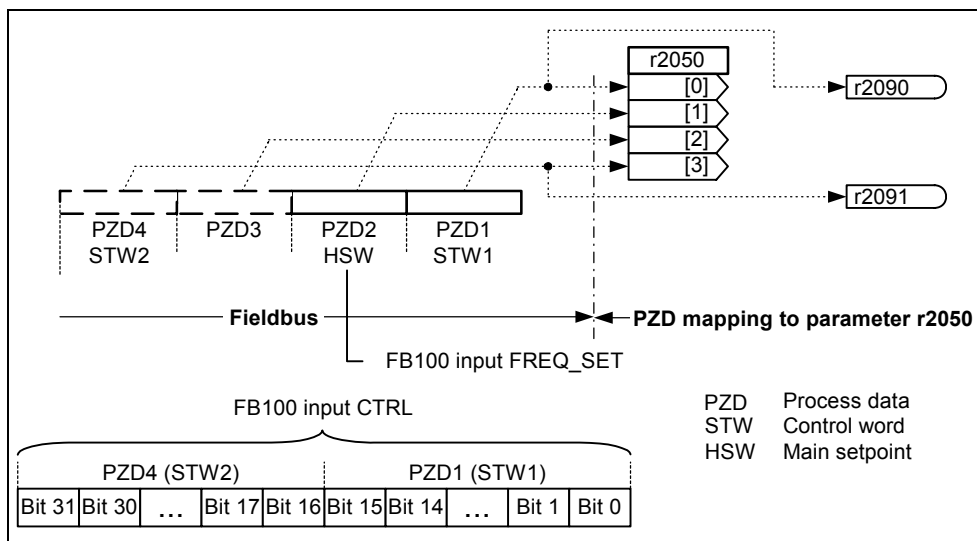


Fig. 5-8 Sending

At the transfer, the 4 most significant bits in STW2 are suppressed. They always have the value 0 and are used for internal communications. The 4 most significant bits cannot be used for PZD 4 (default STW2). For the FB100 input CTRL these are the bits 31, 30, 29 and 28.

When data is being transferred only PZD1 (default STW1) and PZD2 (default HSW) can be completely used. For PZD4 (default STW2) only the 12 least significant bits can be used. PZD3 is completely used for internal communication purposes.

Note

In FB100 V2.0, it is not permissible that bit 10 from PZD1 (STW1) is set to 0. In this case, the frequency converter would ignore all commands from the control.

In FB100 V2.2, bit 10 from PZD1 is always set by the control to 1 and cannot be changed.

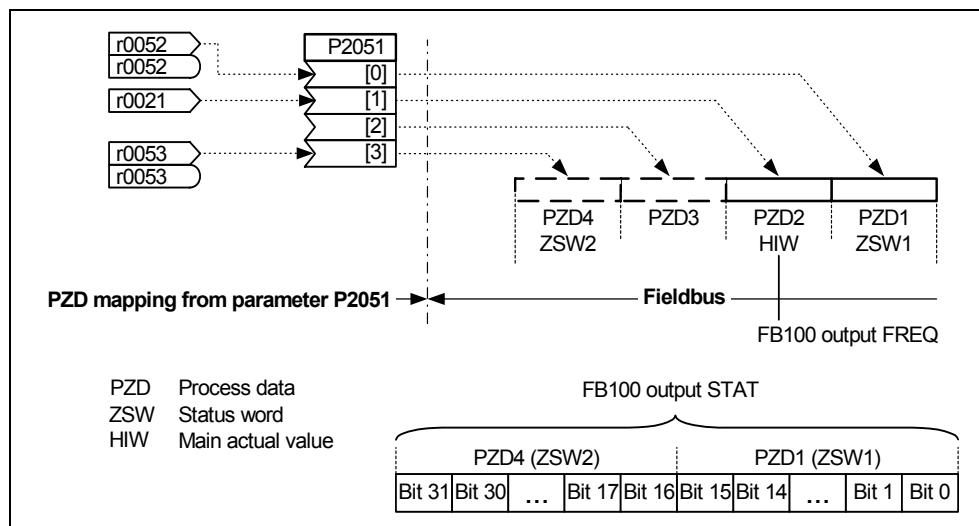
Receiving

Fig. 5-9 Receiving

At transfer the 4 most significant bits in ZSW2 are suppressed. They always have the value 0 and are used for internal communications. The 4 most significant bits cannot be used for PZD4 (default ZSW2).. For the FB100 output STAT these are the bits 31, 30, 29 and 28. In addition, bits 27 and 26 are reserved as status bits for safety-related applications. This means that they cannot be used for an ICU24 control unit. For the ICU24F control units they have the following safety-related significance at output STAT of the FB100:

Bit 26 = 1 Safe standstill active (is immediately set to 1)

or

Safe braking ramp initiated
(is only set to 1 after the down ramp has been completed)

Bit 27 = 1 Safely-reduced speed active
(while the drive is ramping down - bit 27 = 0)

When transferring data only PZD1 (default ZSW1) and PZD2 (default HIW) can be completely used. For PZD4 (default ZSW2) only the 10 least significant bits can be freely used. PZD3 is only used for internal communications.

5.2 Configuring the communications

Note

In the factory setting, status word 1 (r0052) with bit 3 (fault active) is transferred in PZD1. This bit is used in the FB100 to detect a frequency converter fault. If p2051 index 0 is assigned another word – then an error is signaled with bit 3 = 1 of this word. This means that the factory setting should not be changed.

5.2.5 Program example – ET 200S FC

A program example of commissioning the ET 200S FC is provided in the Internet under: <http://support.automation.siemens.com/WW/view/de/18698679/133000>

5.3 Error messages via the user program

Overview

Communication errors, parameterizing errors and drive faults/errors are output via the user program. A detailed description of the individual messages is provided on the following pages.

Communication errors

An SFC_ERR occurs if there is communications error between the frequency converter to PROFIBUS DP as a result of a read or write error.

Read and write access errors are displayed via the outputs SFC_ERR_RD and SFC_ERR_WR of the FB100. The actual error numbers and associated information are provided in the following Tables.

Table 5-3 Error numbers for SFC_ERR_RD

Error No.	Description
0000	An error has not occurred.
8090	This message is output if one of these errors occurs: <ul style="list-style-type: none"> You have not configured a board/module for the specified logical basis address You have not taken into consideration the restrictions regarding the length of the consistent data, You have not configured a module for the specified logical address or you have ignored the restriction concerning the length of consistent data or you have not entered the start address in the LADDR parameter in hexadecimal format
8092	Type data not equal to BYTE is specified in ANY reference. Only for S7-400
8093	No DP module from which you can read consistent data exists at the logical address specified in LADDR
80A0	Access error detected while the I/O device were being accessed
80B0	Slave failure at an external DP interface
80B1	The length of the specified destination area is not identical to the user data length configured with STEP 7
80B2	System error for an external DP interface module
80B3	System error for an external DP interface module
80C0	The data was still not read from the module
80C2	System error for an external DP interface module
80Fx	System error for an external DP interface module
87xy	System error for an external DP interface module
808x	System error for an external DP interface module
8xyy	General error information

5.3 Error messages via the user program

Table 5-4 Error number for SFC_ERR_WR

Fault No.	Description
0000	An error has not occurred.
808x	System error for an external DP interface module
8090	This message is output if one of these errors occurs: <ul style="list-style-type: none"> For the specified logical basis address, you have not configured a board/module, You have not taken into consideration the restrictions regarding the length of the consistent data, You have not entered the start address in the LADDR parameter in hexadecimal format
8092	Type data not equal to BYTE is specified in ANY reference. Only for S7-400
8093	No DP module where you can write consistent data exists at the logical address specified in LADDR
80A1	Access error detected while the I/O device were being accessed
80B0	Slave failure at an external DP interface
80B1	The length of the specified source area is not identical to the useful data length configured with STEP 7.
80B2	System error for an external DP interface module
80B3	System error for an external DP interface module
80C1	The data of the previous write task on the module is not processed by the module.
80C2	System error for an external DP interface module
80Fx	System error for an external DP interface module
85xy	System error for an external DP interface module
8xyy	General error information

Parameterizing errors

Parameterizing errors are output via the "PAR_ERR_NO" output of the FB100 if one of the following condition applies:

- Incorrect parameter number in PAR_ADDRESS
- Incorrect index in PAR_INDEX
- Incorrect value in WRITE_DATA_VALUE
- PAR_ERR remains valid until it is acknowledged via PAR_ERR_ACK.

Fault numbers, refer to the following table

Note

A new read/write request via FB100 can only be sent, if the following conditions are fulfilled.

- PAR_ERR = 0
 - PAR_ERR_ACK = 0
-

5.3 Error messages via the user program

Table 5-5 Parameterizing error numbers

Fault/ error No.	Description
0	Invalid parameter number (PNU); when PNU not present. An attempt was made to change a parameter although the change is inhibited via p0927, bit 0 = 0.
1	Parameter value cannot be changed; if the parameter is a monitoring parameter.
2	Lower or upper value limit exceeded
3	Incorrect sub index
4	No array
5	Incorrect data type
6	No setting permitted (can only be reset)
7	Description element cannot be changed; never possible
11	Control priority has not been assigned
12	Keyword missing; device parameter: 'access key' and/or 'parameter special access' do not match
15	No text array present
17	Request cannot be performed because of the operational state; converter status does not currently permit the request.
30	No communication with PLC within the time value TIME_OUT_CYCLE. The parameter value p8451 is too small. In the start up phase/ directly after start up phase from PLC and ICU is the fault number 30 okay.
31	Internal communications error
101	Parameter number currently deactivated; parameter does not have any function in the current state of the converter (e.g. control type).
102	Channel width too small; only for short channels; The parameterized length of the PKW area has been chosen too large because of internal device restrictions. This fault message can occur on the T 100 technology module only for the USS protocol when this interface accesses parameters of the base device.
103	PKW count incorrect; only for G-SST 1/2 and SCB interface (USS); The fault number is transferred in the following two cases: When the request affects all indexes of an indexed parameter (request index is 255) or the complete parameter description is requested and no variable telegram length has been parameterized. If the parameterized number of PKW data items in the telegram is too small for the request (e.g.: change of the double word and PKW number equal to 3 (words)).
104	Invalid parameter value; This fault number is transferred when no function has been assigned in the device to the parameter value to be passed or internal reasons at the time of the change mean it cannot be passed (although it lies within the limits).
105	The parameter is indexed e.g. request: 'PWE change word' for indexed parameter.
106	Request not implemented
107	Incorrect sequence of data transmission from ET200S
108	The control unit does not respond to a read/write task from the FB100 within the TIME_OUT_PARA cycle (p8450).

5.3 Error messages via the user program

Drive faults

ET 200S FC drive faults are output via the "ERR_NO" output of the FB100. ERR_NO contains the value of r0947.

Note

In order to evaluate drive faults and errors for the plant/system control, output "ERR_NO_VALID" of the FB100 should be used!

A table with all of the possible drive faults is provided in the Parameter Manual of the ET 200S FC in the Chapter "Alarm and fault messages".

A diagnostics alarm for the particular fault can be programmed using the OB82.

Note

The diagnostic messages can be activated or de-activated using parameter p8452 "DIA_LOCK".

5.4 Diagnostics using the user program

Group fault

If there is a fault in r0947, then a group fault is output on the ICU24(F), the IM 151 and the CPU.

System diagnostics

Note

The diagnostic messages can be activated or de-activated using parameter p8452 "DIA_LOCK".

For the user program (e.g. SIMATIC S7), the organizational blocks OB82, OB86 and OB122 are available to evaluate diagnostics of faults in the slave (ET 200S station).

- OB82 for diagnostic alarms for drive faults
- OB86 for diagnostic alarms for IM slave (ET 200S station has failed)
- OB122 for diagnostic alarms for I/O access errors

A specific response to faults can be programmed in this organizational block. If the particular OB is not available, the control system - and therefore also the frequency converter - go into the STOP state when a fault condition occurs.

Note

Depending on the CPU used, additional organization blocks for diagnostics can be incorporated.

It is not possible to completely monitor communications using the standard blocks SFC14 / SFC15 used in the FB100. Diagnostic functions OB82, OB83, ... should be used to completely monitor communications.

5.4 Diagnostics using the user program

Diagnostics for drive faults

Table 5-6 ET 200S diagnostic messages

Fault No.	Message	Cause	Associated alarm or fault message
			Fault
1	Short-circuit	Current too high, ground fault	1, 22, r0052[11]*
2	Undervoltage	Faulty power supply	3
3	Overvoltage	<ul style="list-style-type: none"> • Supply voltage too high • Ramp-down time too short • Required braking power too high • DC-link overvoltage 	2
4	Overload	<ul style="list-style-type: none"> • Converter overtemperature • Overcurrent • Converter overload 	4, 5, 27, 28, 453, r0052[15]*
5	Overtemperature		
6	Line breakage	<ul style="list-style-type: none"> • Motor not connected • Motor cable breakage • Sensor cable breakage, encoder fault 	20, 23, 26, 60
7	Upper limit value overshoot		
8	Lower limit value undershoot		
9	Fault	Internal fault: EPROM fault, RAM fault, watchdog, fan fault removed power section, internal communications error.	51, 52, 61, 62, 63, 100, 101
16	Parameterization fault	<ul style="list-style-type: none"> • Module has not been parameterized • Module contains incorrect parameters • Configuration fault (CB) • Incorrect data from the PowerStack 	35, 41, 42, 452, 396, 397, 398, 399
17	Encoder or load voltage missing		
18	Fuse defective		
20	Ground fault		
21	Reference channel fault		
22	Process alarm lost		
23	Actuator warning		
24	Actuator disconnection	<ul style="list-style-type: none"> • Motor overtemperature (also produced from the I²t calculation) • Communication to the CB is disturbed 	11, 15, 70, 71, 72, r0052[13]*
25	Safety-related disconnection	Safe Stop initiated (storing because of the fault state)	1600, 1610, 1611, 1612, 1613, 1614, 1630, 1649, 1650, 1655, 1659, 1660,
26	External fault		85
27	Fault not clear		25, 499

Footnote to the Table: * r0052 is status word 1

6

Commissioning and Operation

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6.1 Parameters

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6.1 Parameters

Overview

ET 200S FC frequency converters are adapted to the particular drive application using parameters. Each parameter is identified using a unique parameter number and also specific attributes (e.g. can be read, can be written into, BICO attribute, group attribute, etc.).

For ET 200S FC frequency converters, parameters can be accessed using the following operator units:

- PC with the "STARTER" commissioning tool via the RS232 interface with USS protocol
- Higher-level control with PROFIBUS DP via the ET 200S interface module IM 151



Caution

Only STARTER may be used to change safety-relevant parameters.

6.1.1 Setting / monitoring parameters and parameter attributes

Parameter types and attributes

The parameter types are a main differentiating feature between the parameters.

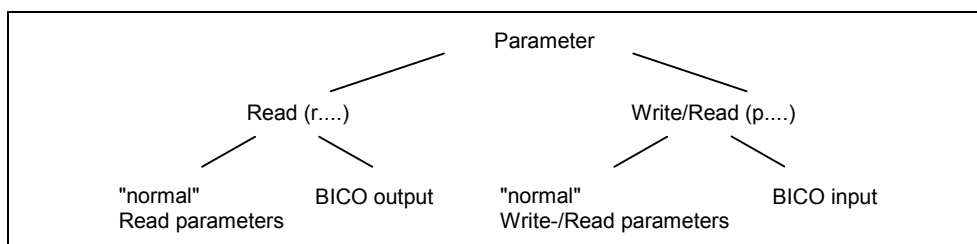


Fig. 6-1 Parameter types

6.1 Parameters

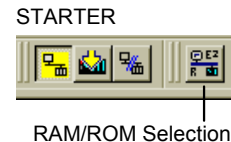
6.1.2 Setting parameters

"p" parameters – can be written into and read

These parameters are activated/de-activated in the individual functions and directly influence the behavior of a function. The value of these parameters is saved in the EEPROM if the appropriate option was selected (non-volatile data save).

For STARTER, the button in the STARTER screen form must be pressed:

Otherwise, these values are saved in the volatile memory (RAM) of the processor. These values are then lost if the power fails.

**Notation (examples)**

p0927 setting parameter 927
 p1750.1 setting parameter 1750, bit 01
 p0719[1] setting parameter 719, index 1
 p0013[0...19] setting parameter 13 with 20 indices (indices 0 to 19)

Shortened notation:

p0013[20] setting parameter 13 with 20 indices (indices 0 to 19)

6.1.3 Monitoring parameters

"r" parameters - can only be read

These parameters are used to display internal quantities - for example statuses and actual values. These parameters are indispensable when it comes to diagnostics.

Notation

r0002 monitoring parameter 2
 r0052.3 monitoring parameter 52, bit 03
 r0947[2] monitoring parameter 947, index 2
 r0964[0...4] monitoring parameter 964 with 5 indices (indices 0 to 4)

Abbreviated notation:

r0964[5] monitoring parameter 964 with 5 indices (indices 0 to 4)

6.1.4 Parameter attributes

Description

In addition to the parameter number and the parameter text, every setting or monitoring parameter has different attributes. These are used to define the characteristics of the particular parameter.

Listing the attributes in the parameter list

The attributes and attribute groups are shown in the header line of the parameter in the parameter list. This is shown as an example using parameter p0305 in the diagram, Fig. 6-2. These attributes will be described in detail in the subsequent text.

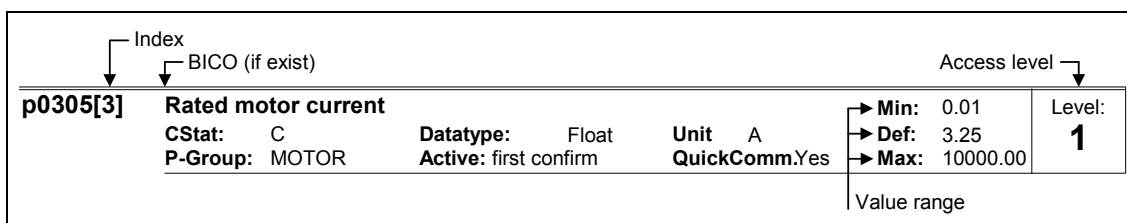
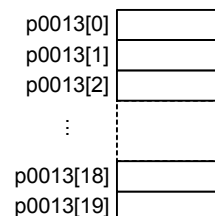


Fig. 6-2 Header line of parameter p0305

Index

Using the index, a parameter (e.g. p0013[20]) is defined with several consecutive elements (in this case, 20). Each individual index is defined using a numerical value. When transferred to a parameter this means that an indexed parameter can have several values. The values are addressed using the parameter number including the index value (e.g. p0013[0], p0013[1], p0013[2], p0013[3], p0013[4], ...).



Indexed parameters are used, for example:

- Drive Data Sets (DDS)
- Command Data Sets (CDS)
- Sub-functions

Additional information on the data sets, refer to Section 6.1.6.

6.1 Parameters

BICO

Description for a Binector Input (BI), Binector Output (BO), Connector Input (CI), Connector Output (CO) and Connector Output / Binector Output (CO/BO). For additional information, please refer to Section 6.1.5

Table 6-1 Parameter attributes - BICO

BICO	Description
BI	Binector input
BO	Binector output
CI	Connector input
CO	Connector output
CO/BO	Connector output / binector output

Access stage

Parameter p0003 is used to control the access stage. There are access stages 0 to 4.

Table 6-2 Parameter attributes- access stage

Access stage	Description
0	User-defined parameter list (refer to p0013)
1	Standard, access to the most often used parameters
2	Expanded, access to the extended parameter list
3	Experts, access to all of the parameters being used (this is only for experienced users)
4	Service access only for authorized service personnel – with password protection.

Note

In STARTER, all of the user parameters (access stage 3) are always displayed using the expert list – for the setting p0003 = 0, 1, 2 or 3.

Note

When changing parameters using STARTER, or via a high-level control system, parameter value changes always become immediately effective.

CStat

"p" parameters can only be modified as a function of the drive state. The parameter value is not accepted if the instantaneous state is not listed in the parameter attribute "CStat". For instance, the commissioning parameter p0010 with the attribute "CT" can only be changed in the quick commissioning "C" or drive ready to run "T" - but not in operation "U".

Table 6-3 Parameter attributes – CStat

CStat	Description
C	Quick commissioning
U	Drive running
T	Drive ready to run

Data type

The data type of a parameter defines the maximum possible value range. For calculations made in the frequency converter, data types are used that either represent an integer unsigned value (U16, U32) or an integer value with sign (I16, I32) or a floating-point value (float). Frequently, the value range is restricted by the minimum, maximum value (min, max) or the frequency converter/motor size. To the higher-level control, only the float data type is used.

Table 6-4 Parameter attributes - data type

Data type	Description
U16	Unsigned integer 16-bit value
U32	Unsigned integer 32-bit value
I16	Signed integer 16-bit value
I32	Signed integer 32-bit value
Float	A basic precise 32-bit floating-point value in compliance with the IEEE standard format, max. value range: $-3.39e^{+38}$ – $+3.39e^{+38}$

6.1 Parameters

Units

The units of a parameter are the units of a physical quantity (e.g. m, s, A). Quantities are properties/features of physical objects, processes, states - that can be measured - and are represented using formula characters (e.g. $V = 9\text{ V}$).

Table 6-5 Parameter attributes – unit

Unit	Description
-	No dimensions
%	Percentage
A	Amps
V	Volt
Ohm	Ohm
us	Microseconds
ms	Milliseconds
s	Seconds
Hz	Hertz
kHz	Kilohertz
RPM	Revolutions per minute
m/s	Meters per second
Nm	Newton meter
W	Watt
kW	Kilowatt
Hp	Horsepower
kWh	Kilowatt hours
°C	Degrees Celsius
m	Meter
kg	Kilogram
°	Degrees (angular degrees)

P group

The parameters are classified in groups according to their functionality. This increases the transparency and allows a parameter to be quickly found.

Table 6-6 Parameter attributes – P group

P group	Description	Main parameter range
INVERTER	Frequency converter parameters	0200 0299
MOTOR	Motor parameters	0300 0399 + 0600 0699
ENCODER	Speed encoder	0400 0499
TECH_APL	Technical applications / units	0500 0599
COMMANDS	Control commands, digital I/O	0700 0749 + 0800 0899
TERMINAL	Analog inputs/outputs	0750 0799
SETPOINT	Setpoint channel and ramp-function generator	1000 1199
FUNC	Frequency converter functions	1200 1299
CONTROL	Open-loop/closed-loop motor control	1300 1799
COMM	Communications	2000 2099
ALARMS	Faults, alarms, monitoring functions	2100 2199
TECH	Technology controller (PID controller)	2200 2399
SAFETY	Safety-related functions	9600 9899

Active

This specifies whether changes to parameter values are immediately effective after they have been entered or they must be acknowledged.

Table 6-7 Parameter attributes – active

Active	Description
Immediately	Changes to parameter values are immediately effective after they have been input
After acknowledgement	Changes to parameter values only become effective after they have been acknowledged

Note

Parameter values that are changed using STARTER or a higher-level control do not have to be acknowledged.

6.1 Parameters

Quick commissioning

This parameter attribute designates as to whether the parameter is included in the quick commissioning (p0010 = 1).

Table 6-8 Parameter attributes – quick commissioning

Quick start-up	Description
No	Parameter is not included in the quick commissioning
Yes	Parameter is included in the quick commissioning

Value range

The value range that is specified by the data type is restricted by the minimum, maximum value (min, max) or by the frequency converter/motor quantities. Straightforward commissioning is ensured in so much that the parameters have a default value. These values (min, def, max) are permanently saved in the frequency converter. The user cannot change them.

Table 6-9 Parameter attributes - value range

Value range	Description
-	No value data (e.g.: "r parameters")
Min	Minimum value
Def	Default value
Max	Maximum value

6.1.5 Interconnecting signals (BICO technology)

BICO technology and quick commissioning

The BICO technology allows internal and external signals to be interconnected (setpoint / actual value or control / status signals) so that the drive can be flexibly adapted to a new application. For standard applications, parameters p0700 / p1000 have been created so that drives can be quickly parameterized. Subsequent parameter assignments (parameterization) are triggered using this parameter and certain signal connections are automatically interconnected in the drive.

Selecting command source p0700 and frequency setpoint source p1000

The setpoints and control signals can be quickly interconnected using the following parameters:

- p0700 "selects the command source"
- p1000 "selects the frequency setpoint source"

The appropriate subsequent parameter assignments (BICO technology) are executed by setting these parameters. These parameters are used to define via which interface the frequency converter receives the setpoint or the power-on / power-off command. For the command source p0700 and the setpoint source p1000, the interfaces listed in Table 6-10 can be selected.

Table 6-10 Parameters p0700 and p1000

Parameter values	Significance / command / setpoint source
4	USS on RS232 (RS232 interface with USS protocol)
6	Fieldbus (PROFIBUS DP via IM 151 (factory default))

The selection of the command source is in this case independent of the selection of the frequency setpoint source. This means that the source to enter the setpoint does not have to match the source to enter the power-on / power-off command (command source).

6.1 Parameters

BICO technology

Using the BICO technology, process data can be freely interconnected using the "standard" drive parameterization. In this case, all of the freely interconnectable values (e.g. frequency setpoint, frequency actual value, current actual value, etc.) can be defined as "connectors" and all freely interconnectable digital signals (e.g. ON/OFF, signaling/message functions for signaling when a limit has been violated, etc.) are defined as "binectors".

In a drive unit there are numerous interconnectable input and output quantities as well as some quantities within the closed-loop control. BICO technology can be used to adapt the drive unit to a wide range of requirements.

A binector is a digital (binary) signal without any units and can either have the value 0 or 1 (refer to Fig. 6-3). In this case, the binector input is always designated using a "p" parameter plus attribute "BI" (e.g.: p0840 "BI: ON/OFF1") and supplies the values for a subsequent function. The binector output is always shown as "r" parameter plus attribute "BO" (e.g.: r2811 "BO: AND1") and this is used to transfer the result of a previous function.

As can be seen from the examples above, the binector parameters have the following abbreviations in front of the parameter names:

BI Binector input, signal receiver ("p" parameter)

- The BI parameter can be interconnected as signal receiver with a binector output as source. This is realized by entering the parameter number of the binector output (BO parameter) as value in the BI parameter (e.g.: Interconnecting the "BO" parameter r2811 with the "BI" parameter p0840 → p0840 = 2811). The BI parameter is symbolically shown as a socket.

BO Binector output, signal source ("r" parameter)

- The BO parameter can be used as source for BI parameters. For the interconnection, the BO parameter number must be entered into the BI parameter (e.g.: Interconnecting the "BO" parameter r2811 with the "BI" parameter p2816 → p2816 = 2811). Symbolically, the BO parameter is represented as connector.

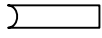
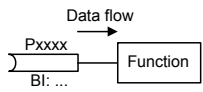

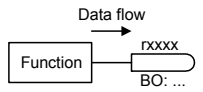
Abbreviation and symbol	Name	Function
BI 	Binector input (signal receiver)	
BO 	Binector output (signal source)	

Fig. 6-3 Binectors

A connector is a value (16 or 32 bit) that can contain both a normalized quantity (without any dimensions) as well as a quantity with dimensions (refer to Fig. 6-4). The same as for binectors, the connector input is characterized by a "p" parameter plus attribute "CI" (e.g.: p2885 "CI: CMP 1") and supplies an analog value for a subsequent function. The connector outputs are always represented using an "r" parameter plus attribute "CO" (e.g.: r0021 "CO: Smoothed output frequency") and are used to transfer the result of a previous function.

As can be seen from the examples above, the connector parameters have the following abbreviations in front of the parameter names:

CI Connector input, signal drain ("p" parameter)

- The CI parameter can be interconnected, as signal drain with a connector output as source by entering the parameter number of the connector output (CO parameter) as value into the CI parameter (e.g.: p2885 = 21). p2885 = 21 means that the smoothed output frequency is connected to comparator 1.

CO Connector output, signal source ("r" parameter)

- The CO parameter can be used as source for CI parameters. To establish the interconnection the CO parameter number must be entered into the CI parameter (e.g.: p2885 = 21).

Further, there are "r" parameters where several binector outputs are combined in a word (e.g.: r0052 CO/BO: Status word 1). This feature reduces the number of parameters and simplifies parameterization using the serial interface (data transfer). This parameter also does not have any units and each bit represents a digital (binary) signal.

As can be seen from the parameter example, these combined parameters have the following abbreviation in front of the parameter names:

CO/BO Connector / binector output, signal source ("r" parameter)

- CO/BO parameters can be used as source for CI parameters or BI parameters:
 - a) In order to interconnect the complete CO/BO parameter, the parameter number must be entered into the appropriate CI parameter (e.g.: p2019[0] = 52).
 - b) When interconnecting a single digital signal, in addition to the CO/BO parameter number, the bit number must be entered into the BI parameter (e.g.: p0840 = 52.8)

6.1 Parameters


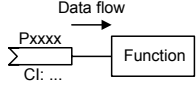
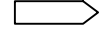
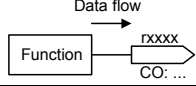
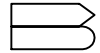
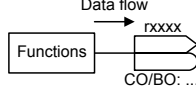
Abbreviation and symbol	Name	Function
CI 	Connector input (signal receiver)	
CO 	Connector output (signal source)	
CO BO 	Binector/connector output (signal source)	

Fig. 6-4 Connectors

In order to interconnect two signals, a BICO setting parameter (signal receiver) must be assigned the required BICO monitoring parameter (signal source). The BICO interconnection is shown using the following examples.

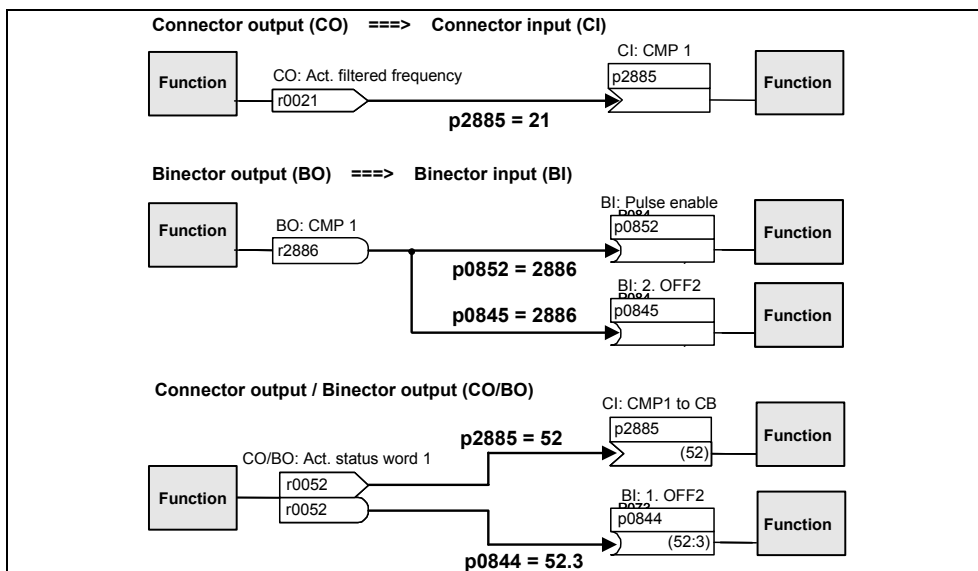


Fig. 6-5 BICO connections (examples)

Note

BICO parameters with the attribute CO, BO or CO/BO can be used a multiple number of times.

6.1.6 Data sets

Description

For many applications it is an advantage if several parameters can be simultaneously modified using one external signal while the drive is running or the drive is ready to run.

This functionality can be implemented by using indexed parameters. In this case, the parameters are combined, as far as the functionality is concerned, to form a group (data set) and indexed. As a result of the indexing, several different settings can be saved in each parameter; these are then activated by changing-over the data set.

The following data sets are available:

- CDS (**C**ommand **D**ata **S**et) Command data set
to quickly change the drive control
- DDS (**D**rive **D**ata **S**et) Drive data set
to quickly change drive settings

For each of the data sets, 3 independent settings are possible; these can be selected using the index of the particular parameter:

- CDS1 ... CDS3
- DDS1 ... DDS3

Example:

- The frequency converter should be changed-over from motor 1 to motor 2.

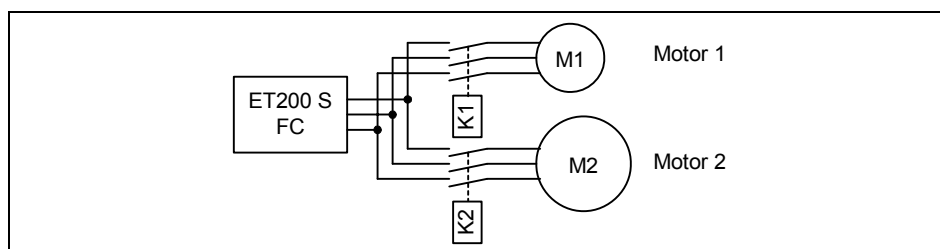


Fig. 6-6 Changing-over the drive data set to activate the drive parameter for motor 2

6.1 Parameters

Command data set (CDS)

Those parameters (connector and binector inputs) are assigned to the command data set (CDS) that handle the control of the drive and/or the setpoint input. The signal sources for the control commands and setpoint values are interconnected using BICO technology. In this case, connector and binector inputs are assigned the appropriate connector and binector outputs as signal sources. The following belong to a command data set:

- **Command sources and binector inputs for control commands (digital signals) e.g.:**
 - selects the command source p0700
 - ON/OFF1 p0840
 - OFF2 p0844
 - selects JOG, clockwise p1055
 - selects JOG, counter-clockwise p1056
- **Setpoint sources and connector inputs for setpoints (analog signals) e.g.:**
 - selects freq. setpoint source p1000
 - selects the main setpoint p1070

The parameters combined in a command data set have an index in the parameter list:

pxxxx[0] : 1st command data set (CDS)

pxxxx[1] : 2nd command data set (CDS)

pxxxx[2] : 3rd command data set (CDS)

Note

A complete list of all of the CDS parameters can be taken from the parameter list.

Toggleing between command data sets

BICO parameters p0810 or p0811 are used to toggle between command data sets - whereby the active command data set is displayed in parameter r0050. The command data sets can be toggled both in the "drive ready to run" as well as in the "drive running" states. When changing-over (toggleing) using FB100 input CTRL_SRC this overwrites the setting of p0810.

	selected CDS		active CDS
	p0811	p0810	r0050
1. CDS	0	0	0
2. CDS	0	1	1
3. CDS	1	0	2
3. CDS	1	1	2

Note

For p0811 = 1 - data sets cannot be toggled using the FB100

A frequent application is, for example, the implementation of a function to toggle between the automatic and manual modes. One data set then uses e.g. the higher-level control as command and setpoint source and another data set the serial interface (‘manual’) for operator control via an USS-Master.

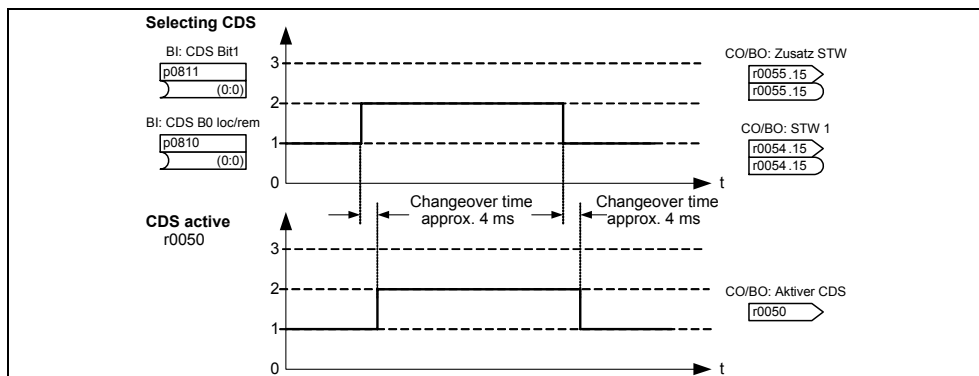


Fig. 6-7 Toggling between CDS

Copying command data sets

There is an integrated copy function that is used to transfer command data sets. This function can be used to copy the CDS parameters corresponding to the particular application.

The copy operation is controlled using p0809:

1. p0809[0] = number of the command data set that should be copied (source)
2. p0809[1] = number of the command data set into which data should be copied (target)
3. p0809[2] = 1 → copying is started
 Copying has been completed, if p0809[2] = 0.

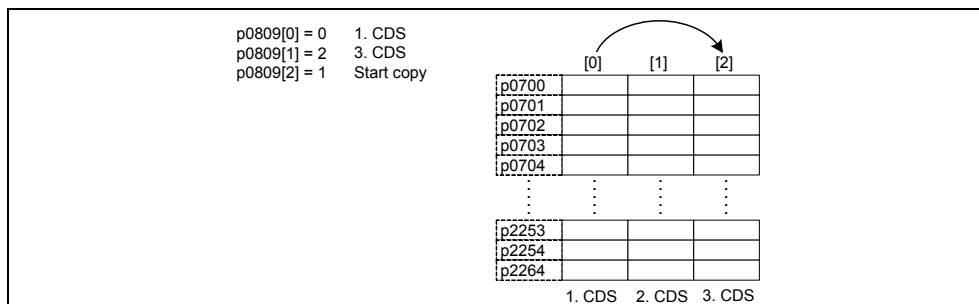


Fig. 6-8 Copying from CDS1 to CDS3

6.1 Parameters

Drive data set (DDS)

A drive data set (DDS) contain various setting parameters that are of significance for the open-loop and closed-loop control of a drive:

- **Motor and encoder data, e.g.:**
 - selects the motor type p0300
 - rated motor voltage p0304
 - main inductance p0360
 - selects the encoder type p0400
- **Various closed-loop control parameters, such as:**
 - JOG frequency p1058
 - min. frequency p1080
 - ramp-up time p1120
 - control type p1300

The parameters combined in a drive data set are provided with an index in the parameter list:

pxxxx[0] : 1st drive data set (DDS)

pxxxx[1] : 2nd drive data set (DDS)

pxxxx[2] : 3rd drive data set (DDS)

Note

A complete list of all of the DDS parameters can be taken from the parameter list.

Toggleing between drive data sets

BICO parameters p0820 and p0821 are used to toggle between drive data sets, whereby the active drive data set is displayed in parameter r0051. It is only possible to toggle between drive data sets in the "drive ready to run" state. This takes approximately 50 ms.

Different drive configurations (closed-loop control type, closed-loop control data, motors) can be very simply implemented by toggling between various drive data sets.

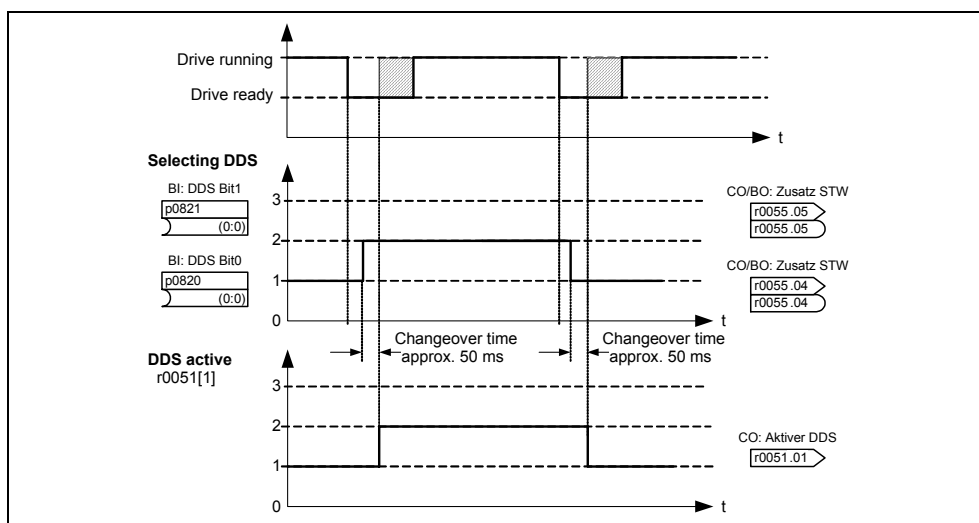


Fig. 6-9 Toggling between DDS

Copying drive data sets

Just the same as for the command data sets, it is also possible to copy drive data sets. The copy operation is controlled using p0819 as follows:

1. p0819[0] = number of the drive data set that is to be copied (source)
2. p0819[1] = number of the drive data set in which data is to be copied (target)
3. p0819[2] = 1 → copying is started
Copying has been completed, if p0819[2] = 0.

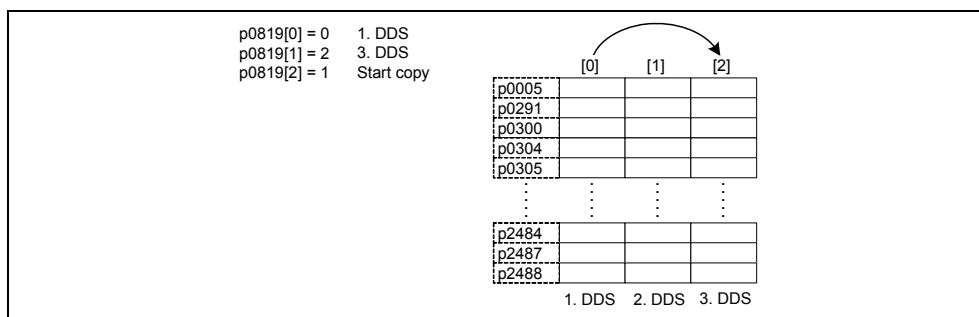


Fig. 6-10 Copying from DDS1 to DDS3

6.1.7 Status and control words

Description

The ET 200S FC has two status and two control words.

6.1 Parameters

The drive converter can be diagnosed using the status words; the control words indicate the presently available commands and setpoints.

You will find the individual messages/signals in the Parameter Manual, Chapter "Parameter list" under the following parameter numbers:

- r0052 status word 1 (ZSW1)
- r0053 status word 2 (ZSW2)
- r0054 control word 1 (STW1)
- r0055 control word 2 (STW2)

Note

When communications are established through FB100, specific bits of the status and control words are used for internal processes – and are masked-out. For details please refer to "Connection to SIMATIC S7".

6.2 Commissioning

Description

In order to commission the ET 200S FC frequency converter, the ET 200S station must be correctly assembled and configured with all of the components and the power modules must be connected-up.

Note

The techniques described in this Section are valid for both Standard as well as also for safety-relevant applications. Additional and supplementary commissioning steps for safety-relevant functions are provided in the Section "Commissioning Safety Integrated functionality"

Prerequisites

- For all of the activities, carefully observe the ESDS measures.
- All of the frequency converter components (terminal modules, control module, power module and brake control module (optional)) are correctly inserted.
- The control module ICU24(F) is supplied via the associated power module PM-D(F).
- If an ICU24(F) with MMC parameter memory was configured, then an MMC-PS must be inserted.
- All screws must be tightened with their specified torque.
- All connectors / option modules are correctly inserted, interlocked and screwed into place.
- All of the components are grounded at the appropriate locations and all of the shields connected.
- The mechanical, climatic and electrical limit values are maintained. These may neither be exceeded in operation nor during transport. The following must be especially observed:
 - conditions of the mains supply
 - level of pollutants
 - gases that can have a negative impact on the function
 - ambient climatic conditions
 - storage / transport
 - shock stressing
 - vibration stressing
 - ambient temperature
 - installation altitude

In order to successfully commission the equipment, in addition to completely carrying-out all of the installation work, the frequency converter may not be isolated

6.2 Commissioning

from the mains during commissioning work. If commissioning is interrupted due to a mains failure, then parameters can be lost. In this case, commissioning must be re-started (if required, reset the ET 200S FC frequency converter to the factory setting (refer to Section 6.2.7)).

Commissioning software and commissioning functions

The parameterization to commission (start-up) the ET 200S FC is realized using the PC-based "STARTER" commissioning (start-up) software via the RS232 interface on the ICU24(F) control module of the ET 200S FC.

STARTER offers the following functionality

- Configuring drives:
Menu-prompted commissioning of the ET 200S FC (from STARTER V3.2 onwards)
- Commissioning a drive with the expert list:
Parameter-orientated commissioning (STARTER V3.1 SP2)

While the menu-prompted commissioning is self-explanatory or is explained using the online help, when commissioning the drive with the expert list, the user is supported by the following flow diagrams:

- quick commissioning
- motor data identification
- calculating motor / control (closed-loop) data
- series commissioning
- commissioning an application

When commissioning a drive using the expert list, to start, a quick or series commissioning should be carried-out. The application should only be commissioned if the frequency converter - motor combination already runs satisfactorily.

Note

In the flow diagrams, the parameter name is located to the right of the parameter number. The setting possibilities are listed below it.

Parameters designated with a "*" have more setting possibilities than are actually displayed in the flow diagram. All of the setting possibilities are listed in the parameter list.

If the drive is to be commissioned from a defined state, then the frequency converter can be reset into the initial state (factory setting) (refer to the Section 6.2.7 "Restoring parameters to the factory setting").

Note

The STARTER software is available through the Internet <http://support.automation.siemens.com/WW/view/de/10804985/133100> or as CD-ROM under the following Order No. 6SL3072-0AA00-0AG0.

This STARTER software is designed for ET 200S FC frequency converters and also for the fail-safe version.

Control and parameterizing priority

The ET 200S FC frequency converter can either be controlled via the RS232 interface using the "STARTER" commissioning tool or via the IM 151 (PROFIBUS DP coupling).

STARTER is used to changeover between the control priority (entering the command and setpoint source) of the ET 200S FC.

- In operation, the higher-level control has the control priority). This means that the command and setpoint sources are defined by the settings of parameter p0700 (command source) and p1000 (setpoint source). These two parameters are set in the factory so that the higher-level control has the control priority.
- For commissioning, the control priority is set to the RS232 interface using STARTER. This is realized automatically by pressing the "Assume control priority" button in STARTER. After this selection has been made, commands and setpoints can be output from STARTER. This means that the control priority can be returned to the higher-level control.

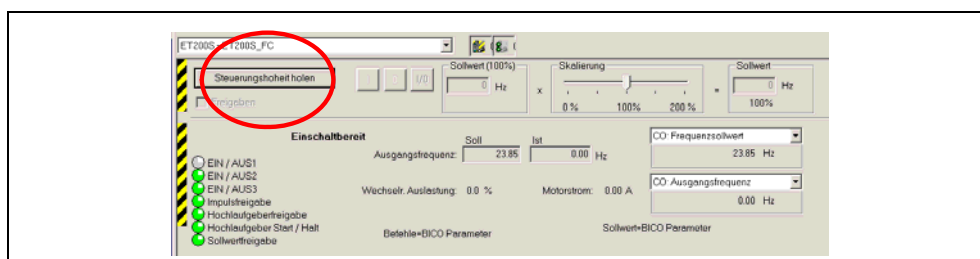


Fig. 6-11 Fetching the control priority

In the standard setting, parameter values can either be modified via higher-level control as well as also via the RS232 interface (STARTER).

6.2 Commissioning

Note

If parameter changes via the RS232 interface are to be interlocked in process operation in order to prevent the control priority from being accidentally changed-over to the RS232 interface, then bit 2 of p0927 should be set to 0. This then means that no parameter values can be modified via the RS232 interface – with the exception of the value for p0003 and p0927 itself.

Commissioning sequence

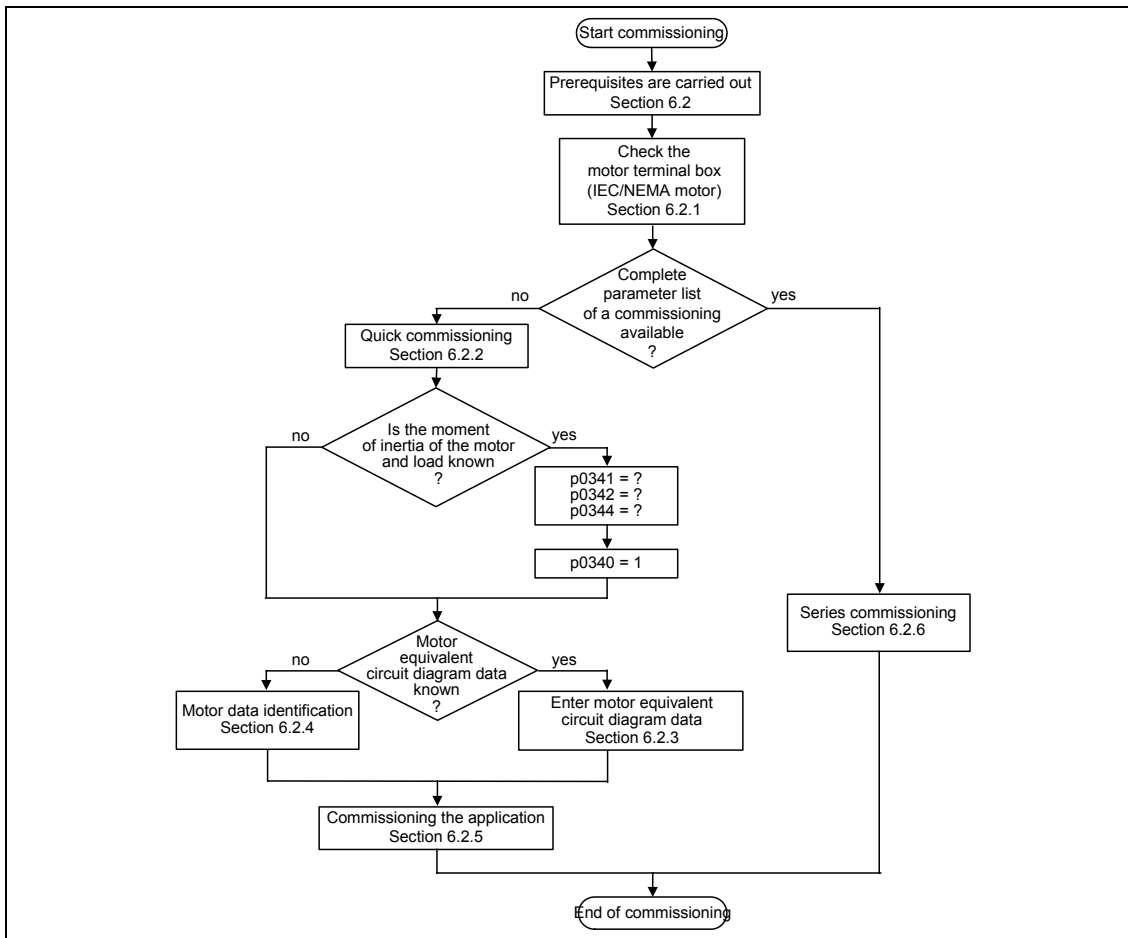


Fig. 6-12 Commissioning sequence

6.2.1 Checking the motor terminal box (IEC/NEMA motor)

In order to successfully commission the frequency converter it is essential that the interconnections in the motor terminal box (refer to Fig. 6-13) match the inputs of the rated motor voltage p0304 and the rated motor current p0305.

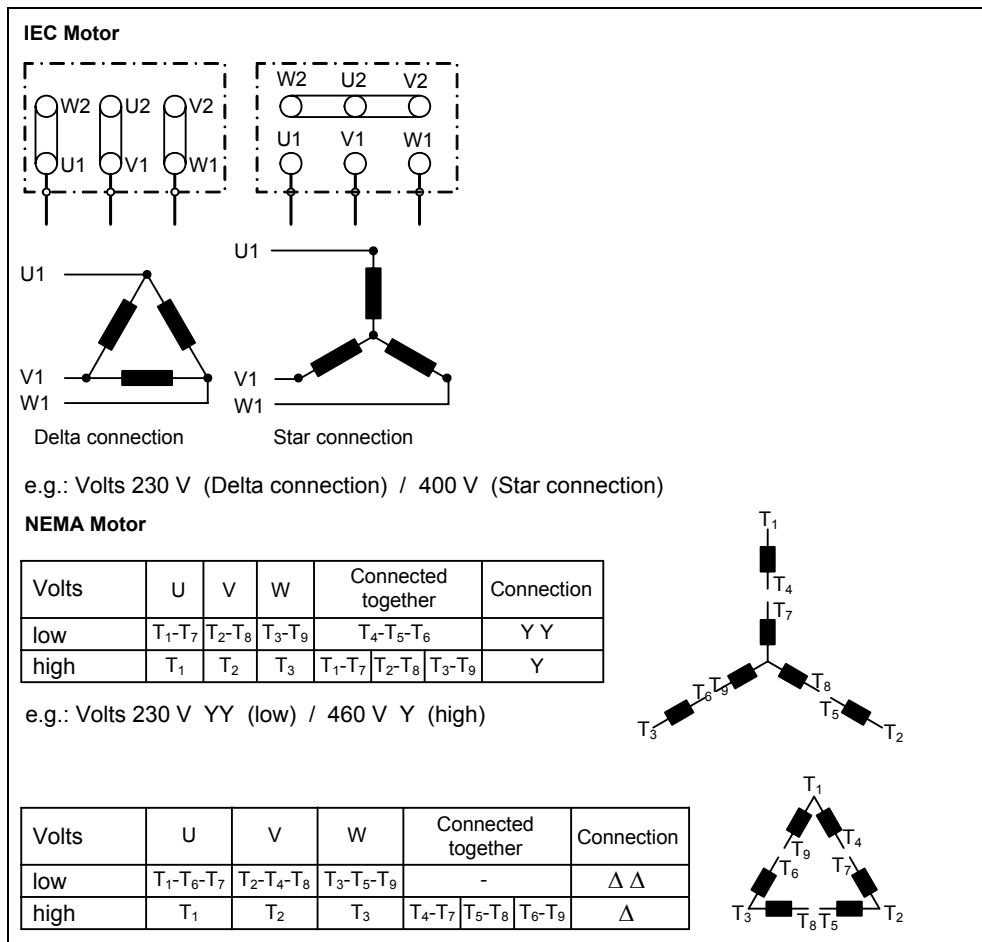


Fig. 6-13 Motor terminal box

When entering the rating plate data or equivalent circuit diagram data, the following must be carefully observed:

- The outer conductor voltage/phase-to-phase voltage (voltage U₁₂ between the outer conductors L1, L2) and the outer conductor current I₁ are always specified on the rating plate.
- The rated motor voltage p0304 and the rated motor current p0305 must always be entered in accordance with the particular motor circuit configuration (delta/star).
- If the rated motor data (p0304, p0305) that are available are not consistent with the motor circuit configuration, then an appropriate conversion must be made and then entered.
- If the equivalent circuit diagram data (p0350, p0354, p0356, p0358, p0360) is available, then this should be entered according to the motor circuit

6.2 Commissioning

configuration. If there is no consistency between the motor circuit configuration and the equivalent circuit diagram data, then the equivalent circuit diagram data should be converted and entered essentially the same as the data on the rating plate (p0304, p0305).

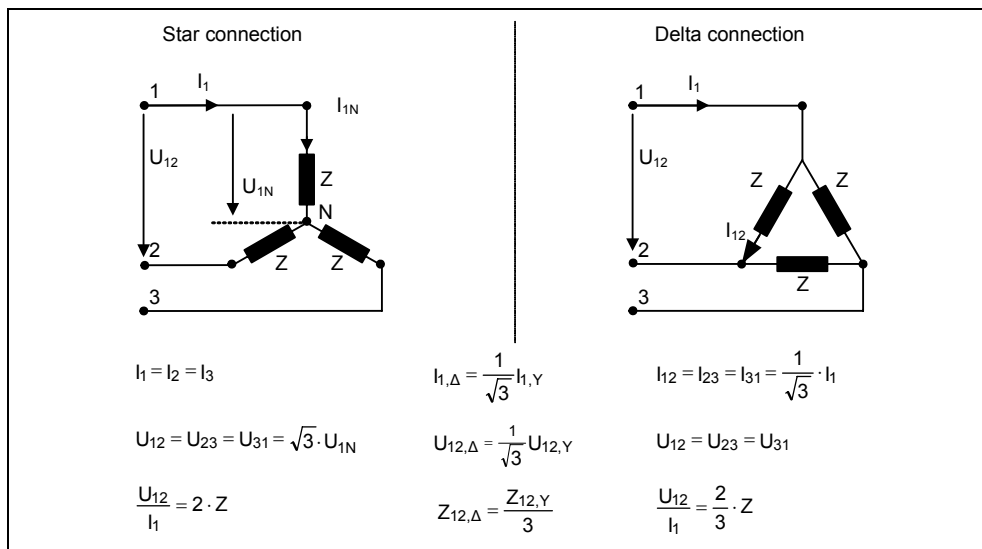


Fig. 6-14 Conversion, star / delta circuit configuration

Note

The correctness of the motor rating plate data can be checked using the following formula:

$$P_N = \sqrt{3} \cdot V_{NY} \cdot I_{NY} \cdot \cos \varphi \cdot \eta \approx \sqrt{3} \cdot V_{N\Delta} \cdot I_{N\Delta} \cdot \cos \varphi \cdot \eta$$

with	P_N	rated motor power	p0303
	$V_{NY}, V_{N\Delta}$	rated motor voltage (star / delta)	p0304
	$I_{NY}, I_{N\Delta}$	rated motor current (star / delta)	p0305
	$\cos \varphi$	power factor	p0308
	η	efficiency	p0309

6.2.2 Quick commissioning

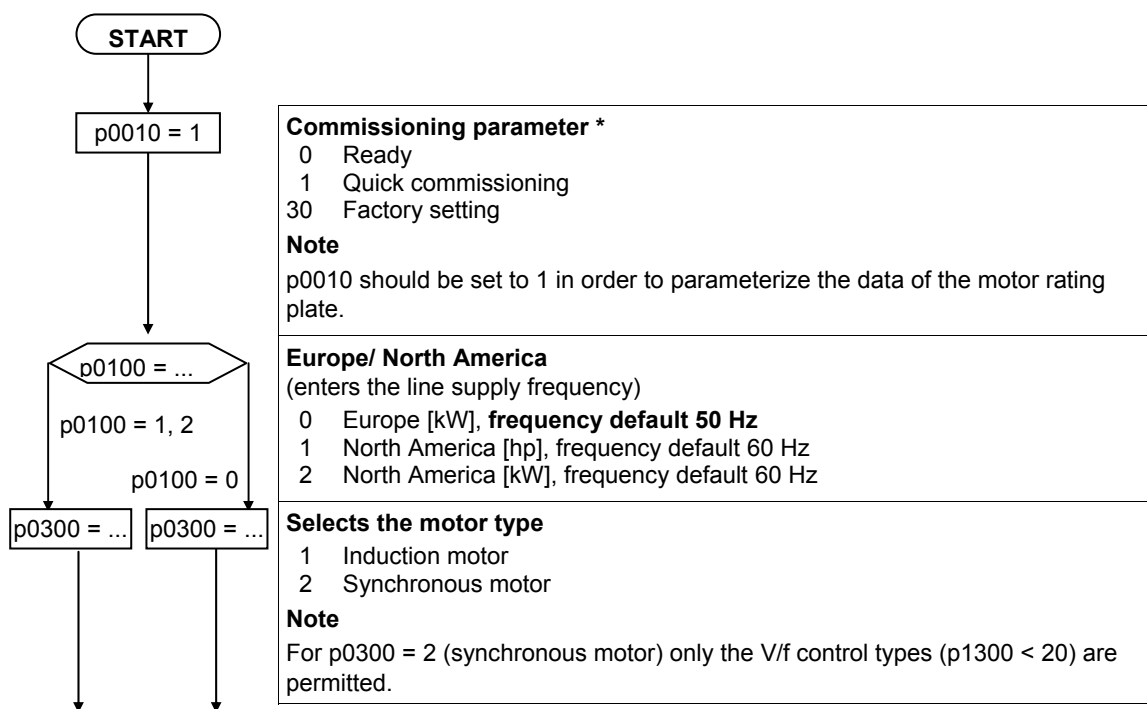
Description

If there is still no matching parameter set for the drive, then quick commissioning including a motor data identification routine must be carried-out - both for the closed-loop Vector control as well as for the V/f control.

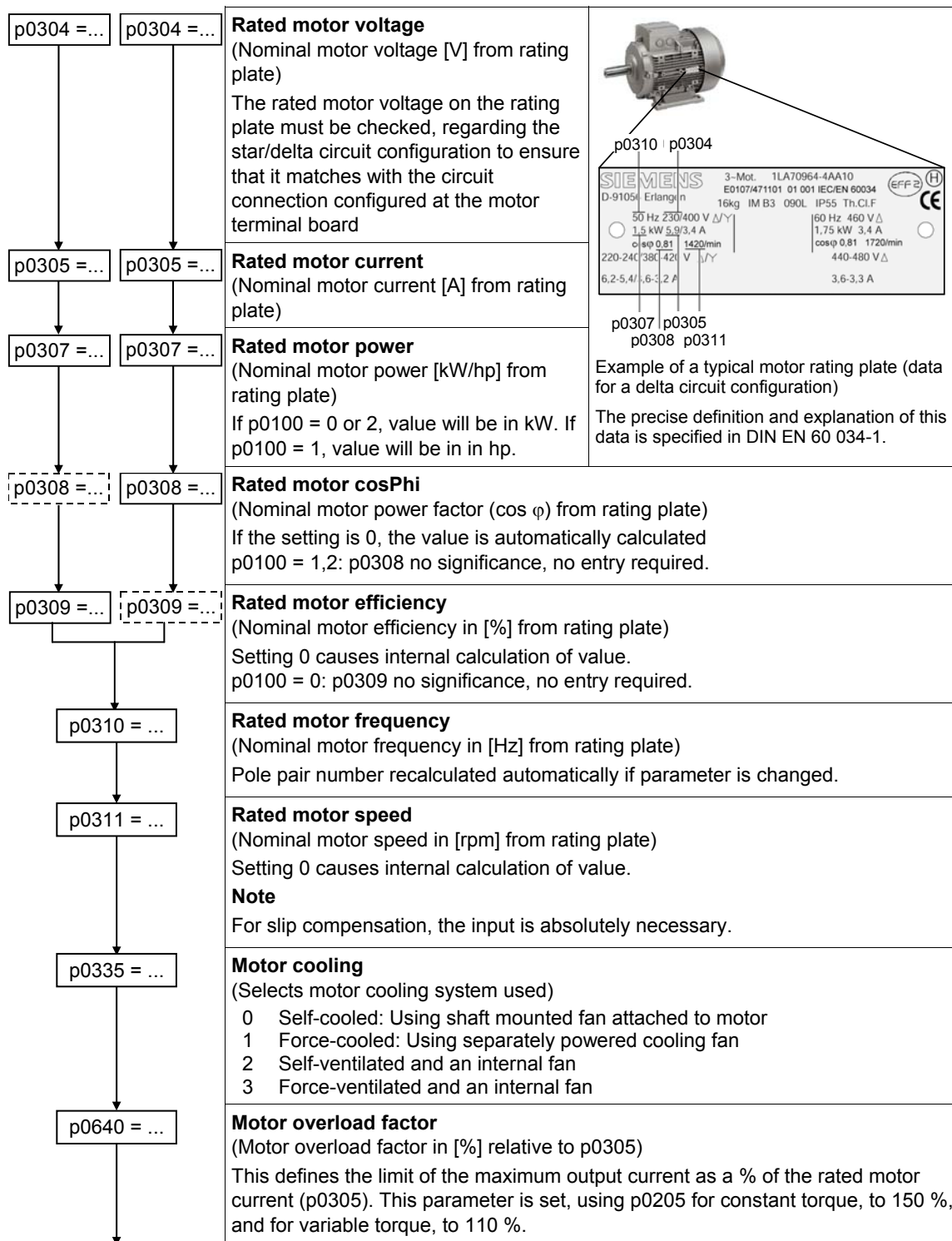
The quick commissioning is the basic commissioning for the motor - frequency converter combination. Before starting quick commissioning, the following must be available:

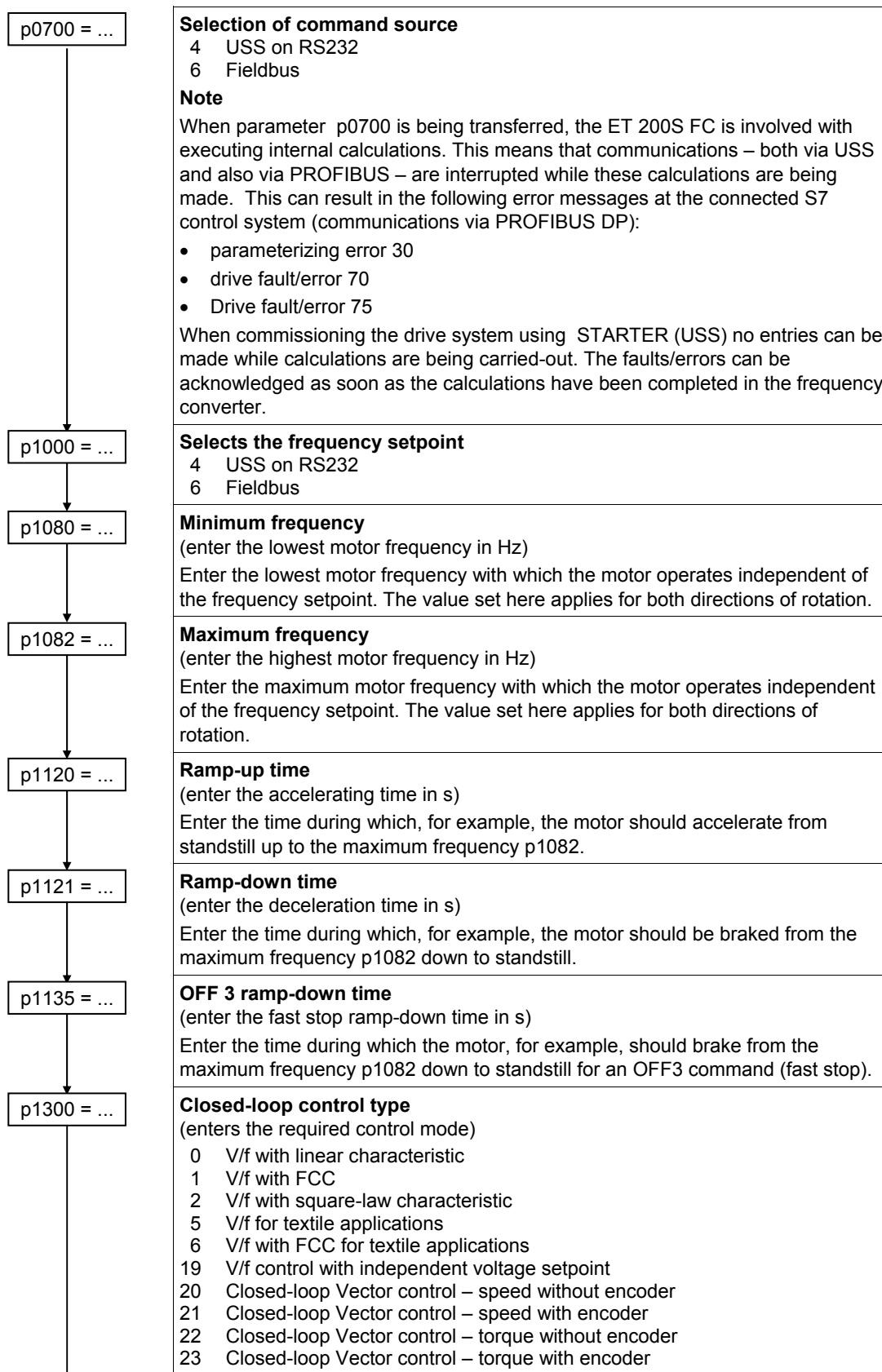
- Completely assembled ET 200S station with ET 200S FC frequency converter components
- PC with the "STARTER" commissioning tool - connected to the control module with null modem cable via the RS232 interface.
- The following data must be known:
 - mains frequency
 - rating plate data of the motor
 - general application-specific data (min. / max. frequency, ramp-up / ramp-down time, closed-loop control type)

"Quick commissioning" flow diagram



6.2 Commissioning





6.2 Commissioning

p1500 = ...

p3900 = 1



END

Selection of torque setpoint source

(enter the source for the torque setpoint)

this is only important for closed-loop Vector control p1300 = 22 or 23

- 4 USS on RS232
- 6 Fieldbus

End of quick commissioning

(start of the motor calculation)

- 0 no quick commissioning** (no motor calculation)
- 1 motor calculation and all of the other parameters, that are not included in the quick commissioning, are reset (attribute "quick commissioning" = no), to the factor setting.
- 2 motor calculation and the I/O settings are reset to the factory setting.
- 3 Only motor calculation. The remaining parameters are not reset.

Note

For p3900 = 1,2,3 → internally, p0340 is set to 1 and the appropriate data is calculated (refer to Section 6.2.3).

Note

When parameter p3900 is being transferred, the ET 200S FC is involved with executing internal calculations. This means that communications – both via USS and also via PROFIBUS – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

- parameterizing error 30
- drive fault/error 70
- Drive fault/error 75

When commissioning the drive system using STARTER (USS) no entries can be made while calculations are being carried-out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter.

If the frequency converter is parameterized using the STARTER commissioning tool, then the data is not automatically saved in the EEPROM. Data is only transferred from the RAM into the ROM after this button has been pressed in the STARTER screen form. If "MMC required" is configured, then the parameter set must also be written to the MMC-PS via p0802.

End of the quick commissioning/drive setting

If a frequency converter is to have additional functions, then use the "**Application commissioning**" instructions (Section 6.2.5). It is recommended for drives with a high dynamic response (with closed-loop vector control).

Note

The precise equivalent circuit diagram data is extremely important for the stability of the closed-loop Vector control and for the voltage boost of the V/f characteristic. The data of the equivalent circuit diagram can only be roughly/inaccurately estimated from the rating plate data. This means that the equivalent circuit diagram data must be determined by one of the following processes:

- using the motor data identification (refer to Section 6.2.4)
- must be entered from an existing motor data sheet (refer to Section 6.2.3).

6.2.3 Calculating the motor / closed-loop control data

Description

Parameter p0340 or also indirectly parameter p3900 (refer to Section 6.2.2) or p1910 (refer to Section 6.2.4) are used to initiate the calculation of the internal motor / closed-loop control data. For instance, the functionality of parameter p0340 can be used if the equivalent circuit diagram data or the moment of inertia is known. The following settings are possible for p0340. Possible settings for parameter p0340 are described in Table 6-11. Which parameters are calculated for the different settings are shown in Table 6-12.

Table 6-11 Parameter p0340

Parameter	Description
p0340 = 0	No calculation
p0340 = 1	Starting from the rating plate parameters (p0300 - p0335), the motor equivalent circuit diagram parameters (ECD, p0350 - p0369) and the motor weight /moment of inertia (p0344, p0341) are determined. The V/f control/vector control parameters and reference quantities are then pre-assigned (this includes all of the calculations of p0340 = 2,3,4).
p0340 = 2	Starting from the rating plate parameters, the motor equivalent circuit diagram parameters (ECD, p0350 - p0369) are calculated (without any additional pre-assignments being made).
p0340 = 3	Starting from the motor equivalent circuit diagram parameters (ECD, p0350 - p0369) and motor weight/moment of inertia, moment of inertia ratio (p0344, p0341, p0342), the V/f control/vector control parameters are determined (includes all of the calculations of p0340 = 4).
p0340 = 4	Starting from the motor equivalent circuit diagram parameters (ECD, p0350 - p0369) and motor weight/moment of inertia, moment of inertia ratio (p0344, p0341, p0342), the vector control parameters are pre-assigned.

Note

When parameter p0340 is being transferred, the ET 200S FC is involved with executing internal calculations. This means that communications – both via USS and also via PROFIBUS – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

Parameterizing error 30

Drive fault/error 70

Drive fault/error 75

When commissioning the drive system using STARTER (USS) no entries can be made while calculations are being carried-out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter. These calculations can take up to 1 minute.

6.2 Commissioning

Table 6-12 Parameters – whose calculation is controlled using p0340

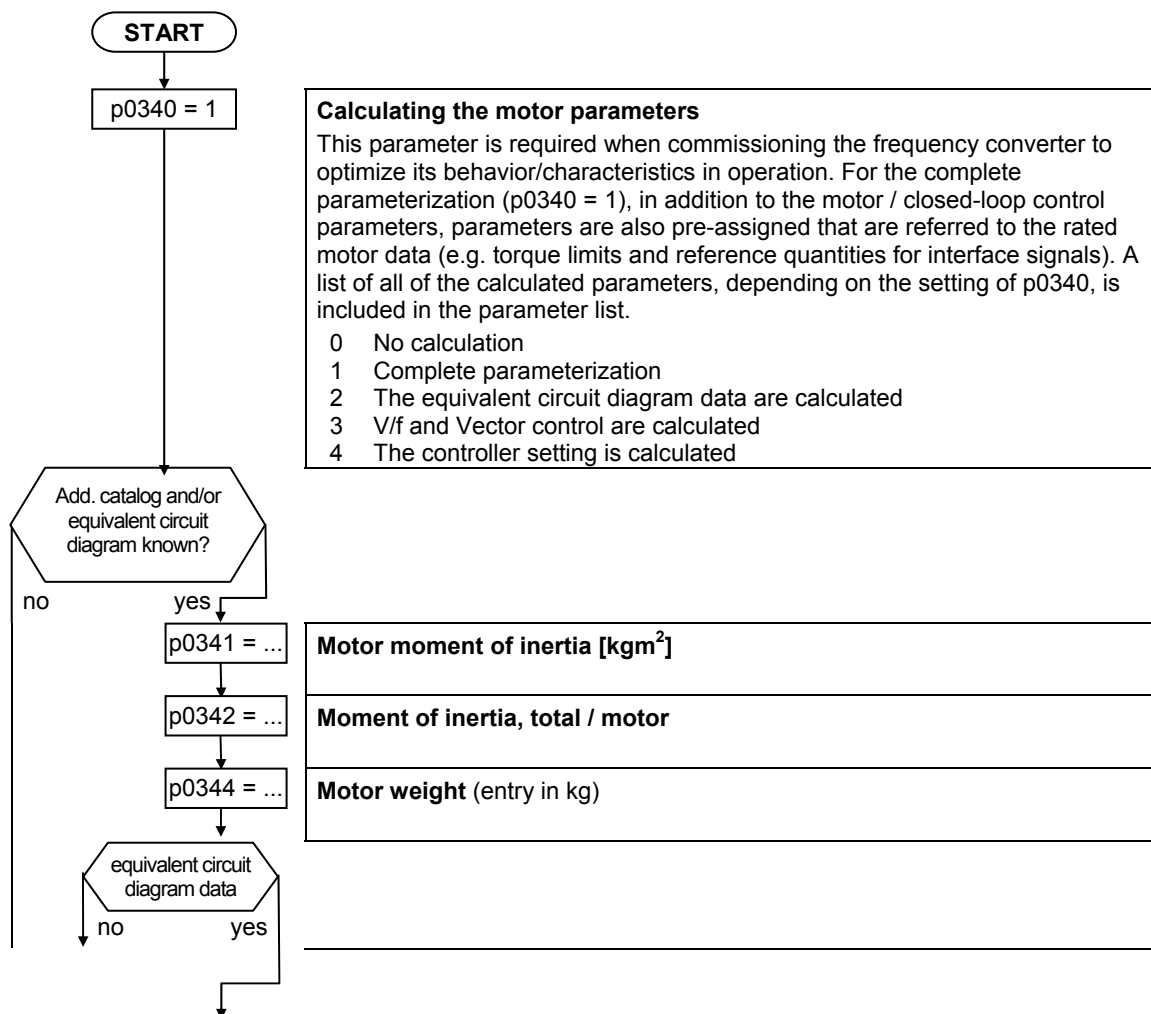
	p0340 = 1	p0340 = 2	p0340 = 3	p0340 = 4
p0341[3] Motor inertia [kg*m^2]	x			
p0342[3] Total/motor inertia ratio	x			
p0344[3] Motor weight	x			
p0346[3] Magnetization time	x		x	
p0347[3] Demagnetization time	x		x	
p0350[3] Stator resistance (line-to-line)	x	x		
p0352[3] Cable resistance	x	x		
p0354[3] Rotor resistance	x	x		
p0356[3] Stator leakage inductance	x	x		
p0358[3] Rotor leakage inductance	x	x		
p0360[3] Main inductance	x	x		
p0362[3] Magnetizing curve flux 1	x	x		
p0363[3] Magnetizing curve flux 2	x	x		
p0364[3] Magnetizing curve flux 3	x	x		
p0365[3] Magnetizing curve flux 4	x	x		
p0366[3] Magnetizing curve imag 1	x	x		
p0367[3] Magnetizing curve imag 2	x	x		
p0368[3] Magnetizing curve imag 3	x	x		
p0369[3] Magnetizing curve imag 4	x	x		
p0625[3] Ambient motor temperature	x	x		
p1253[3] Vdc-controller output limitation	x		x	
p1316[3] Boost end frequency	x		x	
p1460[3] Gain speed controller	x		x	x
p1462[3] Integral time speed controller	x		x	x
p1470[3] Gain speed controller (SLVC)	x		x	x
p1472[3] Integral time n-ctrl. (SLVC)	x		x	x
p1520[3] CO: Upper torque limit	x			
p1521[3] CO: Lower torque limit	x			
p1530[3] Motoring power limitation	x			
p1531[3] Regenerative power limitation	x			
p1715[3] Gain current controller	x		x	x
p1717[3] Integral time current controller	x		x	x
p1764[3] Kp of n-adaption (SLVC)	x		x	x
p1767[3] Tn of n-adaption (SLVC)	x		x	x
p2000[3] Reference frequency	x			
p2002[3] Reference current	x			
p2003[3] Reference torque	x			
p2174[3] Torque threshold M_thresh	x			
p2185[3] Upper torque threshold 1	x			
p2186[3] Lower torque threshold 1	x			
p2187[3] Upper torque threshold 2	x			
p2188[3] Lower torque threshold 2	x			
p2189[3] Upper torque threshold 3	x			
p2190[3] Lower torque threshold 3	x			

There are different scenarios (refer to the following flowchart) when calculating the motor / closed-loop control data using p0340. These scenarios can be called-up as a function of the data known.

Note

- When exiting the quick commissioning with p3900 > 0 (refer to Section 6.2.2), then internally, p0340 is set to 1 (complete parameterization).
- For the motor data identification (refer to Section 6.2.4), after the measurement has been completed, internally p0340 is set to 3.
- Equivalent circuit diagram data always refers to the star configuration equivalent circuit diagram. If data is available for the delta configuration equivalent circuit diagram (ECD) – then these must first be converted before being entered into the star equivalent circuit diagram.
- If ECD diagram data (p0350, . . . , p0360) is available, then it must be entered according to the motor circuit configuration (a star circuit configuration requires star ECD data). If there is no consistency between the motor circuit configuration and the ECD data, then the ECD data should be converted according to the actual motor circuit configuration (p0350_Δ = p0350_Y, etc.).

Flow diagram "Calculating motor / closed-loop control data"

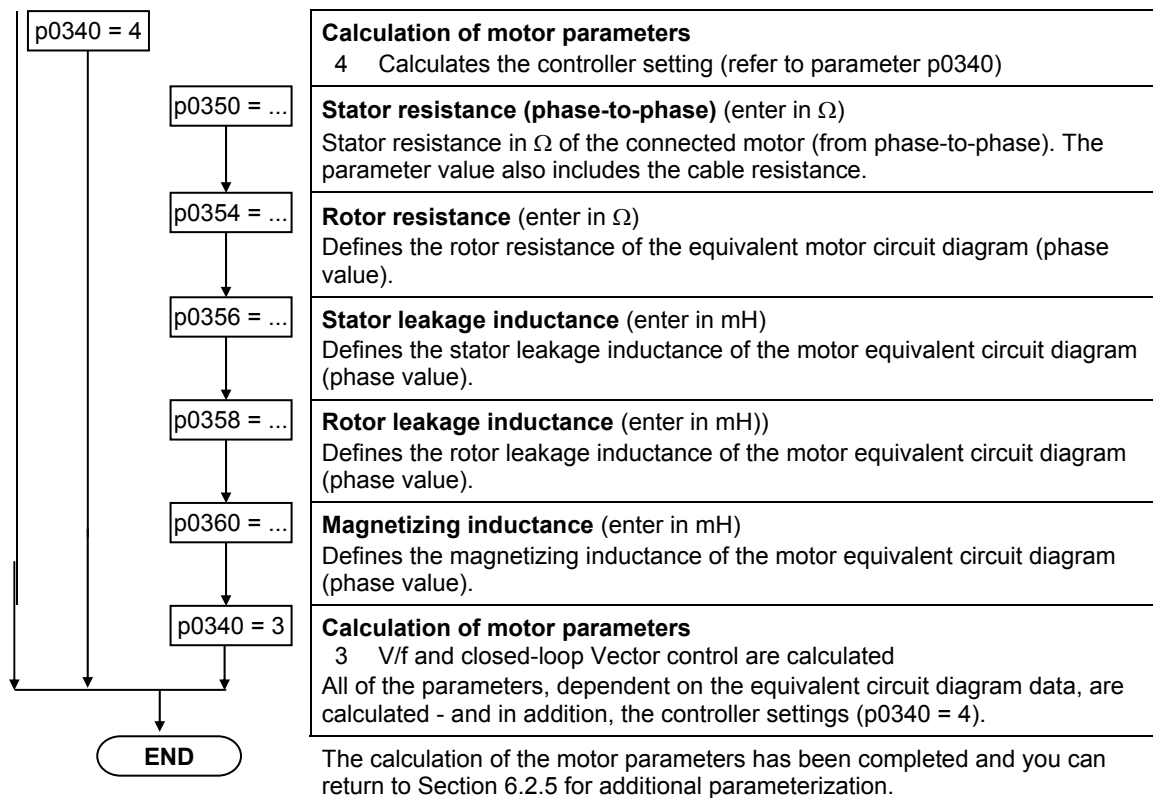


Calculating the motor parameters
 This parameter is required when commissioning the frequency converter to optimize its behavior/characteristics in operation. For the complete parameterization (p0340 = 1), in addition to the motor / closed-loop control parameters, parameters are also pre-assigned that are referred to the rated motor data (e.g. torque limits and reference quantities for interface signals). A list of all of the calculated parameters, depending on the setting of p0340, is included in the parameter list.

0	No calculation
1	Complete parameterization
2	The equivalent circuit diagram data are calculated
3	V/f and Vector control are calculated
4	The controller setting is calculated

p0341 = ...	Motor moment of inertia [kgm²]
p0342 = ...	Moment of inertia, total / motor
p0344 = ...	Motor weight (entry in kg)

6.2 Commissioning



6.2.4 Motor data identification

Description

The frequency converter has a measuring technique to determine the motor parameters:

- Equivalent circuit diagram data (refer to Fig. 6-15) → p1910 = 1
- Magnetizing characteristic (refer to Fig. 6-16) → p1910 = 3

For closed-loop control related reasons, we strongly recommend that the motor identification routine is carried-out. The reason for this is that starting from the rating plate data, the equivalent circuit diagram data, the motor cable resistance, the IGBT on-state voltage and the compensation of the IGBT gating unit deadtimes can only be roughly estimated. For instance, the stator resistance - that can be precisely determined from the motor data identification run, is extremely important for the stability of the closed-loop Vector control and for the voltage boost associated with the V/f characteristic. The motor data identification routine must be especially carried-out for long feeder cables or when third-party motors are being used.

If the motor data identification routine is started for the first time, then starting from the rating plate data (rated data), the following data are determined with p1910 = 1:

- Equivalent circuit diagram data
- Motor cable resistance
- IGBT on-state voltage and compensation of the IGBT gating unit deadtimes

The rating plate data represent the initialization values for the identification routine. This is the reason that the correct and consistent entry of the rating plate data is required in order to determine the data specified above (refer to Section 6.2.2).

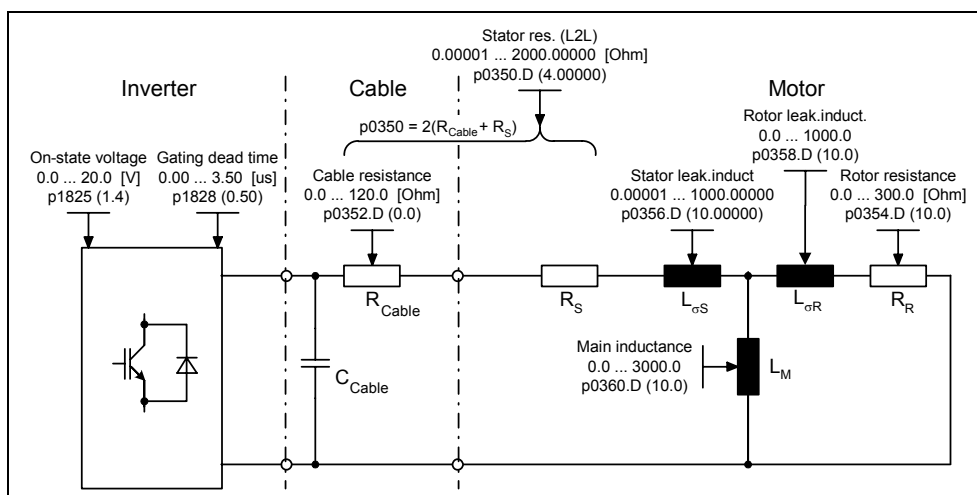


Fig. 6-15 Equivalent circuit diagram

In addition to the equivalent circuit diagram data, the motor magnetizing characteristic can be determined using the motor data identification routine (p1910 = 3) (refer to Fig. 6-16). If the motor - frequency converter combination is operated in the field-weakening range, then this characteristic should be especially defined for closed-loop Vector control. Using this magnetizing characteristic, in the field-weakening range, the frequency converter can more precisely calculate the field-generating current - therefore achieving a higher torque accuracy.

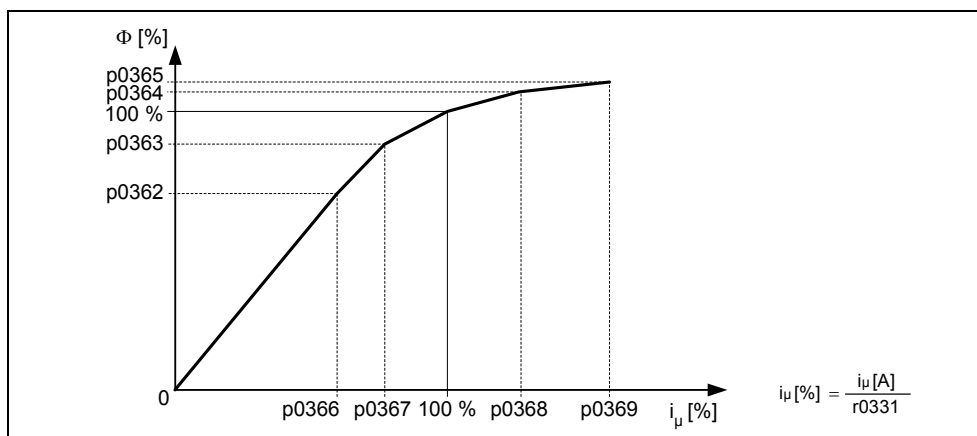


Fig. 6-16 Magnetizing characteristic

6.2 Commissioning

After the motor data identification routine has been selected using parameter p1910, Alarm A0541 is immediately generated. As a result of the continuous (static) ON command, the motor data identification routine is started and the motor is subject to various excitation signals (DC and AC voltages). The measurement is carried-out with the motor stationary and takes between 20 s and 4 min for each selection and this includes the data calculation time (p1910 = 1, 3).

The motor data identification routine should be carried-out with the motor in the cold condition. This then allows the motor resistances, that have been saved, to be assigned to the parameter of the ambient temperature p0625. Only then can the various resistance values be correctly adapted according to the temperature in operation.

The motor data identification routine operates with the results of the "complete parameterization" p0340 = 1 or p3900 = 1,2,3 or with the motor equivalent circuit diagram data that was last saved. This is the reason that the results continually improve when the identification routine is carried-out several times (up to 3 times).



Warning

The motor data identification routine may not be carried-out for potentially hazardous loads (e.g. suspended loads for crane applications). Before the motor data identification routine is started, the potentially hazardous load must be secured (e.g. by lowering the load to the floor or by clamping the load using the motor holding brake).

When the motor data identification routine is started, the rotor may move into a preferred position. This is especially obvious for higher-rating motors.

Note

Safety functions should not be initiated while carrying-out the MotID (p1910) (measurement and calculation).

If a safety function was to be initiated, this would interrupt the MotID routine and p1910 would remain set at the selected value.

Note

- The equivalent circuit diagram data (p0350, p0354, p0356, p0358, p0360) are, with the exception of parameter p0350, entered as phase values. In this case, parameter p0350 (phase-to-phase value) corresponds to twice the phase value.
- The equivalent circuit diagram data always refer to the star equivalent circuit diagram data. If data is available for the delta equivalent circuit diagram (ECD) then before these are entered it must be converted into the star equivalent circuit diagram data.
- The motor cable resistance p0352 is defined as phase value.
- With the motor data identification routine, the stator resistance and the motor cable resistance are determined and entered into parameter p0350. If a correction is not made in parameter p0352, then the motor cable resistance is defined by the relationship $p0352 = 0.2 * p0350$.
- If the motor cable resistance is known, then the value can be entered into parameter p0352 after the motor data identification routine. As a result of the entry, the stator resistance is appropriately reduced and is therefore more precisely adapted to motor operation and the ambient conditions.
- It is not necessary to lock the motor rotor when carrying-out the motor data identification routine. However, if it is possible to lock the motor rotor during the identification routine (e.g. by closing the motor holding brake), then this should be used when determining the equivalent circuit diagram data.
- The correctness of the motor rating plate data can be checked using the following formula:

$$P_N = \sqrt{3} * V_{N_Y} * I_{N_Y} * \cos\varphi * \eta \approx \sqrt{3} * V_{N_\Delta} * I_{N_\Delta} * \cos\varphi * \eta$$

with	P_N	rated motor power	p0303
	V_{N_Y}, V_{N_Δ}	rated motor voltage (star / delta)	p0304
	I_{N_Y}, I_{N_Δ}	rated motor current (star / delta)	p0305
	$\cos\varphi$	power factor	p0308
	η	efficiency	p0309

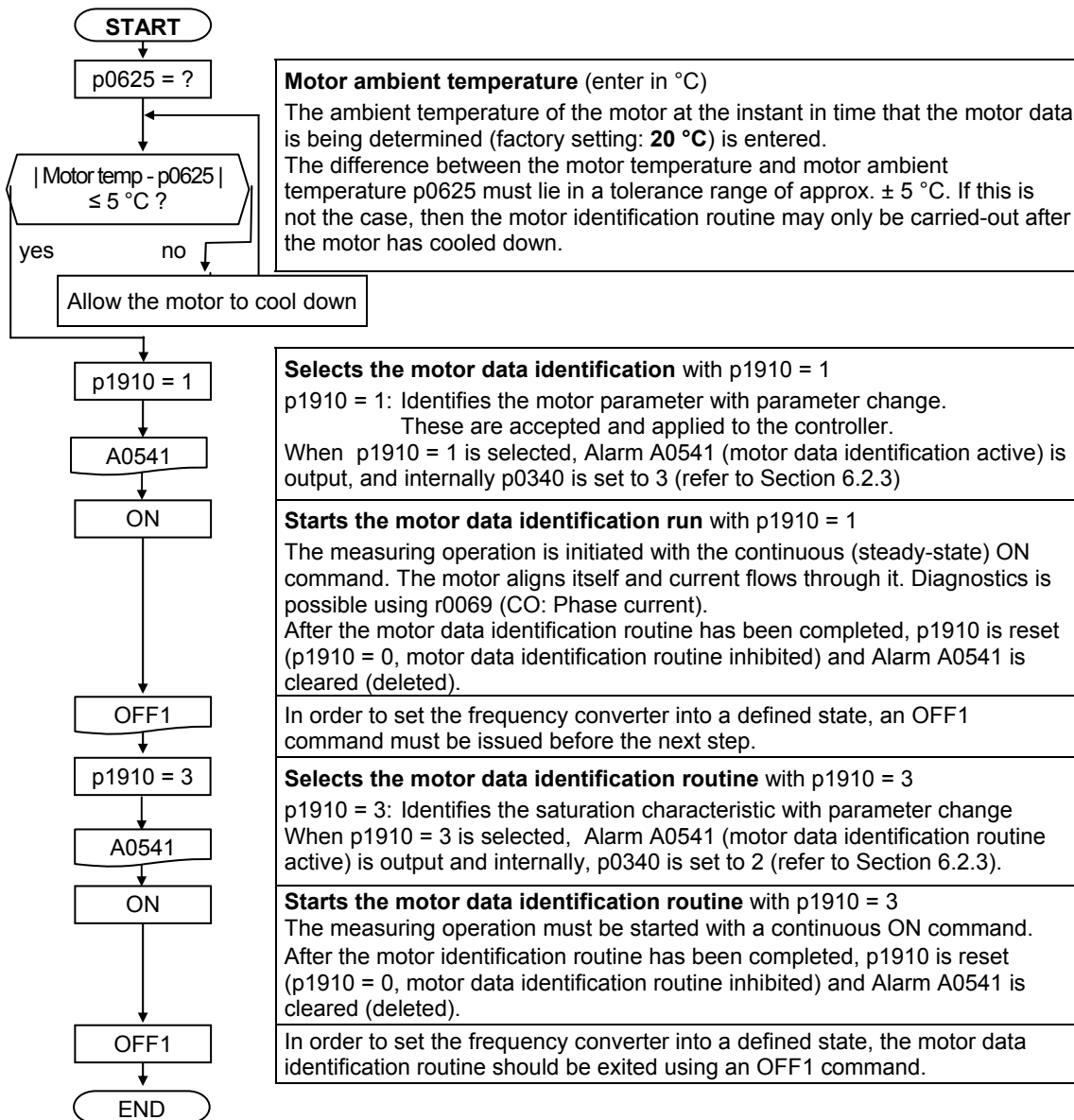
Note

When parameter p1910 is being transferred, the ET 200S FC is involved with executing internal calculations. This means that communications – both via USS and also via PROFIBUS – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

- Parameterizing error 30
- Drive fault/error 70
- Drive fault/error 75

When commissioning the drive system using STARTER (USS) no entries can be made while calculations are being carried-out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter.

6.2 Commissioning

"Motor data identification" flow diagram

If problems occur during the identification routine, e.g. if the current controller oscillates (the frequency converter noise fluctuates), the rating plate data must be again checked and an approximately correct magnetizing current p0320 entered. The motor data identification routine should then be re-started after calling p0340 = 1 (refer to Section 6.2.3) (also refer to <http://support.automation.siemens.com/WW/view/de/20279537>).

Note

Safety functions should not be initiated while carrying-out the MotID (p1910) (measurement and calculation).

If a safety function was to be initiated, this would interrupt the MotID routine and p1910 would remain set at the selected value.

6.2.5 Application commissioning

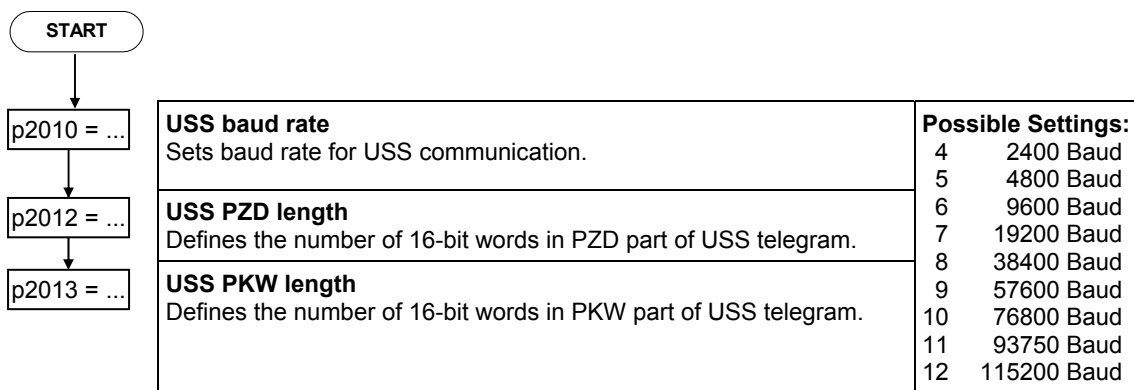
Description

After the motor/frequency converter combination has been commissioned using the quick commissioning or series commissioning procedure, parameters should be adapted as follows, in order to bring the settings into line with the technological requirements. In this case, the following points should be taken into consideration as example:

- Limit values
- Dynamic requirements
- Starting torques
- Load surge requirements
- Overload capability
- Overload
- Diagnostics

If the application includes a functionality that is not covered by the quick commissioning or series commissioning procedure, you should refer to the following function description sections, or to the parameter list.

6.2.5.1 Serial Interface (USS)



6.2 Commissioning

6.2.5.2 Selection of command source

p0700 = ...

Selection of command source

Selects digital command source.

- 0 Factory default setting
- 4 USS on RS232
- 6 Fieldbus

Note

While parameter p0700 is being transferred, the ET 200S FC executes internal calculations. This means that communications – via both USS and PROFIBUS DP – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

- Parameterizing error 30
- Drive fault/error 70
- Drive fault/error 75

When commissioning the drive system using STARTER (USS), no entries can be made while calculations are being carried out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter.

6.2.5.3 Selection of frequency setpoint

p1000 = ...

Selection of frequency setpoint

- 4 USS on RS232
- 6 Fieldbus

6.2.5.4 JOG

p1058 = ...

p1059 = ...

p1060 = ...

p1061 = ...

JOG frequency right

Frequency in Hz when the motor is rotating clockwise in JOG mode.

JOG frequency left

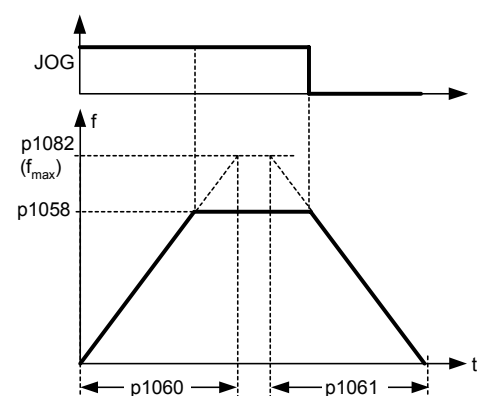
Frequency in Hz when the motor is rotating counter-clockwise in JOG mode.

JOG ramp-up time

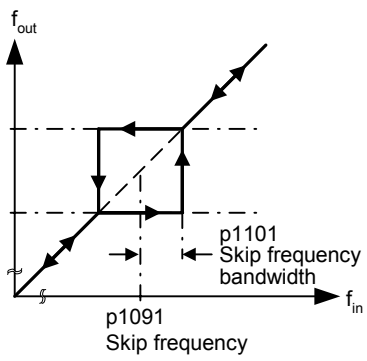
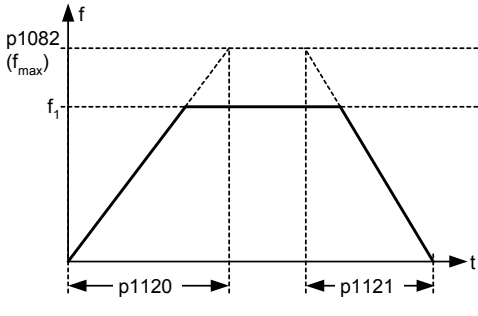
Ramp-up time in s from 0 to the maximum frequency (p1082). JOG ramp-up is limited by p1058 or p1059.

JOG ramp-down time

Ramp-down time in s from the maximum frequency (p1082) to 0.



6.2.5.5 Ramp-function generator (RFG)

<p>p1091 = ...</p> <p>↓</p> <p>p1092 = ...</p> <p>↓</p> <p>p1093 = ...</p> <p>↓</p> <p>p1094 = ...</p> <p>↓</p> <p>p1101 = ...</p> <p>↓</p> <p>p1120 = ...</p> <p>↓</p> <p>p1121 = ...</p> <p>↓</p> <p>p1130 = ...</p> <p>↓</p> <p>p1131 = ...</p> <p>↓</p> <p>p1132 = ...</p> <p>↓</p> <p>p1133 = ...</p> <p>↓</p> <p>p1134 = ...</p> <p>↓</p> <p>p1135 = ...</p>	<p>Skip frequency 1 (entered in Hz) Avoids effects of mechanical resonance and suppresses frequencies within the skip frequency range +/- p1101 (skip frequency bandwidth).</p> <p>Skip frequency 2</p> <p>Skip frequency 3</p> <p>Skip frequency 4</p> <p>Skip frequency bandwidth (entered in Hz)</p> <p>Ramp-up time (enters the accelerating time in s)</p> <p>Ramp-down time (enters the deceleration time in s)</p> <p>Ramp-up initial rounding time (entered in s)</p> <p>Ramp-up final rounding time (entered in s)</p> <p>Ramp-down initial rounding time (entered in s)</p> <p>Ramp-down final rounding time (entered in s)</p> <p>Rounding type 0 Continuous smoothing (without undue torque pulsations) 1 Discontinuous smoothing</p> <p>OFF3 ramp-down time Defines ramp-down time from maximum frequency to standstill for OFF3 command.</p>	 <p>The graph shows a linear relationship between input frequency f_{in} and output frequency f_{out}. A dashed line represents the ideal linear response. A solid line shows the actual response, which has a flat region (a notch) at the skip frequency $p1091$. The width of this notch is the skip frequency bandwidth $p1101$. Arrows indicate the notch is centered on $p1091$ with a width of $p1101$.</p>
		 <p>The graph shows frequency f on the y-axis and time t on the x-axis. It illustrates a trapezoidal frequency profile. The ramp-up time is $p1120$ and the ramp-down time is $p1121$. The maximum frequency is $p1082 (f_{max})$ and the frequency during the constant speed region is f_1.</p>
		<p>The rounding times are recommended as abrupt responses can be avoided, thereby reducing stress and damage to the mechanical system.</p> <p>The ramp-up and ramp-down times are extended by the temporal component of the rounding ramps.</p>

6.2 Commissioning

6.2.5.6 Reference/limit frequencies

p1080 = ... ↓	<p>Min. frequency (entered in Hz) Sets minimum motor frequency [Hz] at which motor will run, irrespective of the frequency setpoint. If the setpoint falls below the value of p1080, then the output frequency is set to p1080, taking the sign into account.</p>
p1082 = ... ↓	<p>Max. frequency (entered in Hz) Sets maximum motor frequency [Hz] at which motor will run. If the setpoint exceeds the value of p1082, then the output frequency is limited. The value set here applies to both clockwise and anticlockwise rotation.</p>
p2000 = ...	<p>Reference frequency (entered in Hz) The reference frequency in Hertz corresponds to a value of 100%. This is automatically changed to 60 Hz if the standard 60 Hz frequency has been selected using p0100.</p> <p>Note This reference frequency affects the setpoint frequency, since both the frequency setpoints via USS and via PROFIBUS (FB100) refer to this value (4000H hex $\hat{=}$ 100% $\hat{=}$ p2000).</p>

6.2.5.7 Motor control (V/f)

p1300 = ...

p1310 = ...

Control mode
 The control type is selected using this parameter. For the "V/f characteristic" control type, the ratio between the frequency converter output voltage and the frequency converter output frequency is defined.

- 0 V/f with linear characteristic
- 1 V/f with FCC
- 2 V/f with square characteristic
- 3 V/f with programmable characteristic (→ p1320 – p1325)
- 5 V/f for textile applications
- 6 V/f with FCC for textile applications
- 19 V/f control with independent voltage setpoint
- 20 Vector control – speed without encoder
- 21 Vector control – speed with encoder
- 22 Vector control – torque without encoder
- 23 Vector control – torque with encoder

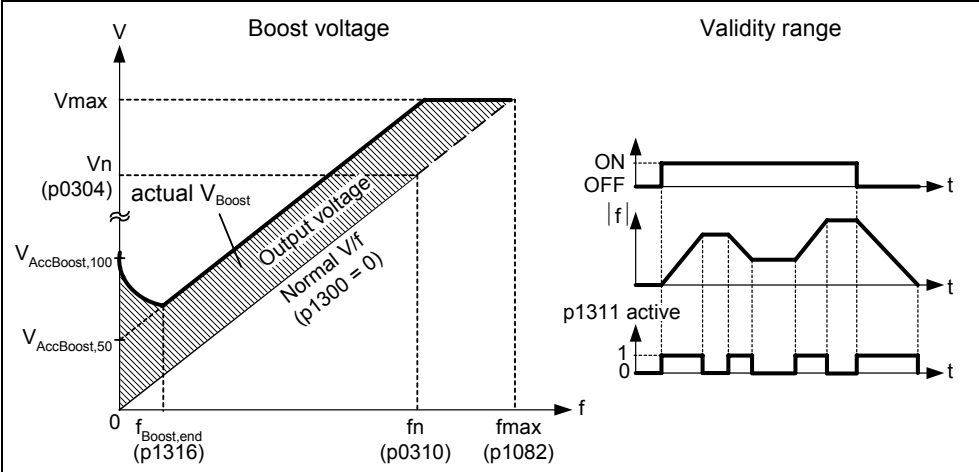
Continuous boost (entered in %)
 Voltage boost as a % relative to p0305 (rated motor current) and p0350 (stator resistance). p1310 is valid for all V/f versions (refer to p1300). At low output frequencies, the ohmic effective resistance values of the winding can no longer be neglected in order to maintain the motor flux.

Validity range

6.2 Commissioning

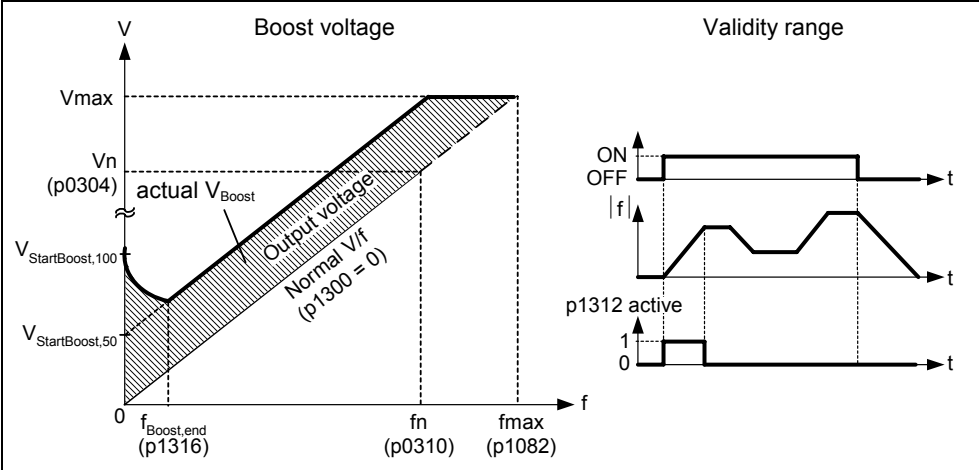
p1311 = ...

Acceleration boost (entered in %)
 Voltage boost for accelerating/braking as a % relative to p0305 and p0350. p1311 only results in a voltage boost during ramp-up/ramp-down and generates an additional torque for accelerating/braking. Contrary to parameter p1312, which is only active for the 1st acceleration operation after the ON command, p1311 is effective each time that the drive accelerates or brakes.



p1312 = ...

Starting boost (entered in %)
 Starting voltage boost (after an ON command) when using the linear or square V/f characteristic as a % relative to p0305 (rated motor current) or p0350 (stator resistance). The voltage boost remains active until
 1) the setpoint is reached for the first time and
 2) the setpoint is reduced to a value that is less than the instantaneous ramp-function generator output.



p1320 = ...	Programmable V/f freq. coord. 1 Sets V/f coordinates (p1320/1321 to p1324/1325), in order to define the V/f characteristic.	<p style="text-align: center;">$V_{max} = f(V_{dc}, M_{max})$</p> <p style="text-align: center;">$p1310[V] = \frac{p1310[\%]}{100[\%]} \cdot \frac{r0395[\%]}{100[\%]} \cdot p0304[V]$</p>
p1321 = ...	Programmable V/f volt. coord. 1	
p1322 = ...	Programmable V/f freq. coord. 2	
p1323 = ...	Programmable V/f volt. coord. 2	
p1324 = ...	Programmable V/f freq. coord. 3	
p1325 = ...	Programmable V/f volt. coord. 3	
p1335 = ...	Slip compensation (entered in %) Dynamically adjusts output frequency of converter so that motor speed is kept constant, regardless of the motor load.	
p1338 = ...	Resonance damping gain V/f Defines resonance damping gain for operation with V/f characteristic.	

6.2 Commissioning

6.2.5.8 Converter/motor protection

p0290 = ...	<p>Converter overload reaction Selects reaction of converter to an internal overtemperature.</p> <ul style="list-style-type: none"> 0 Reduce output frequency 1 Trip (F0004) 2 Reduce pulse frequency and output frequency 3 Reduce pulse frequency then trip (F0004)
↓	
p0292 = ...	<p>Converter temperature warning Defines the temperature difference (in °C) between the overtemperature trip threshold and the warning threshold of the converter. The trip threshold is stored internally by the converter and cannot be changed by the user.</p>
↓	
p0335 = ...	<p>Motor cooling (enters the motor cooling system)</p> <ul style="list-style-type: none"> 0 Self-cooled using shaft mounted fan attached to motor 1 Force-cooled using separately powered cooling fan 2 Self-ventilated and internal fan 3 Force-ventilated and internal fan
↓	
p0610 = ...	<p>I²t reaction with motor overtemp. Defines reaction when motor temperature reaches warning threshold.</p> <ul style="list-style-type: none"> 0 No reaction, warning only 1 Warning and I_{max} reduction (results in decreased output frequency) 2 Warning and trip (F0011)
↓	
p0640 = ...	<p>Motor overload factor [%] Defines motor overload current limit in [%] relative to p0305 (rated motor current). Limited to maximum converter current or to 400% of rated motor current (p0305), whichever is lower.</p> $p0640_{\max} = \frac{\min(r0209, 4 \cdot p0305)}{p0305} \cdot 100$

6.2.5.9 Speed controller

Limitations

<p>p0640 = ...</p>	<p>Motor overload factor [%] Defines motor overload current limit in [%] relative to p0305 (rated motor current). Limited to maximum converter current or to 400% of rated motor current (p0305), whichever is lower.</p>	
<p>p1520 = ...</p>	<p>CO: Upper torque limit Specifies fixed value for upper torque limitation.</p> <p>$p1520_{max} = \pm 4 \cdot r0333$</p>	
<p>p1521 = ...</p>	<p>CO: Lower torque limit Enters fixed value of lower torque limitation.</p> <p>$P1521_{max} = \pm 4 \cdot r0333$</p>	
<p>p1530 = ...</p>	<p>Motoring power limitation Defines fixed value for the max. permissible motoring active power.</p> <p>$P1530_{max} = 3 \cdot P0307$</p>	
<p>p1531 = ...</p>	<p>Regenerative power limitation Enters fixed value for the max. permissible regenerative active power</p> <p>$P1531_{max} = -3 \cdot P0307$</p>	

6.2 Commissioning

Sensorless vector control (SLVC)

p1300=20	<p>Control mode</p> <p>20 Vector control – speed without encoder</p> <p>SLVC can provide excellent performance for the following types of application:</p> <ul style="list-style-type: none"> • Applications which require high torque performance • Applications which require fast respond to shock loading • Applications which require torque holding while passing through 0 Hz • Applications which require very accurate speed holding • Applications which require motor pull out protection
p1452 = ...	<p>Filter time for act. freq (SLVC)</p> <p>Sets time constant of PT1 filter to filter the frequency deviation of the speed controller in operation mode SLVC (sensorless vector control).</p> <p>Decreasing the value results in more dynamic speed regulation, but if the value is too low (or too high), there is a risk of instability. p1452 = 2 can be set for most applications.</p>
p1470 = ...	<p>Speed controller gain (SLVC)</p> <p>Enters gain of speed controller for sensorless vector control (SLVC).</p>
p1472 = ...	<p>Speed ctrl integration time (SLVC)</p> <p>Enters integration time constant of speed controller for sensorless vector control (SLVC).</p>
p1610 = ...	<p>Continuous torque boost (SLVC)</p> <p>Sets continuous torque boost in lower frequency range of SLVC (sensorless vector control). Value is entered in [%] relative to rated motor torque r0333.</p> <p>p1610 is only effective in the open-loop mode between 0 Hz and approx. \pmp1755.</p>
p1611 = ...	<p>Acc. torque boost (SLVC)</p> <p>Sets acceleration torque boost in lower frequency range of SLVC (sensorless vector control). Value is entered in [%] relative to rated motor torque r0333.</p> <p>p1611 is only effective in the open-loop mode between 0 Hz and approx. \pmp1755.</p> <p>In contrast to p1610, the acceleration torque boost p1611 is only activated in the event of a change in the setpoint, and is deactivated again when the setpoint is reached.</p>

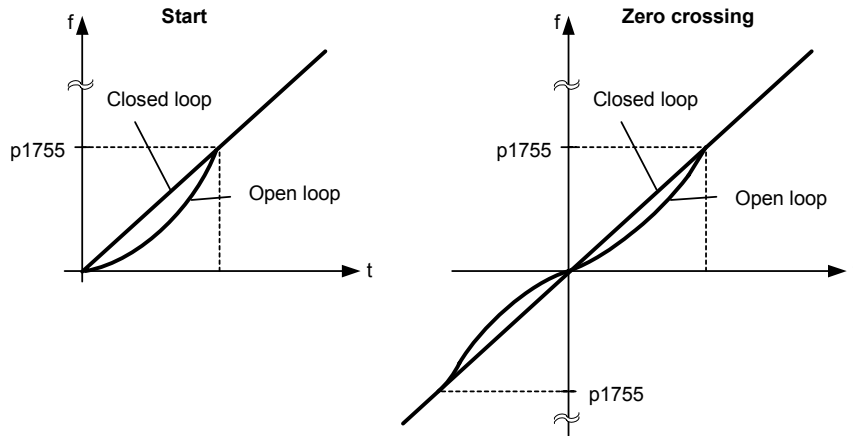
p1750 = ...

Control word of motor model

This parameter defines the behavior at 0 Hz:

Bit00 Start SLVC open loop 0 NO 1 YES
 (Operation directly after an ON command)

Bit01 Zero crossing SLVC open loop 0 NO 1 YES
 (zero crossing)

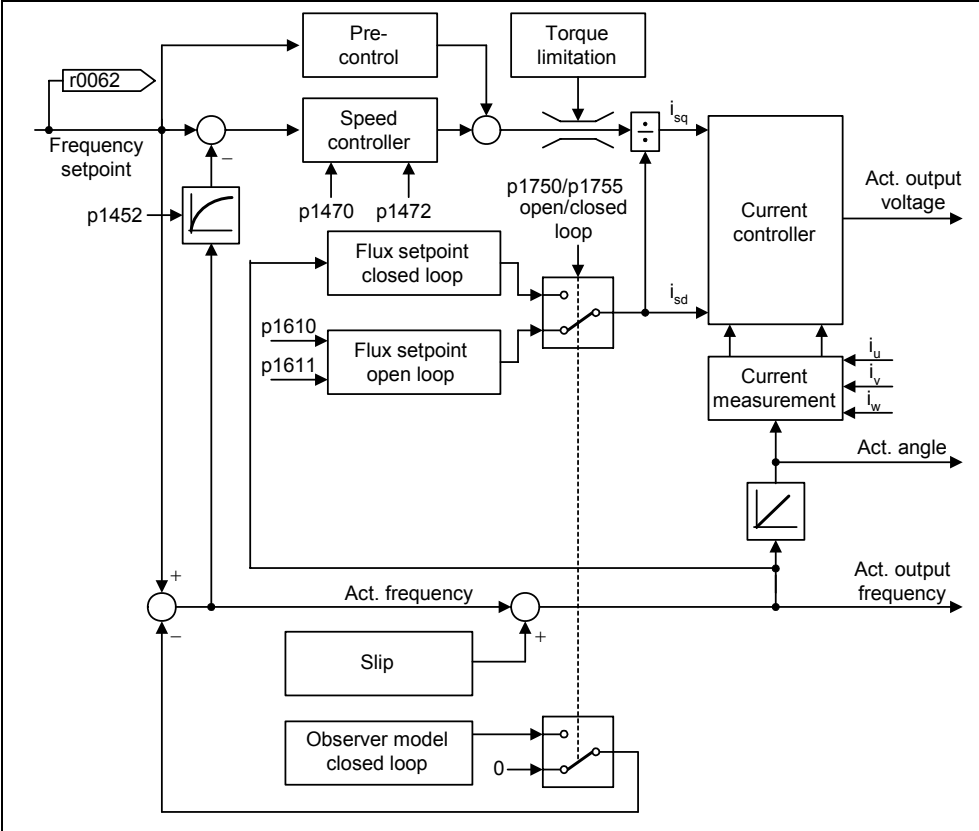


For most applications the setting of parameter p1750 = 0 gives the best result at low frequency.

p1755 = ...

Start-freq. motor model (SLVC)

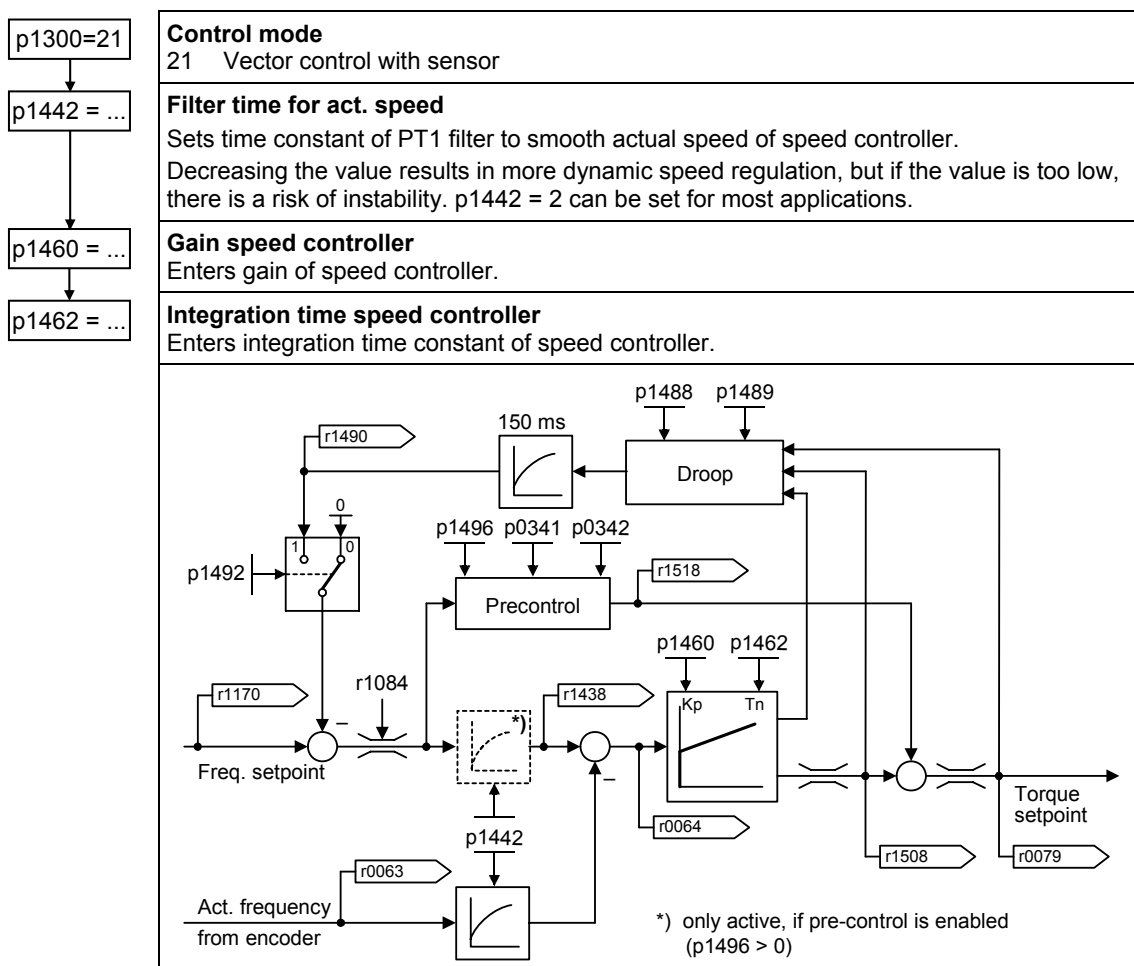
Enters the frequency at which sensorless vector control (SLVC) switches over from open-loop to closed-loop operation.



6.2 Commissioning

Vector control (VC)

- First step: Parameterizing the speed encoder (refer to Chapter "Interfaces", Section " Speed encoder interface")
- When commissioning vector control with encoder-feedback (VC), the drive should be configured for V/f mode (p1300 = 0) first. With a rotating motor and a connected speed encoder (activated via p0400), the following values must match in parameters r0061 and r0021:
 - Sign
 - Magnitude (deviation of a few percent is allowed)
 Only when both criteria are fulfilled can vector control be activated with the encoder (p1300 = 21/23).
- Encoder loss detection must be disabled (p0492 = 0) if torque is limited externally.



6.2.5.10 Converter-specific functions

Overview

Additional information on converter-specific functions can be found in Section "Operating functions".

Flying start

<p>p1200 = ...</p> <p>↓</p> <p>p1202 = ...</p> <p>↓</p> <p>p1203 = ?</p>	<p>Flying start Switches converter to a spinning motor by rapidly changing the output frequency of the converter until the actual motor speed has been found.</p> <ul style="list-style-type: none"> 0 Flying start disabled 1 Flying start is always active, start in direction of setpoint 2 Flying start is active, if power on, fault, OFF2 3 Flying start is active, if fault, OFF2 4 Flying start is always active, only in direction of setpoint 5 Flying start is active, if power on, fault, OFF2, only in direction of setpoint 6 Flying start is active, if fault, OFF2, only in direction of setpoint
	<p>Motor current: Flying start (entered in %) Defines search current used during flying start.</p>
	<p>Search rate: Flying start (entered in %) Sets factor by which the output frequency changes during flying start to synchronize with turning motor.</p>

Automatic restart

<p>p1210 = ...</p>	<p>Automatic restart Configures automatic restart function.</p> <ul style="list-style-type: none"> 0 Disabled 1 Trip reset after power ON 2 Restart after power failure 3 Restart after undervoltage or fault 4 Restart after undervoltage 5 Restart after power failure and fault 6 Restart after undervoltage/power failure or fault
--------------------	--

6.2 Commissioning

Holding brake

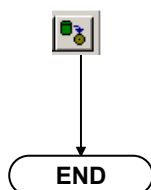
p1215 = ...	Holding brake enable Enables/disables holding brake function (MHB). 0 Motor holding brake disabled 1 Motor holding brake enabled
p1216 = ...	Holding brake release delay (entered in s) Defines the time interval during which the frequency converter runs with the min. frequency p1080 after magnetizing, before the ramp-up starts.
p1217 = ...	Holding time after ramp-down (entered in s) Defines time for which converter runs at minimum frequency (p1080) after ramping down.

Note

In safety-relevant applications, the motor holding brake is always initiated as soon as "Safe Stop1" is present. Initiation via "Safe Stop1" has a higher priority than the MHB function signal (p1215). Initiation via "Safe Torque Off" has a higher priority than the signal via the brake control module.

Imax controller for regenerative operation

p1253 = ...	Limitation Vdc or Imax when regenerating (only V/f control) Limits maximum effect of Imax controller when regenerating. For regenerative operation at the rated or maximum frequency it is possible that the output frequency exceeds the value of p1082 by the absolute value set in this parameter. One of the following measures should be applied if this is not acceptable: <ul style="list-style-type: none"> • Appropriately reduce the maximum frequency (p1082) • Set p1253 to 0 • Prevent regenerative feedback at the maximum frequency by applying suitable measures
-------------	---

End

If the frequency converter is parameterized using the STARTER commissioning tool, then the data is not automatically saved in the EEPROM. Data is only transferred from the RAM into the ROM after this button has been pressed in the STARTER screen form. If "MMC required" is configured, then the parameter set must also be written to the MMC-PS via p0802.

Note

While parameter p0340 is being transferred (refer to Section 6.2.3), the ET 200S FC executes internal calculations. This means that communications – via both USS and PROFIBUS DP – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

- Parameterizing error 30
- Drive fault/error 70
- Drive fault/error 75

When commissioning the drive system using STARTER (USS), no entries can be made while calculations are being carried out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter.

6.2 Commissioning

6.2.6 Series commissioning

Description

It is extremely simple to establish identical parameter settings for several frequency converters using the series commissioning function - e.g. for the series use of frequency converters or for group drives.

Note

Series commissioning is not permissible for the safety functions of the ICU24F. These parameters must always be set online.

When commissioning a series of frequency converters, an ET 200S FC parameter set is downloaded one after the other into several ET 200S FC frequency converters.

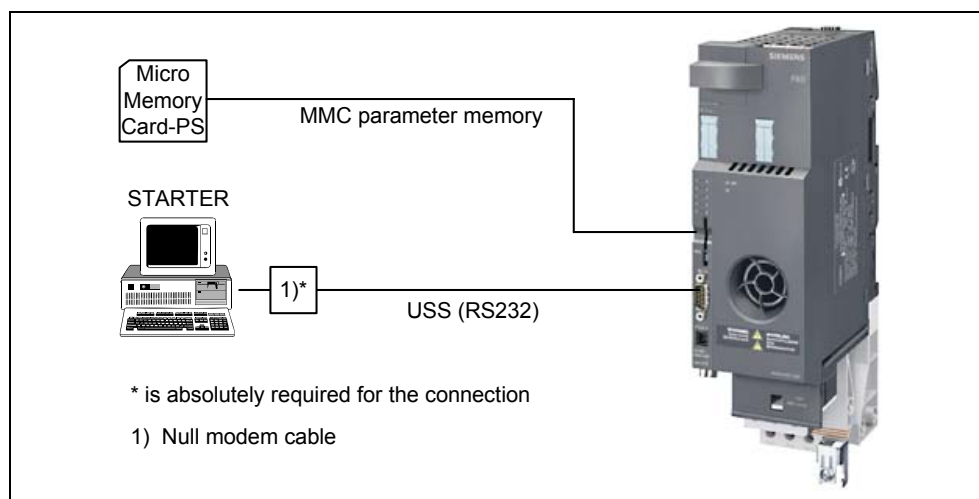


Fig. 6-17 Upread / download

Creating a parameter set for download

A parameter set can be created in the following ways:

- Adapt the parameter set in the frequency converter using STARTER via the RS232 interface (and following upread); refer to the STARTER program
- Adapt the parameter set offline at the PC using STARTER; refer to the STARTER program (not for safety-related parameters)

Interfaces to upload a parameter set from a frequency converter

A parameter set can be read-out (uploaded) from the frequency converter or from the MMC-PS in the following ways:

- **ET 200S FC → PC/PG**
Via the RS232 port (interface) using the "STARTER" commissioning (start-up) tool – also refer to Chapter "Interfaces", Section "Communication interface".
- **ET 200S FC → MMC-PS**
p0010 = 30, p0802 = 2 (for details, refer to the Parameter Manual, p0802).
- **MMC-PS → PC/PG**
Parameter sets can be transferred (as binary file) from an MMC parameter memory to a PC using a card reader.

Interfaces to download a parameter set

A parameter set can be downloaded in the following ways:

- **PC/PG → ET 200S FC**
via the RS232 port (interface) using the "STARTER" commissioning (start-up) tool, also refer to Chapter "Interfaces", Section "Communication interfaces".
- **MMC-PS → ET 200S FC**
e.g. manual download via p0010 = 30, p0803 = 2 or
automatic download after each power OFF/ON (control unit)
- **PC/PG → MMC-PS**
Parameter sets can be transferred (as binary file) from a PC to an MMC-PS via a card reader.

Note

Additional information regarding upreading and downloading parameter sets is provided in the Section "Handling ET 200S FC frequency converters"

Caution

- Presently, it is still not possible to download/upload parameter sets via PROFIBUS DP.
 - It is not possible to download safety-related parameters using STARTER.
 - It is not possible to manually download safety-relevant parameters from the MMC-PS.
-

6.2 Commissioning



Warning

- For the series commissioning, all of the interfaces are re-initialized. This results in a brief communications failure.

This can result in the following error messages at the connected SIMATIC S7 control (communications via PROFIBUS DP):

- • Parameterizing error 30
 - • Drive error/fault 70
 - • Drive error/fault 75
- When commissioning the drive using STARTER (USS), data cannot be entered while calculations are being made. Faults/errors can be acknowledged as soon as the calculation operations have been completed in the frequency converter.
 - Before starting series commissioning, all potentially hazardous loads (e.g. hanging (suspended) loads for crane applications) must be carefully secured. The following possibilities exist:
 - lower the load to the floor
 - clamp the load using the motor holding brakeThe motor holding brake can be opened while downloading the parameter set. This means that the motor holding brake control must be interrupted by the ET 200S FC during the series commissioning; if this is not done, then it is not permissible that the series commissioning is carried-out.
-

6.2.7 Restoring parameters to the factory setting

Description

The factory setting is a defined initial status of all of the frequency converter parameters. The frequency converters are shipped from the factory in this state. The frequency converters have the following default settings:

- Control with PROFIBUS DP via IM 151 (command and setpoint input, control commands, status and diagnostic signals/messages, for details refer to Section "Function block ET200S_FC_DRIV, FB100")
- The control type is a basic V/f characteristic (p1300 = 0)
- Induction motor (p0300 = 1)

The ET 200S FC frequency converter is ready to run if the ET 200S system has been assembled/configured and there is a control program in the higher-level PLC (refer to the assembly/configuration of an ET 200S station and integration of an ET 200S FC project in S7). You can always restore this initial state by resetting the parameters to the factory setting. All of the parameter changes made since the frequency converter was shipped are undone. The factory setting for each setting parameter is provided in the parameter description under "Def".

The following parameters cannot be reset and are, therefore, an exception to the above:

- P0014: STORE_MODE
- P0100: SWITCHEUROUSA
- P0201: POWERSTACKCODE
- P2010: USS_BAUDRATE
- P2011: USS_ADDRESS
- P7841: PS_SER_NO
- P8455: SPICPU and PMMC
- P8457: CONVERTERNEWFLAG

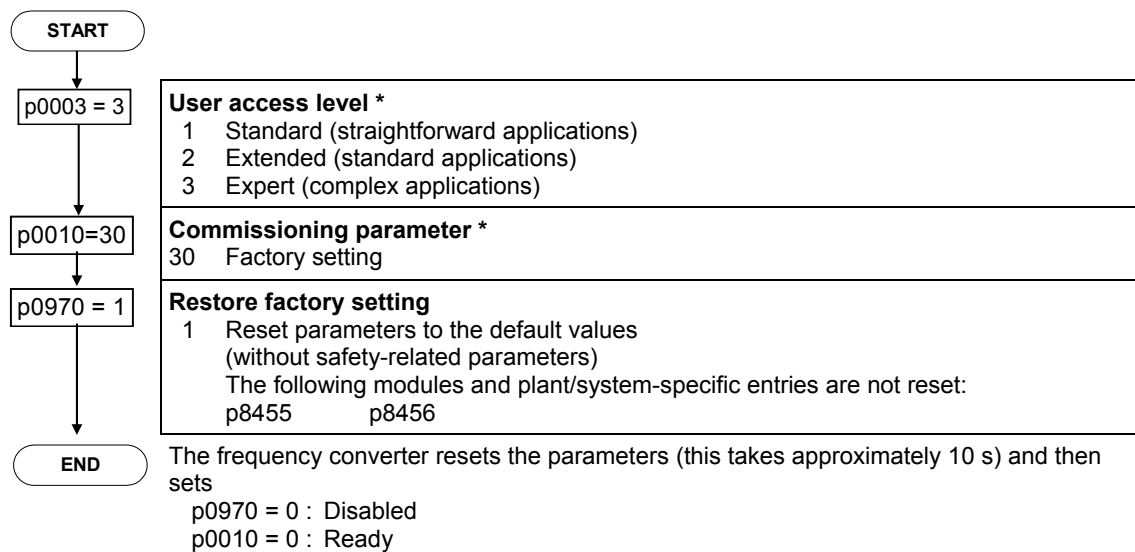
Note

While parameter p0970 is being transferred, the ET 200S FC executes internal calculations. This means that communications – via both USS and PROFIBUS DP – are interrupted while these calculations are being made. This can result in the following error messages at the connected S7 control system (communications via PROFIBUS DP):

- Parameterization error 30
- Drive fault/error 70
- Drive fault/error 75

When commissioning the drive system using STARTER (USS), no entries can be made while calculations are being carried out. The faults/errors can be acknowledged as soon as the calculations have been completed in the frequency converter.

6.2 Commissioning

Step 1: Restoring factory setting

6.3 Commissioning safety functions

Permissible applications for the SIMATIC ET 200S FC safety functions

Notes

In the definition of safety functions in IEC Draft 61800-5-2, "Adjustable speed electrical power drive systems", a number of new terms relating to drive-based safety functions have been adopted:

- Safe standstill (SH) = Safe torque off (STO)
- Safe braking ramp (SBR) = Safe stop 1 (SS1)
- Safely reduced speed (SG) = Safely limited speed (SLS)

The ET 200S FC frequency converter is an open-type device that conforms to UL 50. The ET 200S FC frequency converter is an open-type drive unit corresponding to UL 50. In order to protect the ET 200S FC frequency converter with active safety functionality against mechanical damage and ingress of dirt, it must be operated in cabinets with degree of protection IP54 according to EN 60529.

Safety-relevant parameters are always available twice: once in the area p9600 and once in p9800. Both values have to be entered and they must effectively be identical. Please note in particular that values have to be entered using different decimal powers (e.g.: 5 ms = 0.005 s).

Summary

The fail-safe function "Safe torque off" (STO) can be used without restriction for all applications.

The fail-safe functions "Safe stop 1" (SS1) and "Safely limited speed" (SLS) are permissible for all applications where there can be no acceleration of the load after the frequency converter has been shut down.

Description of permissible applications

1. The fail-safe, drive-autonomous SIMATIC ET 200S FC functions

With its integrated, drive-autonomous safety functions, the SIMATIC ET 200S FC frequency converter (with ICU 24F control unit) is also ideal for use in applications with increased safety requirements corresponding to SIL2 in accordance with IEC 61508 and Cat.3 pursuant to EN954-1:

Safely limited speed: The frequency converter monitors whether a set motor speed limit value is exceeded, without additional external components

Safe Stop 1: The frequency converter reduces the speed of the motor using a braking ramp until it reaches a standstill, and continually monitors this braking process without additional external components

Safe torque off: The frequency converter switches the motor to a torque-free state

2. Prerequisites for using fail-safe functions

6.3 Commissioning safety functions

For each machine, a risk assessment must have been carried out (e.g., in accordance with EN ISO 1050, "Safety of machinery – Principles for risk assessment"). This risk assessment provides both the functional requirements for safety-related controls and the required classification, e.g., in accordance with SIL (Safety Integrity Level).

In order to make use of the SIMATIC ET 200S FC frequency converter's fail-safe functions the closed-loop control must work perfectly. The drive (drive = converter + motor + brake + driven machine) must be set up in such a way that all operations of the driven machine are properly controlled and the converter remains below its limit values (for current, temperature, voltage, etc.). The converter's power and parameter settings must be suited to both the connected motor and to the application.

When the system has been successfully commissioned, it is necessary to check the typical operating conditions and those related to the limit values, in the form of an acceptance test.

3. Types of closed-loop control

Assuming that the above prerequisites are met, all fail-safe functions ("Safe torque off", "Safe stop 1" and "Safely limited speed") are permissible and certified for V/f control and vector control.

4. Applications with safe evaluation of the converter feedback

In applications where safe machine functions may only be carried out if the motor speed is below a certain threshold value, it is essential that the feedback from the converter be evaluated accurately. An example of this kind of application would be bolting a protective door in a drive that is still spinning.

The SIMATIC ET 200S FC frequency converter does not have any safe output signals. However, on a safe PLC, for example, the converter feedback can still be safely evaluated with reference to the following converter signals:

- Evaluation of the converter operating state as required by the SS1 function. Once requested, the SS1 function requires the converter to feed back an STO function at the end of the ramp time for SS1. If this does not occur, it must be assumed that the drive has not come to a standstill.
- Evaluation of the converter operating state as required by the SLS function, mode 1. Once requested, the SLS function, mode 1, requires the converter to report that the reduced speed has been reached at the end of the SS1 ramp time. If this does not occur, it must be assumed that the drive has not reached the reduced speed.
- Evaluation of converter fault messages. Additionally, the safety function converter faults and standard function converter faults (r0052, bit03/r9772, bit02 and bit 03) should always be evaluated. No faults are expected to occur during a safe function, but if a fault is signaled, it must be assumed that the safety function has malfunctioned.

5. Tolerances and reaction times

6.3 Commissioning safety functions

Frequency monitoring is carried out with 15% tolerance because fail-safe functions SS1 and SLS are executed without an encoder.

The minimum frequency for reliable processing is 1 Hz.

The typical device-internal reaction time to the activation of a safety function can be taken from the following table:

SIMATIC ET 200S FC	FW Version 1.03
Typical reaction time to a shutdown group signal:	20 ms

For the total reaction time within the system or machine, the following must be taken into account alongside the time stated above:

- The time taken to detect a signal (depending on the sensor being used)
- The time taken to process the signal (depending on the CPU being used, if one is required, and its program scope)

If necessary, the time taken to transfer the signal via PROFI-safe (depending on the bus system being used, the number and type of bus nodes, and the baud rate)

An Excel tool helps with estimating this reaction time:

<http://support.automation.siemens.com/WW/view/en/21627074>.

The fault reaction times of the internal monitoring of functions SS1 and SLS depend on the currently applicable output frequency of the converter. For details, please refer to this Operating Manual.

These minimum tolerance and reaction times should be taken into account when configuring the system, e.g., in the layout of the safety clearances for the components.

6. Connecting a mechanical brake

Connecting a mechanical brake is recommended in the case of applications with functions SS1 and SLS, modes 0 and 1, where dangerous states can occur as a result of external events such as a power failure. In the event of a fault, the converter controls its brake directly, thereby reducing the risk of undefined machine states.

6.3 Commissioning safety functions

7. Forbidden applications

This is particularly pertinent to applications with overhauling loads. With an overhauling load, the friction torque of the mechanical components (motor, gearbox, etc.) is not enough to prevent the mechanical system from accelerating when the drive is switched off (Figs. b and c).

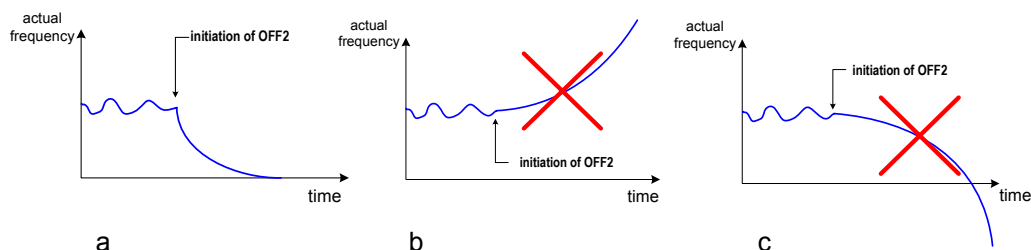


Fig. a: Permissible speed characteristic after the converter has been shut down - application of all safety functions permissible

Figs. b and c: Overhauling load – not all safety functions are permissible

Examples of overhauling loads are hoisting gears (due to gravitation) and winders (due to a second drive).

Fail-safe functions SS1 and SLS must not be used with overhauling loads.

Regenerative operation of the motors (which can occur in the case of, braking with function SS1 for example) is permitted if there is no overhauling load.

There are no restrictions for the STO function. Of course, for risk assessment and machine design purposes, it should be remembered that an overhauling load can only be stopped by means of a suitable brake when the motor has been switched to a torque-free state.

Note

Functions SS1 and SLS must not be used in conjunction with torque control.



Warning:

Safety function converter faults F0396...F0399 cannot be masked if standard function converter faults are pending. In this case, an acceptance test with a full load should be carried out.

Description

In order to commission the Safety Integrated functions, the ET 200S FC frequency converter must be equipped with the ICU24F control module. Safety-related parameters may **only be set and changed with "STARTER"**.

Safety-relevant parameters **can only be changed in the online mode**.

The following safety-related functions have been implemented for the drive: converter:

- Safe standstill (SH)
- Safe braking ramp (SBR)
- Safely reduced speed (SG)

Notes on safety-related functions

Shutting down from the "Safely reduced speed" operating status

Note

If "Safely reduced speed" is selected, the drive can be shut down using "Safe standstill" or "Safe braking ramp".

It is not possible to shut down using the non-safety-related commands OFF1/OFF3. However, the frequency converter can be shut down using the non-safety-related command OFF2 (pulse disable).

De-selecting "Safely reduced speed and "Safe braking ramp"

Note

The "Safely reduced speed" and "Safe braking ramp" statuses can be revoked by removing the safety-related signal. The frequency converter then returns to the setpoints that are present, unless it has already reached the "Safe standstill" status via the "safe braking ramp" function.

To restart the drive, the safety signal must first be canceled, and a new ON command is always required.

Notice

When configuring the drive, the centrifugal mass and torque of the drive must be taken into account for the purpose of setting the braking ramp.

6.3 Commissioning safety functions

Settings for control units with activated safety-related functionality

The safety-related functionality is activated using parameters p8456 and p9601/p9801.

The value of p8456 is set when the ICU24F powers up on the basis of the PRM telegram from STEP 7. It cannot be changed. The following applies:

- p8456 = 4 Safety-related functionality, activated without MMC-PS
- p8456 = 5 Safety-related functionality, activated with MMC-PS

The safety-related functionality is set on the frequency converter side using p9601 and p9801. The following applies:

- p9601 = p9801 = 1 safety-related functionality activated without forced checking procedure
- p9601 = p9801 = 3 safety-related functionality activated with forced checking procedure

The frequency converter only operates if the safety-related functionality is activated both on the control side and the frequency converter side. If this is not the case, the frequency converter shuts down with fault message F0396.

Possibilities for using the ICU24F control unit

A control unit with integrated safety-related functionality (ICU24F) may be used in ET 200S stations with or without configured safety-related functionality.

The higher-level control does not differentiate between an ICU24 and an ICU24F.. For this reason, it is possible to interchange these control units. If, in this case, the safety-related functionality is subsequently activated, then the frequency converter shuts down with F0396.

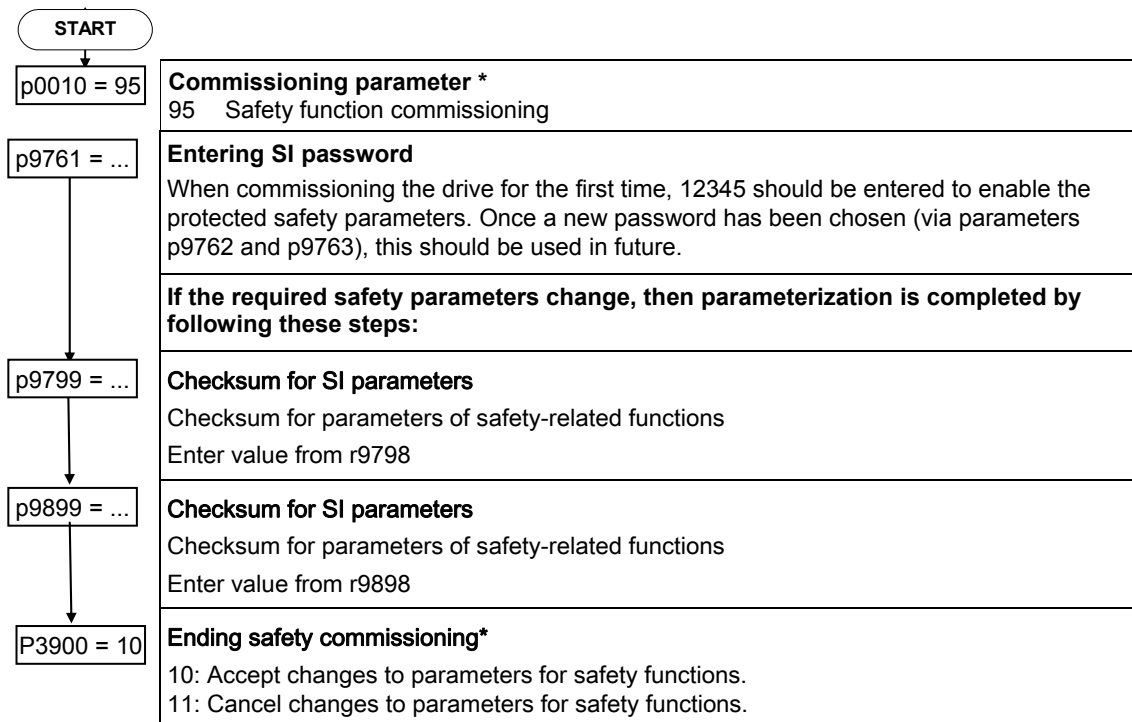
If "MMC required" is configured, the ICU24 and ICU24F modules with deactivated safety-related functionality cannot be interchanged, since the clone00.bin files for an ICU24 and an ICU24F are not compatible.

Notice

If, while commissioning the safety functions (p0010 = 95), the power supply (24 V) is interrupted, then parameter p0010 is automatically set to 0. Since p0010 has been reset due to a power failure reset of the frequency converter, the frequency converter is **not** in the "Ready" state following this. In order to transfer the drive to this state, the frequency converter must be either powered down and powered up again (24 V), or briefly disconnected from the power supply by disconnecting and reconnecting it. Alternatively, the following parameterization must be carried out:

1. p0010 = 30
 2. p0010 = 0
-

Activating safety functions



Note

The following steps must always be carried out when changing safety-related parameters:

1. p0010 = 95 commissioning mode (safety)
2. p9761 = Password
3. Change the safety parameters
4. p3900 = 10, exit safety commissioning, accepting the changes

6.3 Commissioning safety functions

Enter the password

p9761 = ...	<p>SI input password</p> <p>When commissioning the drive system for the first time, 12345 should be entered here in order to enable the protected safety parameters. Once a new password has been chosen (via parameters p9762 and p9763), this should be used in future.</p>
p9762 = ...	<p>SI change password</p> <p>Enter the new password to access safety parameters. The password must contain at least 5 and a maximum of 8 digits and may not include a leading zero.</p>
p9763 = ...	<p>SI change password confirmation</p> <p>The new password must be confirmed here. If p9762 and p9763 are the same, then this value is written into r9760. In the future, safety parameters can be accessed by entering this password into p9761.</p>

Enabling the safety functions

p9601 = ...	<p>Enable SI safety parameter</p> <p>Safety parameters for enabling individual safety control functions</p> <p>Bit 00 = 1/0: Activation/deactivation of all safety functions</p> <p>Bit 01 = 1/0: Activation/deactivation of the forced checking procedure following the STO function</p>
p9801 = ...	<p>Enable SI safety parameter</p> <p>Refer to p9601</p>
p9603 = ...	<p>Select SI safety group for SH</p> <p>Here, the safe bus via which "Safe standstill" (SH) is to be initiated is selected. Safe buses 1 to 5 are available for selection. Safe bus 6 is reserved for the "Safely reduced speed" (function).</p>
p9803 = ...	<p>Select SI safety group for SH</p> <p>Refer to p9603</p>

Setting the self-test interval

p9659 = ...

SI maximum time until self-test

Enter the period of time between self-tests. The time remaining until the next self-test is required is displayed in r9660. When r9660 reaches the value 0, this indicates that the time interval has expired and alarm A1699 is output as a reminder that a self-test is required. The user should select a self-test at the next available opportunity. The warning does not impair the functionality of the drive.

The self-test is selected in the following cases:

- Every time the drive is powered up
- When STO is selected, when bit 01 is set in p9601/9801
- Upon exiting the function "Passivate the frequency converter"

During the self-test, the shutdown paths are checked and a self-test of the processor is executed. The timer for the forced checking procedure (refer to r9660) is set to the default value specified in p9659, and alarm A1699 is canceled under the following conditions:

- After p9659 has been reduced to below the actual value in r9660
- Each time the drive is powered up
- When the STO function is selected, when bit 01 is set in p9601/p9801 and the test has been completed
- When the LSTO function has been acknowledged once the test is complete.

The default value for the timer is 8 hours.

p9659 = ...

Remark:

For reasons of safety, it is necessary to trigger a safe stopping process in intervals of a maximum of 8 hours, so that the functionality of the safety system can be monitored. Eight hours after the last activation of the safe stopping process, the converter sets a status bit (r9772, bit 8) and generates alarm A1699. The process control (e.g., PLC) must then trigger a safe stopping process at the next available opportunity – for instance, when the drive already has a short phase when its speed is 0. If the forced checking procedure has not been deactivated (refer to parameter p9601/p9801, bit 01), the safety hardware is monitored from the moment that the safe stopping process begins to run. If the converter feeds back the status signal "Safe torque off (STO) selected", the safe stopping process can be canceled, since part of the test will continue in the background. The immediate switching-on process remains deactivated for approx. 2.4 seconds. As soon as the self-test is complete, the forced checking procedure bit (r9772, bit 6) is automatically cleared. The higher-level control (e.g., PLC) must log that the status bit and forced checking procedure bit have been set and cleared. In order to recognize faults when writing and saving safety-related data, the control must request all safety-related parameters every 8 hours and compare them with the values that are expected. If there is a discrepancy between them, the safe stopping process should be triggered with the aid of the safety signals (STO or SS1), or a switch-off should be performed via the functions OFF1, OFF2 and OFF3, and an error message should be output.

In all cases, this process must be appropriately logged.

6.3 Commissioning safety functions

Setting for Safe braking ramp (SBR) = Safe stop 1 (SS1)

p9680 = ...	<p>SI braking ramp delay</p> <p>Time [in ms] between selecting the "Safe stop 1" function and activating the monitoring ramp. The actual frequency is compared with the frequency of the monitoring ramp when SS1 is active. If the actual frequency is higher than the frequency of the monitoring ramp, a "Passivate the frequency converter" (LSTO) function is triggered. The converter enters the "Safe torque off" status of its own accord and outputs an error message. For applications with variable loads, increasing the values in p9690/p9880 or p9691/p9891 is recommended. Any large discrepancy between the actual frequency and the reference value can then be accepted.</p> <p>Remark: A value of 99000 would deactivate the monitoring of the SS1 function and, for this reason, is not permissible. p9880 should be set accordingly. Upon selecting the SLS or SS1 functions, however, "Safe stop" follows the coasting down time in p9681/9881.</p>
p9880 = ...	<p>SI braking ramp delay</p> <p>Refer to p9680.</p>
p9681 = ...	<p>SI braking ramp down time</p> <p>This parameter defines the braking ramp coasting down time for "Safe stop 1" (SS1) in seconds. The ramp coasting down time is used for the SS1 function and the monitoring ramp. The total braking time T_x can be derived from the following formulae, where f_x represents the currently applicable frequency:</p> <p>a) To trigger the SLS function: $T_x = p9681 * (f_x - p9690)/200 \text{ Hz}$ b) To trigger the SS1 function: $T_x = p9681 * (f_x - p9682)/200 \text{ Hz}$</p> <p>Remark: In contrast to other coasting down times (e.g., p1120, p1121), the safe braking time relates to 200 Hz and not to p1082. Refer to the formulae above.</p>
p9881 = ...	<p>SI braking ramp coasting down time</p> <p>Refer to p9681.</p>
p9682 = ...	<p>SI minimum speed for standstill detection</p> <p>Any speed that falls below the threshold values in p9682/p9882 is deemed to be a standstill. If SS1 has been selected, "Safe torque off" (STO) is triggered.</p>
p9882 = ...	<p>SI minimum speed for standstill detection</p> <p>Refer to p9682.</p>

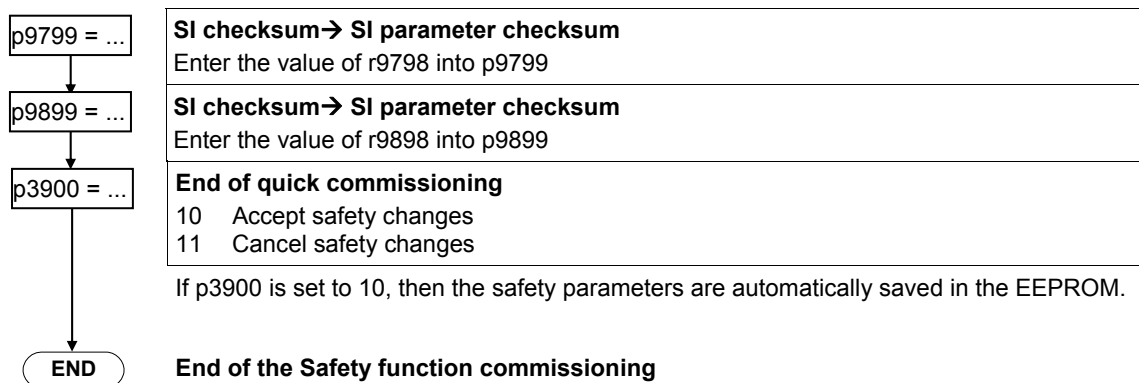
Safely reduced speed (SG) = Safely limited speed (SLS)

Notice

"Safely reduced speed" (SG) may only be used for V/f and vector control; it may **not** be used for torque control (p1300 = 22, 23)!
 For torque control, there is no reaction when "Safely reduced speed" is selected.

p9690 = ...	<p>SI setpoint for SG Setpoint used when "Safely reduced speed" is selected. Depending on the setting of p9692/p9892, the frequency from p9690/p9890 can also be used as a speed threshold value instead of a setpoint (refer to p9692).</p> <p>Remark: If the frequency rises above the SLS limit (p9691/p9891) due to dynamic loads, an LSTO is triggered. If, by contrast, the frequency drops below the accuracy limit (1 Hz) for the same reason, then an STO is triggered. Such errors should be avoided by taking the dynamic load impulses into account during system configuration. Moreover, the acceptance test should be performed under the least favorable load conditions.</p>
↓	
p9890 = ...	<p>SI setpoint for SG (SLS) Refer to p9690.</p>
↓	
p9691 = ...	<p>SI tolerance for SG (SLS) Upper tolerance range for the SLS function. If the actual frequency is below the value in p9691/p9891 when "Safely limited speed" is triggered and later exceeds this value, a "Passivate the converter" function is triggered. The converter enters the "Safe torque off" status of its own accord and outputs an error message. The tolerance, determined by the difference between p9691 and 9690 (or p9891 and p9890) is also set for the monitoring ramp when SS1 is active. For applications with variable loads, increasing the values in p9691/p9891 is recommended.</p> <p>Remark; The value in p9691 must be greater than that in p9690. This is checked upon completion of safety commissioning.</p>
↓	
p9891 = ...	<p>SI tolerance for SG (SLS) Refer to p9691.</p>
↓	
p9692 = ...	<p>SI reaction to selecting SLS Reaction to a speed that exceeds the limit value after "Safely limited speed" has been activated:</p> <ul style="list-style-type: none"> • 0: Activates speed monitoring and freezing of the speed setpoint. If the actual speed value exceeds the parameterized speed limit value when the SLS function is activated, the "Passivate the frequency converter" function is initiated. • 1 Brakes down to the set speed along the braking ramp, then activates the monitoring function and passivates the setpoint channel.
↓	
p9892 = ...	<p>SI reaction to selecting SLS Refer to p9692.</p>

6.3 Commissioning safety functions

Completing commissioning of the safety functions

6.3.1 Restoring safety-relevant parameters to the factory setting

Description

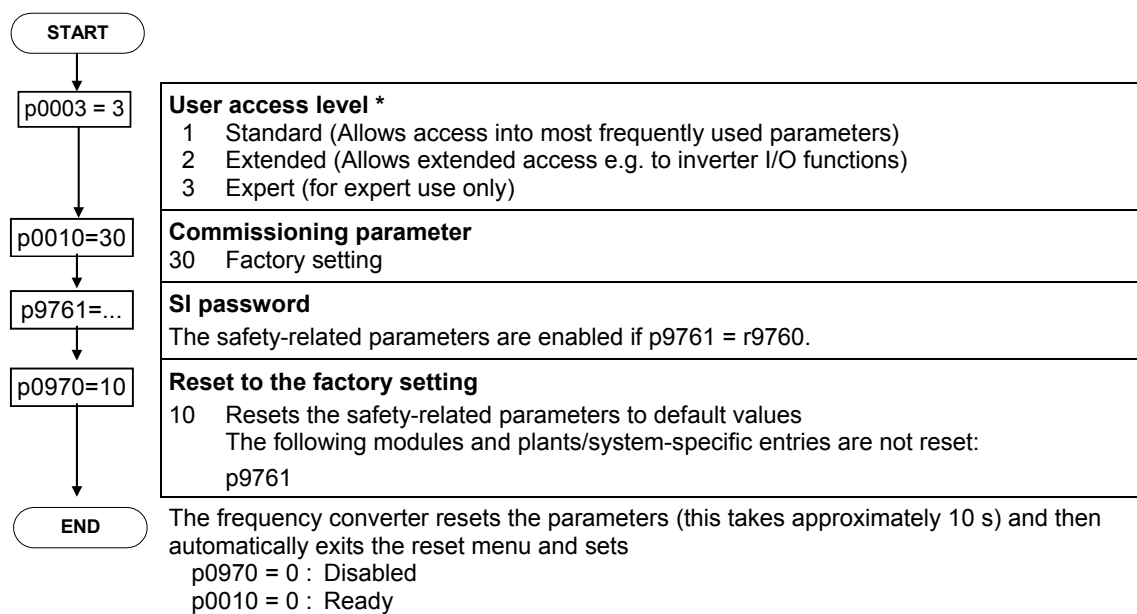
Fail-safe frequency converters (ICU24F) are reset to the factory setting in two steps:

1. The standard parameters are reset (refer to "Parameter reset to the factory setting")
2. The safety-relevant parameters are reset

Step 1: Reset to the factory setting for standard parameters

Refer to Section 6.2.7 "Parameter reset to the factory setting".

Step 2: Reset the safety-relevant parameters



6.4 Operating functions

Overview

The ET 200S FC frequency converter offers a whole series of functions for frequency converter operation. These are:

- **Setpoint channel**
With adjustable ramp-up and ramp-down times
- **Jog mode**
To manually move and position the drive
- **Free function blocks**
Logical and arithmetic operations and latching elements that are interconnected using BICO technology
- **Positioning down ramp**
Brakes down to standstill along a defined residual distance
- **Automatic restart**
This automatically restarts the frequency converter after a power failure
- **Flying restart**
This function switches the frequency converter to a motor that is still spinning
- **Braking functions**
Motor holding brake and regenerative braking function

6.4.1 Setpoint channel

Description

The setpoint channel forms the transition element between the setpoint source and the closed-loop motor control.

The generation and subsequent modification (influencing the direction, skip frequency, ramp-up/down ramp) of the complete setpoint is carried-out in the setpoint channel.

6.4.1.1 Overview

This function allows a basic scaling functionality to be implemented – e.g. when the user appropriately parameterizes the system.

A reversing operation involves forwards and reverse motion. By selecting the reversing functionality, after the endpoint/endstop has been reached a direction of rotation reversal can be initiated in the setpoint channel.

On the other hand, if it should be prevented that a direction of rotation reversal or a negative frequency setpoint is entered through the setpoint channel – then this can be inhibited using BICO parameter p1110.

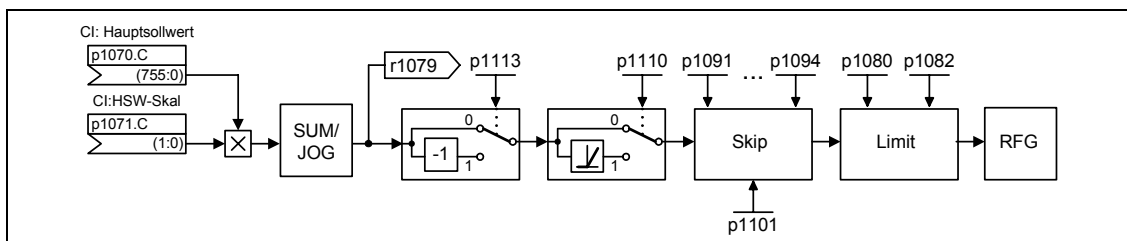


Fig. 6-18 Modifying the frequency setpoint

Driven loads can have one or several resonant points in the range between 0 Hz and the setpoint frequency. These resonance effects result in vibration levels that under worst case conditions can damage the driven load. Skip frequencies can be parameterized in the frequency converter so that these resonance frequencies are passed through as quickly as possible.

6.4 Operating functions

6.4.1.2 Ramp-function generator (RFG)

Data

Parameter range	p1120, p1121 r1119, r1170 p1130 – p1142
Alarms	-
Errors	-
Function chart numbers	FP5000, FP5300

Description

The ramp-function generator is used to limit the rate of acceleration when the setpoint suddenly changes (e.g. as a step function). This means that it helps to reduce the stress on the mechanical system of the connected machine. An acceleration ramp and a braking ramp can be independently set using the ramp-up time p1120 and ramp-down time p1121. This means that a controlled transition can be realized for setpoint changes (refer to the following diagram).

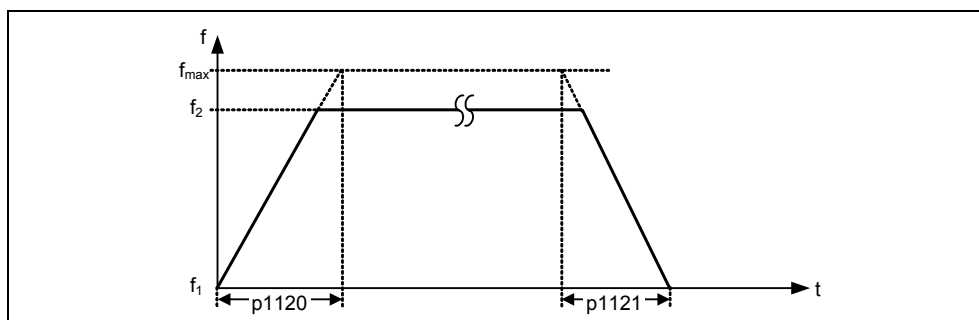


Fig. 6-19 Ramp-function generator without rounding-off

In order to avoid torque surges at the transitions (constant velocity phase \longleftrightarrow accelerating / braking phase), additional rounding-off times p1130 – p1133 can be programmed. This is of special significance for certain applications (e.g. pumping liquids or for crane applications) that require an especially "smooth" bumpless acceleration or braking.

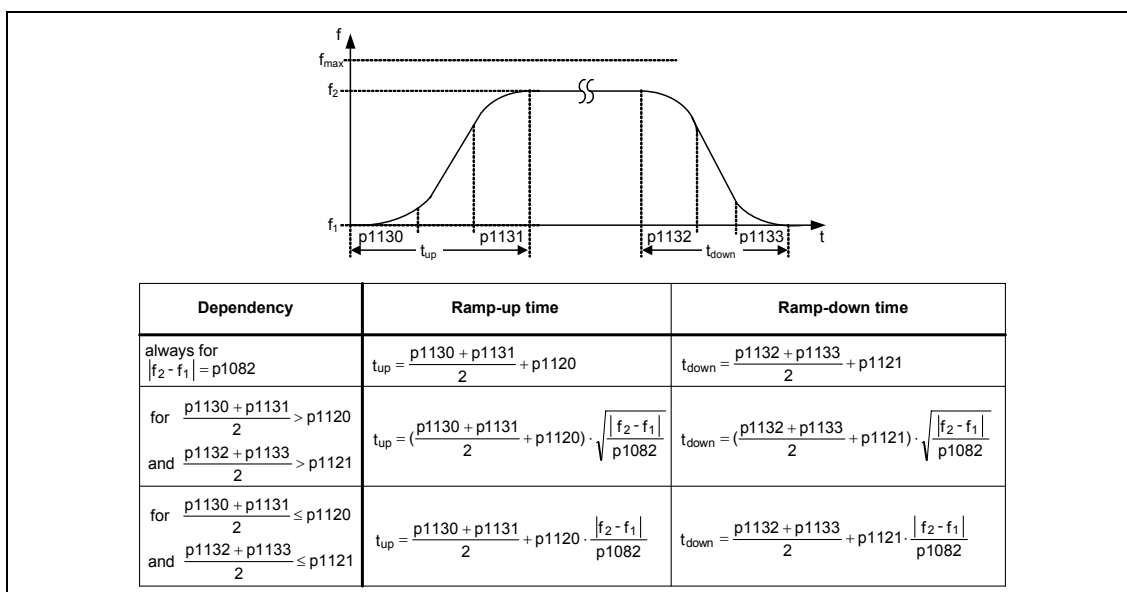


Fig. 6-20 Ramp-function generator with rounding-off

If the OFF1 command is initiated while the drive is accelerating, then a rounding-off function can be activated or de-activated using parameter p1134 (refer to the following diagram). The rounding-off times are defined by parameters p1132 and p1133.

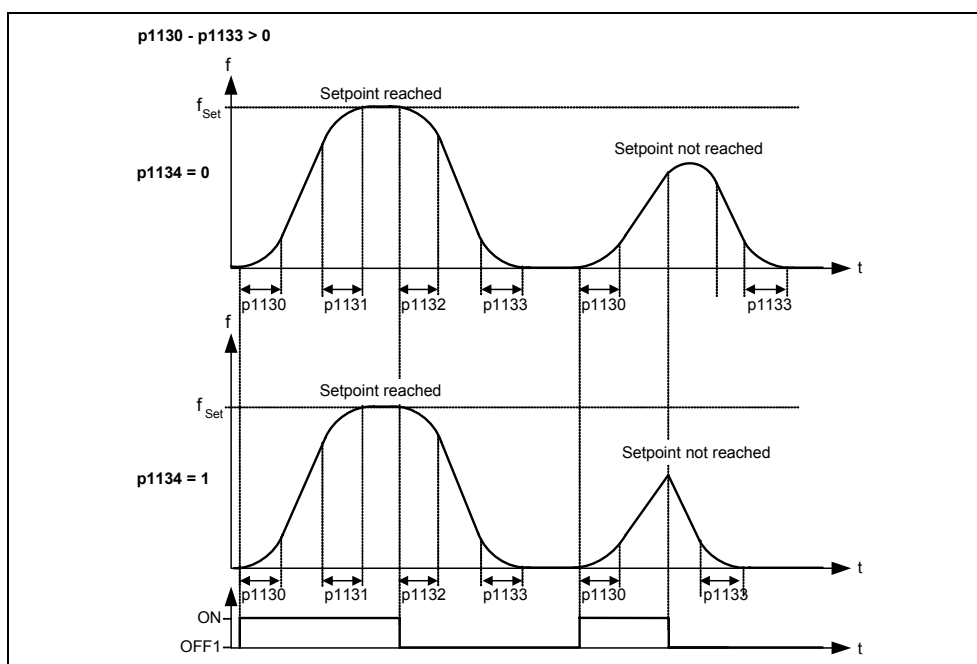


Fig. 6-21 Rounding-off after an OFF1 command

In addition to the rounding-off times, the ramp-function generator can be influenced using external signals. The ramp-function generator offers the following functionality using BICO parameters p1140, p1141 and p1142 (refer to the following table).

6.4 Operating functions

Table 6-13 BICO parameters for the ramp-function generator

Parameter		Description
p1140	BI: Ramp-function generator enable	= 0 the ramp-function generator <u>output</u> is set to 0 = 1 ramp-function generator is enabled
p1141	BI: Ramp-function generator start	= 0 the ramp-function generator <u>output</u> keeps the actual value = 1 the ramp-function generator starts - if enabled
p1142	BI: Ramp-function generator, setpoint enable	= 0 the ramp-function generator <u>input</u> is set to 0 and the output is reduced to 0 via the ramp-function generator ramp = 1 the input of the ramp-function generator ramp is enabled

The ramp-function generator itself is released after the pulses have been enabled (inverter enable) and after the excitation time has expired (p0346). The setpoint (reference) speed for the closed-loop control (r1170) is obtained after limiting the maximum speeds for the positive and negative directions of rotation (p1082, -p1082 or 0 Hz when a specific direction of rotation is inhibited).

Note

The maximum frequency converter output frequency is defined by parameter p1082 in the setpoint channel. For operating modes with V/f characteristic, the maximum frequency is 650 Hz; for operating modes with closed-loop Vector control, the maximum frequency is limited to 200 Hz (r1084).

6.4.2 Jog mode

Data

Parameter range: p1055 – p1061

Alarms: A0923

Errors: -

Function chart number: FP5000

Description

The "jog" control command is provided for the following preparatory activities:

- To check the functionality of the motor and frequency converter after the drive has been commissioning (the first traversing motion, checking the direction of rotation, etc.)
- Positioning a drive / a driven load at a specific position
- Traversing a drive, e.g. after the program has been interrupted

The drive is traversed by entering fixed frequencies p1058, p1059 using this function. The "jog" control command can be selected via the RS232 interface (refer to the example) and also via PROFIBUS DP via IM 151. The traversing of the drive is not dependent on an ON/OFF command, but depends on activating the "jog" control command – selected via the BICO parameter p1055 or p1056.

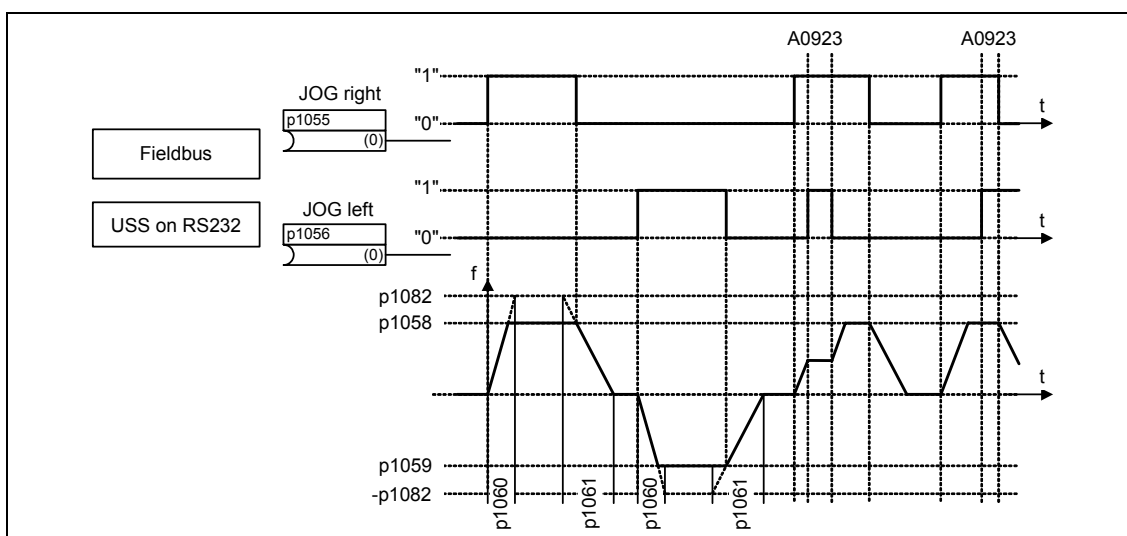


Fig. 6-22 Jogging ccw or jogging cw

After the "jog" control command has been activated, the frequency converter accelerates the motor up to the fixed frequency within time p1060. This fixed frequency is specified using parameter p1058 or p1059. This frequency is only left

6.4 Operating functions

after de-selection and the drive is braked down to 0 Hz within time p1061. If both jog parameters (p1055, p1056) are simultaneously activated, then the instantaneous frequency is kept (constant velocity phase) and Alarm A0923 is output.

In addition to the direct parameterization (p1055 and p1056), the "jog" control command can also be enabled using parameter p0700 or p0719 (indirect parameterization). In this case, for a p0700 value assignment, the BICO parameters are appropriately modified.

Example

Jogging via the RS232 interface:

- Standard method → p0700 = 4
- BICO method → p1055 = 2036.8
p1056 = 2036.9

Note:

When using STARTER, these settings are not required.

With the command Fetch master control, **OFF/ON** and **Jogging** are always possible using the appropriate keys in STARTER.

6.4.3 Free function blocks (FFB)

Data

Parameter range:	p2800 – p2890
Alarms:	-
Errors:	-
Function chart numbers:	FP4800 – FP4830
Cycle time:	< 128 ms

Description

For many applications, interlocking logic is required to control (open-loop) the frequency converter. This interlocking logic interlocks several states (e.g. access monitoring, system state) to a specific control signal (e.g. ON command). In addition to logical interlocks, increasingly, arithmetic operations and data storage elements are required in frequency converters that quickly form a new unit from several physical quantities. Within the ET 200S FC frequency converter, this functionality is available using the freely programmable function blocks (FFB).

The following function blocks are integrated into the ET 200S FC frequency converter:

Table 6-14 Free function blocks

No.	Type	Example															
3	AND	<p>AND 1</p> <table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	A	B	C	0	0	0	0	1	0	1	0	0	1	1	1
A	B	C															
0	0	0															
0	1	0															
1	0	0															
1	1	1															
3	OR	<p>OR 1</p> <table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	1
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0	1	1															
1	0	1															
1	1	1															
3	XOR	<p>XOR 1</p> <table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	B	C	0	0	0	0	1	1	1	0	1	1	1	0
A	B	C															
0	0	0															
0	1	1															
1	0	1															
1	1	0															

6.4 Operating functions

No.	Type	Example																																										
3	NOT	<p>NOT 1</p> <table border="1"> <thead> <tr> <th>A</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </table>	A	C	0	1	1	0																																				
A	C																																											
0	1																																											
1	0																																											
2	D flip-flops	<p>D flip-flops 1</p> <table border="1"> <thead> <tr> <th>SET</th> <th>RESET</th> <th>D</th> <th>STORE</th> <th>Q</th> <th>Q̄</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0</td> <td>x</td> <td>x</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>x</td> <td>x</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>x</td> <td>x</td> <td>Q_{n-1}</td> <td>Q̄_{n-1}</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>↑</td> <td>1</td> <td>0</td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>↓</td> <td>0</td> <td>1</td> </tr> <tr> <td colspan="4">POWER-ON</td> <td>0</td> <td>1</td> </tr> </tbody> </table>	SET	RESET	D	STORE	Q	Q̄	1	0	x	x	1	0	0	1	x	x	0	1	1	1	x	x	Q _{n-1}	Q̄ _{n-1}	0	0	1	↑	1	0	0	0	0	↓	0	1	POWER-ON				0	1
SET	RESET	D	STORE	Q	Q̄																																							
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1	1	x	x	Q _{n-1}	Q̄ _{n-1}																																							
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POWER-ON				0	1																																							
3	RS flip-flops	<p>RS flip-flops 1</p> <table border="1"> <thead> <tr> <th>SET</th> <th>RESET</th> <th>Q</th> <th>Q̄</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Q_{n-1}</td> <td>Q̄_{n-1}</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>Q_{n-1}</td> <td>Q̄_{n-1}</td> </tr> <tr> <td colspan="2">POWER-ON</td> <td>0</td> <td>1</td> </tr> </tbody> </table>	SET	RESET	Q	Q̄	0	0	Q _{n-1}	Q̄ _{n-1}	0	1	0	1	1	0	1	0	1	1	Q _{n-1}	Q̄ _{n-1}	POWER-ON		0	1																		
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1	1	Q _{n-1}	Q̄ _{n-1}																																									
POWER-ON		0	1																																									
4	Timer	<p>Timer 1</p>																																										

6.4 Operating functions

No.	Type	Example
2	ADD	<p>ADD 1</p> <p>Result = $x1 + x2$ If: $x1 + x2 > 200\%$ → Result = 200% $x1 + x2 < -200\%$ → Result = -200%</p>
2	SUB	<p>SUB 1</p> <p>Result = $x1 - x2$ If: $x1 - x2 > 200\%$ → Result = 200% $x1 - x2 < -200\%$ → Result = -200%</p>
2	MUL	<p>MUL 1</p> <p>Result = $\frac{x1 * x2}{100\%}$ If: $\frac{x1 * x2}{100\%} > 200\%$ → Result = 200% $\frac{x1 * x2}{100\%} < -200\%$ → Result = -200%</p>
2	DIV	<p>DIV 1</p> <p>Result = $\frac{x1 * 100\%}{x2}$ If: $\frac{x1 * 100\%}{x2} > 200\%$ → Result = 200% $\frac{x1 * 100\%}{x2} < -200\%$ → Result = -200%</p>
2	CMP	<p>CMP 1</p> <p>Out = $x1 \geq x2$ $x1 \geq x2$ → Out = 1 $x1 < x2$ → Out = 0</p>
2	FFB setpoints (connector settings)	<p>Connector setting as a %</p> <p>Range : -200% ... 200%</p>

Example 2

Enabling individual FFB including allocating a priority:

p2801[3] = 2	OR 1
p2801[4] = 2	OR 2
p2802[3] = 3	Timer 4
p2801[0] = 1	AND 1

The FFBs are computed in the following sequence:

Timer 4, OR 1, OR 2, AND 1

BICO technology is used to interconnect the function blocks (refer to Section 6.1.5). In so doing, the function blocks can be interlocked with one another as well as with the remaining signals and quantities if these signals / quantities have the appropriate attribute (BO, BI, CO or CI).

6.4.4 Positioning down ramp

Data

Parameter range:	p0500, r0090 p2480 – r2489
Alarms:	-
Errors:	-
Function chart numbers:	-

Description

The positioning down ramp (this is enabled via p0500) can be used for applications where there is a requirement that, dependent on external event (e.g. BERO switch), a specific distance is moved through before the drive stops. In this case, the ET 200S FC frequency converter generates a steady (continuous) braking ramp by selecting OFF1 as a function of the actual load speed / velocity. This braking ramp stops/positions the drive.

6.4 Operating functions

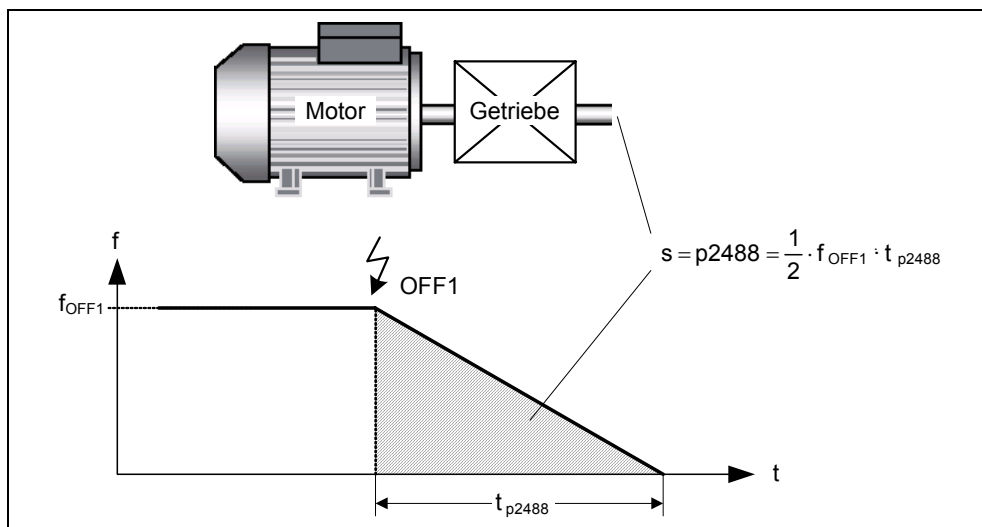


Fig. 6-23 Positioning down ramp

The distance to be moved through p2488 must be entered referred to the load. In order to calculate the distance to be moved through on the load side, the mechanical properties of the axis (gear ratio, linear or rotary axis) must be parameterized using the appropriate parameters.

	Aufbau	Parameter
lin		$\ddot{U} = \frac{\text{Motorumdrehungen}}{\text{Lastumdrehungen}} = \frac{p2481}{p2482}$ $z = \text{Schraubspindel} = \frac{\text{Anzahl Umdrehungen}}{1 \text{ [Einheit]}} = p2484$
rot		$\ddot{U} = \frac{\text{Motorumdrehungen}}{\text{Lastumdrehungen}} = \frac{p2481}{p2482}$

Fig. 6-24 Rotary or linear axis

Using this data, the ET 200S FC frequency converter calculates the ratio between distance and motor revolutions and can therefore analyze the motion on the load side.

Note

r0090 indicates the position of the rotor in °. r2489 indicates the number of revolutions up to f = 0.

6.4.5 Automatic restart (WEA)

Data

Parameter range:	p1210, p1211
Alarms	A0571
Errors	F0035
Function chart number:	-

Description

Using the automatic restart function it is assumed that the ON command is continually made.

If p1210 is set > 2, then the motor can automatically start after the power returns without the ON command having to be re-issued. The frequency converter then automatically acknowledges the existing faults.

A differentiation is made between the following scenarios when it comes to power failure:

Mains undervoltage

A "mains undervoltage" condition exists if the 400 V power supply of the power module is briefly interrupted - however the control unit ICU24(F) supply is still available.

Mains failure

A "mains failure" exists if the power supply of the power module IPM25 **and** the 24 V power supply of the ICU24(F) have both failed.

Different drive responses can be parameterized depending on the event and the setting of parameter p1210:

p1210 = 0

- Automatic restart inhibited (this setting makes sense for networked drives).
- After the power returns, it may be necessary to acknowledge possible faults. A new ON command must be issued so that the frequency converter starts.

p1210 = 1

- After a power failure, the frequency converter automatically acknowledges all of the faults (resets them) as soon as the power is restored.
- Faults caused by a mains undervoltage are not automatically acknowledged.
- The frequency converter doesn't automatically restart.
- The frequency converter only resumes operation after the ON command was re-issued after the power is restored.

6.4 Operating functions

p1210 = 2

- After a power failure, the frequency converter automatically acknowledges Fault F0003 (it resets this fault) as soon as the power is restored; the frequency converter then automatically restarts.
- All other faults are not automatically acknowledged.
- Faults due to a mains undervoltage condition are not automatically acknowledged.
- When the ON command is issued with the frequency converter in a no-voltage condition, then this only results in an automatic restart if the frequency converter was in the "ready to run" state when the power failed.

p1210 = 3

- The frequency converter automatically acknowledges all of the faults (it resets them) as soon as the power is restored, it automatically restarts.
- The frequency converter behavior is independent of the power failure or mains undervoltage.
- When the ON command is issued in the no-voltage state, this has no effect if the frequency converter was ready to run before the power failure.
- The number of start attempts can be set (if the automatic restart is interrupted due to a new fault).

p1210 = 4

- After a power failure or a mains undervoltage condition, the frequency converter automatically resets Fault F0003 (it resets the fault) as soon as the power voltage is restored and then it automatically restarts.
- All other faults are not automatically acknowledged.
- An ON command in the no-voltage state has no effect.
- The number of start attempts can be set (if the automatic restart is interrupted due to a new fault).

p1210 = 5

- After a power failure, the frequency converter automatically acknowledges all of the faults (it resets these) as soon as the power is restored, it automatically restarts.
- Faults due to a mains undervoltage are not automatically acknowledged.
- When an ON command is issued in the no-voltage state, this always results in an automatic start. Possible faults are first automatically acknowledged.

p1210 = 6

- The frequency converter automatically acknowledges all of the faults (it resets them) as soon as the power is restored, and then automatically restarts. The behavior of the frequency converter is independent of the power failure or mains undervoltage condition.
- If the ON command is issued during the power failure, then the frequency converter is always automatically restarted. Possible faults are first automatically acknowledged.

The automatic restart p1210 as a function of external states / events is summarized in the following (refer to Table 6-16).

Table 6-16 Automatic restart

p1210	ON always active (permanent)				ON in no-voltage condition	
	Fault F0003 on Blackout	Brownout	All other faults on Blackout	Brownout	All faults on Blackout	No faults on Blackout
0	-	-	-	-	-	-
1	Fault acknowl.	-	Fault acknowl.	-	Fault acknowl.	-
2	Fault acknowl. + restart	-	-	-	-	Restart
3	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	-
4	Fault acknowl. + restart	Fault acknowl. + restart	-	-	-	-
5	Fault acknowl. + restart	-	Fault acknowl. + restart	-	Fault acknowl. + restart	Restart
6	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Restart

The number of start attempts is specified using parameter p1211. The number is internally decremented for each unsuccessful attempt. After all of the attempts have been unsuccessfully completed, the automatic restart function is interrupted with Message F0035. After a successful start attempt, the counter is again reset to the initial value.

Note

The "flying restart" function (refer to Section 6.4.6) must be additionally activated if, when automatically restarting, the frequency converter is to be connected to a motor that is already spinning.



Danger

For longer power failures and when the automatic restart function is activated, it can appear that the frequency converter is powered-down for a longer period of time. However, when the power is restored, the motors can automatically restart without any additional operator action!

When the operating zone of the motors is entered when the frequency converter is in this state, this can result in death, severe bodily injury or material damage.

6.4 Operating functions

6.4.6 Flying restart

Data

Parameter range:	p1200 p1202, p1203 r1204, r1205
Alarms:	-
Errors:	-
Function chart number:	-

Description

The "flying restart" function (enabled using p1200, refer to Table 6-17) allows a frequency converter to be connected to a motor that is still spinning. If the frequency converter would be powered-up without a flying restart function having been activated, there would be a very high probability that Fault F0001 would be output with overcurrent. This is because as the flux in the motor must first be established and the V/f control or closed-loop Vector control must be set corresponding to the motor speed. With the flying restart function, the frequency converter frequency is synchronized to the motor frequency.

When the frequency converter is powered-up as "standard" it is assumed that the motor is stationary and the frequency converter accelerates the motor from standstill up to the setpoint speed. However, in many cases this pre-condition is not present. A typical example is a fan drive. For fan drives when the frequency converter is powered-down, the air flowing through the fan can cause it to rotate in any direction.

Table 6-17 Settings for parameter p1200

Parameter p1200	Flying restart active	Search direction
0	Inhibited	-
1	Always	Starts in the direction of the setpoint
2	For power on and fault	Starts in the direction of the setpoint
3	For fault and OFF2	Starts in the direction of the setpoint
4	Always	Only in the direction of the setpoint
5	For power on, fault and OFF2	Only in the direction of the setpoint
6	For fault and OFF2	Only in the direction of the setpoint

Note

If p1215 is set to 1 (motor holding brake is active) for OFF2 the drive is always ramped down to 0 Hz. This is the reason that in this case the flying restart function is not necessary.

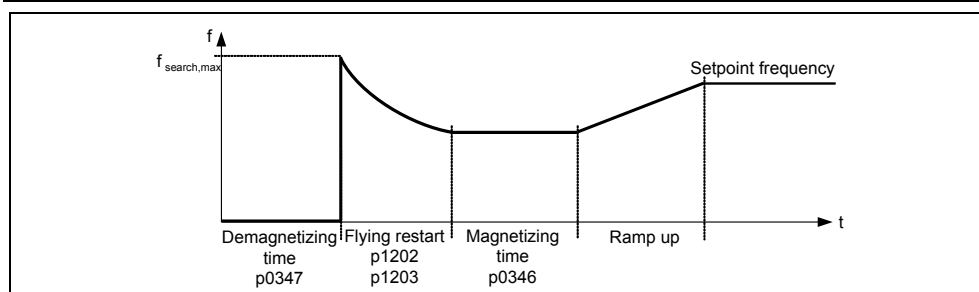


Fig. 6-25 Flying restart

Flying restart without speed encoder

After the de-magnetization time p0347 has expired, depending on p1200, flying restart is started with the maximum search frequency $f_{\text{search,max}}$ (refer to Fig. 6-25).

$$f_{\text{search,max}} = f_{\text{max}} + 2 \cdot f_{\text{slip,standard}} = p1802 + 2 \cdot \frac{r0330}{100} \cdot p0310$$

This is realized either after the power is restored and the automatic restart function is activated or after the last shutdown with OFF2 command (the pulses are disabled).

V/f characteristic (p1300 < 20):

The search frequency is reduced as a function of the DC link current using the search speed that is calculated from parameter p1203. In so doing, the parameterizable search current p1202 is impressed. If the search frequency is close to the rotor frequency, then the DC link current suddenly changes as the flux in the motor is established. Once this state has been reached, the search frequency is kept constant and the output voltage is changed to the voltage value of the V/f characteristic with the magnetizing time p0346 (refer to Fig. 6-25).

Closed-loop Vector control without speed encoder (SLVC):

Starting from the initial value, the search frequency approaches the motor frequency as a result of the impressed current p1202. When these two frequencies coincide, then the motor frequency has been found. The search frequency is then kept constant and the flux setpoint is changed to the rated flux with the magnetizing time constant (this is dependent on p0346).

After the magnetizing time p0346 has expired, the ramp-function generator is set to the speed actual value and the motor is operated at the actual setpoint (reference) frequency.

6.4 Operating functions

Flying restart with speed encoder

After the de-magnetizing time p0347 has expired, depending on parameter p1200, a flying restart is started with the maximum search frequency $f_{\text{search,max}}$:

- After the power has been restored and the automatic restart function has been activated, or
- After the last shutdown with OFF2 command (pulses disabled)

V/f characteristic (p1300 < 20):

For the V/f control, the output voltage of the frequency converter is linearly increased from 0 to the V/f characteristic value within the magnetizing time p0347.

Closed-loop Vector control with speed encoder (VC):

For the closed-loop Vector control, the necessary magnetizing current is established within the magnetizing time p0347.

After the magnetizing time p0346 has expired, the ramp-function generator is set to the speed actual value and the motor is operated at the actual setpoint (reference) frequency.

Note

- A higher search speed p1203 results in a flatter search curve and therefore in a longer search time. A lower value has the opposite effect.
- For a "flying restart" a braking torque is generated which, for drives with low moment of inertia, can cause them to brake.
- The "flying restart" function should not be activated for group drives due to the different run-down behavior of the individual motors.



Warning

- When "flying restart" is active (p1200 > 0), the drive, in spite of being at standstill and with a setpoint 0, can accelerate as a result of the search current !
- When the operating zone of the motors is entered when the frequency converter is in this state, this can result in death, severe bodily injury or material damage.

Caution

The "flying restart" function interacts with the "safely reduced speed" safety function.

Fault F1600 is output if the "safely reduced speed" is activated during the flying restart.

6.4.7 Braking functions

Overview

The ET 200S FC frequency converter offers different braking functions for the various applications:

- **Motor holding brake**
This secures the motor, when it is powered-down, against undesirable motion.
- **Regenerative brake**
Kinetic energy is fed back into the line supply.

6.4.7.1 Motor holding brake (MHB)

Data

Parameter range:	p1215 p0346, p1216, p1217, p1080 r0052 bit 12
Alarms:	-
Faults:	-
Function chart number:	-

Description

The brake sequence control of the frequency converter (this is enabled via p1215) can be used to control the motor holding brake for drives that must be secured against undesirable motion when they are switched off. The brake is always closed when the MHB is not activated.

Before the brake is opened, a current must be established that maintains the drive in the relevant position. Pulses must be enabled to generate this current. In this case, the current is defined by the min. frequency p1080. A typical value for this is the rated motor slip r0330. In order to protect the motor holding brake against permanent damage, the motor may only be moved further after the brake has been released (brake release times between 15 ms and 500 ms). This delay must be taken into account in parameter p1216 "release delay, holding brake" (refer to the following diagram).

Furthermore, the following two modules have an effect on the MHB:

- Safe Torque Off (STO)
- Motor holding brake (MHB).

Both modules can access the brake at the same time. The STO function has top priority and cannot be overridden by any other function.

6.4 Operating functions

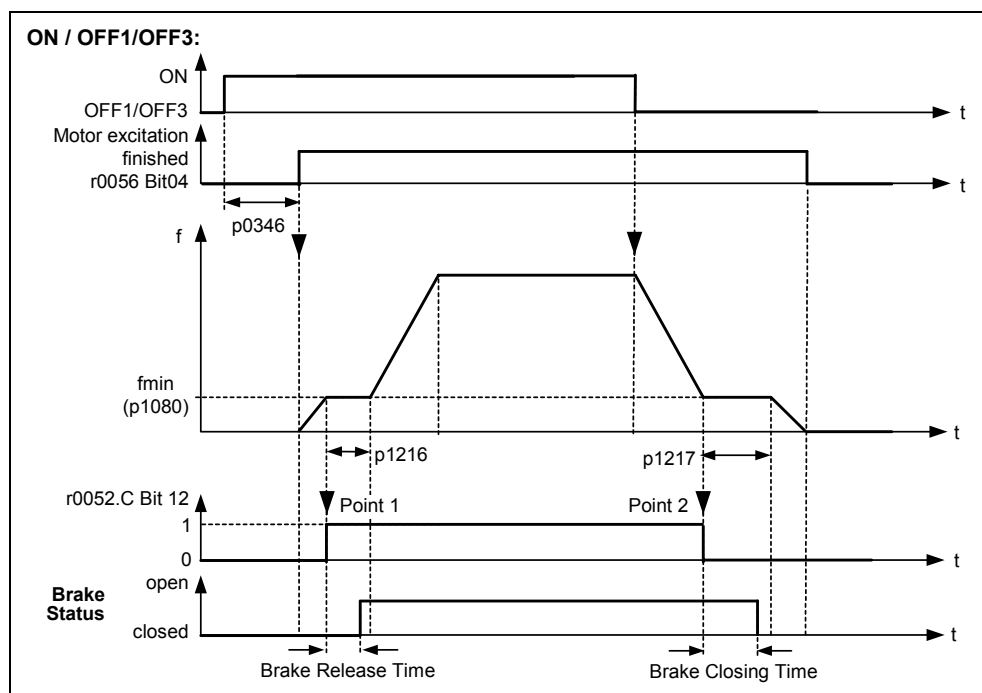


Fig. 6-26 Motor holding brake after ON/OFF1 and ON/OFF3

The motor holding brake is closed either using OFF1/OFF3 or OFF2. For OFF1/OFF3, when the motor reaches the min. frequency p1080, this frequency is maintained until the brake has closed (brake closing times between 15 ms and 300 ms). This time is specified using parameter p1217 "Holding time after runout" (refer to the diagram above). If, on the other hand, an OFF2 command is initiated, status signal r0052 bit 12 "Motor holding brake active" is reset, regardless of the motor status. This means that the brake immediately closes after an OFF2 command (rapid deceleration).

The mechanical brake is controlled using status signal r0052 bit 12 "Motor holding brake active" from the brake control. This signal is transmitted to the brake control module.



Warning

To activate the motor holding brake, parameter p1215 must also be set to 1.

If the motor holding brake is controlled by the frequency converter, then it is not permissible to carry out series commissioning for potentially hazardous loads (e.g., suspended loads for crane applications) unless the load is secured. Potentially hazardous loads can be secured as follows before series commissioning:

- Lower the load to the floor
 - Clamp the load using the motor holding brake
(Notice: During series commissioning, the frequency converter must be prevented from controlling the motor holding brake).
-

Note

Motors have optional holding brakes that are not designed as operating brakes. The holding brakes are only designed for a limited number of emergency braking operations/motor revolutions with the brake closed (refer to the Catalog data).

When commissioning a drive with integrated holding brake, it is therefore extremely important to ensure that the holding brake functions correctly. A "clicking" sound in the motor indicates that the brake has correctly released

Before installing a motor holding brake, it is necessary to establish a torque that will secure the motor in the required position. The frequency converter pulses must be enabled in order to create the required torque, which is defined by the lowest frequency in parameter p1080. A typical value for this is the rated motor slip r0330. In addition, this torque can be changed using the following parameters:

- V/f control/boost parameter p1310
- SLVC boost parameters p1610 and p1611
- VC torque auxiliary setpoint p1511

If the motor shaft rotates while the holding brake is applied, the motor holding brake can be permanently damaged. Controlling the motor holding brake at the correct time is therefore extremely important.

6.4 Operating functions

6.4.7.2 Regenerative braking

Data

Parameter range:	p0307, p0310, p1082, p1531, r1537
Alarms:	A0502
Errors:	F0002, F0028
Function chart number:	-

Description

For certain drive applications, the motor can operate as a generator in specific operating states. Typical examples of these types of applications include:

- Cranes
- Traversing drives
- Conveyor belts where the material is being transported downwards

For regenerative motor operation, the motor energy is fed back into the mains supply via the inverter and the mains-commutated rectifier of the ET 200S FC frequency converter. The advantages of regenerative braking include:

- The kinetic energy is not converted into heat in the motor
- The kinetic energy does not have to be converted into heat in an external resistor
- It has a significantly higher dynamic response and can be used in all operating states (not only for an OFF command)
- It allows precise braking along a down ramp
- Continuous regenerative operation is possible - e.g. for cranes
- Only a low level of harmonics are injected back into the mains supply for regenerative braking

Note

If regenerative feedback into the line supply is required at the rated frequency the maximum frequency (p1082) must be greater than the rated motor frequency (p0310).

Caution

If the power fed back into the mains supply exceeds the rated power of the ET 200S FC frequency converter, then the frequency converter is shut down with fault F0028.

6.5 Safety Integrated

Data

Parameter range:	p9601 – p9899
Alarms:	A1690 – A1699
Faults:	F1600 – F1660
Function chart number	

Safety Integrated (SI)

Highly-effective personnel and machine protection can be implemented in-line with that required in practice using the EC type-tested safety-functions of "Safety Integrated". This safety technology allows the following to be implemented:

- High degree of safety
- Higher degree of cost-effectiveness
- Higher degree of flexibility
- Higher degree of plant/system availability

The following safety functions (SI functions) are available for the ET 200S FC frequency converter with ICU24F control unit:

Safe standstill (SH) = Safe torque off (STO)

"Safe standstill" is used when a fault condition occurs or in conjunction with a machine function (e.g. Emergency Stop) to safely disconnect the power feed to the motor.

The "safe standstill" (SH) is a function to avoid unexpected starting according to EN 60204 – 1, Section 5.4.

Safe braking ramp (SBR) = Safe stop 1 (SS1)

This function is based on the expected condition that after a stop request, the speed or velocity of a drive must be reduced down to standstill. After the stop request has been output, the system permanently checks as to whether the speed or velocity decreases within the set limits.

Safely-reduced speed (SG) = Safely-limited speed (SLS)

This function is used to safely monitor a limit value for the speed or velocity of a drive.

Note

The safety functions run on the processors of the ET 200S FC frequency converter with ICU24F. After the safety function has been initiated, no higher-level control is required.

6.5 Safety Integrated

Information regarding safety-relevant functions**Shutting down from the "safely-reduced speed" operating state**

Note

If "safely-reduced speed" is selected, the drive can be shutdown using "safe standstill".

It is not possible to shutdown using the non-safety relevant commands OFF1 / OFF3. However, the frequency converter can also be shut down using the non-safety relevant OFF2 (pulse inhibit).

"Safely reduced speed" and "safe braking ramp" not for V/f control

**Warning**

the V/F control type is not suitable to maintain the speed within a tolerance bandwidth, required by the "safely-reduced speed" and "safe braking ramp" function.

This means that the safety-related functions "safely reduced speed" and "safe braking ramp" may not be used when V/f control is being used.

De-selecting the "safely reduced speed and "safe braking ramp"

Note

The "safely reduced speed" and "safe braking ramp" states can be withdrawn by removing the safety-relevant signal. The frequency converter then returns to the setpoints that are present unless it already reached the state "safe standstill" via the "safe braking ramp" function.

The "safe standstill" state is **not** withdrawn by just withdrawing the safety-relevant signal. A new on command is always required in order to initiate the "safe standstill" state.

Effective cooperation and competent partner

This safety concept is the result of close cooperation with the "Institute for Occupational Safety and Health (BIA)" in St. Augustin and Siemens AG in Erlangen.

Standards and Directives

Various Standards and Directives must be maintained and observed in safety-related systems.

Directives are mandatory both for the manufacturer as well as for the company actually operating the machines.

Standards reflect the general state-of-the-art technology and provide support when implementing safety concepts; however, contrary to the Directives, they are not binding (mandatory).

The following list shows an excerpt of Standards and Directives in safety technology.

- EC Machinery Directive 98/37/EC
This Directive defines basic protective goals in safety systems
- EN 292 - 1
Basic terminology and general design guidelines
- EN 954 - 1
Safety-related parts of controls
- EN 1050
Risk assessment
- DKE 226.03
Safety-related function of electrical drive systems and machines
- EN 61800-3
EMC product standard including special test techniques
- EN 61800-5-1
Requirements placed on the safety of variable-speed electric drive systems
- IEC 61508
Functional safety of electrical and electronic systems

This Standard defines so-called Safety Integrity Levels (SIL) that define a certain safety integrity level of safety-related software as well as quantitatively defined ranges of probability that the hardware develops a fault.

Note

The safety functions for ET 200S FC frequency converters fulfill the following requirements:

- Category 3 according to EN 954 - 1
 - SIL 2 according to IEC 61508
-

6.5 Safety Integrated

Shutdown paths

In the ICU24F control unit there are two shutdown paths that are independent of one another for the power electronics. All of the shutdown paths are low active. This means that it is guaranteed that when a component fails or when a cable is interrupted, the system is always switched into the safe state.

If a fault/error is detected in the shutdown paths, the "safe standstill" function is activated thus preventing a restart. In this case, the fault cannot be simply acknowledged as the "safe standstill" was caused by a fault state.

Two-channel monitoring structure

All of the hardware and software functions that are important for Safety Integrated are implemented in two monitoring channels that are independent of one another (e.g. shutdown paths, data management, data comparison).

Expected state

The monitoring functions in each monitoring channel are based on the principle that before an action, the system must be in a defined state and after the action, a certain feedback signal must have been received.

If this expected state is not fulfilled in a monitoring channel, then the drive is shutdown through two channels and an appropriate message is output.

Forced checking procedure and testing the shutdown paths

The forced checking procedure of the shutdown paths is used to detect faults/errors in the software and hardware of the two monitoring channels as early as possible. This test is automatically executed when selecting/de-selecting the "safe standstill" function or for OFF/ON (24 V) the frequency converter.

When selecting/de-selecting the "safe standstill" function it should also be noted that the parameters to activate the forced-checking procedure (p9601/p9801) must be set to 3. This means that a higher-level control is not required for the safety functions.

In order to fulfill the requirements specified in EN 954 - 1 to detect faults/errors early, the two shutdown paths must be tested at least once within a specific time interval to ensure that they are operating correctly. The user must implement this by either manually initiating the forced checking procedure or initiating it in the automated process.

A timer r9660 (timer for the forced checking procedure) is used to monitor that the forced checking procedure is carried-out at the appropriate times. The timer parameter r9660 can be set using parameter p9659.

The shutdown paths must be subject to a forced checking procedure at least once within the time set in this parameter.

After this time interval has expired, an appropriate alarm is output (A1699). This is present until a new forced checking procedure has been carried-out.

After each successful forced checking procedure the timer is reset to the value selected in p9659.

For an operational machine it can be assumed that there are no potential hazards for personnel as a result of the appropriate safety devices and equipment (e.g. protective doors). This is the reason that the user is only flagged using alarm A1699 when a forced-checking procedure should be carried-out therefore prompting him to carry-out the forced-checking procedure at the next possible opportunity. This alarm has no negative effect on the operation of the machine.

The user must set the time interval to carry-out the forced-checking procedure between 1 and 8760 hours depending on his particular application.

Examples for carrying-out the forced-checking procedure:

- When drives are stationary after the plant/system has been powered-up
- When opening a protective door
- In a specified cycle (e.g. in an 8-hour cycle)
- In the automatic mode, dependent on the time and specific events

Note

For safety-relevant reasons, the forced checking procedure must be cyclically activated in order to check the safety functions. The cycle can be set in p9659. The default setting is 8 hours.

After the time set in p9659 has expired, the frequency converter sets a status bit (r9772, bit 6) and outputs Alarm A1699. This flags the necessity to carry-out a forced checking procedure. This means that the process control must, at the next opportunity, activate the "forced checking procedure". This next opportunity could be if the drive was to briefly stop with speed 0 anyway. Setting and deleting the safety status bus (r9772) and the forced checking procedure must be logged by the higher-level control as process data.

Caution

The forced checking procedure is always carried-out independent of the setting in p9601/p9801

- After switching-in the voltage for the control unit (24 V) (powering-up)
- If the "safe standstill" state is exited as a result of an internal fault

It can be disabled using p9601/p9801 if "safe standstill" was exited due to an operating state (e.g. a protective door was opened).

6.5 Safety Integrated

Note

If the safety functionality and forced checking procedure are activated (p9601 = 3 or p9801 = 3) the drive executes a processor self test and tests the shutdown paths. r0052.6 = 1 for this time (approx. 2.4 s); this means that the power-on command is inhibited.

If a power-on command is issued during this time, then it is ignored. The drive only accepts the power-on command after the forced checking procedure has been completed and after r0052.6 was set to 0. For a power-on command, the drive only responds to positive signal edges. This is the reason that before issuing the power-on command r0052.6 = 0 is checked using FB100 (STAT output) and only then can the power-on command be output.

If the "safe standstill" function is initiated during the forced checking procedure, then this appears in the safety status word as selected (r9772.0 = 1), but not active (r9772.1 = 0). When exiting the forced checking procedure, the "safe standstill" function is then automatically set to active (r9772.1 = 1).

Caution

When carrying-out the forced checking procedure, the shutdown paths of the motor brake are also tested. This results in the motor brake briefly opening (2 ms – 16 ms).

The mechanical part of the brake generally requires longer than 20 ms to open. This means that this dynamic operation generally has no influence on the motor shaft itself.

However, if a mechanical brake is used that quickly responds, then in addition, the "motor holding brake" function should be additionally activated (p1215 = 1). In this case, the mechanical brake always remains closed.

Monitoring clock cycle

The safety-relevant monitoring functions for the drives are cyclically executed in the millisecond range.

6.5.1 Integrating the fail-safe frequency converter into the ET 200S system

Description

The safety functions of the frequency converter were initiated by safety-relevant shutdown groups within the ET 200S system. These shutdown groups are fed from a power module (PM-D F Profisafe or PM-D F X1) and evaluated by the frequency converter using safety-relevant inputs.

There are three different concepts to control the fail-safe functions of the ET 200S FC frequency converter:

1. Control using PROFIsafe

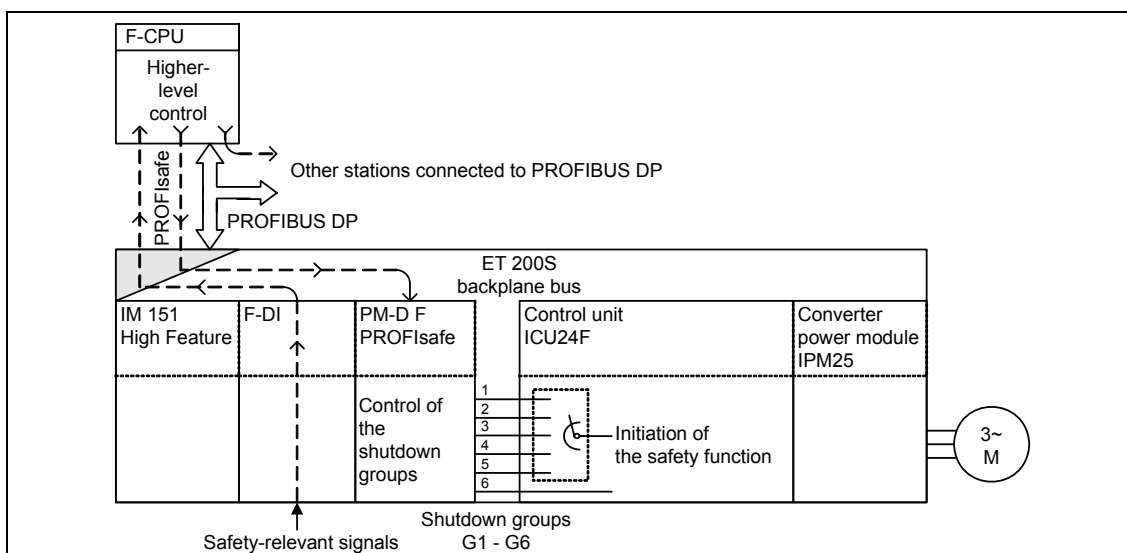


Fig. 6-27 System structure (control via PROFIsafe)

The safety functions are initiated by the PM-D F PROFIsafe power module. This receives its data via the backplane bus from the IM 151 High Feature interface module. The power modules communicate with the higher-level control via PROFIBUS DP with the additional PROFIsafe protocol.

6.5 Safety Integrated

2. Local functional cell with fail-safe CPU

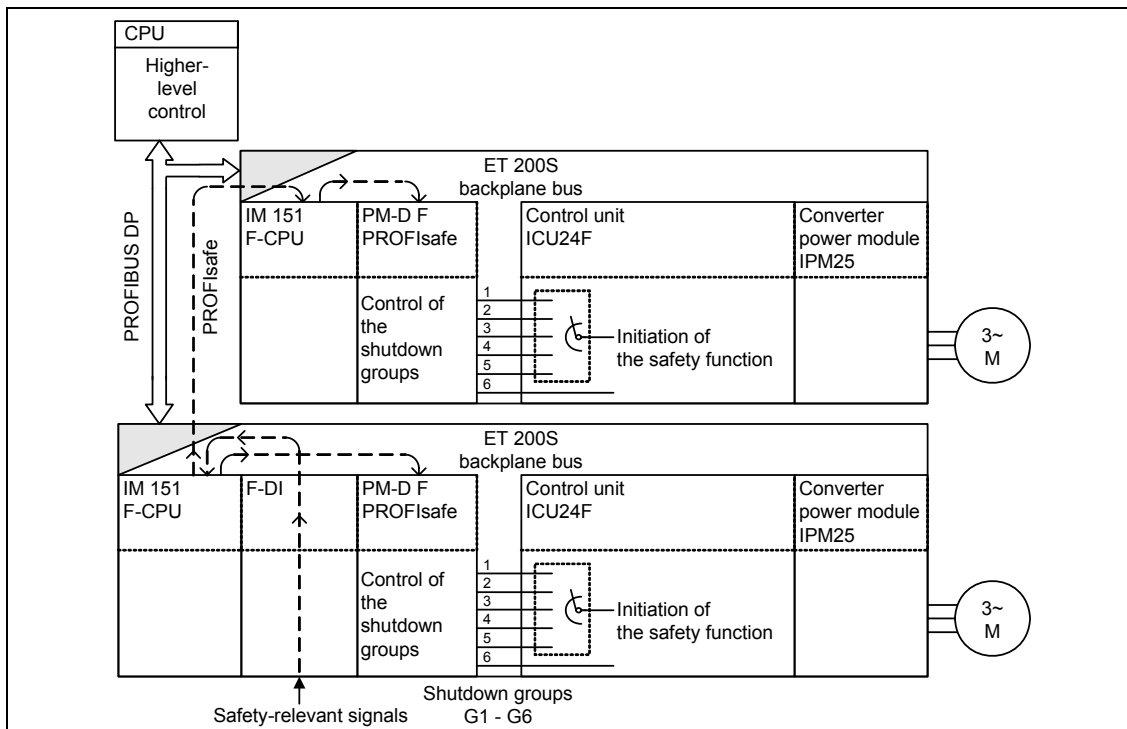


Fig. 6-28 System structure (with fail-safe CPU)

The PM-D F PROFIsafe power module can also be directly controlled via an IM 151 F-CPU - i.e. via an interface module with integrated, fail-safe CPU. Several of these IM 151 F-CPU can communicate with one another in a safety-related fashion using PROFIBUS DP if a higher-level fail-safe CPU is being used.

3. Conventional control via terminals

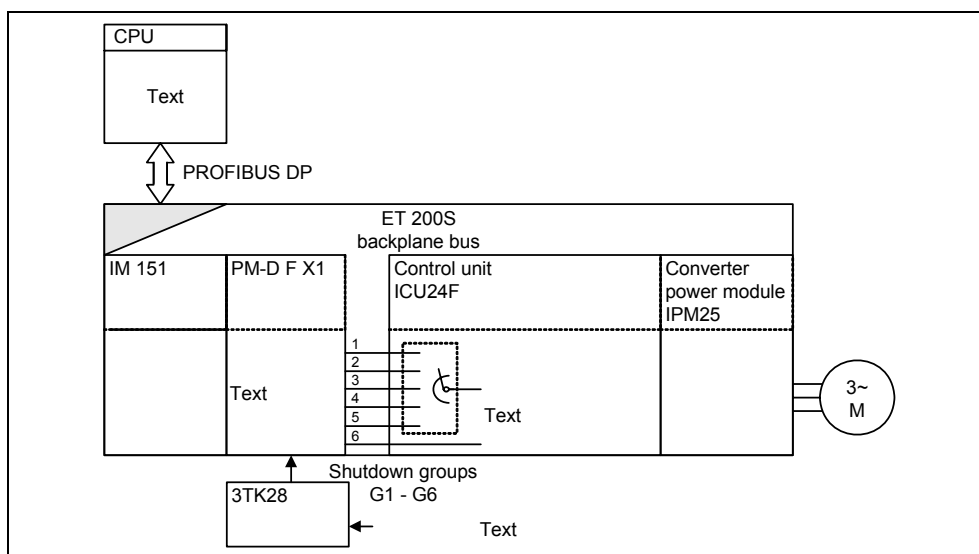


Fig. 6-29 System structure (control via terminals)

The shutdown groups can be directly controlled from external safety equipment and devices via the PM-D F X1 power module. These devices can include, for example, Emergency Stop pushbuttons, protective door contacts or light curtains. However, the safety-related signals cannot be transferred further via PROFIBUS DP.

Shutdown groups

The PM-D F power modules generate six safety-related output signals (low active: 0 = 24 V, 1 = 0 V) - which means that they operate according to the closed-circuit principle. In this case, shutdown group 6 (G6) is permanently assigned "safely-reduced velocity". One of the shutdown groups 1 (G1) to 5 (G5) is defined for the "safe standstill" function by appropriately parameterizing the system (p9603/p9803). This means that there are four possibilities of combining the signals; their significance and associated system behavior when the appropriate signal combination occurs are listed in the following table.

Table 6-18 Selecting the safety functions

1 bus from 1 to 5	Bus 6	System behavior	Priority
0 (24 V)	0 (24 V)	Standard operation	4
0 (24 V)	1 (0 V)	Safely-reduced speed (SG)	3
1 (0 V)	1 (0 V)	Safe braking ramp (SBR)	2
1 (0 V)	0 (24 V)	Safe standstill (SH)	1

The priority of the system behavior defines which of the safety functions can disable another safety function.

6.5 Safety Integrated

Caution

The "safe standstill" safety function cannot be terminated or withdrawn using the normal OFF1, OFF2 and OFF3 functions.

The "safely-reduced speed" function can be withdrawn by an OFF2, "safe standstill", or safe braking ramp.

The function "safe braking ramp" is interrupted by an OFF2 or "safe standstill".

Note

It is technically not possible to simultaneously select both buses at precisely the same time. This is the reason that when transitioning from one safety function to another, where the states of both buses should be simultaneously changed (e.g. standard operation -> "safe braking ramp"), the safety function with the lower priority is always first selected. The reason for this is that this can be exited in the direction of a safety function with a higher priority.

For example, in order to select the "safe braking ramp" function (SBR) from the normal operating mode, initially, shutdown group 6 ("safely-reduced speed", priority 3) and then after a delay (> 16 ms) the parameterized shutdown group (G1 - G5) should be selected. If simultaneously selected, under certain circumstances, "safe standstill" would be immediately selected as it would no longer be possible to exit in the direction of "safe braking ramp" due to the higher priority.

The corresponding applies for the transition from the "safe braking ramp" into the normal operating mode - whereby, as a result of assigning priorities, "safely-reduced speed" is again initially selected.



Warning

If "safely-reduced speed" is selected, the drive can be shut down using "safe standstill".

However, it is not possible to shut down using the non safety-relevant OFF1/OFF3 commands. However, the converter can also be shut down using the non safety-relevant OFF2 command (pulse inhibit).

6.5.2 Parameters, checksum, password

Properties of parameters for Safety Integrated

For the Safety Integrated parameters, the following applies:

- They are separately saved for each monitoring channel.
- Changes are only possible in the safety commissioning mode (p0010 = 95).
- They are additionally protected against incorrect use/manipulation using a password.

At run-up, after parameter changes and every 4 ms, two actual checksums (CRC) are generated over all safety-related parameters. These are cyclically compared with setpoints that have been manually entered.

Note

For new ICU24F control units, p8457 is at 1. It is set to 0, if

- the frequency converter is connected to the control
- a converter power module is inserted
- a parameter value is changed – with the exception of parameters p0010, p0803 and p3900.

In certain cases (hot swap, etc.) it may be necessary to set p8457 = 1 also for a control unit that is not brand new. In order to avoid that this parameter is accidentally reset in the safety mode, for ICU24F control units this parameter is password protected.

Password

Safety-related parameters are protected against unauthorized changes using the safety password.

In the commissioning mode for Safety Integrated (p0010 = 95), it is only possible to change safety-related parameters after the valid safety password has been entered in p9761.

- The following applies when first commissioning Safety Integrated:
 - safety password r9760 = 12345
- Changing the password:
 - p0010 = 95 commissioning mode
 - p9761 = enter the "old safety password from r9760"
 - p9762 = enter a "new password"
 - p9763 = acknowledge the "new password"

From now onwards, the new acknowledged safety password, that can be seen in r9760, is effective.

6.5 Safety Integrated

Checking the checksum

Within the safety-related parameters, there is one parameter each for the actual and reference checksum (CRC) for all of the checked safety-related parameters.

When commissioning the safety system, the actual checksum must be read and manually entered into the appropriate parameters of the reference checksum.

- r9798/r9898 actual checksum of the SI parameters
- p9799/p9899 reference checksum of the SI parameters

The actual checksum is calculated for all of the safety-related parameters every 4 ms and then compared with the reference checksum.

If the actual and reference checksums are different, then the "safe standstill" is automatically initiated. In this particular case it cannot be simply acknowledged as this would result in a fault state.

Monitoring the safety-related parameters

Errors when writing into safety-related parameters in the processors can only be eliminated by regularly reading them out (upload). This is the reason that the higher-level control cyclically reads-out (uploads) all of the safety-related parameters and compares them with the data saved there.

Note

In order to detect errors when writing and saving safety-relevant data, the control system must read-out all of the safety-related parameters after powering-up the control unit and before the pulse enable as well as in an 8-hour cycle and compare them with the expected values. In the case of a deviation, the system should go into a "safe standstill" state via the shutdown group and a message issued. This operation should be logged.

6.5.3 Handling the safety-related parameters

Description

For reasons of safety, all safety-relevant parameters in the frequency converter are saved at two different locations. This is the reason that every safety-relevant parameter is available twice with two different parameter numbers (e.g. p9601 and p9801).

Safety-related parameters can be changed in the following way:

- During commissioning (a safety password is required).
- By resetting the safety parameters to the basic setting (the safety password is required).
- By automatically copying from an MMC-PS after a new start (in this case a safety password is not required).

Caution

The safety password prevents the safety functions from being modified - either as a result of accidental or incorrect parameterization. This is the reason that the safety password should only be made accessible to appropriately trained personnel.

When automatically copying from the MMC-PS after a new start (e.g. after a basic frequency converter replacement), in order to ease the handling, it is not necessary to enter the safety password. However, in order to prevent incorrect parameterization, various internal safety prompts have been integrated. These are intended to accidentally prevent using an incorrect parameter set. These safety prompts depend on specific secondary conditions/limitations and parameters that are described in the following section.

6.5 Safety Integrated

6.5.3.1 Protection against inadmissible parameterization

Description

When the control unit runs-up after power failure or after it has been withdrawn/ inserted, a check is made as to whether the module is inserted in the correct slot. The run-up procedure is the same for frequency converters with and without integrated safety functionality.

While running-up, the following safety-relevant parameters are transferred from the control system that were configured using HW Config when commissioning the system in the SIMATIC Manager (refer to the Chapter "SIMATIC S7 coupling):

- Configuring the safety functionality – safety system
- Configuring the MMC-PS - MMC (PMMC)
- Slot identifier - ID (SPICPU)

Note

The names in the brackets indicate the names of the parameters that can be set in the hardware configuration of the ICU24(F). The internal frequency converter designation of these parameters is as follows:

- ID (SPICPU) = p8455
- MMC (PMMC) = p8456
- Safety-Unit (PMMC) = p8456

Additional information is provided in the Section "Handling ET 200S FC frequency converters"

6.5.3.2 Slot identifier – ID (SPICPU)

Description

The ID for the slot is defined when configuring the ET200S in HW Config.

The slot identifier couples the parameterization of the frequency converter with a specific slot within the ET200S system.

After the frequency converter has established a connection to the control (PLC), it compares this slot ID sent from the control (SPICPU) with the internally saved slot (p8455) - therefore checking as to whether it is permissible to start.

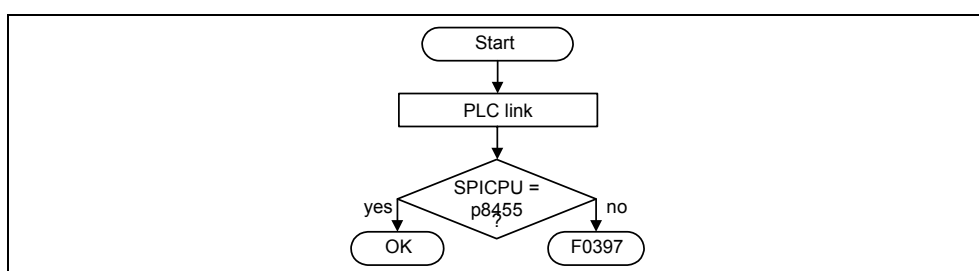


Fig. 6-30 Checking the slot ID

The internal slot ID (p8455) can only be changed in the following cases:

- Automatically overwritten by the control (PLC), if the frequency converter is new (p8457.0 = 1).
- Overwriting by parameters of an inserted MMC-PS.
- For a direct access if the drive is new (p8457.0 = 1).

Note

From the cases described here, it can be seen that a frequency converter only starts if it has a parameter set that was generated in the same slot (the same ID) or a new drive was directly assigned the correct ID in p8455. This is generally realized by making a direct parameter assignment during the commissioning (start-up) phase. The parameter set thus generated can be saved on an MMC-PS. This allows a frequency converter to be easily replaced.

If parameters are to be copied between different frequency converters (slots) then for the IDs (SPICPU), these slots must be assigned the same value in HW Config. However, this only makes sense if the drives of the various slots should also behave the same.

6.5 Safety Integrated

Caution

If the ICU24F control unit does not establish a coupling to the control (PLC), then the resulting wait state (waiting for PRM telegram) can be skipped by activating or exiting the safety commissioning mode

1. p0010 = 95
2. p3900 = 10 and p3900 = 11

In this case, the frequency converter always assumes (even for p3900 = 11), that the safety functions have been successfully commissioned and an acceptance test carried-out. This is the reason that the subsequent check of the slot ID and safety functionality are skipped.

It is **expressly** forbidden to deliberately disconnect the control (PLC) and frequency converter in order to skip the wait state.

The following procedure is used to modify the frequency converter slot ID:

5. p0010 = 95 commissioning mode
6. p9761 = password
7. p8457 = 1
8. p3900 = 11
9. p8455 = ID

Caution

The user is always responsible in ensuring a correct and suitable assignment of the slot IDs (SPICPU). If several drives are assigned to the same slot ID, then parameter sets can be copied between these drives. If the drives are incorrectly configured this could destroy the machine or even result in the safety functionality being lost.

6.5.4 Safety functions

Overview

The following safety functions (SI functions) are used for the ET 200S FC frequency converter with ICU24F control unit:

- Safe standstill (SH)
- Safe braking ramp (SBR)
- Safely reduced speed (SG)

Typical safety function reaction times

- When selecting/deselecting via shutdown groups: 20 ms.
 - For an error in a monitoring channel: 100 ms.
-

Note

The term "actual frequency" is used below to refer to the actual value of the converter output frequency (r0066) and not to the motor actual frequency.

Notes on safety-related functions

Shutting down from the "Safely reduced speed" operating status

Note

In the definition of safety functions in IEC draft 61800-5-2, "Adjustable speed electrical power drive systems", some new terms were adopted in respect of drive-related safety functions:

- Safe standstill (SH) = Safe torque off (STO)
 - Safe braking ramp (SBR) = Safe stop 1 (SS1)
 - Safely reduced speed (SG) = Safely-limited speed (SLS)
-

If "Safely reduced speed" is selected, the drive can be shut down using "Safe standstill" or "Safe braking ramp".

It is not possible to shut down using the non-safety-related commands OFF1/OFF3. However, the frequency converter can also be shut down using the non-safety-related command OFF2 (pulse disable).

Deselecting "Safely reduced speed" and "Safe braking ramp"

Note

The "Safely reduced speed" and "Safe braking ramp" statuses can be revoked by canceling the safety signal. The converter then runs up to the setpoints that are available, unless the "Safe standstill" status has already been reached via the "Safe braking ramp" function.

To restart the drive, the safety signal should first be revoked, and a new ON command is required.

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Notice

When configuring the drive, the centrifugal mass and torque of the drive must be taken into account for the purpose of setting the braking ramp.

**Warning**

The "Safe braking ramp" and "Safely reduced speed" functions are permitted for all applications where there can be no acceleration of the load after the frequency converter has been shut down.

With an overhauling load, the friction torque of the mechanical components (motor, gearbox, etc.) is not enough to prevent the mechanical system from accelerating when a drive has been shut down.

Examples of overhauling loads are hoisting gears (due to gravitation) and winders (due to a second drive).

The safety-related functions "Safe braking ramp" and "Safely reduced speed" must not be used with overhauling loads.

6.5.5 Safe standstill (SH) = Safe torque off (STO)

Description

For ET 200S FC frequency converters with safety functions (ICU24F control unit), "Safe standstill" can be achieved in various ways:

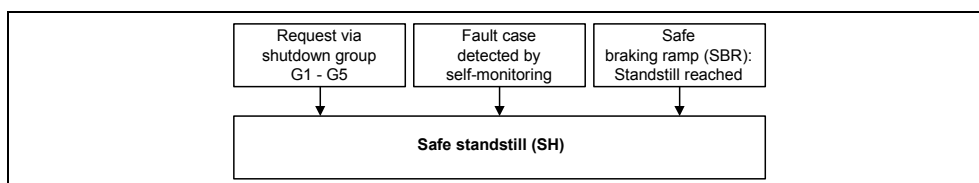


Fig. 6-31 Initiating "Safe standstill"

"Safe standstill" can be consciously and deliberately activated, with the intention of safely preventing the drive from restarting when, for example, the machine is being worked on. This state can be exited by canceling the appropriate shutdown group.

In contrast to this, "Safe standstill" can also be activated if the drive has to be stopped due to a fault condition that has been detected, but in this case, the drive may only be restarted after the fault has been removed and acknowledged.

"Safe standstill" can be operationally reached using the "Safe braking ramp" function. After selecting this function, the speed is reduced along the braking ramp and, when it falls below the lower limit frequency, which is parameterized using p9682/p9882, the "safe standstill" function is initiated.

Parameter range:	P0003, P0010
	P09761
	P9603/P9803
	P9690/P9890
	P9691/P9891
	P9692/P9892
	P9799/P9899/P3900
Warnings:	A1691, A1692, A1696, A1699
Faults:	F1600, F1616

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The "Safe torque off" (STO) function is the most straightforward safety function. Its purpose is to stop the torque safely. As soon as STO is activated, the motor is prevented from restarting. It can only restart once the STO signal has been canceled and an ON command has been sent. The pulse disable from the power module safely prevents motor-generated torque and if a mechanical brake is connected, this will be applied immediately.



Notice**Fault reaction time**

During an STO function, an internal fault will be recognized within 100 ms and will immediately result in the drive being passivated.

Once an STO function has been triggered, the converter performs the following processes:

- Power module pulse disable.
- The mechanical brake (if connected) is immediately applied.
- The SH status LED comes on.

Once the STO signal has been canceled, the converter performs the following processes:

- The converter runs a self-test.
- The process checking procedure is carried out (always).
- The forced checking procedure is carried out (if parameterized using p9601 and p9801).
- The timer for the forced checking procedure (p9660) is reset to the value in p9659 (as long as the forced checking procedure has been carried out successfully).
- The mechanical brake (if connected) is released.
- The SH status LED goes off.
- The motor can be switched back on with a positive edge (OFF1/ON).

These processes are displayed in the following image:

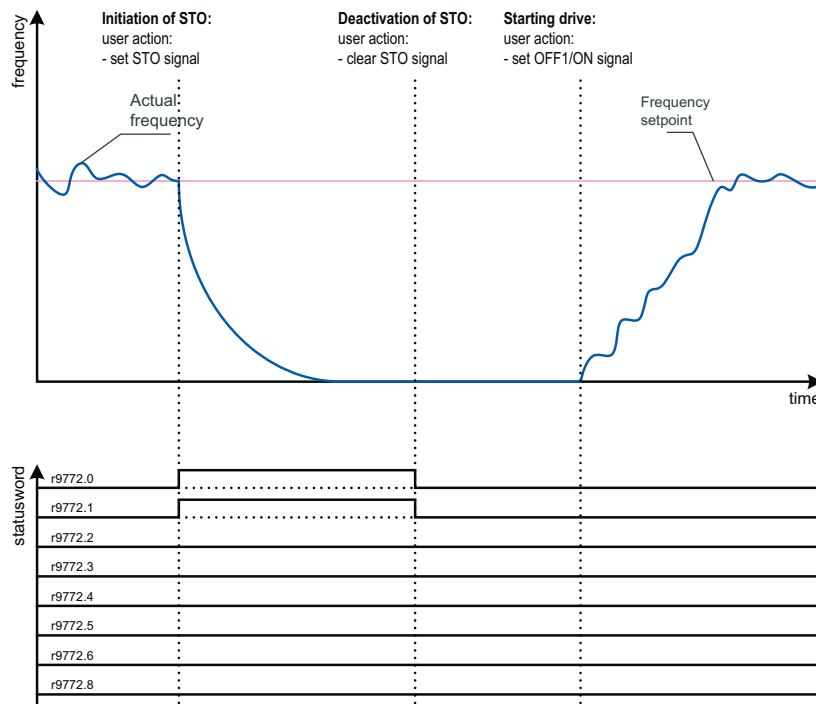


Fig. 6-1 "Safe torque off" function

The STO function has the highest priority and cannot be revoked by any other function.

Note

The status of the converter is displayed using r9772.

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Passivate the frequency converter (LSTO)

The "Passivate the frequency converter" function is always started when a safety function fault is detected that requires the drive to be shut down. The drive can only be operated again once the fault has been expressly acknowledged and a forced checking procedure has been carried out. The "Passivate the frequency converter" function is exited as follows:

- Shut down the drive by outputting an OFF1 signal.
- Acknowledge all active faults.

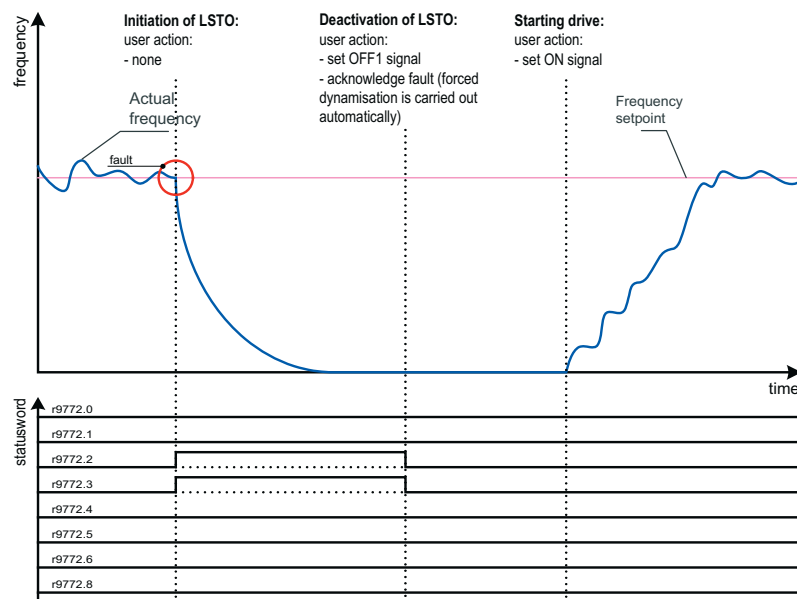


Fig. 6-2 "Passivate the frequency converter" function

**Notice**

Following a "Safe torque off" or "Passivate the frequency converter" function, it is possible – although fairly unlikely – that the field-generating components could produce an individual rising rotating field edge, which could cause the motor to electrically jerk by up to 60°.

The angle of rotation at the motor shaft is smaller than the electrical angle, depending on the motor's inertia and number of pole pairs.

Note

Please note that the "Passivate the frequency converter" function is always triggered by an operational fault within the drive. This means that the drive must always carry out a forced checking procedure before restarting.

**Warning**

Passivating the drive can cause a delay of up to approx. 1 s with short, extreme load impulses.

6.5.6 Safe braking ramp (SBR) = Safe stop 1 (SS1)

Description

Parameter range:	p0003, p0010 p09761 p9603/p9803 p9680/p9880 p9681/p9881 p9682/p9882 p9799/p9899/p3900
Warnings:	A1691, A1692, A1696, A1699
Faults:	F1600, F1616

In contrast to the STO function, the actual speed of the motors influences the behavior of the SS1 (Safe stop 1) function. When SS1 is triggered, the motor speed is scanned: if it is lower than the speed threshold value for standstill set in p9682 and p9882, the STO function is immediately activated and the motor brought to a standstill. If the motor speed is higher than the speed threshold value for standstill, the motor is decelerated using the brake coasting down time that has been set in p9681 and p89881.

Please refer to the figure below.

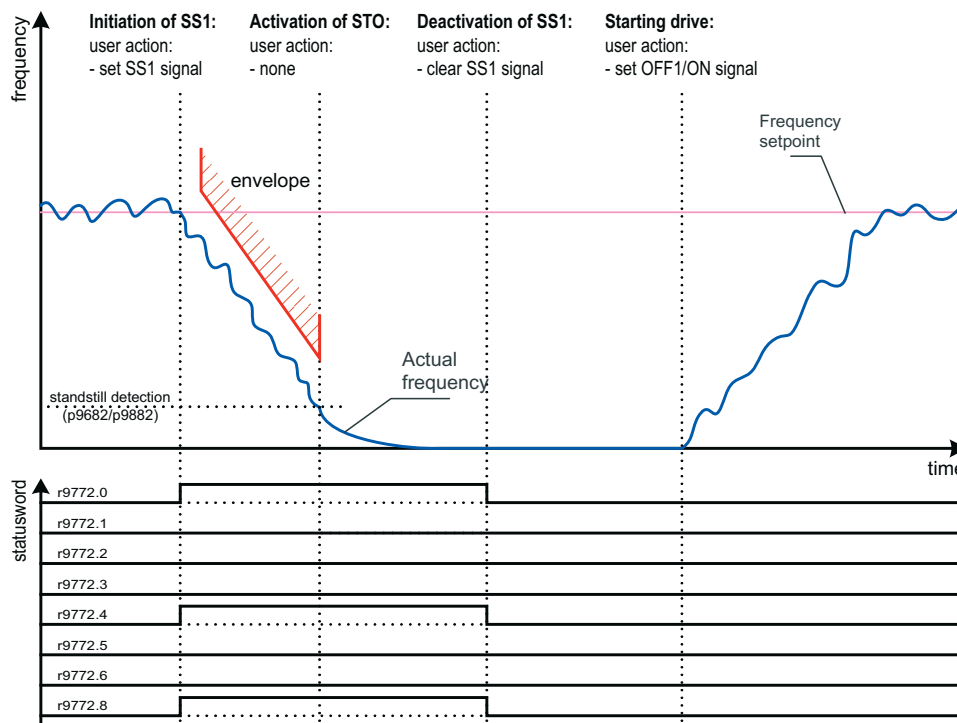


Fig. 6-3 Safe stop 1 function (SS1)

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If SS1 is activated, the converter performs the following processes:

- Both shutdown paths activate a controlled, safe ramp function, which includes detection of the motor speed.
- The motor is decelerated by means of the safe ramp function.
- When the speed threshold value has been reached, the STO function is activated.
- The mechanical brake (if installed) is applied.

Function SS1 can be interrupted by either an OFF2 command or the STO function.

If SS1 is deactivated before the speed threshold value for standstill has been reached, the converter carries out the following processes:

- Monitoring of the actual speed is passivated.
- The drive accelerates up to the speed setpoint.

If SS1 is deactivated after the speed threshold value for standstill has been reached and the STO function has been activated, the converter performs the following processes:

- STO is deactivated
- A forced checking procedure is carried out (if parameterized using p9601 und p9801).
- The timer for the forced checking procedure (p9660) is reset to the value in p9659 (as long as the forced checking procedure has been carried out successfully).

Note

The status of the converter is displayed by r9772.

6.5.7 Safely reduced speed (SG) = Safely-limited speed (SLS)

Description

Note

When the "safely reduced speed" function is activated by clearing shutdown group G6, parameter r0002 is set to 5 (stopping (ramping down)).

The value also remains after "Safely reduced speed" has been reached and is only set to the corresponding value (e.g., r0002 = 4 (drive running)) after "safely reduced speed" has been exited.

Parameter range:	p0003, p0010 p09761 p9603/p9803 p9799/p9899/p3900 p9690/p9890 p9691/p9891 p9692/p9892
Warnings:	A1691, A1692, A1696, A1699
Faults:	F1600, F1616

The purpose of the "Safely reduced speed" function is to monitor the motor speed and ensure that it does not exceed the tolerance range for speed reduction set using parameters p9691 and 9891.

If this is exceeded, the SLS triggers a braking procedure, which is monitored with the aid of the safe ramp function. If a stationary status is determined, the "Safe torque off" function is activated in order to bring the motor to a safe standstill. If the braking function fails - something which is detected as a fault – the "Passivate the drive" function is activated and cannot be cleared until the fault has been explicitly acknowledged.

The SLS function can be canceled using the following commands:

- Safe torque off (STO)
- OFF2

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The reaction of the system to the standard OFF commands can, however, have unpredictable consequences. If the standard OFF commands are used in conjunction with fail-safe functions, the effect that the commands have on the system will automatically be monitored by the fail-safe system in the background (i.e., the non-fail-safe commands cannot affect the acceleration of the converter in an unsafe way because the "Passivate the drive" function is triggered automatically).

Behavior modes

The SLS function has two behavior modes, which allow the user to adopt the functionality that best suits the specific application concerned. These SLS function behavior modes are controlled by setting the required values in parameters p9692 and p9892.

Notice

If the frequency rises above the SLS limit (p9691/p9891) due to dynamic loads, an LSTO is triggered. If, by contrast, the frequency drops below the accuracy limit (1 Hz) for the same reason, then an STO is triggered. Such errors should be avoided by taking the dynamic load impulses into account during system configuration. Moreover, the acceptance test should be performed under the least favorable load conditions.

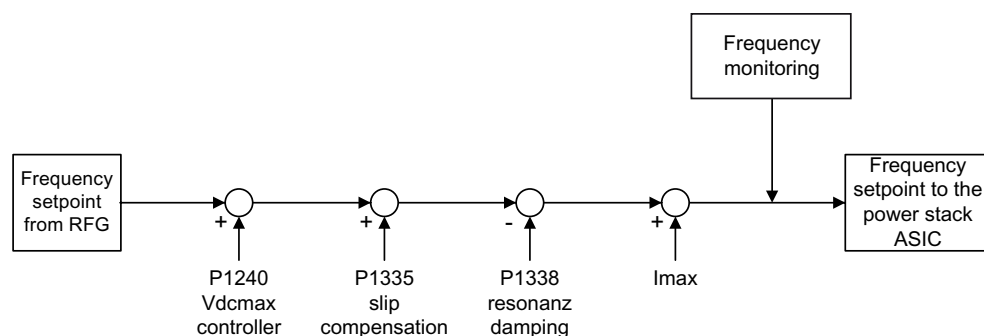
6.5.7.1 Frequency monitoring

Notice

The frequency setpoint may increase, depending on the following functions:

- Slip compensation
- Resonance damping
- I_{\max}

The user should take this increase into account when parameterizing the safety frequency limit values, as monitoring of the frequency only begins once these values have been added.



6.5.7.2 SLS mode 0

$$p9692 = p9892 = 0$$

Once the SLS function has been triggered, if the motor exceeds the p9691 and p9891 set upper limit values for SLS, the frequency converter is passivated. The motor speed setpoint is blocked during the activation of the SLS function. A drop in the motor speed (e.g., as a result of additional loading of the motor) is not classed as an error in terms of the SLS function and is not monitored. See the table that follows. While SLS mode 0 is active, the STO reaction time is determined on the basis of the following formula:

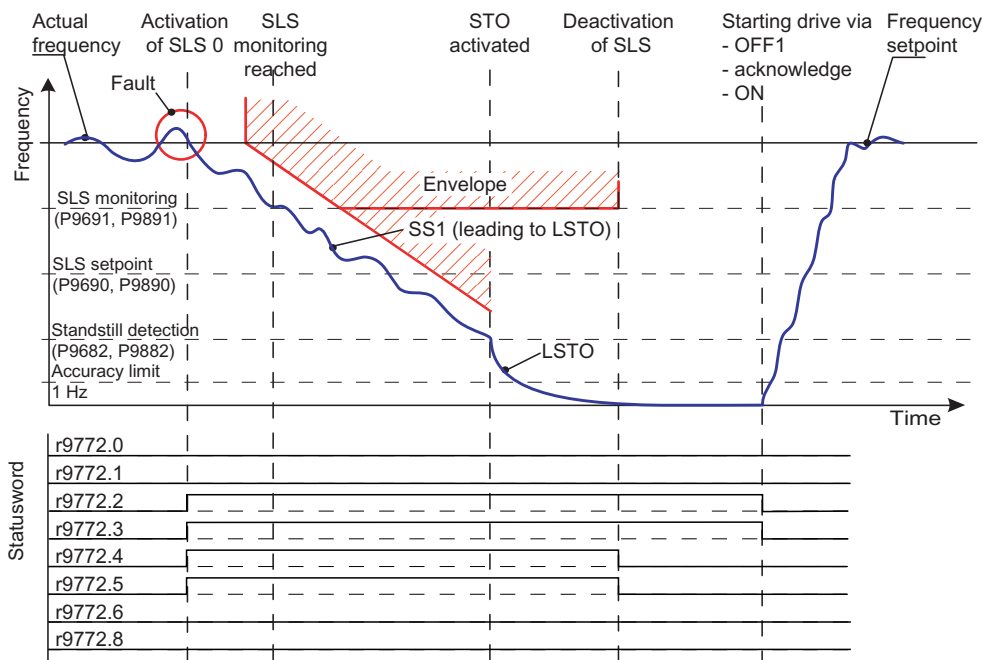
$$\Delta t_{\text{reaction time}} = \frac{F_{\text{max reach}} - F_{\text{max}}}{m}$$

where rise m is defined as

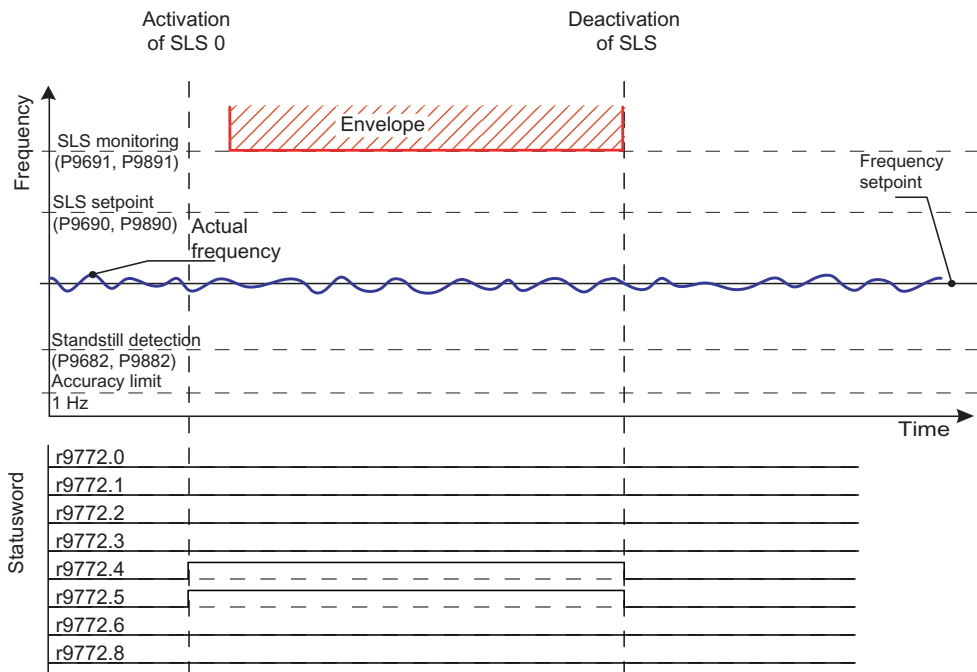
$$m = \frac{200}{P9681}$$

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Case 1:	Frequency setpoint > SLS monitoring (p9691/p9891) > SLS setpoint	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated • Ramping down with SS1 to SLS setpoint
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on • Frequency setpoint is inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off • Frequency setpoint is activated • SLS monitoring off • OL and SH off • G6 on • Frequency setpoint is activated and runs up to setpoint

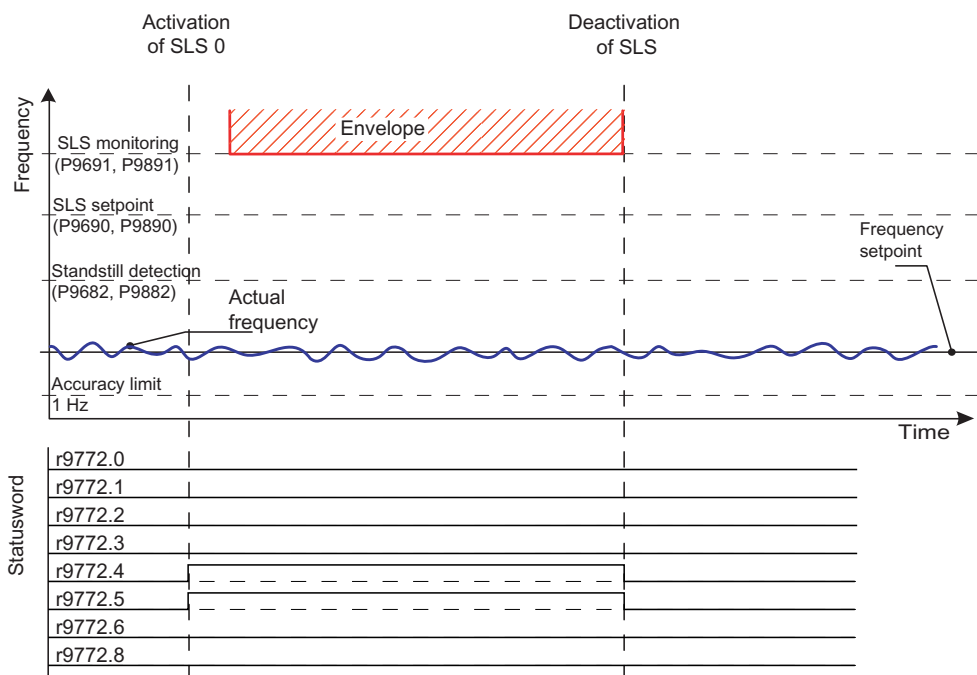


Case 2:	SLS setpoint > Frequency setpoint > Standstill detection (p9682/p9882)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off • Frequency setpoint inactive • SLS monitoring off • OL and SH off
		<ul style="list-style-type: none"> • G6 on

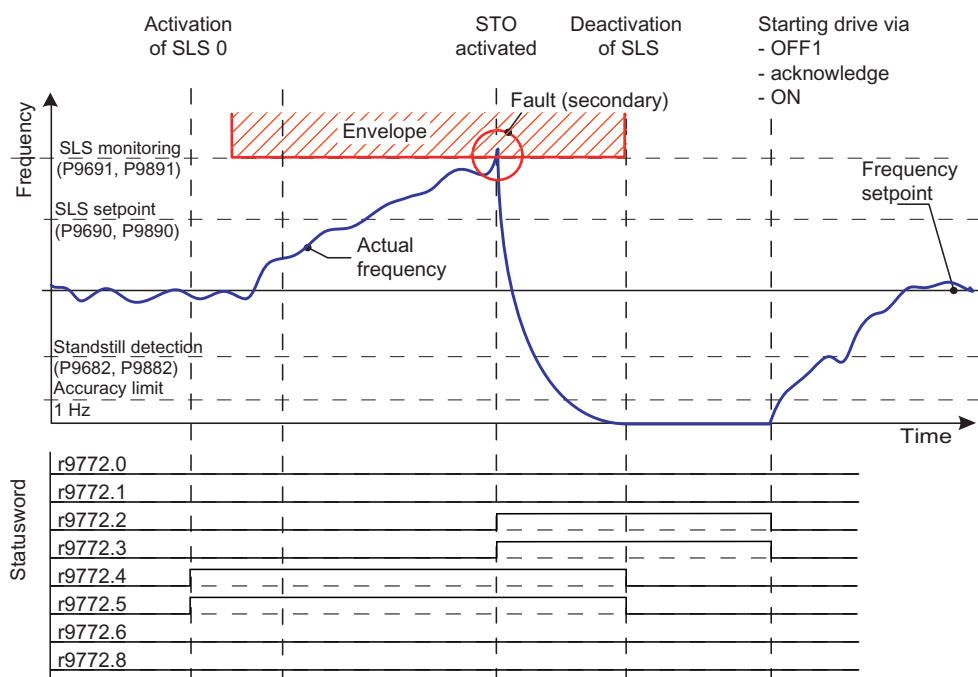


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Case 3:	Standstill detection (p9682/p9882) > Frequency setpoint > Minimum detectable frequency	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated
		<ul style="list-style-type: none"> • OL and SH on
		<ul style="list-style-type: none"> • G6 flashes
		<ul style="list-style-type: none"> • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on
		<ul style="list-style-type: none"> • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off
		<ul style="list-style-type: none"> • Frequency setpoint activated
		<ul style="list-style-type: none"> • SLS monitoring off
		<ul style="list-style-type: none"> • OL and SH off
		<ul style="list-style-type: none"> • G6 on

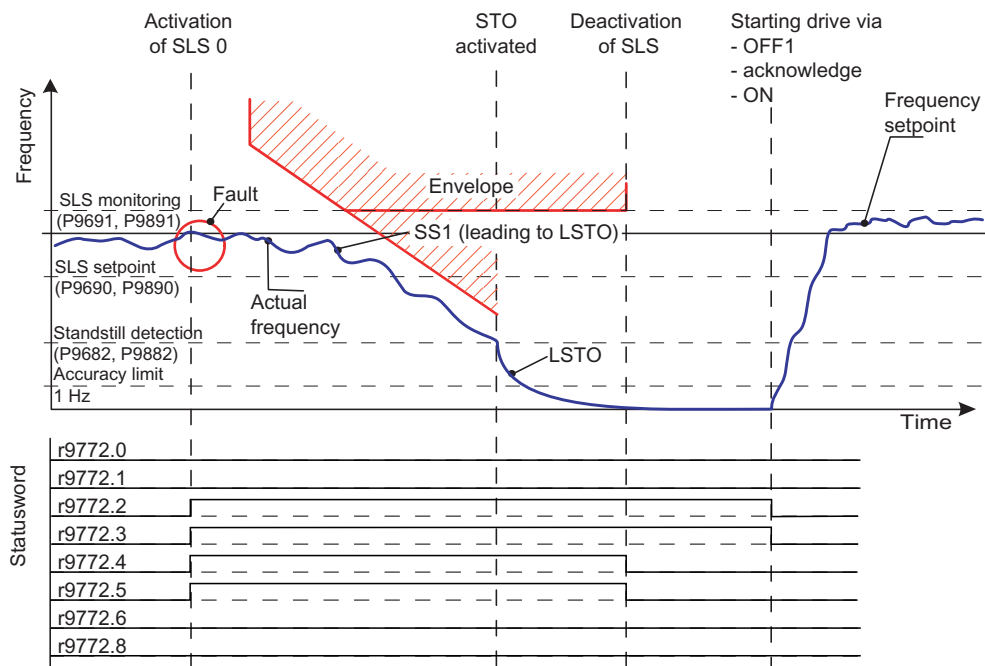


For cases 1 to 3:		
	<ul style="list-style-type: none"> If the speed exceeds the upper SLS limit (e.g., due to slip compensation) => 	<ul style="list-style-type: none"> Frequency converter is passivated (LSTO)
		<ul style="list-style-type: none"> SF on
		<ul style="list-style-type: none"> SH on
	<ul style="list-style-type: none"> Deactivate SLS => 	<ul style="list-style-type: none"> G6 on
For a restart, the "Passivate the frequency converter" function (LSTO) must be acknowledged and a new ON command is required for ramping up to the frequency setpoint.		

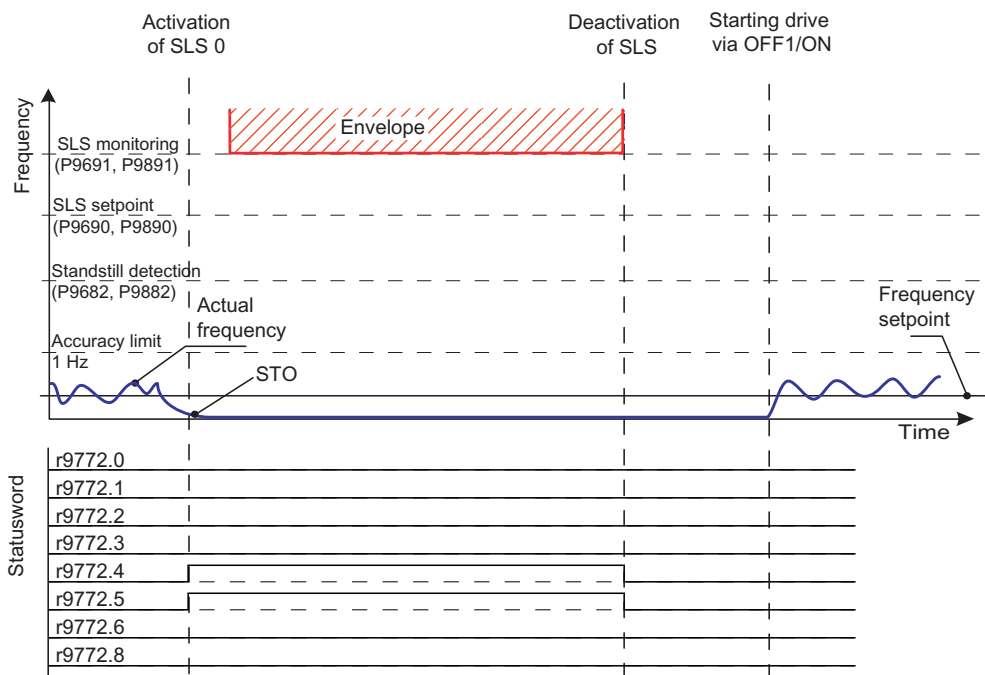


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Case 4:	SLS monitoring (p9691/p9891) > Frequency setpoint > SLS setpoint	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated
		<ul style="list-style-type: none"> • SLS monitoring on
		<ul style="list-style-type: none"> • OL and SH on
		<ul style="list-style-type: none"> • G6 flashes
		<ul style="list-style-type: none"> • Frequency setpoint is deactivated
		<ul style="list-style-type: none"> • Ramping down with SS1 to standstill detection
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off
		<ul style="list-style-type: none"> • Frequency setpoint is activated
		<ul style="list-style-type: none"> • SLS monitoring off
		<ul style="list-style-type: none"> • OL and SH off
		<ul style="list-style-type: none"> • G6 on
		<ul style="list-style-type: none"> • Frequency setpoint is activated and runs up to setpoint

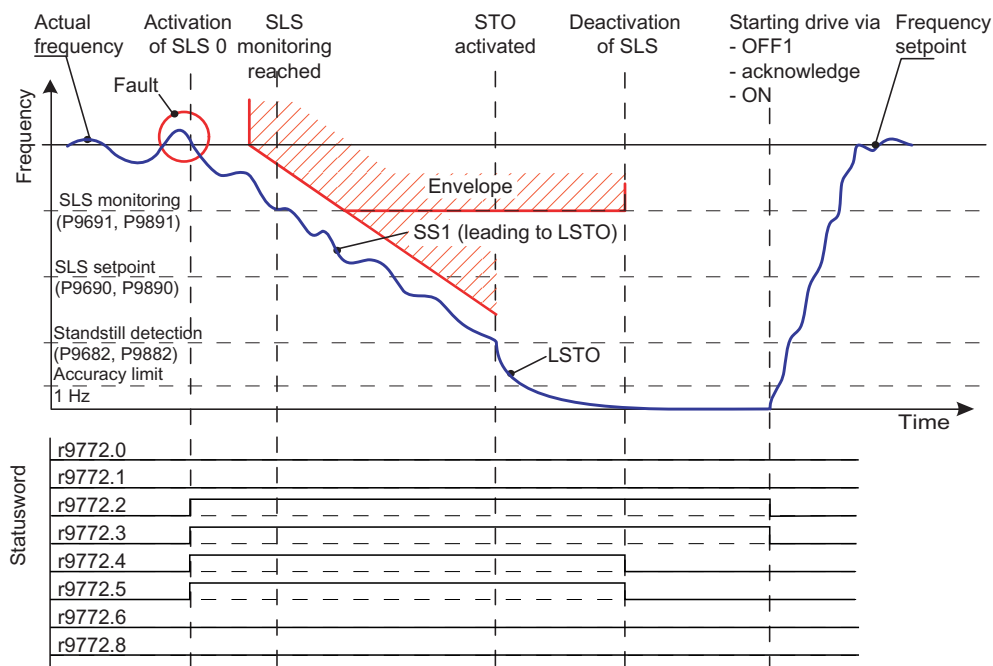


Case 5:	Minimum detectable frequency > Frequency setpoint	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated
		<ul style="list-style-type: none"> • STO is activated
		<ul style="list-style-type: none"> • OL and SH on
		<ul style="list-style-type: none"> • G6 flashes
		<ul style="list-style-type: none"> • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off
		<ul style="list-style-type: none"> • Frequency setpoint is activated
		<ul style="list-style-type: none"> • SLS monitoring off
		<ul style="list-style-type: none"> • OL and SH off
		<ul style="list-style-type: none"> • G6 on

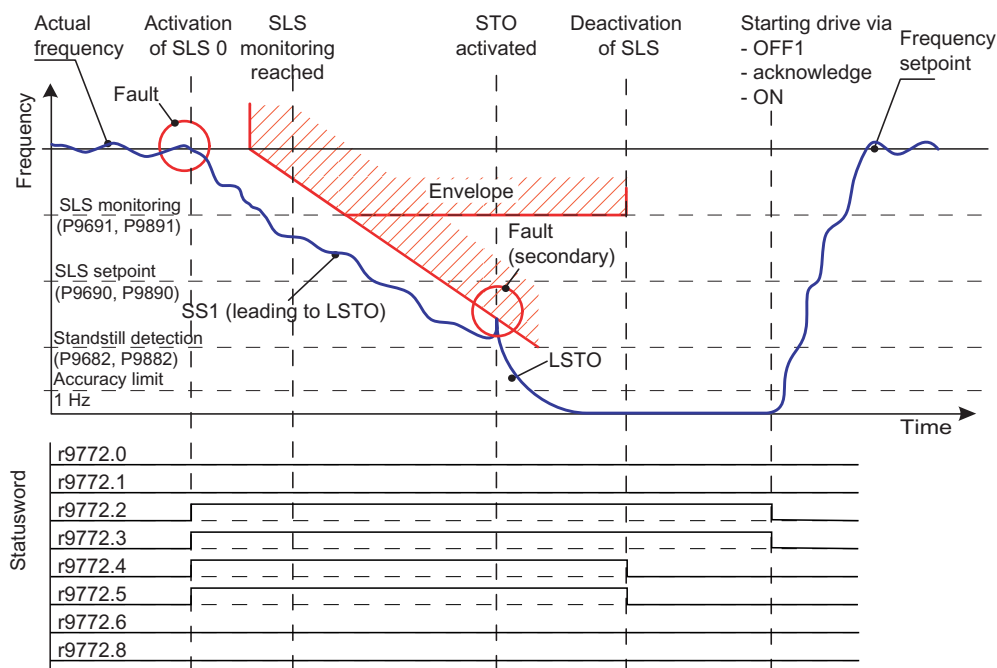


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Case 6.1:	Frequency setpoint > SLS monitoring (p9691/p9891)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated • Ramping down with SS1 to standstill
	<ul style="list-style-type: none"> • When standstill detection is reached => 	<ul style="list-style-type: none"> • Frequency setpoint inactive • Frequency converter is passivated (LSTO activated)
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • No action
<p>For a restart, the "Passivate the frequency converter" function (LSTO) must be acknowledged and a new ON command is required for ramping up to the frequency setpoint.</p>		



Case 6.2:	Frequency setpoint > SLS monitoring (p9691/p9891)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated • Ramping down with SS1 to standstill
	<ul style="list-style-type: none"> • If the SS1 actual frequency is exceeded, ramping-down monitoring is reached before standstill is detected 	<ul style="list-style-type: none"> • Frequency setpoint inactive • Passivate frequency converter (LSTO activated immediately)
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • No action
<p>For a restart, the "Passivate the frequency converter" function (LSTO) must be acknowledged and a new ON command is required for ramping up to the frequency setpoint.</p>		



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Note

It should be noted that when a fault is detected during SLS mode 0, the first thing that happens is that an attempt is made to brake the drive using the safe braking ramp.

The braking time is determined by means of parameters p9681/p9881. In this operating status, the braking ramp cannot be interrupted by any other function (e.g., STO).

For braking time p9681/p9881, it is recommended that you parameterize the shortest ramp time as appropriate for the application.

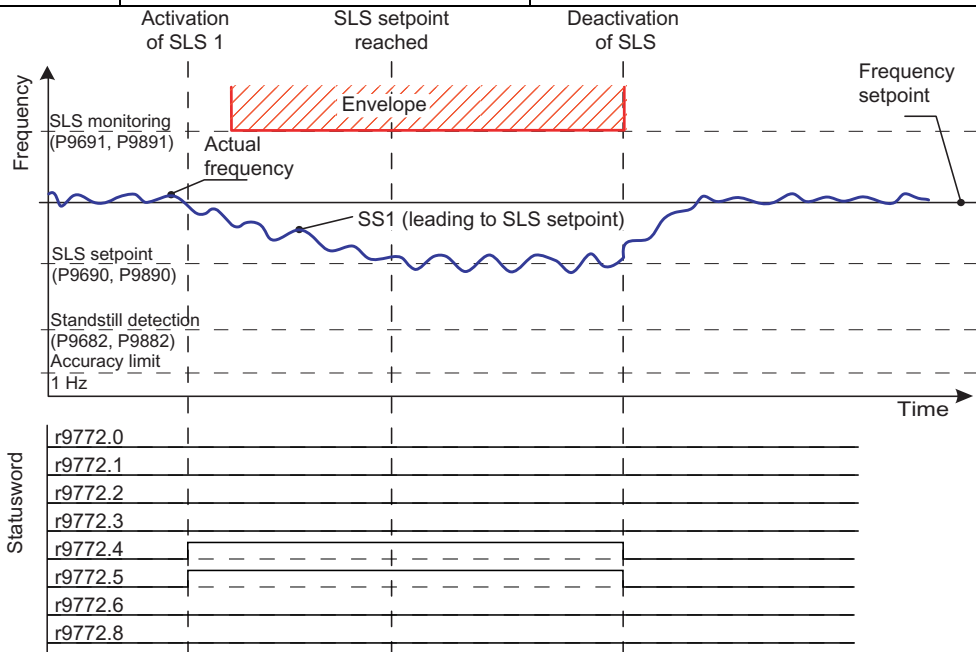
6.5.7.3 SLS mode 1

p9692 = p9892 = 1

p9691 and p9891 are used to specify a monitoring value for the speed, which must not be exceeded. As soon as the SLS mode 1 function is activated, the frequency converter checks whether the current motor speed is higher than a setpoint defined by the p9690 and p9890 parameters. If so, the motor will be braked along the SS1 function braking ramp until it has slowed down to this setpoint. Speed limit value monitoring will then be activated (p9691 and p9891).

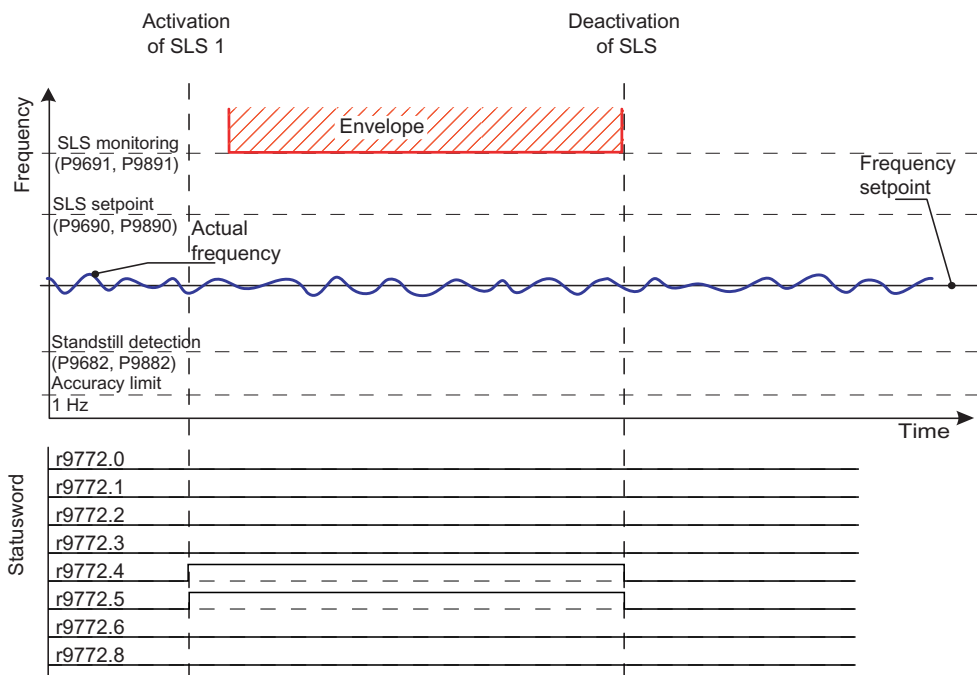
A drop in the motor speed to a value below that of p9690 and p9090 (e.g. as a result of additional loading of the motor) is not classed as an error in terms of the SLS function and is not monitored.

Case 1:	Frequency setpoint > SLS monitoring (p9691/p9891) > SLS setpoint	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated • Ramping down with SS1 to SLS setpoint
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off • SLS monitoring off • OL and SH off • G6 on • Frequency setpoint is activated and runs up to setpoint

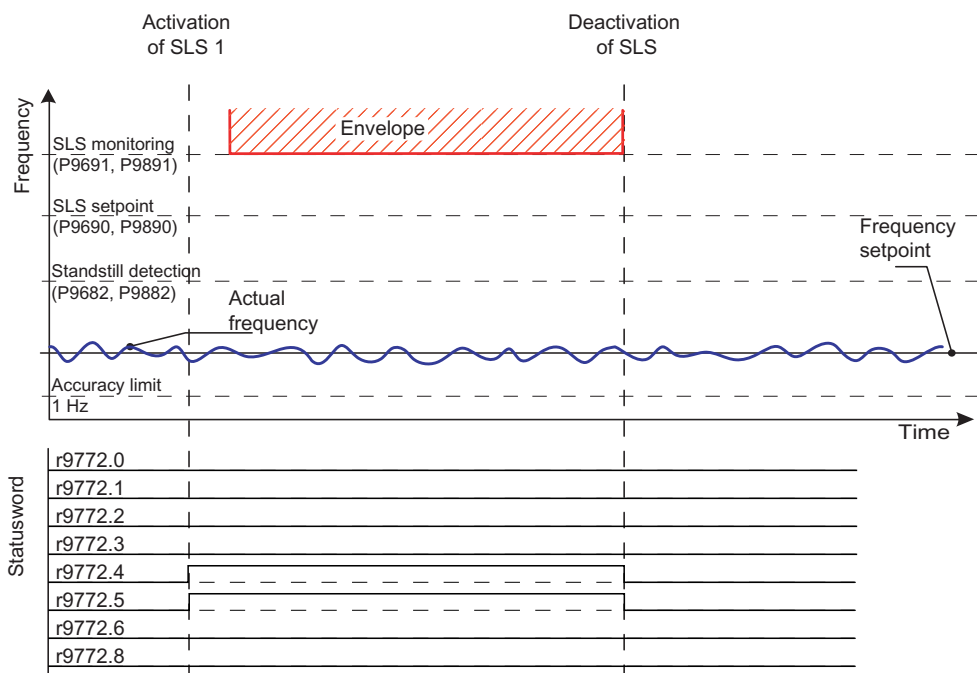


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Case 2:	SLS setpoint > Frequency setpoint > Standstill detection (p9682/p9882)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated
		<ul style="list-style-type: none"> • OL and SH on
		<ul style="list-style-type: none"> • G6 flashes
		<ul style="list-style-type: none"> • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on
		<ul style="list-style-type: none"> • ES LED is illuminated
		<ul style="list-style-type: none"> • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off
		<ul style="list-style-type: none"> • SLS monitoring off
		<ul style="list-style-type: none"> • OL and SH off
		<ul style="list-style-type: none"> • G6 on
		<ul style="list-style-type: none"> • Frequency setpoint is activated and runs up to setpoint

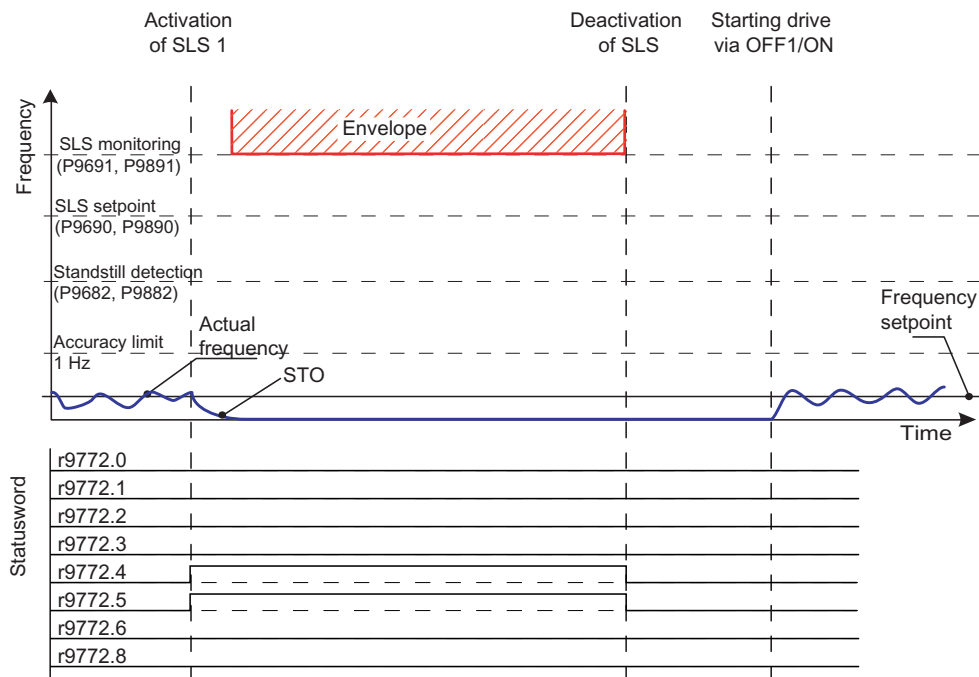


Case 3:	Standstill detection (p9682/p9882) > Frequency setpoint > Minimum detectable frequency	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated
		<ul style="list-style-type: none"> • OL and SH on
		<ul style="list-style-type: none"> • G6 flashes
		<ul style="list-style-type: none"> • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on
		<ul style="list-style-type: none"> • ES LED is illuminated
		<ul style="list-style-type: none"> • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off
		<ul style="list-style-type: none"> • SLS monitoring off
		<ul style="list-style-type: none"> • OL and SH off
		<ul style="list-style-type: none"> • G6 on
		<ul style="list-style-type: none"> • Frequency setpoint is activated and runs up to setpoint

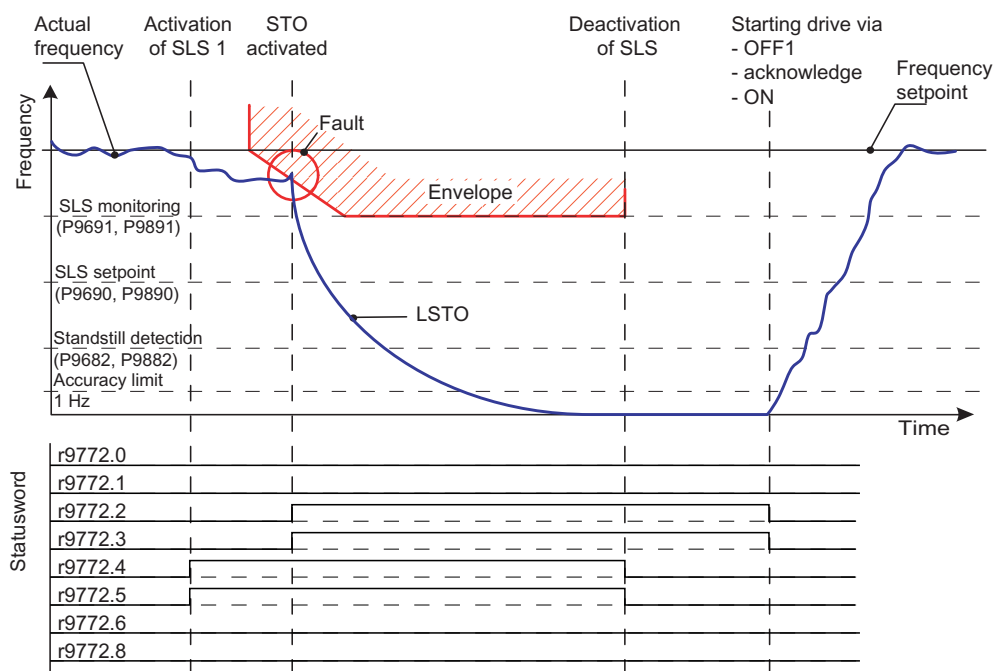


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Case 4:	Minimum detectable frequency > Frequency setpoint	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When SLS is reached => 	<ul style="list-style-type: none"> • SLS monitoring on • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring off • SLS monitoring off • OL and SH off • G6 on • Frequency setpoint is activated and runs up to setpoint

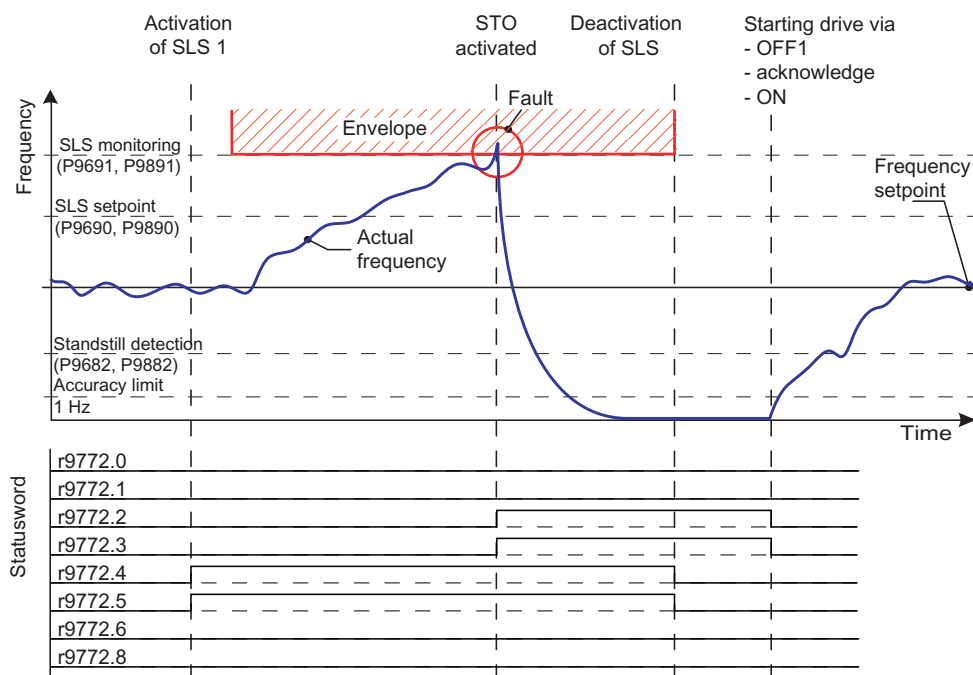


Case 5:	Frequency setpoint > SLS monitoring (p9691/p9891)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint is deactivated
	<ul style="list-style-type: none"> • When standstill detection is reached => 	<ul style="list-style-type: none"> • SLS monitoring is activated • SF on • SH on • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • G6 on
	For a restart, the "Passivate the frequency converter" function (LSTO) must be acknowledged and a new ON command is required for ramping up to the frequency setpoint.	



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Case 6:	SLS setpoint > Frequency setpoint > Standstill detection (p9682/p9882)	
	<ul style="list-style-type: none"> • Activate SLS => 	<ul style="list-style-type: none"> • Ramp monitoring is activated • OL and SH on • G6 flashes • Frequency setpoint deactivated
	<ul style="list-style-type: none"> • When standstill detection is reached => 	<ul style="list-style-type: none"> • SLS monitoring is activated • SF on • SH on • Frequency setpoint inactive
	<ul style="list-style-type: none"> • Deactivate SLS => 	<ul style="list-style-type: none"> • G6 on
	<p>For a restart, the "Passivate the frequency converter" function (LSTO) must be acknowledged and a new ON command is required for ramping up to the frequency setpoint.</p>	



6.5.8 Limit values for SS1 and SLS

Description

When parameterizing an envelope curve for SLS and SS1 with parameters p9680/p9880 and p9691/p9891, the lower limit values listed below should be observed, in order to guarantee maximum drive availability.

Remark:

If the frequency rises above the SLS limit (p9691/p9891) due to dynamic loads, an LSTO is triggered. If, by contrast, the frequency drops below the error limit for the same reason, then an STO is triggered. Such errors should be avoided by taking the dynamic load impulses into account during system configuration. Moreover, the acceptance test should be performed under the least favorable load conditions.

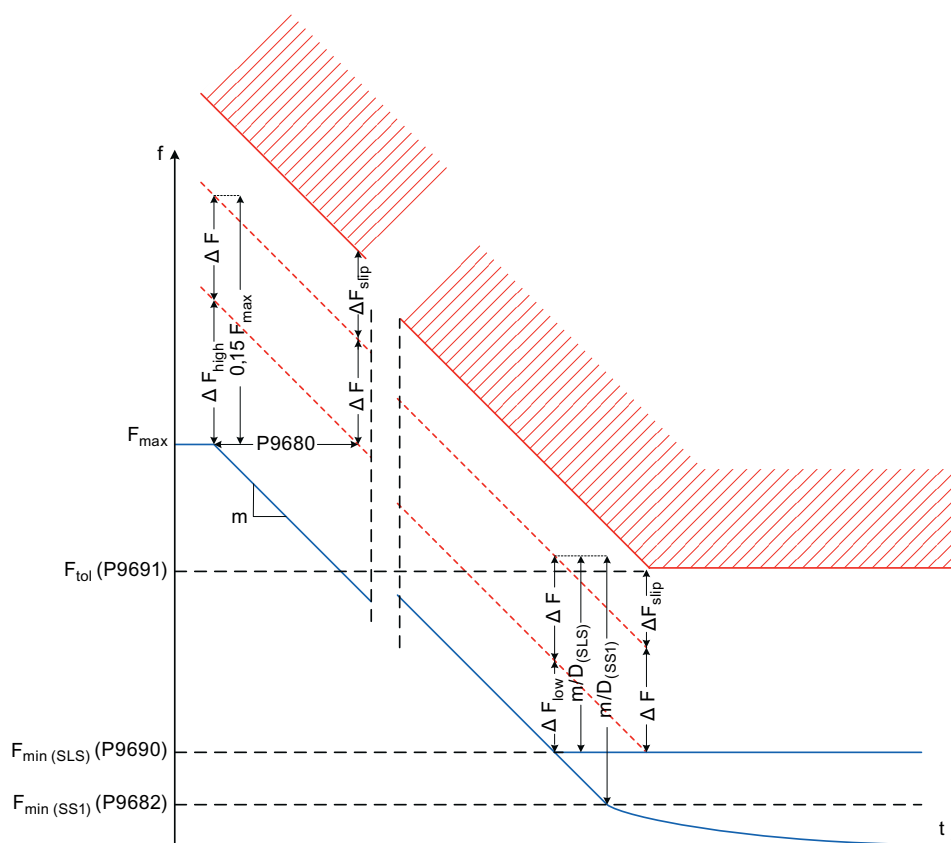


Fig. 6-4 Safety limits for SLS and SS1

1. The lower limits for speed monitoring parameter p9691 should be set to $P9691 \geq 1.15 \cdot P9690 + \Delta F_{slip}$
 This means that the lower frequency limit is defined as $\Delta F = P9691 - P9690 - \Delta F_{slip}$.
 $\Delta F_{slip} = r0330 \cdot r0310$.
 Thus, by means of measuring errors and additional slip compensation, failures

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can be prevented. It should be noted that, according to the formula for the lower frequency limit, ΔF P9691 must also be set if the SLS function has not been parameterized.

2. Because of the lower frequency limit at high frequencies, the resulting frequency ΔF_{high} is thus determined by:

$$\Delta F_{\text{high}} \geq 0.15 \cdot F_{\text{max}} - \Delta F$$
 where F_{max} defines the higher frequency when SLS or SS1 is initialized.
3. Because of the lower frequency limit at lower frequencies, the resulting frequency limit ΔF_{low} is thus determined by:

$$\Delta F_{\text{low}} \geq \frac{m}{D} - \Delta F$$

whereby the rise m is defined as:

$$m = \frac{200}{P9681}$$

The value for D in the formula above is calculated as follows:

SLS parameterized: $D = 2 \cdot p9690$

SS1 parameterized: $D = 2 \cdot p9682$

SLS and SS1 parameterized: $D = 2 \cdot \min [p9682, p9690]$

4. The valid delay, ΔF_{delay} , is determined as the maximum of of:

$$\Delta F_{\text{delay}} = \max[\Delta F_{\text{low}}, \Delta F_{\text{high}}]$$
5. The minimum braking ramp delay can then finally be calculated using:

$$P9680 \geq \frac{\Delta F_{\text{delay}}}{m}$$
6. The envelope curve for the safe frequency is produced from a time delay ($p9690$) in the t -direction, an additional frequency tolerance ΔF (caused by measuring errors) and ΔF_{slip} (caused by slip compensation) in the F -direction. The total envelope curve delay $\Delta t_{\text{envelope}}$ is calculated using:

$$\Delta t_{\text{envelope}} = P9680 + \frac{\Delta F}{m} + \frac{\Delta F_{\text{slip}}}{m}$$

whereby the rise m is defined as in point 3.

Example of how to calculate the limit values for SS1 and SLS

The following example illustrates how the fail-safe formulae are calculated for the 1LA7060-4AB10-Z motor and for the fail-safe parameter factory settings. The motor technical data and values for calculating the necessary fail-safe parameters are given in the tables below.

Table 6-19 Technical data

Parameter	Parameter text	Value
p0300	Select motor type	1; induction motor
p0304	Rated motor voltage	230/400 [V] Δ/Y
p0305	Rated motor current	0.73/0.42 [A]
p0307	Rated motor power	0.12 [kW]
p0308	Rated motor cosPhi	0.75
p0310	Rated motor frequency	50 [Hz]
p0311	Rated motor speed	1350 [1/min]
r0313	Motor pole pairs	2

Table 6-20 Fail-safe parameter factory settings

Parameter	Parameter text	Value
p9681	SI braking ramp Ramp-down time	10 [s]
p9682	SI minimum speed for standstill detection	5.0 [Hz]
p9690	SI setpoint for SLS	10.0 [Hz]

- Upper tolerance range for SLS p9691

The slip frequency is calculated as follows:

$$F_{\text{slip}} = r0330 \cdot p0310,$$

where the rated motor slip r0330 is

$$\begin{aligned} - r0330 &= (p0310 - p0311 \cdot r0313 / 60) / p0310 \cdot 100\% \rightarrow \\ - F_{\text{slip}} &= (50 \text{ [Hz]} - 1350 \text{ [rpm]} \cdot 2 / 60) / 50 \text{ [Hz]} \cdot 100\% \cdot 50 \text{ [Hz]} \rightarrow \\ &= 5 \text{ [Hz]} \text{ or } 10 \text{ [\%]} \text{ of } 50 \text{ [Hz]} \text{ (p2000 = } 50 \text{ [Hz])} \end{aligned}$$

The upper tolerance range for SLS p9691 is therefore:

$$p9691 \geq 1.15 \cdot p9690 + F_{\text{slip}}, \quad \text{or}$$

$$p9691 \geq 1.15 \cdot 10 \text{ [Hz]} + 5 \text{ [Hz]},$$

$$p9691 \geq 16.5 \text{ [Hz]}$$

At this point, parameter p9691 should be selected,

e.g., p9691 = 16.5 [Hz] (or 17 [Hz]).

The minimum frequency tolerance is calculated as follows:

$$\Delta F = p9691 - p9690 - F_{\text{slip}} \quad \text{or}$$

$$\Delta F = 16.5 \text{ [Hz]} - 10 \text{ [Hz]} - 5 \text{ [Hz]} = 1.5 \text{ [Hz]}$$

- Resulting frequency tolerance ΔF_{high}

The following formula is used to determine the upper frequency tolerance

ΔF_{high} :

$$\Delta F_{\text{high}} \geq 0.15 \cdot F_{\text{max}} - \Delta F$$

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If, for example, $F_{max} = 50$ [Hz], then:

$$\Delta F_{high} \geq 0.15 \cdot 50 \text{ [Hz]} - 1.5 \text{ [Hz]},$$

$$\Delta F_{high} \geq 6 \text{ [Hz]}$$

- Resulting frequency tolerance ΔF_{low}
The following formula is used to determine the lower frequency tolerance ΔF_{low} :
$$\Delta F_{low} \geq m / D - \Delta F$$

The rise m is calculated as follows:

$$m = 200 / p9681 = 200 \text{ [Hz]} / 10 \text{ [s]} = 20 \text{ [Hz/s]}$$

Value D is calculated as follows for each of the items below:

$$\text{SLS parameterized - } D = 2 \cdot p9690 = 2 \cdot 10 \text{ [Hz]} = 20 \text{ [Hz]}$$

$$\text{SS1 parameterized - } D = 2 \cdot p9682 = 2 \cdot 5 \text{ [Hz]} = 10 \text{ [Hz]}$$

$$\begin{aligned} \text{SLS and SS1 parameterized - } D &= 2 \cdot \min [p9682, p9690] \\ &= 2 \cdot \min [5 \text{ [Hz]}, 10 \text{ [Hz]}] = 10 \text{ [Hz]} \end{aligned}$$

Let us consider a situation in which both the SLS and SS1 functions are parameterized.

In this case, the formula for the resulting frequency tolerance ΔF_{low} is as follows:

$$\Delta F_{low} \geq m / D - \Delta F,$$

$$\Delta F_{low} \geq 20 \text{ [Hz/s]} / 10 \text{ [Hz]} - 1.5 \text{ [Hz]},$$

$$\Delta F_{low} \geq 0.5 \text{ [Hz]}$$

- Delay ΔF_{delay}
Please note that ΔF_{low} and ΔF_{high} are capable of assuming both negative values and a value of 0. Therefore, it is important to compare ΔF_{delay} with 0 and to determine the maximum value.

The formula is as follows:

$$\Delta F_{delay} = \max [\Delta F_{low}, \Delta F_{high}, 0]$$

$$= \max [0.5 \text{ [Hz]}, 6 \text{ [Hz]}, 0] = 6 \text{ [Hz]}$$

- Minimum delay of braking ramp
The minimum delay of braking ramp is calculated as follows:
$$p9680 \geq \Delta F_{delay} / m,$$

$$p9680 \geq 6 \text{ [Hz]} / 20 \text{ [Hz/s]},$$

$$p9680 \geq 0.3 \text{ [s]}$$

Parameter $p9680$ must be set to 300 [ms].

Thus, the results of our calculations are as follows:

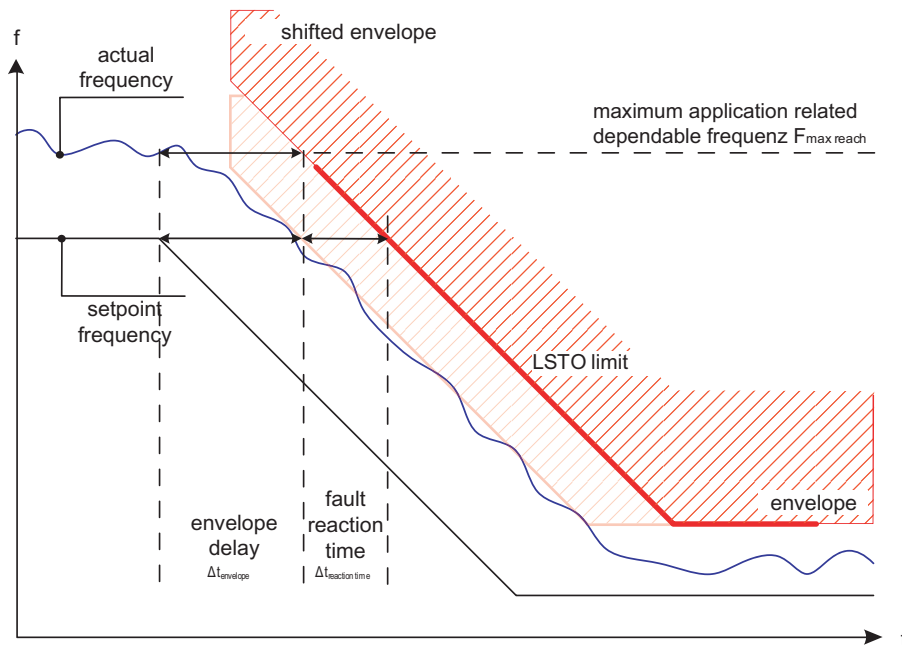
- Upper tolerance range $p9691 = 16.5$ [Hz]
- Minimum delay of braking ramp $p9680 = 300$ [ms]

Fault reaction time

Notice

A "Passivate the drive" function is triggered whenever the frequency of the parameterized envelope curve is exceeded. Please note that the actual frequency can deviate from the set frequency setpoint as a result of statuses that also occur in normal operation (slip compensation, etc.) or internal converter faults.

Since the starting frequency of the envelope curve is therefore related to the actual frequency, the parameterized curve can be moved as shown in the figure.



The maximum envelope curve offset is related to the fault reaction time $\Delta t_{\text{reaction time}}$

$$\Delta t_{\text{reaction time}} = \frac{F_{\text{max reach}} - F_{\text{max}}}{m}$$

whereby the rise m is defined as in point 3.

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6.5.9 Acceptance test and acceptance log

Description

In order to verify the safety-related parameters, an acceptance test must be carried-out when commissioning the machine and also when changing a completely backed-up data set of the safety-relevant parameters. This acceptance test must be appropriately logged and documented. An example for an appropriate acceptance log is included in this Section. The acceptance logs should be adequately archived.

Note

However, a new acceptance test is not required if a frequency converter was replaced with a parameter set that was completely backed-up and the frequency converter ran-up correctly.

6.5.9.1 General information on acceptance

Acceptance test

The machinery construction company (OEM) must carry-out an acceptance test for the safety functions that have been activated at the machine.

Authorized person, acceptance log

Appropriately authorized personnel must test each of the safety functions. These must be documented/logged in an acceptance log and must be signed. The acceptance log must be inserted/attached in/to the logbook of the machine
Authorized in this case means a person from the machinery construction company (OEM) that as a result of their training and knowledge regarding safety functions, can appropriately carry-out an acceptance test.

Note

The information/instructions and descriptive information regarding commissioning in Section 6.3 of this Manual must be carefully observed.

If safety-related parameters are changed, then a new acceptance test must be carried-out and included as acceptance log.

The template for the acceptance log is provided in printed form as example or recommendation in this Chapter of the Commissioning Manual.

Contents of a complete acceptance test

Documentation (refer to Section 1.1.1.2)

Documentation of the machine including the safety functions.

1. Machine description and overview/block diagram
2. Safety functions for each drive
3. Description of the safety devices/equipment

Function test (refer to Section 1.1.1.3)

Checking the individual safety functions that are used

1. "Safe standstill" function
2. "Safe braking ramp" function
3. "Safely-reduced speed" function

Completing the log (refer to Section 1.1.1.4)

Document/log the commissioning phase and sign.

1. Check the safety-related parameters
2. Document/log the checksums
3. Provide proof that data has been backed-up/archived
4. Sign

Attachment

Measuring traces/plots associated with the function test

- Alarm logs
- Trace plots

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6.5.9.2 Documentation

A recommended acceptance report is shown in the Internet under <http://support.automation.siemens.com/WW/view/de/18687616/130000>.

Overview

Acceptance test No.	
Date	
Person carrying-out	

Table 6-21 Machine description and overview/block diagram

Designation	
Type	
Serial No.	
Manufacturer	
End customer	
Block/overview diagram of the machine	

Table 6-22 Safety functions for each drive

Drive No. (refer to Table 6-23)	Slot ID	FW version	SI version	Safety function
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
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	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	
	p8455 =	r0018 =	r9770 =	

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Table 6-23 Description of the safety equipment/devices

Drive No. (refer to Table 6-22)	Example: Wiring of the SH terminals (protective door, EMERGENCY STOP), grouping of the SH terminals, etc.

6.5.9.3 Function test

Description

The function test must be carried-out separately for each individual drive (assuming that the machine permits this to be done).

Executing the test

First commissioning	Please mark	
Series commissioning		

"Safe standstill" function (SH)

This test comprises the following steps:

Table 6-24 "Safe standstill" function (SH)

No.	Description	Status
1.	Initial state <ul style="list-style-type: none"> • Drive in the "ready" state (p0010 = 0) • Enable safety functions (p9601 / p9801 = 1 or 3) • No safety faults and alarms • r9772.0 = r9772.1 = 0 (SH de-selected and inactive) • p9659 = time intervals for the forced checking procedure correctly set 	
2.	Operate the drive	
3.	Check that the expected drive operates	
4.	Select SH while issuing the command to operate	
5.	Check the following: <ul style="list-style-type: none"> • The drive coasts-down or is braked by the mechanical brake and held if a brake is being used and has also been parameterized • No safety faults • r9772.0 = r9772.1 = 1 (SH selected and active) 	
6.	De-select SH	
7.	Check the following: <ul style="list-style-type: none"> • No safety faults • r9772.0 = r9772.1 = 0 (SH de-selected and inactive) 	
8.	Check that the expected drive is operated In so doing, the following is tested: <ul style="list-style-type: none"> • That the wiring between the control unit and IPM25 converter power module is correct • Correct assignment, drive No. – IPM25 power module – motor • That the hardware is correctly functioning • That the shutdown paths have been correctly wired • Correct assignment of the SH terminals on the control unit • Correct parameterization of the SH function • Routine for the forced checking procedure of the shutdown paths 	

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"Safe braking ramp" function (SBR)

This test comprises the following steps:

Table 6-25 "Safe braking ramp" function (SBR)

No.	Description	State
1.	Initial state <ul style="list-style-type: none"> • Drive in the "ready" state (p0010 = 0) • Enable safety functions (p9601 / p9801 = 1 or 3) • No safety faults and alarms • r9772.0 = r9772.1 = 0 (SH de-selected and inactive) • r9772.4 = r9772.5 = 0 (SG de-selected and inactive) 	
2.	Operate the drive	
3.	Check that the expected drive operates	
4.	Select SBR while issuing the traversing command	
5.	Check the following: <ul style="list-style-type: none"> • Drive speed decreases corresponding to the selected ramp time (if required, use a stop watch) • After the parameterized minimum speed has been fallen below, the drive coasts-down or is braked and held by the mechanical brake if a brake is being used and has also been parameterized • No safety faults • r9772.0 = r9772.1 = 1 (SH selected and active) • r9772.4 = 1 (SG selected) • r9772.5 = 0 (SG not active) 	
6.	De-select SBR	
7.	Check the following: <ul style="list-style-type: none"> • No safety faults • r9772.0 = r9772.1 = 0 (SH de-selected and inactive) • r9772.4 = r9772.5 = 0 (SG de-selected and inactive) 	
8.	Check that the expected drive operates In so doing the following is tested: <ul style="list-style-type: none"> • The wiring between the control unit and IPM25 power module is correct • Correct assignment, drive No. – IPM25 converter power module – motor • Correct functioning of the hardware • Correct wiring of the shutdown paths • Correct assignment, SH terminals on the control unit • Correct parameterization of the SBR function 	

"Safely-reduced speed" function (SG)

This test comprises the following steps:

Table 6-26 "Safely-reduced speed" function (SG)

No.	Description	State
1.	Initial state <ul style="list-style-type: none"> • Drive in the "ready" state (p0010 = 0) • Enable safety functions (p9601 / p9801 = 1 or 3) • No safety faults and alarms • r9772.4 = r9772.5 = 0 (SG de-selected and inactive) 	
2.	Operate the drive (if the machine permits it, at a higher speed than the parameterized safely-reduced speed)	
3.	Check that the expected drive operates	
4.	Select SG while issuing the traversing command	
5.	Check the following: <ul style="list-style-type: none"> • Drive speed decreases corresponding to the selected ramp time (if required, use a stop watch) • After the parameterized safely-reduced speed has been fallen below, the speed remains below this limit • No safety faults • r9772.4 = r9772.5 = 1 (SG selected and active) 	
6.	De-select SG	
7.	Check the following: No safety faults r9772.4 = r9772.5 = 0 (SG de-selected and inactive)	
8.	Check that the expected drive operates In so doing the following is tested: <ul style="list-style-type: none"> • The wiring between the control unit and IPM25 power module is correct • Correct assignment, drive No. – IPM25 converter power module – motor • Correct functioning of the hardware • Correct wiring of the shutdown paths • Correct parameterization of the SG function 	

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6.5.9.4 Completing the log

Safety-related parameters

	Specified value checked?	
	Yes	No
Control unit		

Checksums

Drive		Checksums	
Name	Drive No.	Control unit (r9798)	Control unit (r9898)

Note

The checksum values must be entered as follows:

- Value from r9798 in p9799
- Value from r9898 in p9899

Data back-up/archiving

	Memory medium			Saved where
	Type	Designation	Date	
Parameters				
PLC program				
Circuit diagrams				

Signatures**Commissioning engineer**

Confirms that the above listed tests and checks have been correctly carried-out.

Date	Name	Company / department	Signature

Machinery construction OEM

Confirms the correctness of the parameterization documented above.

Date	Name	Company / department	Signature

6.6 Replacing frequency converter components

6.6 Replacing frequency converter components

Overview

For the ET 200S FC, there are various ways of replacing frequency converter components. The following categories have been defined in order to simplify handling these various possibilities:

- **Converter power module (PM) hot swap is detected for**
 - Replacing the converter power module, control unit under voltage
- **Control unit (CU) hot swap is identified for**
 - Replacing the control unit
the last run-up was with a different converter power module or the control unit is new
 - Replacing the converter power module, control unit in a no-voltage condition (powered-down)
- **No hot swap is detected for**
 - Withdrawing/inserting the converter power module
 - Withdrawing/inserting the control unit

Note

In order to identify a hot swap, the control unit checks the serial number of the converter power module that is inserted.
If a hot swap is not permissible (refer to p7840 and F0399), the serial number is not transferred when the control unit runs-up.

Responses when replacing frequency converter components

The responses to CU hot swap or PM hot swap can be set in p7840.

Note

For a CU hot swap, the values specified in the following table refer to the setting of p7840 in the new control unit.

6.6 Replacing frequency converter components

Table 6-27 Settings for response to hot swap in p7840

P value	CU hot swap	PM hot swap
0	F0399	F0399
1	F0399	Permitted, if Order No. [MLFB] (PM) the same
2	F0399	Permitted, if the Powerstack code is the same
3	F0399	Permitted
10	Permitted, if Order No. [MLFB] (PM) the same	F0399
11	Permitted, if Order No. [MLFB] (PM) the same	Permitted, if Order No. [MLFB] (PM) the same
12	Permitted, if Order No. [MLFB] (PM) the same	Permitted, if the Powerstack code is the same
13	Permitted, if Order No. [MLFB] (PM) the same	Permitted
20	Permitted, if the Powerstack code is the same	F0399
21	Permitted, if the Powerstack code is the same	Permitted, if Order No. [MLFB] (PM) the same
22	Permitted, if the Powerstack code is the same	Permitted, if the Powerstack code is the same
23	Permitted, if the Powerstack code is the same	Permitted
30	Permitted	F0399
31	Permitted	Permitted, if Order No. [MLFB] (PM) the same
32	Permitted	Permitted, if the Powerstack code is the same
33	Permitted	Permitted

Caution

If, when replacing a converter power module (IPM25, 4.0 kW) a power module with a lower rating is inserted (IPM25, 2.2 kW), then parameter p0640 "current limit" (and possibly also p1520, p1521, p1530 and p1531) are automatically adapted to the lower power rating in order to protect the converter power module from destruction.

This parameter change is independent of the setting for a frequency converter replacement/exchange in p7840. This means that the parameter is always changed. This change also remains, even if the control unit does not accept the converter power module and a fault is output.

If, when replacing a converter power module, a power module with a higher power rating is inserted, the value for the current limit in p0640 is kept. The reason for this is that there are absolutely no restrictions when it comes to falling below the maximum current limit.

From this self-protection mechanism of the frequency converter, it follows that when a power module is replaced from a lower rated power to a higher rated power, then under certain circumstances, parameter p0640 must be adapted to the appropriate application (the current limiting required).

For the case that "MMC-PS required" is configured, this means that the values for the power module with the lower rated power must also be written to the MMC-PS. This means that as soon as a larger converter power module is inserted, the data for the power module with lower power rating is written into the RAM.

The data for the larger converter power module must, in this case, be changed in the RAM either before or after the converter power modules was replaced and written to the MMC-PS with p0802.

6.6 Replacing frequency converter components

Replacing a control unit with MMC-PS

When a control unit is replaced, it is assumed that control unit does not have a suitable parameter set. This means that it is either completely new (has never been operated) or was parameterized in another slot. This is the reason that the frequency converter always attempts to download a parameter set from the MMC-PS. To do this, the frequency converter initially checks whether an MMC-PS is available and can be read.

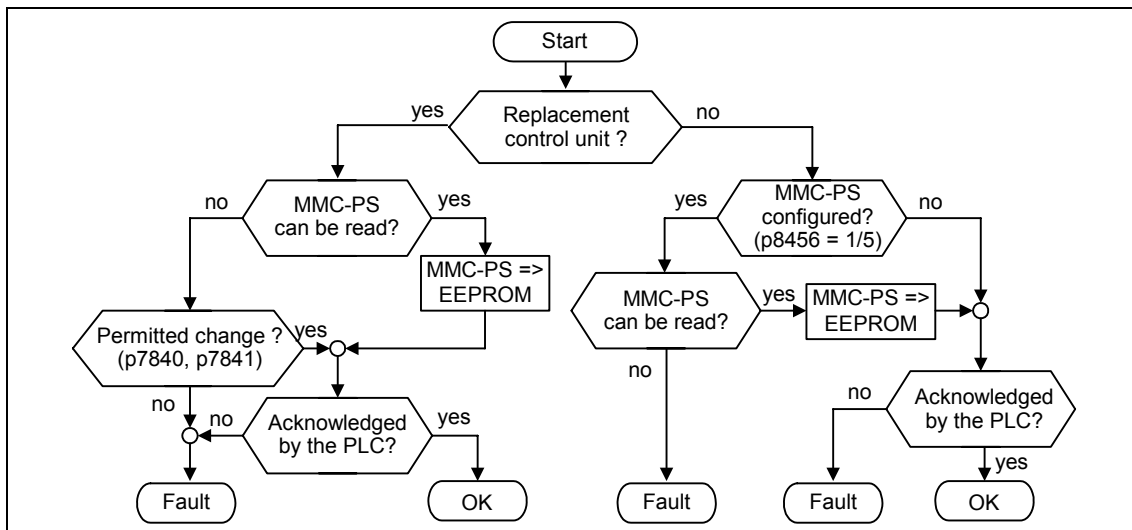


Fig. 6-32 Conditions for start of the converter

If this condition is fulfilled, the frequency converter overwrites its internal memory (EEPROM) with the parameters from the MMC-PS. After this operation, known as initialization, the frequency converter has a connection to the control (PLC) and checks whether the frequency converter may start.

The frequency converter may start if the ID (SPICPU), safety enable and "MMC required" in HW Config conform to the settings of internal parameters p8455, p8456, p9601/p9801.

6.6 Replacing frequency converter components

Caution

If a control unit is replaced with an MMC-PS inserted, then the parameters, saved in the frequency converter, are lost. They are always replaced by the parameter set in the MMC-PS. This is also the case if the MMC-PS that has been inserted does not match this frequency converter (e.g. incorrect slot ID). The frequency converter then outputs an error message and does not start.

In order that the correct parameters of a frequency converter are not lost, a frequency converter should never be replaced without a matching MMC-PS. A matching MMC-PS is generated by transferring parameters from the frequency converter to the MMC-PS (refer to Section 6.7.1).

The user is always responsible in providing a correct or suitable parameter set on the optional MMC-PS.

Replacing a control unit without MMC-PS

It is possible to replace a control unit without MMC-PS if the control unit that was newly inserted, was already parameterized previously with the same slot ID or a new frequency converter from the factory was pre-parameterized without having been connected to a power section.

In this case, an MMC-PS may not be inserted as otherwise the frequency converter would automatically run-up with the MMC-PS. The frequency converter checks whether, for this particular case, it may start.

After this operation, the frequency converter has a connection to the control (PLC) and checks whether the slot ID in the frequency converter matches the ID of the slot.

6.7 Handling ET 200S FC frequency converters

Overview

In this section you are shown which tools you can use to change individual parameters or complete parameter sets, which settings are possible for running-up the control unit and the prerequisites for the individual measures.

These are

- Handling with MMC-PS
 - MMC-PS as parameter memory
 - Transferring parameters from the MMC-PS after CU hot swap (automatic cloning)
 - Transferring parameters from the MMC-PS when (manually) cloning
 - Transferring parameters from the MMC-PS after every OFF/ON
 - MMC-PS for a firmware upgrade
- Handling with Starter
 - The upload and download of parameter sets as well as changing parameters
 - Writing a parameter set from the RAM to the EEPROM
 - Reset to the factory setting
- Handling with FB100
 - Changing parameters
 - Writing a parameter set from the RAM to the EEPROM
 - Reset to the factory setting

6.7.1 MMC-PS as parameter memory to upread, download and in operation

Possibilities of using the MMC-PS as parameter memory

Using MMC-PS, you can copy completed parameter sets into the control unit of a frequency converter. In many cases, this means that commissioning is not required.

Parameters can be transferred from an MMC-PS in the following ways:

- A parameter set can be upread to the MMC-PS
- Series commissioning via the MMC-PS
- Parameters can be transferred from the MMC-PS when downloading
- Parameters can be transferred from the MMC-PS after a CU hot swap
- Parameters can be transferred from the MMC-PS after ever power OFF/ON (24 V)
 - for standard applications
 - for safety-related applications

Notes

- When transferring parameters after a CU hot swap and power OFF/ON, the clone00.bin file is always written from the MMC-PS into the control unit.
- If "MMC not required" is configured in the control and if an MMC-PS is inserted while the frequency converter is operational, then Alarm A0564 "MMC inserted in operation" is output. The frequency converter then continues to operate with the data in the RAM.

This alarm can be acknowledged by withdrawing the MMC-PS:

Caution

The parameter sets of the ICU24 control unit and the ICU24F control unit are not compatible. This means that parameters cannot be transferred between an ICU24 and ICU24F.



Warning

When transferring parameters from an MMC-PS, all of the parameters in the control unit are overwritten with the data from the MMC-PS. Incorrect data can result in significant injury to personnel or material damage.

The user is responsible for ensuring that the data on the MMC-PS is correct.

6.7 Handling ET 200S FC frequency converters

Upread of a parameter set into an MMC-PS

Using the upread function, parameter sets can be written from a control unit to an MMC-PS.

Prerequisites for the upread

The frequency converter must be in the "commissioning" state ($p0010 = 30$); this means that the LED RY on the control unit is dark (the LED is off).

Upread operation

- If required, set the file name using $p0804$
- Insert MMC-PS into control unit and start the upread operation with $p0802 = 2$

Possible faults/errors when upreading

No MMC-PS inserted, → fault F0061.

Counter-measure: Insert the MMC-PS, acknowledge the faults, restart the upread operation.

Notes

- When upreading, the safety-relevant parameters are always also transferred from the control unit.
- The upread operation takes approximately 1 min. All of the LEDs are dark during the upread operation. If upreading has been successfully completed, $p0010$ and $p0802$ are set to 0 and the LED RY is bright (the LED is lit).

Caution

In the factory default setting, the name clone00.bin ($p0804$) is preset (default) for the upread file. A hundred different names can be generated using the digits 00 to 99.

Files that already exist are overwritten when upreading.

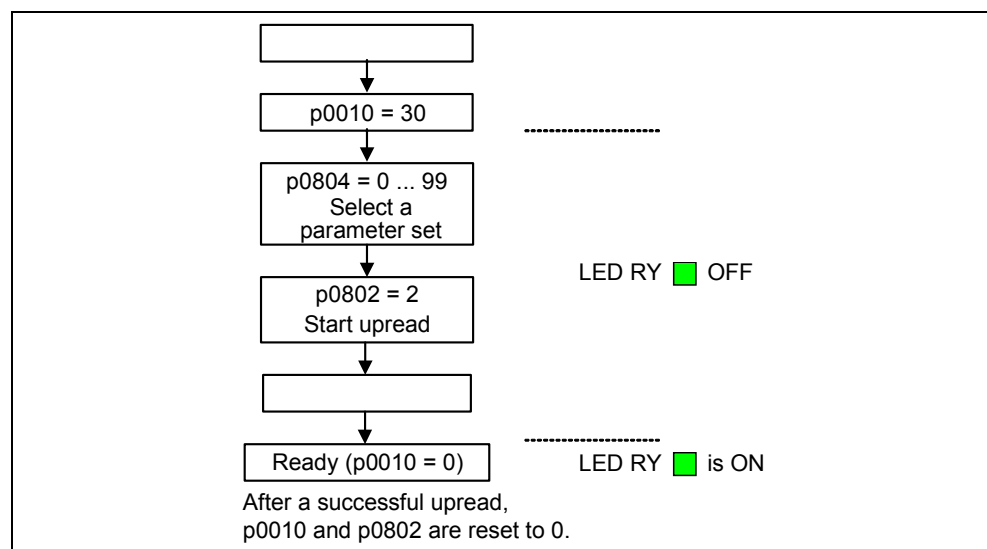


Fig. 6-33 Upread with MMC-PS

Transferring parameters from the MMC-PS after a CU hot swap

Using the function "transferring parameters from the MMC-PS after a CU hot swap" it is possible to replace control units and to write all of the required parameters – including the safety-related parameters – from the MMC-PS into the new control unit.

Transferring parameters from the MMC-PS after a CU hot swap

1. Insert the MMC-PS - with the appropriate data set - into the new control unit
2. Insert the new control unit on the terminal module
3. Establish the connection to the converter power module

Notes

- A CU hot swap is permissible both under voltage (24 V) and in a no-voltage condition. It is started as soon as the control unit is connected to the converter power module and power is available (24 V).
- If the control unit is inserted under voltage (24 V) on the terminal module, or the power switched-in before the MMC-PS is inserted, parameters are not transferred.
 - if "MMC required" is configured → F0061
 - if "MMC not required" is configured, → the frequency converter operates with the old parameter set – if MMC-PS is inserted, → "A0564".
- The copy operation for a CU hot swap takes about 1 min. The LED RY is dark during this time. It is bright again (lit) if copying has been successfully completed – or another fault is present. For details, refer to p0947.

Caution

When transferring parameters after a CU hot swap, the safety-related parameters from the MMC-PS are also transferred and accepted.

6.7 Handling ET 200S FC frequency converters

Series commissioning as an example for transferring parameters after a CU hot swap

After parameters have been transferred from the MMC-PS after a CU hot swap, it is possible to commission several control units (series commissioning).

The following conditions must be fulfilled so that series commissioning is completed without any fault/error message:

- The parameter set for the series commissioning should be adapted to the devices for which series commissioning is to be carried-out.
- In the parameter set, p7840 should be set to a value, that permits a CU hot swap, e.g. p7840 = 22. For p7840 = 0, series commissioning is completed with fault F0399.

However, if series commissioning is completed with a fault/error, this does not mean that series commissioning was unsuccessful, but that a parameter setting must be modified. For details, refer to p0947.

Carrying-out series commissioning

Refer above – "Transferring parameters from MMC-PS after carrying-out a CU hot swap"

Transferring parameters from MMC-PS for a download

Parameter sets can be copied from an MMC-PS to a control unit using the Download function.

Prerequisites for the download

- The frequency converter must be in the "commissioning" state (p0010 = 30); this means that the LED RY on the control unit is dark.
- Communications must have been established to the control
- The connection to the power module must be established
- An MMC-PS with the appropriate data set must be inserted

In order to avoid an accidental download, in addition, the following conditions are interrogated:

From the flow diagram it can be seen that the download is always permissible if the parameter set is received from the same module in which the download should take place – or if p8457 = 1 (also refer to the following note).

Note

For new ICU24(F) control units, p8457 is set to 1 and is set to 0, if

- the frequency converter is connected to the control
 - a converter power module is inserted
 - a parameter value is changed – with the exception of parameters p0010, p0803 and p3900.
-

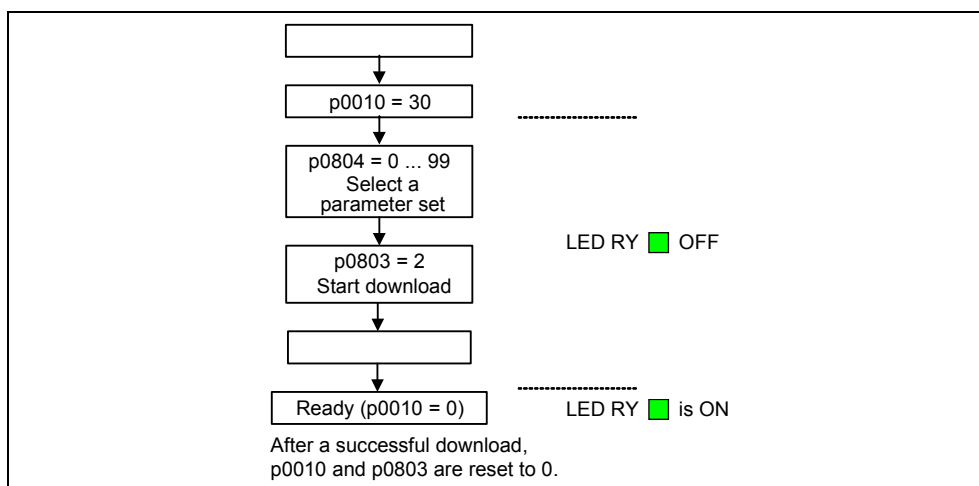


Fig. 6-34 Flow diagram to download a parameter set

Downloading

In the "download permissible" state, start the download with p0803 = 2.

Possible errors when downloading a parameter set:

- No MMC-PS inserted, → fault F0061.
Remedy: Insert an MMC-PS, acknowledge the fault, re-start the download.
- Download with p8457 = 0, → fault F0063.
Remedy: Acknowledge the fault, set p8457 to 1 and restart the download.

Notes

- When downloading, the **safety-related** parameters are **not transferred** from the MMC-PS.
- After a successful download, p0010 and p0803 are set to 0
- The download takes approx. 1 min. The LED RY is dark during this time. It is bright again if the download was successfully completed – unless another fault is present. For details, refer to p0947.

6.7 Handling ET 200S FC frequency converters

Transferring parameters from the MMC-PS after every power OFF/ON (24 V) for standard applications (not Safety)

The parameter transfer operation after every power OFF/ON is set using the object properties of the control unit in HW Config (STEP 7) via MMC (PMMC).

The following settings can be made for MMC (PMMC)

- MMC required
In this setting, each time that the MMC-PS runs-up, the safety parameters are copied into the EEPROM – the standard parameters are copied into the RAM
- MMC not required
In this setting, at each run-up, the parameters are copied from the EEPROM into the RAM

When the control unit runs-up, the settings “MMC required“ and “MMC not required“ are sent to the control unit via the PRM telegram and written into p8456.

For standard applications (not safety), p8456 is set to the following values

- MMC not required → p8456 = 0
- MMC required → p8456 = 1

Note

Parameter p8456 can only be modified via the control.

Caution

If “MMC required“ is configured in the control, but an MMC-PS is not inserted, the frequency converter does not start, but goes into a fault condition with F0061.

Sequence for setting the parameter transfer after each power OFF/ON (24 V)

1. Set “MMC-PS required“ in HW Config and save in the control.
2. The control sends the value 1 or 5 for p8456 to the control unit via the PRM telegram
3. The frequency converter shuts down with fault F0398
4. Insert MMC-PS in the control unit and carry-out an upread (this means that especially the correct value for p8456 is written to the MMC-PS).
5. Acknowledge the fault using power OFF/ON (24 V) and write the correct parameter set from MMC-PS into the control.

Transferring parameters from the MMC-PS after every power OFF/ON for safety-relevant applications (safety)

In addition to the settings for parameter transfer after every power OFF/ON for standard applications, for safety-relevant applications, the "safety technology" parameter must also be set using the object properties of the control module in HW Config (STEP 7):

The "safety technology" parameter offers the following setting possibilities:

- Safety technology activated
- Safety technology not activated

When the control unit runs-up, the following settings are sent to the control unit via the PRM telegram and written into p8456.

- MMC not required, safety technology de-activated → p8456 = 0
- MMC required, safety technology de-activated → p8456 = 1
- MMC not required, safety technology activated → p8456 = 4
- MMC required, safety technology activated → p8456 = 5

Note

Parameter p8456 can only be modified via the control.

Caution

If "MMC required" is configured in the control, but an MMC-PS is not inserted, the frequency converter does not start, but goes into a fault condition with F0061

6.7 Handling ET 200S FC frequency converters

6.7.2 Activating safety technology on the frequency converter side

Description

On the frequency converter side, the safety-relevant applications are set using parameter p9601/p9801:

- p9601/p9801 = 0 → safety technology de-activated
- p9601/p9801 = 1 → safety technology activated
- p9601/p9801 = 3 → safety technology activated (+ forced checking procedure and self-test when selecting SH)

Caution

- If the settings regarding the safety-relevant technology in the frequency converter and in the control do not match, the frequency converter goes into a fault condition with F0396

Note

The following steps must always be maintained when changing safety-related parameters:

1. p0010 = 95 commissioning mode (safety)
 2. p9761 = password
 3. Change safety parameter(s)
 4. p3900 = 10, exit safety commissioning and accept the changes
-

6.7.3 Firmware upgrade with MMC-PS

Description

The firmware for an ET 200S FC frequency converter is always upgraded using an MMC-PS.

Hardware prerequisites

The user requires

- a PC with Internet connection
- a standard card reader
- an MMC-PS

Creating a memory card with a firmware upgrade

1. Delete the data on the MMC-PS
2. Download the file for firmware upgrade, via <http://support.automation.siemens.com/WW/view/de/12834637/133100>
3. Unzip the file and save with a directory structure on the MMC-PS .

Upgrading the operating system

1. Power-down or withdraw the control unit
2. Insert the prepared memory card with firmware upgrade into the control unit.
3. Power-up or insert the control unit
4. The operating system is written from the memory card into the EEPROM of the control unit. All LEDs on the control unit are lit (are bright).

Caution

It is neither permissible that a Power OFF occurs nor the MMC-PS is withdrawn while upgrading. This could mean that the firmware would be lost.

5. The slowly flashing "SF" LED on the control unit indicates when the operating system has been successfully upgraded.
6. Power-down (power OFF) and remove the MMC-PS with the firmware upgrade. When required, the MMC-PS, required for operation, can be inserted.
7. Power ON. The control unit runs-up and is immediately ready for operation.

6.7 Handling ET 200S FC frequency converters

Note

In order to obtain the correct parameter settings – even after a firmware upgrade – the system should be re-commissioned.

Fault displays

When the firmware is being upgraded via the MMC-PS interface, faults that remain and also acknowledgeable faults can occur.

Remaining faults are those faults where the old firmware is already completely or partially replaced by the new firmware before the fault was detected – or the download was interrupted. These faults can only occur when downloading new firmware.

- Possible causes
 - Data is lost during the download
 - The compatibility check after the download was negative
- Remedy
 - Repeat the firmware upgrade; if required, the control unit must be returned to the responsible Siemens office.
 - Repeat the firmware upgrade using a compatible version.

For **acknowledgeable faults**, the fault was detected before download was started and the old firmware is still present. These faults can be acknowledged after removing the MMC-PS. In this case, the frequency converter then continues to run with the old firmware.

- Possible causes
 - Firmware not compatible to the frequency converter.
 - Firmware is unknown
 - The file format is unknown

6.7.4 Handling with STARTER

Possibilities for using the STARTER commissioning tool



The STARTER commissioning tool offers the following possibilities of accessing the ET 200S FC frequency converter to adapt it to the particular drive task.

- Upreading / downloading parameter sets and changing parameters
- Writing a parameter set from the RAM to the EEPROM
- Reset to the factory setting

Connecting-up the PC with the STARTER software is described in the "Interfaces" chapter.

Upreading and downloading parameter sets as well as changing parameters

Parameter sets are uploaded and downloaded from/to the PC using the "STARTER" commissioning program and the following buttons:

- Upread  "Load into the PG" , or
- Download  "Load into the target device"
- Parameter changes using Starter can either be modified using interactive dialog or directly using the Expert list (for details, refer to the STARTER software and STARTER online help).

Note

For p0014 = 1, when downloading, the parameter set is written into the RAM and into the EEPROM; for p0014 = 0 only into the RAM. Various data save types can be set for the control and STARTER using the index of p0014.

- p0014[1] = Setting for STARTER (USS on RS2323)
- p0014[2] = Setting for the control (fieldbus)

For an OFF command (24 V), the parameter settings that were only written into the RAM, are lost.

When running-up or after an OFF/ON (24 V), the actual parameter set - if no MMC-PS is configured - is always copied from the EEPROM to the RAM.

When running-up with configured MMC-PS, the actual parameter set is uploaded from the MMC-PS as follows:

- Safety-relevant parameters: MMC-PS → EEPROM → RAM
 - Standard parameters: MMC-PS → RAM
-

Writing a parameter set from the RAM to the EEPROM

With p0971 = 1 (positive edge), parameters are written from the RAM to the EEPROM. All of the values in the RAM are copied to the EEPROM.

6.7 Handling ET 200S FC frequency converters

After transfer has been completed, p0971 = 0 is set to 0 (standard value). Additional details are provided in the parameter list.

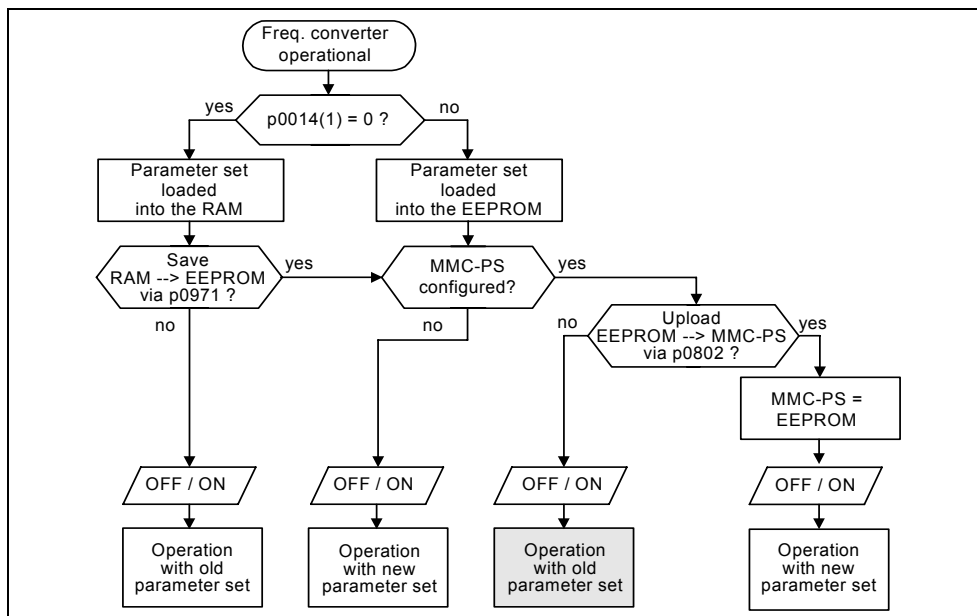


Bild 6-35 Changing parameters with STARTER

Caution

If the drive is powered-down/power-up and the MMC-PS was not updated, then when the frequency converter runs-up, the parameter values in the EEPROM are overwritten by the values in the MMC-PS (grey blocks). This would mean that changes would be lost that were written into the EEPROM, but were not written onto the MMC-PS.

Reset to the factory setting 

p0010 = 30 and p0970 = 1 are used to reset to the factory setting. This is possible using STARTER and also using FB100. Details are provided in the Section “Parameter reset to the factory setting“.

6.7.5 Handling with FB100

Possibilities for the FB100

The FB100 offers the following possibilities of accessing the ET 200S FC frequency converter to adapt the converter to the particular drive task.

- Reading and changing parameters
- Writing a parameter set from the RAM into the EEPROM
- Reset to the factory setting

Several typical cases are shown in the following examples.

Reading parameters

The following example shows how to parameterize the FB100 to read the maximum frequency p1082.

Actions

CALL "ET200S_FC_DRIV", DB100

PAR_ADDRESS	:= 1082	Parameter number (maximum frequency)
PAR_INDEX	:= 0	Index 0
DIRECTION	:= 0	Reading
REQ	:= 1	Start the read request

Consequences/results

BUSY	:= 1	1 if active, 0 if the request has been completed
READ_DATA_VALUE	:= 50.00	50 Hz (real)

Possible fault messages

PAR_ERR	:= 0	1, error when reading 0, no error
PAR_ERR_NO	:= any value	For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

6.7 Handling ET 200S FC frequency converters

Changing parameters

The following example shows how to parameterize the FB100 to change the maximum frequency p1082

Actions

CALL "ET200S_FC_DRIV" , DB100

PAR_ADDRESS	:= 1082	Parameter number (maximum frequency)
PAR_INDEX	:= 0	Index 0
WRITE_DATA_VALUE	:= 100.00	100 Hz (real)
DIRECTION	:= 1	Writing
REQ	:= 1	Start write request

Consequences / results

BUSY	:= 1	1 if active, 0 if the request is completed
------	------	--

Possible fault messages

PAR_ERR	:= 1	1, error when writing 0, no error
PAR_ERR_NO	:= 17	Enquiry cannot be executed. For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

Writing a parameter set from the RAM into the EEPROM

The following example shows how to parameterize the FB100 in order to copy a parameter set from the RAM into the EEPROM.

Actions

CALL "ET200S_FC_DRIV" , DB100

PAR_ADDRESS	:= 971	Parameter number (RAM -> EEPROM)
PAR_INDEX	:= 0	Index 0
WRITE_DATA_VALUE	:= 1	1 (integer)
DIRECTION	:= 1	Writing
REQ	:= 1	Start write request

Consequences/results

BUSY	:= 1	1 if active, 0 if request completed
------	------	-------------------------------------

Possible fault messages

PAR_ERR	:= 0	1, error when writing 0, no error
PAR_ERR_NO	:= any value	For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

Reset to the factory setting

The following example shows how to parameterize the FB100 to reset to the factory setting.

1. Commissioning parameters for set to "factory setting"

Actions

CALL "ET200S_FC_DRIV" , DB100

PAR_ADDRESS	:= 10	Commissioning parameter
PAR_INDEX	:= 0	Index 0
WRITE_DATA_VALUE	:= 30	30 (integer)
DIRECTION	:= 1	Writing
REQ	:= 1	Start write request
BUSY	:= 1	1 if active, 0 if the request has been completed

Possible fault messages

PAR_ERR	:= 0	1, error when writing 0, no error
PAR_ERR_NO	:= any value	For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

2. Starting reset to factory setting

Actions

CALL "ET200S_FC_DRIV" , DB100

PAR_ADDRESS	:= 970	Reset to factory settings
PAR_INDEX	:= 0	Index 0
WRITE_DATA_VALUE	:= 5	5 (integer) correct value for non-safety-related parameters would be 1!
DIRECTION	:= 1	Writing
REQ	:= 1	Start write request

Consequences / results

BUSY	:= 1	1 if active, 0 if the request has been completed
------	------	--

Possible fault messages

PAR_ERR	:= 1	1, error when writing 0, no error
PAR_ERR_NO	:= 104	Value limit exceeded. For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

Additional information is provided in the Section "resetting parameters to the factory setting".

6.7 Handling ET 200S FC frequency converters

Connecting r0052.3 to p2810.1 via a BICO interconnection

The following example shows how status word 1, r0052, bit 3 (fault active, yes/no) is "soft wired" to the input of p2810[1] "BI: AND 1".

The value is transferred from **r0052.3** to **p2810[1]**.

Actions

CALL "ET200S_FC_DRIV" , DB100

PAR_ADDRESS	:= 2810	Select parameter p2810
PAR_INDEX	:= 1	Index 1
WRITE_DATA_VALUE	:= 00340003	Hexadecimal value of r0052.3
DIRECTION	:= 1	Writing
REQ	:= 1	Start write request

Consequences / results

BUSY	:= 1	1 if active, 0 if the request has been completed
------	------	--

Possible fault messages

PAR_ERR	:= 0	1, error when writing 0, no error
PAR_ERR_NO	:= any value	For details, refer to the SIMATIC S7 coupling "fault numbers for parameterizing faults"

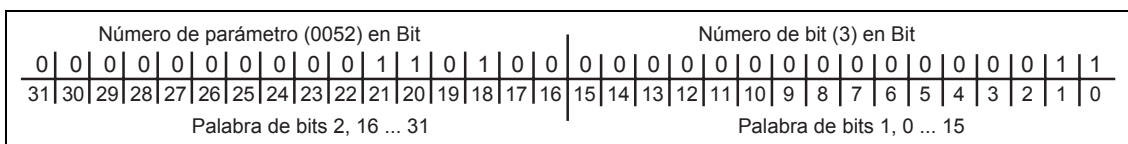


Fig. 6-36 Example for entering r0052.3 as double word in the hexadecimal format:

Note

It is not possible to completely monitor the frequency converter functions using the standard blocks used in FB100. The diagnostic functions OB82, OB83, ... should be used for complete monitoring.

Open-loop and Closed-loop Control Techniques

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7.1 Overview

7.1 Overview

Description

There are several open-loop / closed-loop control techniques for closed-loop speed and torque control that can be used for frequency converters feeding induction and synchronous motors. These techniques can be roughly classified as follows:

- V/f characteristic control (briefly: V/f open-loop control)
- Field-orientated closed-loop control (briefly: Closed-loop Vector control)

An efficient closed-loop torque control cannot be implemented using V/f control (refer to Section 7.2). This is the reason that field-orientated closed-loop control techniques should be used (refer to Section 7.3.2).

The field-orientated closed-loop control techniques – also known as closed-loop Vector control – can be further sub-divided into two groups:

- Closed-loop Vector control without speed feedback (sensorless closed-loop Vector control (SLVC))
- Closed-loop Vector control with speed feedback (closed-loop Vector control (VC))

They differ regarding the closed-loop control quality and the complexity - which in turn are obtained from the requirements of the particular application. The largest proportion of V/f control is used for basic applications (e.g. pumps and fans). Closed-loop Vector control is especially used for sophisticated applications (e.g. winders) where a high control quality and good response to disturbances is required regarding both speed and torque. If these requirements also apply in the range from 0 to approx. 1 Hz, then the speed/torque accuracy without encoder (sensorless) is not adequate and closed-loop Vector control with speed feedback is used.

7.2 V/f control

Data

Parameter range:	p1300 p1310 – p1350
Alarms:	-
Errors:	-
Function chart number:	FP6100

Description

The V/f characteristic is the simplest control solution. In this case, the stator voltage of the induction or synchronous motor is controlled (open-loop) proportional to the stator frequency. This technique has proven itself for a wide variety of "basic" applications such as

- Pumps, fans
- Conveyor belt drives

and similar processes.

The objective of the V/f control is to keep the flux Φ constant in the motor. This is proportional to the magnetizing current I_{μ} and the ratio between voltage V and frequency f .

$$\Phi \sim I_{\mu} \sim V/f$$

The torque M developed by induction motors is in turn proportional to the product (or more precisely stated, the vectorial product $\underline{\Phi} \times \underline{I}$) of flux and current.

$$M \sim \Phi * I$$

In order to generate the highest possible torque for a given current, the motor must operate with a constant flux that is as high as possible. In order to keep flux Φ constant, then when frequency f is changed, voltage V must be changed in proportion so that a constant magnetizing current I_{μ} flows. The V/f characteristic control is derived from these basic principles.

The field-weakening range is located above the rated motor frequency where the maximum voltage is reached. The flux and the maximum torque then decrease with increasing frequency as shown in Fig. 7-1.

7.2 V/f control

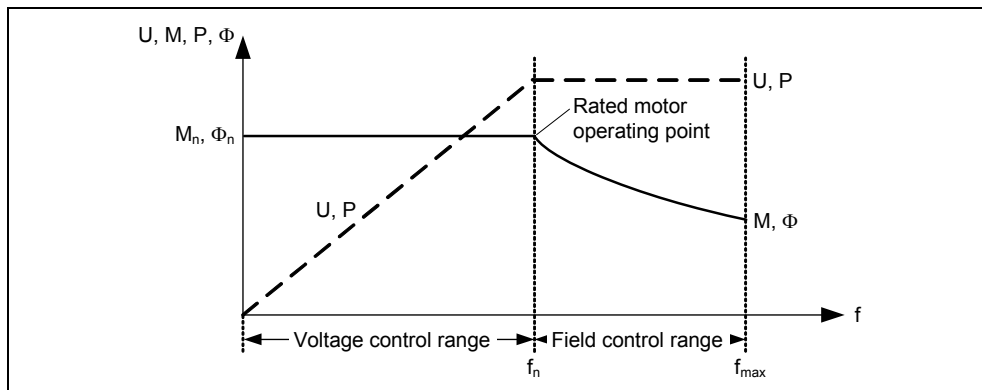
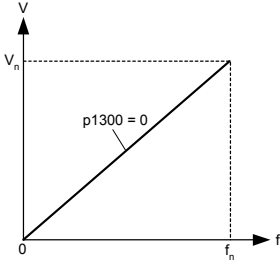
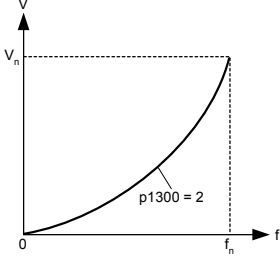


Fig. 7-1 Operating ranges and characteristics of induction motor when fed from a frequency converter

For the V/f characteristic, there are several versions that are shown in the following table.

Table 7-1 V/f characteristic (parameter p1300)

Parameter values	Significance	Use / characteristic
0	Linear characteristic	Standard case 
1	FCC	This is a characteristic that compensates the voltage losses of the stator resistance for steady-state and dynamic loads (flux current control FCC). This is especially relevant for low rating motors as these have a relatively high stator resistance.
2	Square-law characteristic	This is a characteristic that takes into account the torque characteristic of the driven load (e.g. fan / pump) <ul style="list-style-type: none"> • Square-law characteristic (f^2 characteristic) • Energy saving as the low voltage also results in lower currents and losses. 

Parameter values	Significance	Use / characteristic
3	Programmable characteristic	<p>This is a characteristic that takes into account the torque characteristic of the motor / driven load (e.g. synchronous motor).</p> <p style="text-align: center;"> $p1310[V] = \frac{p1310[\%]}{100[\%]} \cdot \frac{r0395[\%]}{100[\%]} \cdot p0304[V]$ </p>
5	Application adaptation	<p>This is a characteristic that takes into account the special technological features of an application (e.g. textile applications),</p> <ul style="list-style-type: none"> • Where the current limiting (I_{max} controller) only influences the output voltage but not the output frequency, or • By inhibiting slip compensation
6	Application adaptation using FCC	<p>This is a characteristic that takes into account the special technological features of an application (e.g. textile applications),</p> <ul style="list-style-type: none"> • Where the current limiting (I_{max} controller) only influences the output voltage but not the output frequency, or • By inhibiting slip compensation
19	Independent voltage-input	<p>The user can enter the frequency converter output voltage independently of the frequency using the BICO parameter p1330 via interfaces.</p>

7.2 V/f control

7.2.1 Voltage boost**Data**

Parameter range:	p1310, p1311, p1312 r0056 bit05
Alarms:	-
Errors:	-
Function chart number:	FP6100

Description

At low output frequencies, the V/f characteristics only supply a low output voltage. Further, at low frequencies, the ohmic (resistive) resistances of the stator winding play a role and when compared to the motor reactance, can no longer be neglected. This means that at low frequencies, the magnetic flux is no longer proportional to the magnetizing current or the ratio V/f.

This means that the output voltage can be too low, to

- Magnetize the induction motor,
- Hold the load,
- To compensate for the voltage drops in the system (ohmic losses in the winding resistances)
- To provide a breakaway / accelerating / braking torque.

In order to prevent this, it is possible to increase (boost) the frequency converter output voltage using the following parameters (also refer to the following Table):

- p1310 constant voltage boost
- p1311 voltage boost when accelerating / braking
- p1312 voltage boost when starting

Table 7-2 Voltage boost

Parameter	Voltage boost	Explanation
p1310	Constant voltage boost	The voltage boost is effective over the complete frequency range whereby the value continually decreases for high frequencies.
p1311	Voltage boost when accelerating / braking	The voltage boost is only effective when accelerating or braking.

7.2 V/f control

Parameter	Voltage boost	Explanation
p1312	Voltage boost when starting	The voltage boost is only active when the drive accelerates for the 1 st time
<p>The figure contains two graphs. The left graph, titled 'Boost voltage', plots Voltage (V) on the y-axis against Frequency (f) on the x-axis. It shows a dashed line for 'Normal V/f (p1300 = 0)' and a solid line for 'actual V Boost'. The actual V Boost curve starts at a higher voltage at 0 Hz, indicated by a dashed line from $V_{StartBoost,100}$ on the y-axis. It then follows the normal V/f curve until frequency $f_{Boost,end}$ (p1316). The normal V/f curve reaches V_n (p0304) at frequency f_n (p0310) and continues to V_{max} at f_{max} (p1082). The right graph, titled 'Validity range', shows three signals over time (t): a pulse for 'ON' and 'OFF' states, a trapezoidal frequency profile f, and a signal for 'p1312 active' which is high (1) during the initial acceleration phase and low (0) thereafter.</p>		

Note

- Especially at low frequencies, the motor temperature is additionally increased as a result of the voltage boost (the motor overheats) !
- The voltage value at 0 Hz is determined from the product of rated motor current p0305, stator resistance p0350 and the appropriate parameters for the voltage boost p1310 – p1312.

7.2.2 Current limiting (I_{max} controller)

Data

Parameter range:	p1340 – p1346 r0056 bit 13
Alarms:	A0501
Faults:	F0001
Function chart number:	FP6100

Description

In order to avoid overload conditions when motoring, in the V/f characteristic mode, the frequency converters have a current limiting controller (I_{max} controller, refer to the Fig. below). This controller protects the frequency converter and the motor from continuous overload by automatically reducing the frequency converter output frequency by $f_{I_{max}}$ (r1343) or the frequency converter output voltage by $U_{I_{max}}$ (r1344). By reducing one of these two values, the frequency converter load is reduced therefore protecting it from permanent damage.

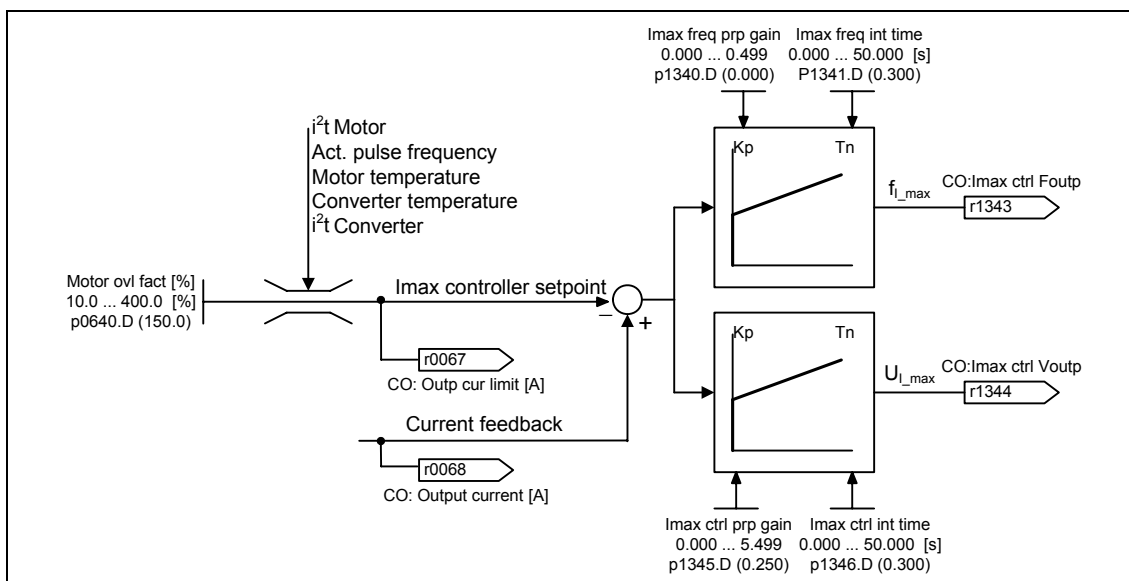


Fig. 7-2 I_{max} controller

Note

The load on the drive is only reduced when the frequency is reduced if at lower speeds the load actually decreases (e.g. square-law speed-torque characteristic of the driven load).

7.2 V/f control

7.2.3 Slip compensation

Data

Parameter range:	p1335
Alarms:	-
Faults:	-
Function chart number:	FP6100

Description

For the V/f characteristic operating mode, the motor frequency is always less than the frequency converter output frequency by the slip frequency f_s . For a constant output frequency the load is increased (the load is increased from M_1 to M_2), then the slip s when motoring increases and the motor frequency decreases (from f_1 to f_2). This behavior of induction motors can be compensated using the slip compensation function p1335. In so doing, the load-related speed reduction is eliminated by increasing (boosting) the frequency converter output frequency (refer to the diagram below).

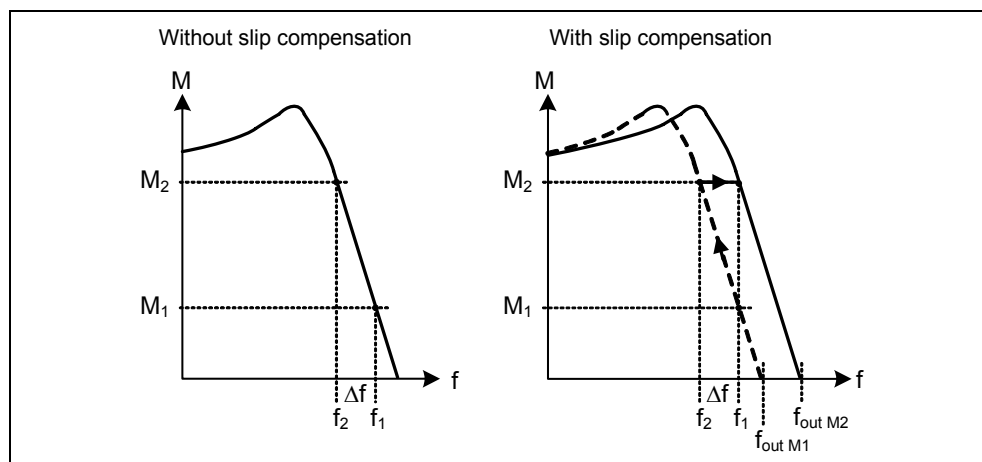


Fig. 7-3 Slip compensation

7.2.4 V/f resonance damping

Data

Parameter range:	p1338
Warnings	-
Faults	-
Function chart number:	-

Description

For variable-speed drives, resonance effects can occur in the upper frequency range (> 20 Hz). These resonance effects result in an increased noise level and also can damage / destroy the mechanical system. These resonance effects can occur for:

- Geared motors
- Reluctance motors
- Large motors
(low stator resistance → poor electrical damping)

Contrary to the "skip frequency" function (refer parameters p1091 to p1094), where the resonance frequency is passed through as quickly as possible, for the V/f resonance damping (parameter p1338), the resonance effects are damped from a control-related perspective. The advantage of this function is that by using this active damping, operation is possible in the resonance range.

The V/f resonance damping is activated and adjusted using parameter p1338. This parameter represents a gain factor that is a measure for the damping of the resonance frequency. The following oscillogram indicates the effect of the resonance damping function using as an example a reluctance motor with gearbox. The phase output currents are displayed for an output frequency of 45 Hz.

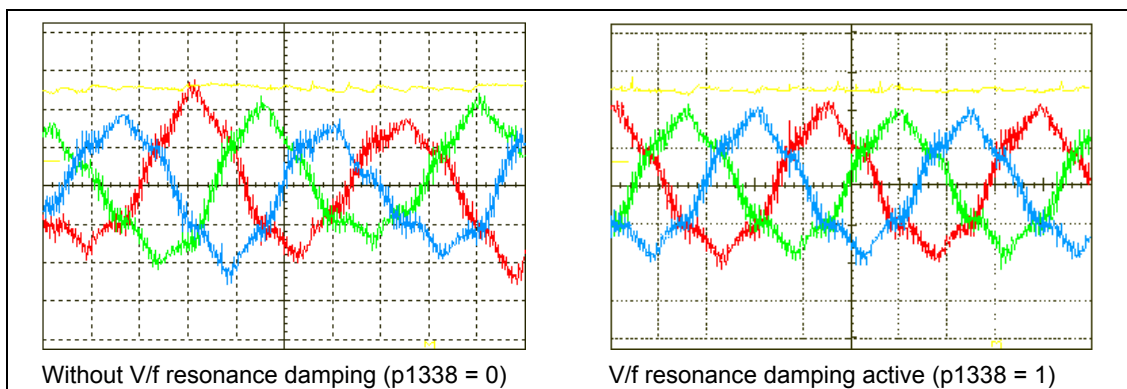


Fig. 7-4 Effect of V/f resonance damping

7.2 V/f control

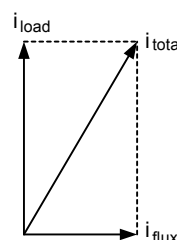
7.2.5 V/f open-loop control with flux current control (FCC)

Data

Parameter range:	p1300, p1333
Warnings	-
Faults	-
Function chart number:	-

Description

An current measurement function has been developed for ET 200S FC drive inverters. This permits the output current to be precisely determined referred to the motor voltage. This measurement guarantees that the output current is sub-divided into a load component and a flux component. Using this sub-division, the motor flux can be controlled and can be appropriately adapted and optimized in-line with the prevailing conditions.



FCC operation is only activated after the FCC starting frequency p1333 has been exceeded. The FCC starting frequency p1333 is entered as a percentage to the rated motor frequency p0310. For a rated motor frequency of 50 Hz and a factory setting of p1333 = 10 %, this results in an FCC starting frequency of 5 Hz. The FCC starting frequency may not be selected too low as this has a negative impact on the control characteristics and can result in oscillation and system instability.

7.3 Closed-loop Vector control

Description

The field-orientated closed-loop Vector control (briefly: Closed-loop Vector control) allows the torque to be far better controlled when compared to V/f control. The principle of the closed-loop Vector control is that for a specified load or required torque the required motor current is impressed with respect to the motor flux so that the appropriate torque is obtained. If the stator current is formed in a rotating coordinate system linked with the rotor flux Φ , then it can be broken-down into a flux-generating current component i_d in parallel to the rotor flux and into the torque-generating current component i_q in quadrature with the rotor flux. These components are corrected to track their setpoints in the current controller. Each has its own dedicated PI controller and in steady-state operation, are identical quantities.

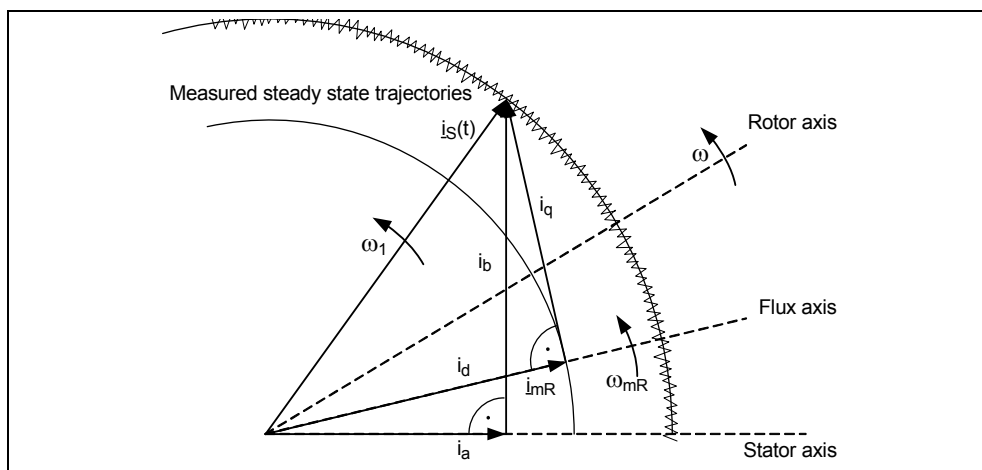


Fig. 7-5 Current Vector diagram in the steady-state condition

In the steady-state condition, the field-generating current component i_d is proportional to the flux Φ and the torque is proportional to the product of i_d and i_q .

$$M \sim \Phi * i_q$$

$$\Phi \sim i_{d,stat}$$

$$M \sim i_d * i_q$$

7.3 Closed-loop Vector control

When compared to V/f control, the closed-loop Vector control has the following advantages:

- High degree of stability during load and setpoint changes
- Short rise times for setpoint changes (→ improved control behavior)
- Short rise times for load changes (→ improved response to disturbances)
- Acceleration and braking are possible with the max. selectable torque
- The motor and the driven load are protected using adjustable torque limits - both when motoring as well as when regenerating
- The drive and braking torque are controlled (closed-loop) independently of the speed
- The full holding torque is available at 0 speed

These advantages are, under certain circumstances, already available without having any speed feedback signal.

The closed-loop Vector control can be used both with and without speed encoder.

The following listed criteria provide a basis in understanding when a speed actual value encoder is required:

- High speed accuracy is required
- High requirements are placed on the dynamic response
 - improved control behavior
 - improved response to disturbances
- Closed-loop torque control is required in the control range 1:10
- A defined and/or changing torque must be maintained for speeds below approx. 10 % of the rated motor frequency p0310

As far as the setpoint input is concerned, the closed-loop Vector control is subdivided into

- Closed-loop speed control, and
- Closed-loop torque / current control (briefly: Closed-loop torque control).

The following Table indicates the various closed-loop Vector control techniques and their associated parameters for velocity and torque monitoring.

Table 7-3 Closed-loop Vector control versions

Closed-loop Vector control	Without encoder	With encoder
Closed-loop speed control	p1300 = 20, p1501 = 0	p1300 = 21, p1501 = 0
Closed-loop torque control	p1300 = 22, p1501 = 1	p1300 = 23, p1501 = 1

When closed-loop speed control is used, then the closed-loop torque control is subordinate to it. This principle of cascading the control loops has proven itself many times over in practice when it comes to commissioning and ensuring that the control circuit is transparent.

7.3.1 Closed-loop Vector control without speed encoder (SLVC)

Data

Parameter range:	p1400 – p1780, p1610, p1611 p1750, p1755, p1756, p1758
Alarms:	-
Errors:	-
Function chart number:	FP7000

Description

For closed-loop Vector control without speed encoder, the position of the flux and the actual speed must be determined using the motor model. In this case, the model is supported by the current and voltage values that are accessible. At low frequencies (≈ 0 Hz), the model cannot determine the speed. This is the reason that due to uncertainties in the model parameters and measuring inaccuracies, in this range, the system changes-over from closed-loop controlled into open-loop controlled operation.

The changeover between closed-loop / open-loop controlled operation is controlled using the time and frequency conditions (p1755, p1756, p1758) (refer to the following diagram). The system does not wait for the time condition to be fulfilled if the setpoint (reference) frequency at the ramp-function generator input and the actual frequency are simultaneously below p1756.

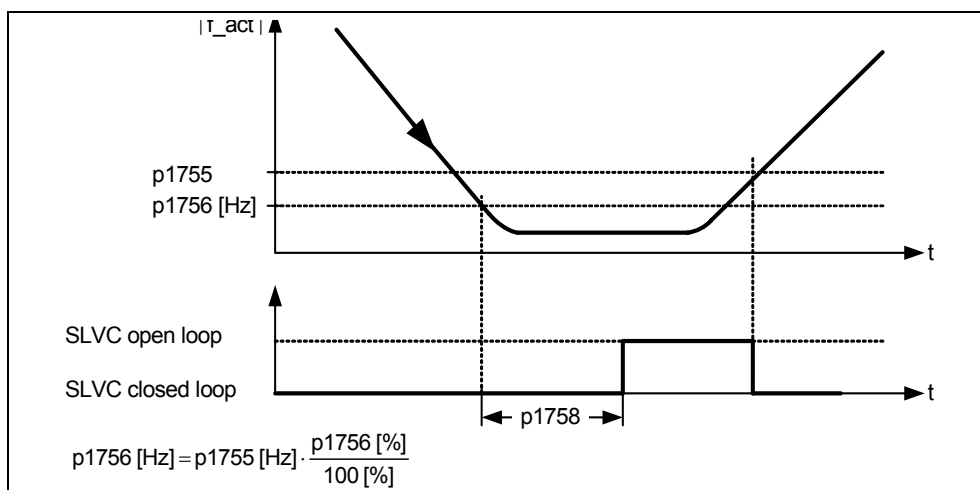


Fig. 7-6 Changeover condition for SLVC

In the open-loop controlled mode, the speed actual value is exactly the same as the setpoint. For suspended loads and when accelerating, parameters p1610 (constant torque boost) and p1611 (torque boost when accelerating) must be

7.3 Closed-loop Vector control

modified in order that the drive can provide the demanded steady-state and dynamic load torque. If p1610 is set to 0 %, then only the magnetizing current r0331 is impressed for a value of 100 %, the rated motor current p0305 is impressed. In order that the drive does not stall when accelerating, p1611 can be increased or the acceleration pre-control can be used. This also makes sense so that the motor is not thermally overloaded at low speeds.

For closed-loop Vector control without speed encoder, our ET 200S FC frequency converter has, in the low frequency range, the following distinguishing features with respect to other frequency converters:

- Closed-loop controlled operation up to ≈ 1 Hz
- It can start in the closed-loop controlled mode (directly after the drive has been energized)
- It passes through the low frequency range (0 Hz) in the closed-loop controlled mode

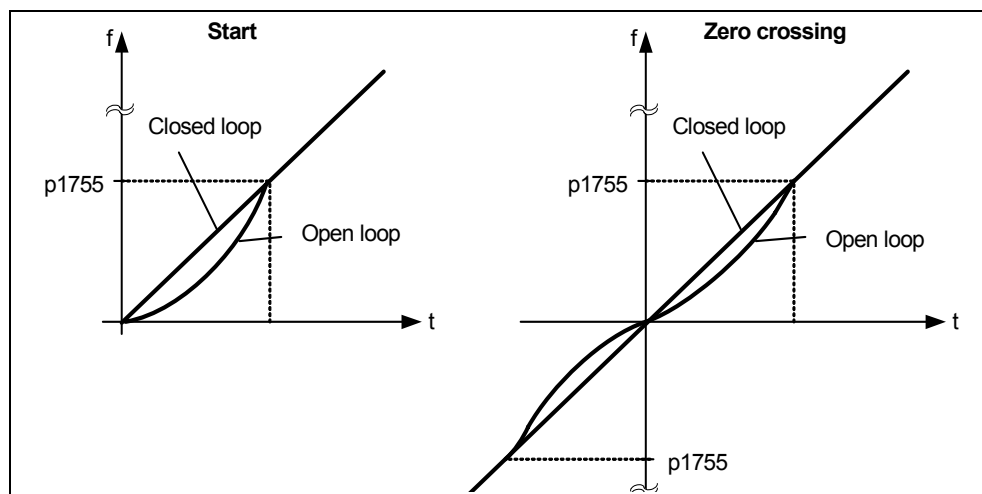


Fig. 7-7 Starting and passing-through 0 Hz in the closed-loop controlled mode

The following advantages are obtained as a result of the closed-loop controlled mode up to approx. 1 Hz (this can be set using parameter p1755) as well as the possibility of starting directly at 0 Hz in the closed-loop controlled mode or reversing in the closed-loop controlled mode (this can be set using parameter p1750):

- It is not necessary to make a changeover within the closed-loop control (bumpless behavior, no frequency dips)
- Continuous closed-loop speed-torque control is possible up to approx. 1 Hz.

Note

For closed-loop controlled reversing or starting from 0 Hz it must be taken into account that for an excessively long dwell time (> 2 s or $> p1758$) in the range around 0 Hz, the control automatically changes-over from the closed-loop to the open-loop controlled mode.

7.3.2 Closed-loop Vector control with speed encoder (VC)

Data

Parameter range:	p1400 – p1740 p0400 – p0494
Alarms:	-
Errors:	-
Function chart number:	FP7000

Description

For closed-loop Vector control with speed encoder (VC), an HTL speed encoder is required in the motor that is referred to ground (so-called single-ended) encoder (examples, refer to Fig. 7-8). The connection at the ICU24(F) control unit is realized through a 9-pin sub-D socket connector. The power supply voltage (24 V) is provided through the control unit.

In order to be able to utilize the functionality of the closed-loop Vector control with speed encoder, the speed encoder must be correctly connected and enabled using parameter p0400. Further, additional parameter assignments must be made in the parameter range p0400 – p0494 (refer to Section 4.6 "Speed encoder interface").

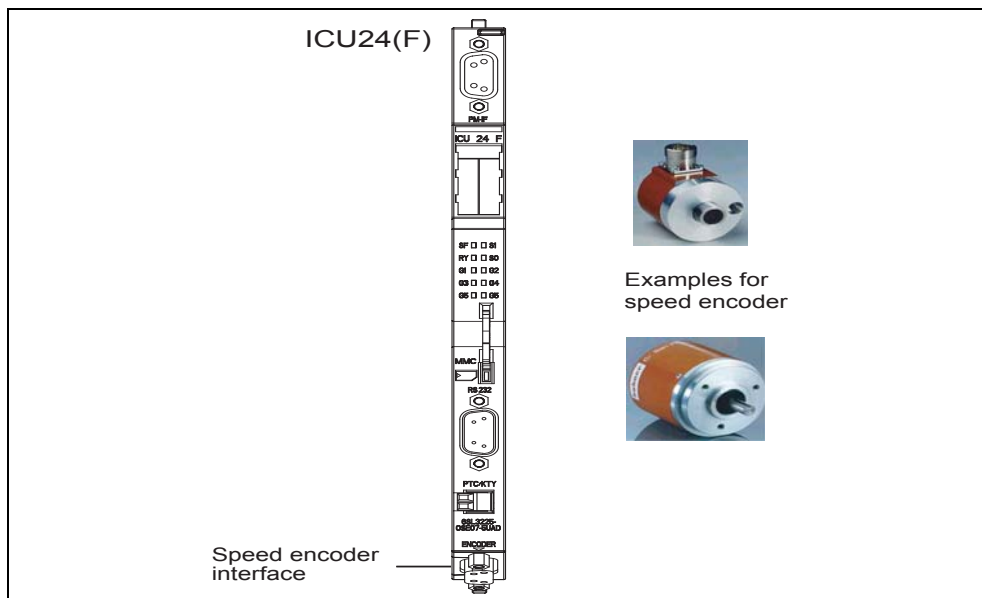


Fig. 7-8 Speed encoder interface with typical speed encoders

7.3 Closed-loop Vector control

Advantages of closed-loop Vector control with encoder

- Closed-loop speed control down to 0 Hz (i.e. at standstill)
- Stable control behavior over the complete speed range
- Constant torque over the rated speed range
- When compared to closed-loop control systems without encoder, the dynamic response of drives using an encoder is significantly increased. This is because the speed is directly measured and is used in generating the model of the current components i_d , i_q .

7.3.3 Speed controller**Data**

Parameter range:	p1300, p1400 – p1780 SLVC: p1470, p1472, p1452 VC: p1460, p1462, p1442
Alarms:	-
Errors:	-
Function chart numbers:	FP7500, FP7510

Description

Both of the closed-loop control techniques (SLVC, VC) have the same speed controller structure - this structure has the following components as core:

- PI controller
- Speed controller pre-control
- Droop

The sum of the output quantities form the torque setpoint. This is reduced to a permissible magnitude using the torque setpoint limiting.

Speed controller (SLVC: p1470, p1472, p1452 - VC: p1460, p1462, p1442)

The speed controller receives its setpoint r0062 from the setpoint channel, the actual value r0063 either directly from the speed actual value encoder for VC or indirectly from the motor model for SLVC. The system deviation is amplified by the PI controller and together with the pre-control, generates the torque setpoint.

When the load torque increases, if droop is active, the speed setpoint is proportionally reduced. This means that the individual drive within a drive group (two or several motors that are mechanically coupled) is relieved when the torque is too high.

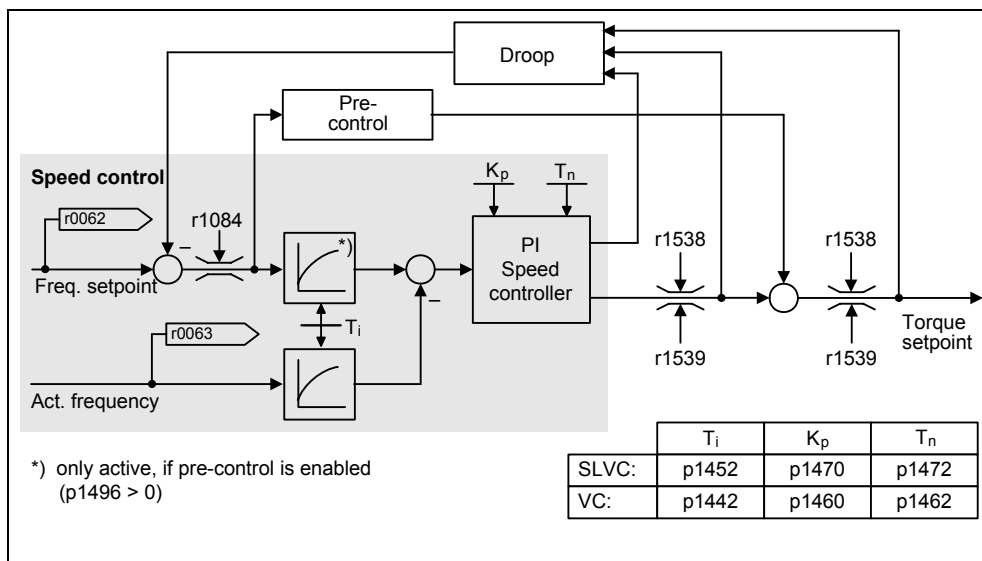


Fig. 7-9 Speed controller

If the moment of inertia was entered, then the speed controller (K_p, T_n) can be calculated using automatic parameterization ($p0340 = 4$). In this case, the control parameters are defined as follows according to the symmetrical optimum:

$$T_n = 4 * T_\sigma$$

$$K_p = \frac{1}{2} * r0345 / T_\sigma = 2 * r0345 / T_n$$

$$T_\sigma = \text{sum of the short delay times}$$

If the system oscillates with these settings, then the speed controller gain K_p should be manually reduced. It is also possible to increase the speed actual value smoothing (this is generally the case for gearbox play or high-frequency torsional oscillations) and the controller calculation should be re-run as the value is incorporated in the calculation of K_p and T_n .

The following interrelationships apply when optimizing the system:

- If K_p is increased, then the controller becomes faster and the overshoot is reduced. However, signal ripple and oscillations in the speed control loop are amplified.
- If T_n is reduced, then the controller also becomes faster. However, the overshoot is increased.

When manually setting the speed control the simplest approach is to initially define the possible dynamic response using K_p (and the speed actual value smoothing) in order that the integral action time can be subsequently reduced as far as possible. In so doing it must be observed that the control must remain stable even in the field-weakening range.

7.3 Closed-loop Vector control

If oscillations occur in the speed control, it is generally sufficient to increase the smoothing time in p1452 for SLVC and p1442 for VC (or reduce the controller gain) in order to dampen any oscillations.

The integral output of the speed controller can be monitored using r1482 and the unlimited controller output, using r1508 (torque setpoint).

Caution

For closed-loop vector control with speed encoder (VC) (p1300 = 21) under the following conditions the speed can increase close to the maximum speed:

- Extremely low gain factor of the speed controller (p1460 \approx 0), and
- Motors running under no-load conditions

In this case it is not possible to shutdown the drive system with an OFF1.

Note

- When compared to closed-loop speed control using an encoder, the dynamic response for drives without encoder (sensorless operation) is significantly lower. The reason for this is that the speed can only be derived from the frequency converter output quantities for current and voltage that have an appropriate noise signal level.
 - The speed controller can be automatically optimized by setting p1960 to 1.
-

Speed controller pre-control (p1496, p0341, p0342)

The speed control loop behavior can be significantly improved by arranging that the speed controller of the frequency converter also generates current setpoint values (corresponding to the torque setpoint) from the speed setpoint. This torque setpoint m_v is calculated as follows

$$m_v = p1496 \cdot \Theta \cdot \frac{dn}{dt} = p1496 \cdot p0341 \cdot p0342 \cdot \frac{dn}{dt}$$

is directly entered / pre-controlled at the current controller via adaptation elements as additive reference variable (enabled via p1496).

For the quick commissioning and complete parameterization (p0340 = 1) the motor moment of inertia p0341 is directly calculated. The factor p0342 between the total moment of inertia and motor moment of inertia must be manually determined (refer to the following diagram).

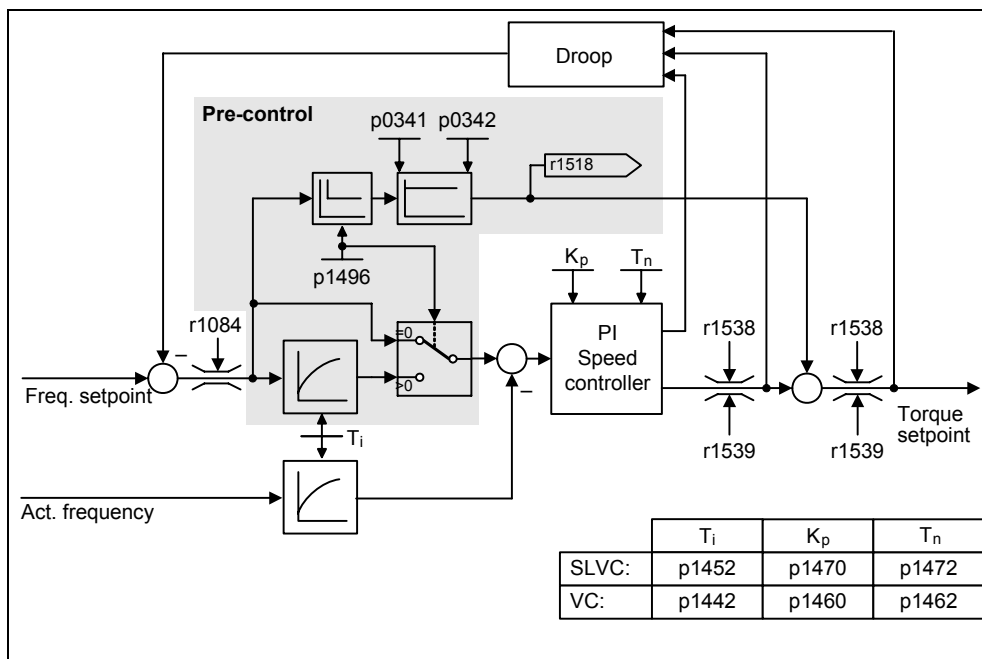


Fig. 7-10 Closed-loop speed controller with pre-control

When correctly adapted this means that the speed controller only has to correct disturbances in its control loop and this can be achieved with a relatively low manipulated variable change. On the other hand, speed setpoint changes are routed past the speed controller and are therefore executed more quickly.

The effect of the pre-control quantity can be adapted depending on the particular application using the pre-control factor p1496. For p1496 = 100 %, the pre-control is calculated according to the motor and load moments of inertia (p0341, p0342). In order that the speed controller does not work against the torque setpoint that has been entered, a balancing filter is automatically used. The time constant of this balancing filter corresponds to the equivalent delay time of the speed control loop. The speed controller pre-control is correctly set (p1496 = 100 %, calibrated via p0342), if the I component of the speed controller (r1482) does not change while ramping-up or ramping-down in the range $n > 20\% \cdot p0310$. This means that with pre-control it is possible to approach a new speed setpoint without any overshoot (prerequisite: The torque limiting does not intervene and the moment of inertia remains constant).

If the speed controller is pre-controlled using the appropriate input signal, then the speed setpoint (r0062) is delayed, just like the actual value (r1445) using the same smoothing (p1442 and p1452). This guarantees that when the drive is accelerating, there is no setpoint - actual value difference (r0064) at the controller input that would only be defined by the signal propagation time.

When activating speed pre-control it must be ensured that the speed setpoint is continuously entered or without a high noise signal level (to avoid torque surges).

7.3 Closed-loop Vector control

Note

The ramp-up and ramp-down times (p1120; p1121) of the ramp-function generator in the setpoint channel should only be set so fast that when the drive accelerates and brakes, the motor speed can track the setpoint. This ensures that the speed controller pre-control optimally functions.

The starting time r0345 is a measure of the overall moment of inertia of the machine and defines that time in which the unloaded drive with rated motor torque r0333 can be accelerated from standstill up to the rated motor speed p0311.

$$r0345 = T_{Start} = \Theta \cdot \frac{2 \cdot \pi \cdot n_{mot, rated}}{60 \cdot M_{mot, rated}} = p0341 \cdot p0342 \cdot \frac{2 \cdot \pi \cdot p0311}{60 \cdot r0333}$$

If this secondary condition matches the application, then the starting time can be used as the lowest value for the ramp-up or ramp-down time.

Droop (p1488 – p1492)

The droop (this is enabled using p1488) means that as the load torque increases, the speed setpoint is proportionally reduced.

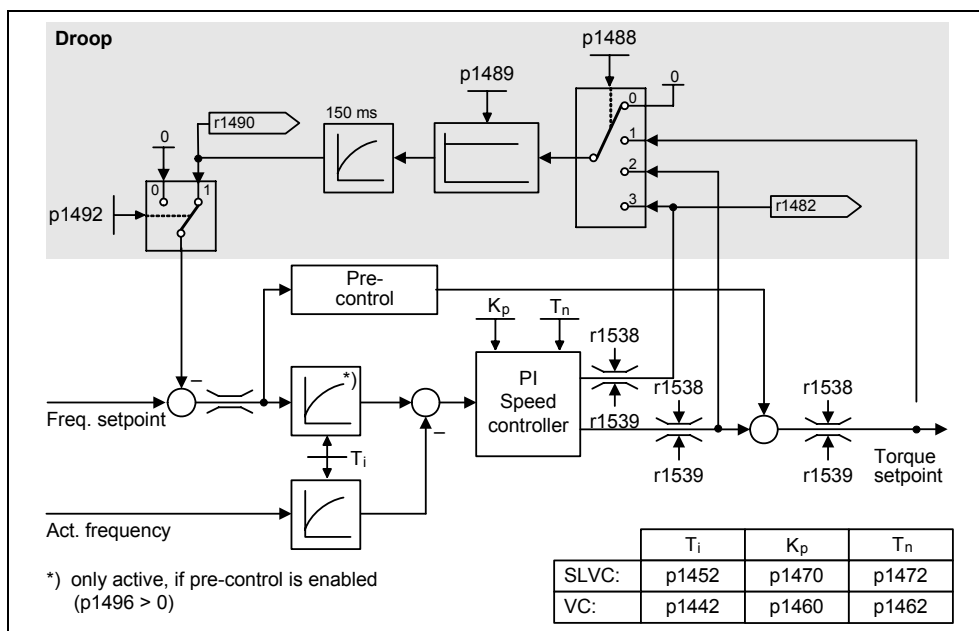


Fig. 7-11 Speed controller with droop

Droop is the simplest technique to provide closed-loop load equalization control. This closed-loop load equalization control however can only be used if the drives only motor and more or less are operated under steady-state condition (i.e. at a constant speed are). For drives that are frequently accelerated and braked with high speed changes, this method is only conditionally suitable.

This basic closed-loop load equalization control is used, e.g. for applications, where two or several motors are mechanically coupled, are operating on a common line shaft and fulfill the requirements mentioned above (refer to the diagram above). The droop function corrects torsional effects and mechanical locking effects that can occur as a result of the mechanical coupling. It achieves this by appropriately modifying the speeds of the individual motors (an individual drive is relieved when an excessively high torque is demanded).

Prerequisites

- All of the drives must be operated in the closed-loop Vector control mode with closed-loop speed control (with or without speed encoder).
- The ramp-up and ramp-down times of the ramp-function generator must be identical for all of the drives.

7.3.4 Closed-loop torque control

Data

Parameter range:	p1300, p1500 – p1511 p1400 – p1780
Alarms:	-
Errors:	-
Function chart numbers:	FP7200, FP7210, FP7700, FP7710

Description

For sensorless closed-loop speed control SLVC (p1300 = 20) or closed-loop speed control VC with encoder (p1300 = 21), it is possible to changeover to closed-loop torque control (slave drive) using BICO parameter p1501. It is not possible to changeover between closed-loop speed and torque control if closed-loop torque control is directly selected using p1300 = 22 or 23. The torque setpoint can either be selected using parameter p1500 or also using BICO parameter p1503 (CI: Torque setpoint).

Note

Only one setpoint can be transferred via the ET 200S backplane bus. The speed and torque setpoints therefore have the same source. The user must ensure that at the instant of the changeover from closed-loop speed to torque control, the setpoint is also appropriately changed-over from speed to torque.

7.3 Closed-loop Vector control

Note

Presently it is not possible to assign fixed torque setpoints. The reason for this is due to the associated safety issues.

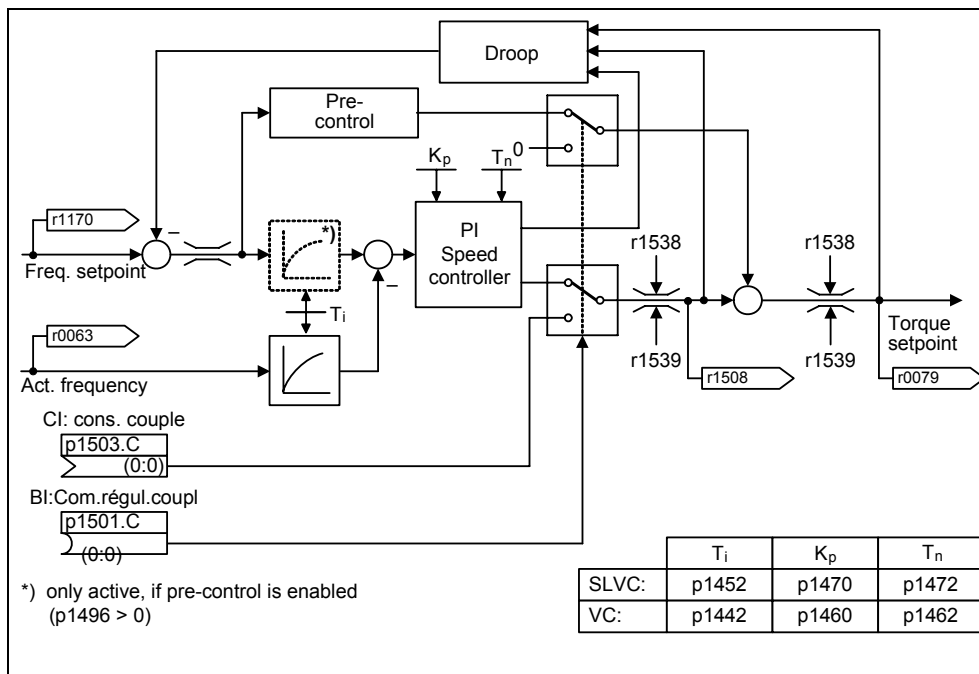


Fig. 7-12 Closed-loop speed/torque control

The torque setpoint is limited in the same way as the torque setpoint of the closed-loop speed control. Above the maximum speed (plus 3 %), a speed limiting controller reduces the torque limit in order to prevent the drive from further accelerating.

A "real" closed-loop torque control (where the speed is automatically set) is only possible in the closed-loop controlled range but not in the open-loop controlled range. In the open-loop controlled range the torque setpoint modifies the setpoint speed through a ramp-up integrator (integration time ~ p1499 * p0341 * p0342). This is the reason that sensorless closed-loop torque control close to standstill is only suitable for applications that require an accelerating torque at that point but no load torque (e.g. traversing drives). For closed-loop torque control with encoders, this restriction does not apply.

If a fast stop command (OFF3) is issued when the closed-loop torque control is active, then the system automatically changes-over to closed-loop speed control and the drive brakes. For a standard stop command (OFF1) there is no changeover. Instead, the system waits until a higher-level closed-loop control brings the drive to a standstill and the pulses are then disabled. This is necessary in order to allow the master and slave drives to be stopped together. For p1300 = 22 or 23, then for an OFF1 the drive is directly powered-down (the same as for OFF2).

7.3.5 Limiting the torque setpoint

Data

Parameter range:	p1520 – p1531, p0640 r0067, r1407 bit08, r1407 bit09
Alarms:	-
Errors:	-
Function chart numbers:	FP7700, FP7710

Description

The following limits all act on the torque setpoint that is either available at the speed controller output for closed-loop speed control or as torque input for closed-loop torque control. The minimum is always used from the different limits. This minimum is cyclically calculated in the frequency converter and is displayed in parameters r1538, r1539:

- r1538 upper torque limit value
- r1539 lower torque limit value

These cyclic values therefore limit the torque setpoint at the speed controller output / torque input and indicate the max. possible torque at that instant in time. If the torque setpoint is limited in the frequency converter, then this is displayed using the diagnostic parameters:

- r1407 bit 08 upper torque limit active
- r1407 bit 09 lower torque limit active

Torque limiting

The value specifies the maximum permissible torque - whereby various limits can be parameterized for motoring and regenerating operation.

- p1520 CO: Upper torque limit value
- p1521 CO: Lower torque limit value
- p1522 CI: Upper torque limit value
- p1523 CI: Lower torque limit value
- p1525 scaling, lower torque limit value

The torque limit values currently active are displayed in the following parameters:

- r1526 CO: Upper torque limit value
- r1527 CO: Lower torque limit value

7.3 Closed-loop Vector control

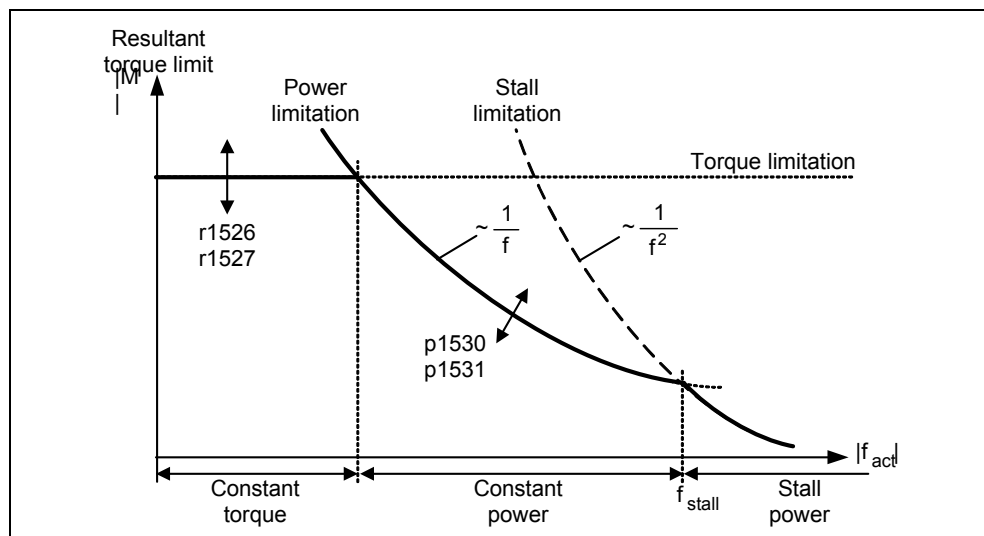


Fig. 7-13 Torque limits

Power limiting

This value specifies the maximum permissible power - whereby different limits can be parameterized for motoring and regenerating operation.

- p1530 power limit when motoring
- p1531 power limit when regenerating

Stall limit

The stall limit is calculated in the drive from the motor data.

Current limiting

The current limit additionally limits the maximum torque that the motor can provide. This means that if the torque limit is increased, a higher torque is only available if a higher current can also flow. It may be necessary to additionally adapt the current limit. The current limit is influenced by:

- p0640
- Thermal motor protection
- Thermal frequency converter protection

After limiting, the maximum possible frequency converter current at this instant in time is displayed in parameter r0067 (limited output current).

Protection and Monitoring Functions

8

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8.1 Monitoring functions / messages

8.1 Monitoring functions / messages**General monitoring functions / messages**

Parameter range:	p2150 – p2180 r0052, r0053, r2197, r2198
Warnings	-
Faults	-
Function chart number:	FP4100, FP4110

MICROMASTER has an extensive range of monitoring functions / messages which can be used for open-loop process control. The control can either be implemented in the drive inverter or also using an external control (e.g. PLC). The interlocking functions in the drive inverter as well as the output of signals for external control are implemented using BICO technology.

The status of the individual monitoring functions / messages are emulated in the following CO/BO parameters:

- r0050 CO/BO: Active command data set
- r0052 CO/BO: Status word 1
- r0053 CO/BO: Status word 2
- r0054 CO/BO: Control word 1
- r0055 CO/BO: Supplementary (additional) control word
- r0056 CO/BO: Status word – closed-loop motor control
- r0403 CO/BO: Encoder status word
- r0722 CO/BO: Status, digital inputs
- r0747 CO/BO: Status, digital outputs
- r1407 CO/BO: Status 2 – closed-loop motor control
- r2197 CO/BO: Messages 1
- r2198 CO/BO: Messages 2

Frequently used monitoring functions / messages including parameter number and bit are shown in the following Table.

8.1 Monitoring functions / messages

Table 8-1 Partial excerpt of monitoring functions / messages

Functions / states	Parameter / bit number	Function chart
Drive ready	52.0	-
Drive ready to run	52.1	-
Drive running	52.2	-
Drive fault active	52.3	-
OFF2 active	52.4	-
OFF3 active	52.5	-
On inhibit active	52.6	-
Drive warning active	52.7	-
Deviation setpoint – actual value	52.8	-
PZD control	52.9	-
Maximum frequency reached	52.A	-
Warning: Motor current limit	52.B	-
Motor holding brake active	52.C	-
Motor overload	52.D	-
Motor runs right	52.E	-
Drive inverter overload	52.F	-
Ramping finished	53.9	-
$ f_act > p1080 (f_min)$	53.2 2197.0	FP4100
$ f_act \leq p2155 (f_1)$	53.5 2197.1	FP4110
$ f_act > p2155 (f_1)$	53.4 2197.2	FP4110
$f_act > zero$	2197.3	FP4110
$f_act \geq setpoint (f_set)$	53.6 2197.4	-
$ f_act \geq p2167 (f_off)$	53.1 2197.5	FP4100
$ f_act > p1082 (f_max)$	2197.6	-
$f_act == setpoint (f_set)$	2197.7	FP4110
$i_act r0068 \geq p2170$	53.3 2197.8	FP4100
Approx. $V_{dc_act} < p2172$	53.7 2197.9	FP4110
Approx. $V_{dc_act} > p2172$	53.8 2197.A	FP4110
No-load operation	2197.B	-
$ f_act \leq p2157 (f_2)$	2198.0	-
$ f_act > p2157 (f_2)$	2198.1	-
$ f_act \leq p2159 (f_3)$	2198.2	-
$ f_act > p2159 (f_3)$	2198.3	-
$ f_set < p2161 (f_min_set)$	2198.4	-
$f_set > 0$	2198.5	-
Motor blocked	2198.6	-
Motor stalled	2198.7	-
$ i_act r0068 < p2170$	2198.8	FP4100
$ m_act > p2174$ & setpoint reached	2198.9	-
$ m_act > p2174$	2198.A	-
Load torque monitoring: Warning	2198.B	-
Load torque monitoring: Fault	2198.C	-

8.2 Motor protection and overload responses

8.2 Motor protection and overload responses

Data

Parameter area:	p0601 – p0640 p0344 p0350 – p0360 r 0035
Alarms:	A0511
Faults:	F0011, F0015
Function chart number:	-

Description

The ET 200S FC frequency converter has a unified, seamless concept to implement thermal motor protection. The basic philosophy is to detect critical thermal conditions, output alarms and initiate responses. This means that the drive can be operated at the thermal power limit and immediate shutdown (trip) can be avoided under all circumstances.

Features

The protective concept (refer to Fig. 8-1) has the following distinguishing features:

- Motor protection with or without temperature sensor
 - without temperature sensor (p0601 = 0): The temperatures are calculated in the motor for various locations in the motor using a thermal motor model (temperature model).
 - with temperature sensor (PTC: p0601 = 1, KTY84: p0601 = 2)
- Selectable responses p0610 that should be initiated when the alarm threshold is exceeded in order to avoid an overload condition.
- Selectable temperature alarm threshold p0604 (default: 130°C) for operation with the temperature model or KTY84 sensor. The drive is shutdown (tripped) or the current reduced as a function of p0610 for a value of p0604 +10%.
- The motor protection is independent of the frequency converter protection. Alarm thresholds and responses for frequency converter protection can be separately parameterized.

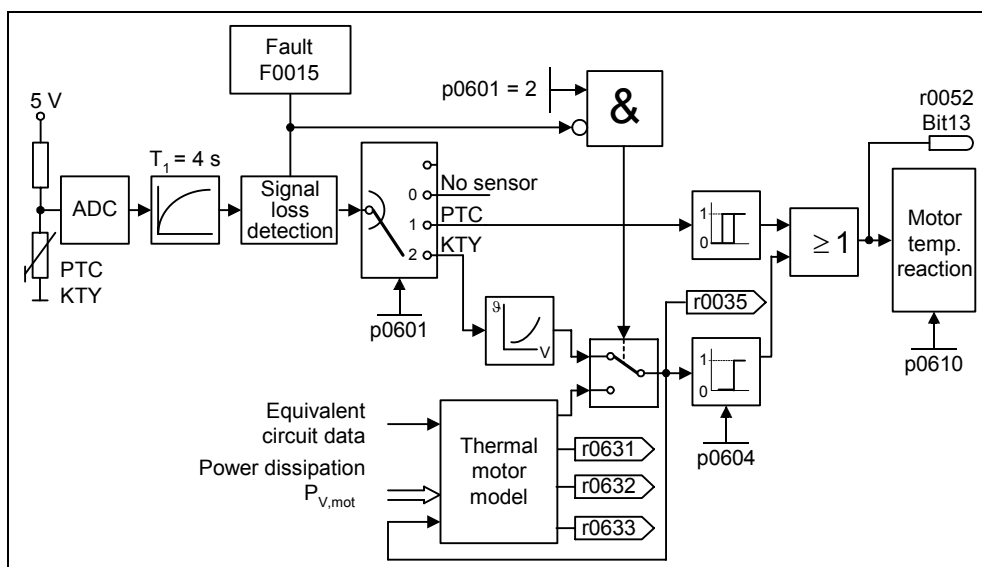


Fig. 8-1 Thermal motor protection

Temperature Classes

For drive systems, issues related to temperature rise play a decisive role when designing and dimensioning electrical machinery (motors and generator). Different temperature limits apply for the various materials that are used in electric motors. Depending on the insulating material used, a differentiation is made according to thermal Classes (refer to the motor rating plate) with defined temperature limits. An excerpt from IEC85 is shown in the following Table.

Table 8-2 Thermal Classes

Excerpt from IEC 85	
Insulation class	End temperature
Y	90 °C
A	105 °C
E	120 °C
B	130 °C
F	155 °C
H	180 °C

For the temperature model and the KTY84 sensor, the appropriate value ϑ_{Alarm} must be calculated and entered into parameter p0604 (temperature alarm thresholds, default: 130°C).

The following applies:
$$p0640 = \vartheta_{alarm} = \frac{\vartheta_{trip}}{1.1}$$

8.2 Motor protection and overload responses

8.2.1 Thermal motor model (motor protection without temperature sensor)

Description

To provide motor protection without using a temperature sensor, the motor temperatures are calculated using a thermal motor model. The necessary data are retrieved from the rating plate data entered during the quick commissioning (refer to the Section, Quick commissioning) and permit a safe, stable operation for standard Siemens motors. For third-party motors it may be necessary to make changes and modifications to the parameterization (parameter assignment). We always recommend that after a quick commissioning, an automatic motor data identification routine is made where the electrical equivalent circuit diagram data are determined. This means that the losses in the motor can be more precisely calculated. This has a positive impact on the accuracy and precision of the thermal motor model.

Note

The thermal motor model is separately calculated for each data set so that when changing-over between various motors (=data sets), the cooling of the non-active (fed) motors is taken into account.

Example

If the stator resistance was parameterized to be too high, then higher losses would be determined in the model than in the actual motor and the calculated motor temperature would be too high.

If changes are required to optimize the thermal model, then to start, the motor weight (p0344) should be checked to ensure that it is plausible. Generally, the motor weight can be taken from the catalog data of the motor manufacturer. The motor model can be further optimized by adapting the standard temperature rises for the stator iron p0626, the stator winding p0627 and the rotor p0628. The standard temperature rises represent the expected steady-state temperature differences at rated operation with respect to the environment and are used to estimate the thermal resistances. Normally, temperature rises are not listed in the Catalog.

The ambient temperature p0625 is another important parameter that influences the accuracy of the model.

8.2.2 Motor protection using temperature sensors

Overview

When operated below the rated speed, the cooling effect of the fan mounted on the motor shaft is somewhat reduced. This is the reason that for most motors for continuous operation at low frequencies, the power must be reduced (de-rating).

Under these conditions, the motor can be protected against an overtemperature condition by using a PTC or KTY84 temperature sensor.

Interruption or short-circuit

If the circuit between the frequency converter and temperature sensor is either interrupted or if a short-circuit occurs, the frequency converter is shutdown and fault F0015 is displayed.

8.2 Motor protection and overload responses

8.2.2.1 Motor temperature monitoring using PTC temperature sensors

Description

As shown in the following table, the PTC temperature sensor must be connected to the PTC/KTY84 interface of the control unit (refer to Section "PTC/KTY84 interface"). Further, p0601 must be set to 1 (PTC monitoring active).

Table 8-3 Connection, PTC sensor

ICU24 Pin	Motor PTC connection terminals
1	1TP3 blue
2	1TP4 black

Note

The motor terminal designations only apply for Siemens motors. The color coding is defined in Standard IEC 60034-8

The motor is tripped (shutdown) with fault F011 as soon as the resistance of the PTC temperature sensor exceeds 2000 Ω

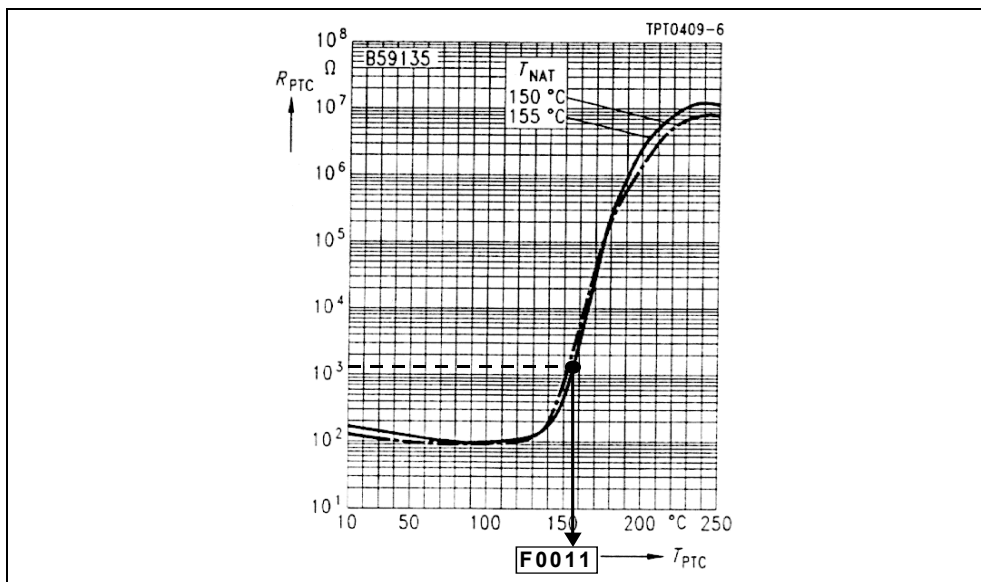


Fig. 8-2 PTC characteristic for 1LG / 1LA motors

8.2.2.2 Motor temperature monitoring using KTY84 temperature sensors

Description

The KTY84 temperature sensor must be connected so that the diode polarity allows it to conduct; this means that the anode is connected to pin 1 and the cathode is connected to pin 2, refer to the following Table.

Table 8-4 Pin assignment for the KTY84 sensor

ICU24 Pin	Motor KTY84 connection terminals	Signal	Description
1	1R1 yellow	KTY +	Anode
2	1R2 green	KTY -	Cathode

Note

The motor terminal designations only apply for Siemens motors. The color coding is defined in Standard IEC 60034-8

If the temperature monitoring function has been activated with the setting p0601 = 2, the sensor temperature (i.e. those of the motor windings) is written into parameter r0035 (refer to Fig. 8-1). The threshold temperature ϑ_{trip} (refer to Table 8-2) of the motor can only be set using the alarm threshold for the motor overtemperature ϑ_{alarm} (parameter p0604) (the factory setting is 130 °C).

In this case, the following applies: $p0640 = \vartheta_{alarm} = \frac{\vartheta_{trip}}{1.1}$

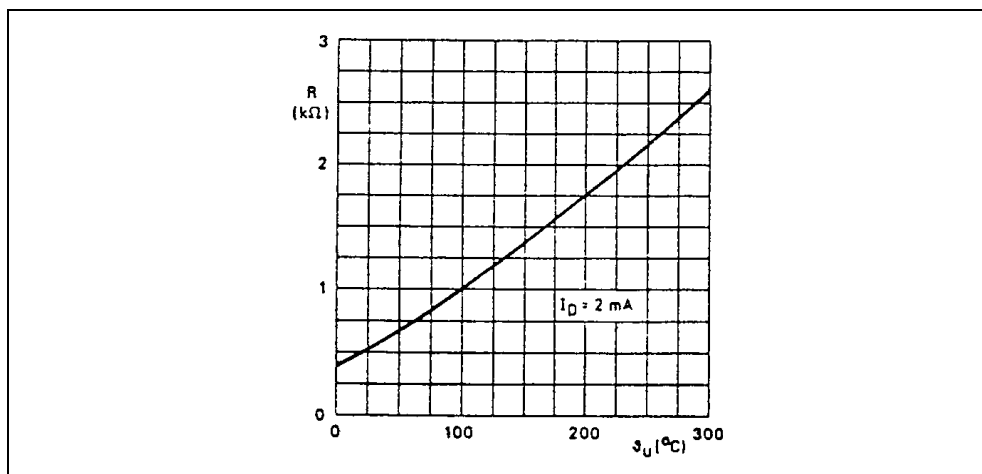


Fig. 8-3 KTY84 characteristic for 1LG / 1LA motors

8.3 Frequency converter protection and overload responses

Overview

Frequency converter protection is sub-divided into two main groups:

- Electrical monitoring:
 - overcurrent / short-circuit
 - DC link overvoltage / DC link undervoltage
 - line phase failure
- Thermal monitoring
 - i2t monitoring
 - heatsink temperature
 - chip temperature

8.3 Frequency converter protection and overload responses

8.3.1 Electrical monitoring and overload responses

Data

Parameter range:	p0640, r0067, r1242, p0210
Alarms:	A0501, A0502, A0503
Faults:	F0001, F0002, F0003, F0020
Function chart number:	-

Description

Essentially the same as for motor protection, ET 200S FC frequency converters have a comprehensive protection function for the power components by monitoring the electrical data. It is sub-divided as follows:

- Alarms and protective function
- Trip (shutdown) and fault message

This concept means that the power components can be utilized to a high degree without the frequency converter being immediately tripped. The following data is monitored:

Table 8-5 General protection of the power components

Monitoring of	Protective function	Alarm	Trip and fault message	
Overcurrent / short-circuit	V/f control	Imax controller , refer to "Current limiting" in the Section "V/f control"	A0501 r0056 bit 09 r0056 bit 13	Trip with F0001
	SLVC / VC	Current limiting , refer to "Current limiting" in the Section "Limiting the torque setpoint"	r0056 bit 09 r1407 bit 08 r1407 bit 09	Trip with F0001
Line supply phase failure detection (refer to p0291)	---		Trip with F0020	

The trip (shutdown) thresholds (righthand column in the table above) are permanently saved in the frequency converter. Users cannot change these. However, the user can modify the alarm thresholds for optimization purposes. These values have been dimensioned in their pre-assignment so that it is avoided that the "fault and trip" thresholds respond.

8.3 Frequency converter protection and overload responses

8.3.2 Thermal monitoring functions and overload responses

Data

Parameter range:	p0290 – p0294 r0036 – r0037
Alarms:	A0504, A0505
Faults:	F0004, F0005, F0012, F0020, F0022
Function chart number:	-

Description

Similar to motor protection, also for thermal converter power module monitoring, the main focus is on detecting critical states. Using the appropriate parameters, users can optimize their specific systems so that the frequency converter can be used at the power limit and preventing an immediate trip (shutdown). However, parameter assignments can only be modified that represent changes below the trip (shutdown) thresholds that the user cannot change.

ET 200S FC frequency converters have the following thermal monitoring functions:

- **i^2t monitoring**

The i^2t monitoring is used to protect components that, in comparison to the semiconductors, have a high thermal time constant. An overload condition regarding i^2t is present if the frequency converter utilization r0036 displays a value greater than 100 % (utilization as a % referred to rated operation).

- **Heatsink temperature**

The heatsink temperature r0037[0] of the power semiconductor (IGBT) is monitored.

- **Chip temperature**

Significant temperature differences can occur between the barrier layer of the IGBT and the heatsink. These differences are taken into account and monitored using the chip temperature r0037[1].

If one of these three monitoring functions detects an overload condition, initially, an alarm is output. The alarm thresholds p0294 (i^2t monitoring) and p0292 (heatsink temperature or chip temperature monitoring) can be parameterized relative to the tripping (shutdown) values.

8.3 Frequency converter protection and overload responses**Example**

The alarm threshold p0292 for the temperature monitoring (chip / heatsink temperature) is set in the factory to 15 °C. This means that alarm A0504 is initiated 15 °C below the trip (shutdown) threshold.

At the same time that the alarm is output, the responses parameterized using p0290 are initiated. Possible responses include:

- **Reduced pulse frequency (p0290 = 2, 3)**

This is an extremely effective method to reduce losses in the converter power module as the switching losses represent an extremely high component of the overall losses. In many applications, it is possible to temporarily reduce the pulse frequency so that at least the process can be maintained.
Disadvantage: As a result of the reduced pulse frequency, the current ripple is increased. This can result in an increased torque ripple at the motor shaft (for a low moment of inertia) and an increase in the noise level. The reduced pulse frequency does not have any influence on the dynamic response of the current control loop as the sampling time of the closed-loop current control remains constant!
- **Reduced output frequency (p0290 = 0,2)**

This version is advantageous if users do not wish to reduce the pulse frequency or if the pulse frequency is already set to the lowest value. Further, the load should have a load-torque characteristics similar to that of a fan - i.e. a square-law torque characteristic with decreasing speed. When the output frequency is reduced, the frequency converter output current is significantly reduced which in turn reduces the losses in the converter power module.
- **No reduction (p0290 = 1)**

This option should be selected if neither a reduction in the pulse frequency nor a reduction in the output current is permitted. In this case, the frequency converter does not change its operating point after the alarm threshold has been exceeded so that the drive can still be operated until the trip (shutdown) values are reached. After reaching the trip threshold the frequency converter powers itself down and outputs fault F0004. However, the time to trip is not defined and depends on the magnitude of the overload condition. Only the alarm threshold can be changed in order to obtain an earlier alarm and if possible, to externally intervene in the drive process (e.g. reduce the load, reduce the ambient temperature).

Note

If the frequency converter fan fails this is determined by indirectly measuring the heatsink temperature.

The system also monitors for wire breakage or short-circuit of the temperature sensor.

8.4 Protective system functions

8.4 Protective system functions

Overview

The ET 200S FC monitors the load torque as a protective system function.

8.4.1 Load torque monitoring

Data

Parameter range:	p2181 p2182 – p2192 r2198
Alarms:	A0452
Fault:	F0952
Function chart number:	-

Description

This function allows the force transmitted between the motor and driven machine to be monitored. Typical applications include, e.g. v-belts, flat belts or chains, that wrap-around the belt pulleys or pinion wheels of drive and drive-out shafts therefore transmitting circumferential speeds and circumferential forces.

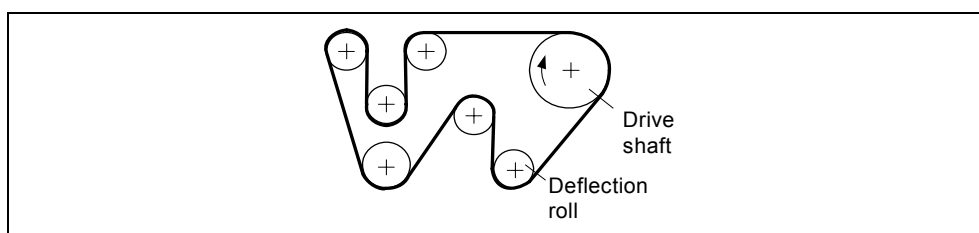


Fig. 8-4 Shaft drive with flat belts

The load torque monitoring can determine when the driven load is blocked and if the belt/chain breaks.

For the load torque monitoring, the actual frequency/torque characteristic is compared to the programmed frequency/torque characteristic (refer to p2182 – p2190). If the actual value lies outside the programmed tolerance bandwidth, then, as a function of parameter p2181, either alarm A0952 is generated or fault F0452. The alarm or fault message can be delayed using parameter p2192. This therefore avoids incorrect alarms that are caused by brief transient states.

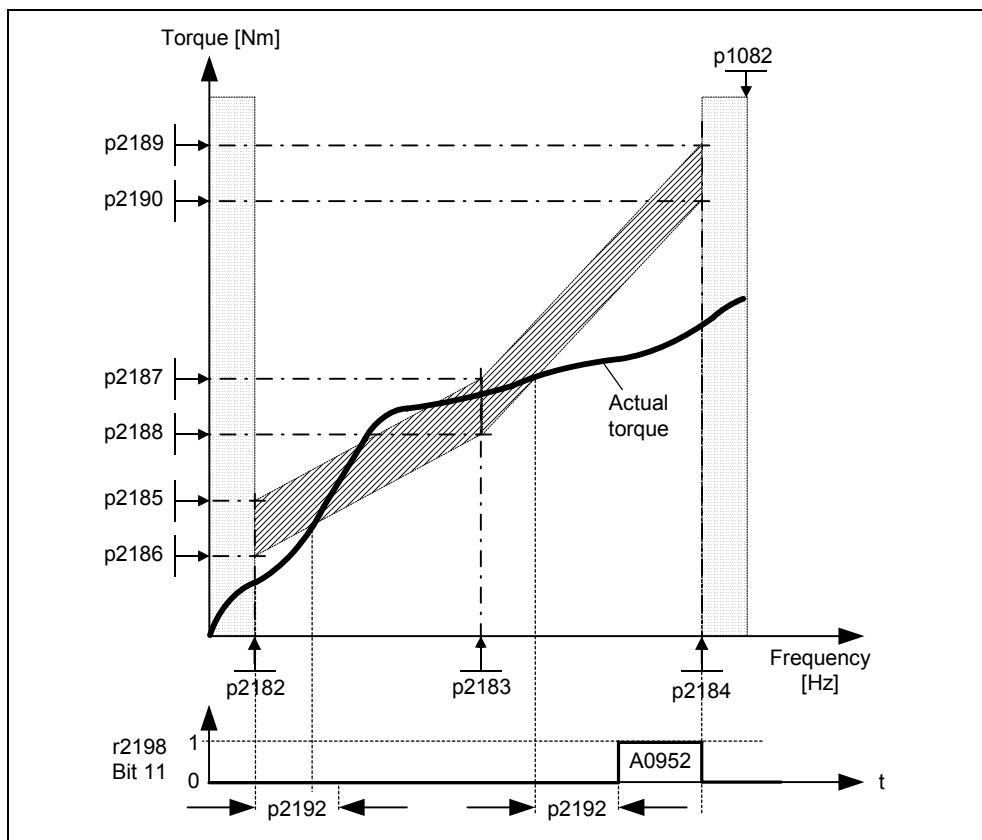


Fig. 8-5 Load torque monitoring (p2181 = 1)

In the following diagram, the frequency/torque tolerance bandwidth is defined using the gray shaded area. The bandwidth is determined by the frequency values p2182 – p2184 and the torque limit values p2186 – p2189. When defining the bandwidth it should be ensured that a specific tolerance is taken into account in which the torque values may move corresponding to the particular application.

8.4 Protective system functions

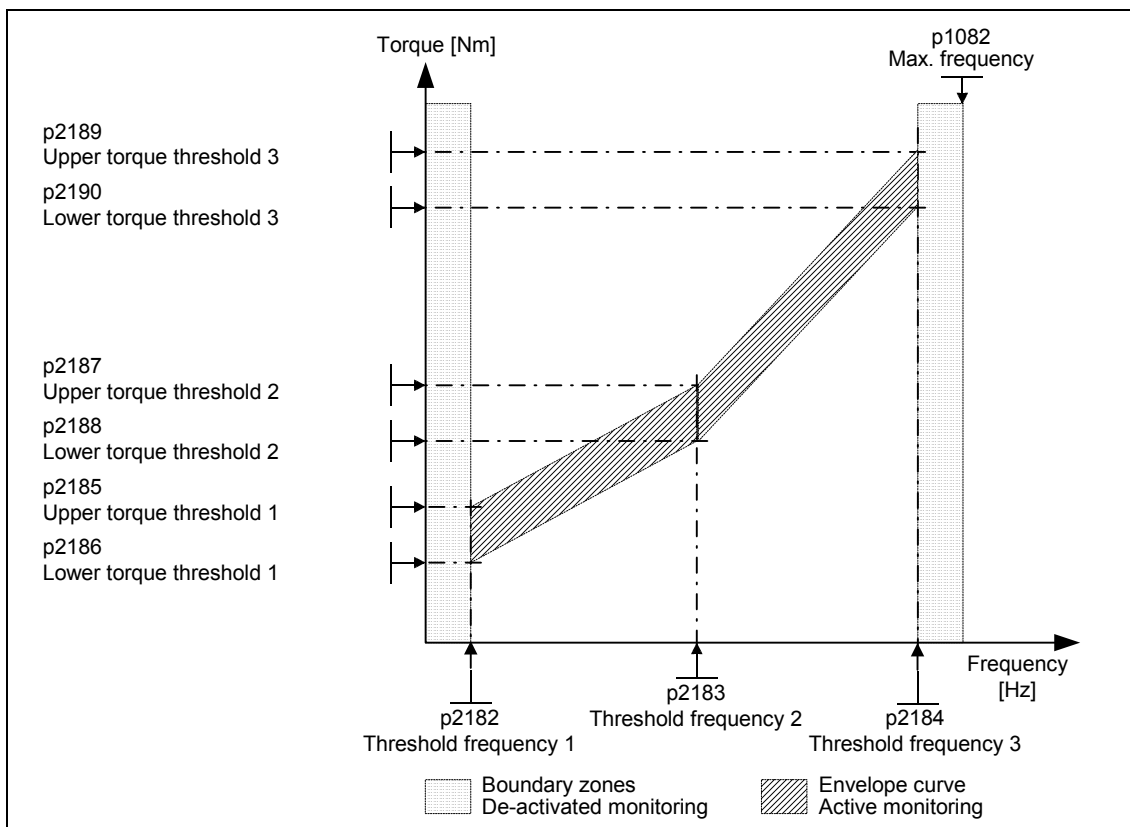


Fig. 8-6 Frequency/torque tolerance bandwidth

8.4.2 Commissioning steps for the load torque monitoring

1. In order to define the position of the tolerance bandwidth, different characteristics must be determined as a function of the required load torque monitoring (p2181). A differentiation can be made between the following cases:

a) **p2181 = 1 / 4**

Load torque monitoring to detect a broken belt, i.e. under fault conditions, the actual load torque is below the permissible tolerance bandwidth. In this case, the **load torque characteristic with minimum permissible load** should be determined.

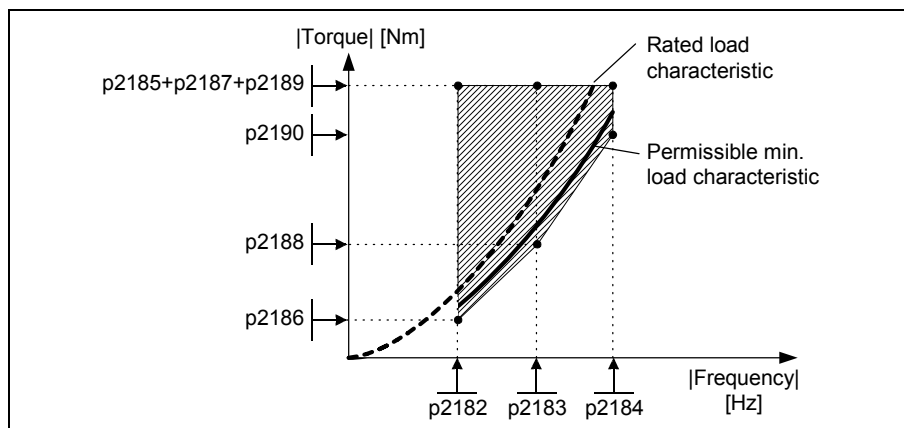


Fig. 8-1 Load torque monitoring with min. permissible load characteristic

b) p2181 = 2 / 5

Load torque monitoring as anti-stall protection. This means that when a fault occurs, the actual load torque is above the permissible tolerance bandwidth. In this case, the **load torque characteristic with maximum permissible load** should be determined.

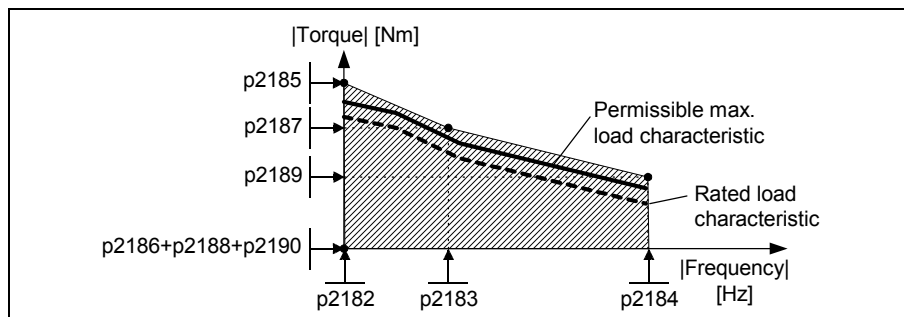


Fig. 8-2 Load torque monitoring with max. permissible load characteristic

c) p2181 = 3 / 6

Load torque monitoring to detect whether the drive is blocked (stalled) or a transmission belt has broken. This means that when a fault occurs, the load torque is either above or below the permissible tolerance bandwidth. In this case, the **load torque characteristic with the minimum and maximum permissible load** should be determined.

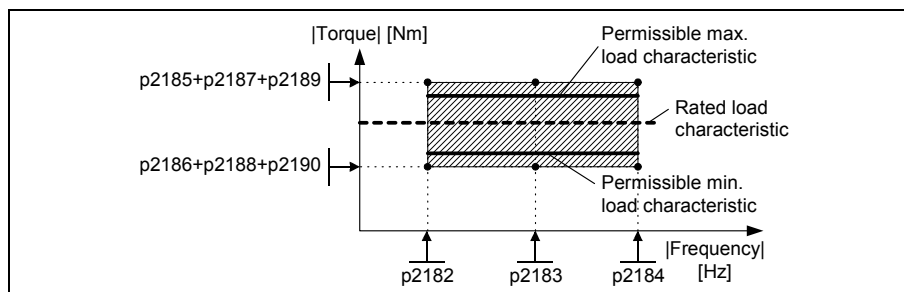


Fig. 8-3 Load torque monitoring with min. / max. permissible load characteristic

8.4 Protective system functions

2. The permissible load torque characteristic must be determined in the operating range of the plant or system. This characteristic can be determined as follows:

- a) **Theoretical determination**

In this case, the prerequisite is that the load torque characteristic in the operating range must first be known. Frequently, this is not the case in practice. Especially changing mechanical effects involve investigations that require considerable time and costs if they are to be forecast in advance.

- b) **Practical determination**

The load torque characteristic is directly determined at the plant/system using a "teach-in technique". In this case, the operating range is passed-through step-by-step and the value pair comprising the actual output frequency r0021 and actual torque r0031 are read-out in the steady-state condition. If necessary, this should be carried-out for both directions of rotation.

3. The position of the tolerance bandwidth (p2182 - p2190) is determined by defining the 3 points along the characteristic.
4. In order to prevent the torque monitoring responding unnecessarily, dynamic states should be suppressed using delay time p2192. As a rule of thumb, p2192 should be > p1120.

Note

- The load torque monitoring is active in all 4 quadrants
 - If it is not possible to determine the min. or max. load torque characteristic at the drive in operation, then the load torque characteristic should be determined for operation at rated load. By taking into account the tolerances, the max. or min. permissible load characteristic can be calculated (e.g. the max. load characteristic is obtained from the 120 % rated load characteristic).
 - If only a specific frequency range is to be monitored, then it is sufficient to plot the load characteristic between the frequency thresholds of the envelope curve (p2182, p2184).
 - If the drive is only permitted to have one direction of rotation, then the load characteristic should only be determined for the permissible direction of rotation.
 - The load characteristic and/or envelope curve determined should be represented in a frequency-torque diagram, e.g. using Microsoft Excel
-

8.5 Display of the actual alarm and fault messages

Description

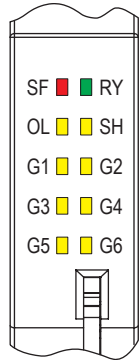
A detailed description of the alarm and fault messages is provided in the List Manual.

Ten LEDs that display various states are provided on the front panel of the ICU24(F) control unit of the ET 200S FC frequency converter.

Displays of the various states

ICU24 display of the various states

The state of the frequency converter is displayed on the front panel of the ICU24 of the ET 200S FC frequency converter using three LEDs (SF, RY and OL). For the ICU24, LEDs SH and G1 to G6 have no significance:



SF (red)	RY (green)	OL (yellow)	Significance
Bright	Dark	Dark	General fault (OFF1/OFF2)
Bright	Dark	Bright	Shutdown with overload fault
Dark	Bright	Dark	Ready
Dark	Dark	Bright	Overload operation
SH (yellow)		No significance	
G1 to G6 (yellow)		No significance	

Fig. 8-7 LED state display on the front panel of the ICU24

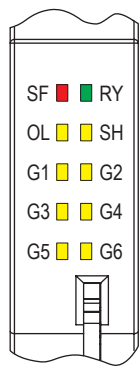
Additional state displays for the ICU24

SF	Flashes (0,5 Hz)	after the firmware has been successfully completed to indicate that a system test is required
RY	Flashes	while the frequency converter is being commissioned – Quick commissioning
RY	Flashes	if no frequency converter fault is present; if communications to a higher-level control have still not been established – but power is present at the ET 200 S station
All LEDs	Are bright (lit)	while the firmware is being updated
	Dark	while uploading and downloading parameters sets when the control unit is running-up ICU(F)

8.5 Display of the actual alarm and fault messages

ICU24F display of the various states

The state of the frequency converter is displayed on the front panel of the ICU24F of the ET 200S FC frequency converter using ten LEDs (SF, RY, SH, OL, G1 - G6).



SF (red)	RY (green)	SH (yellow)	OL (yellow)	Significance
Bright	Dark	Dark	Dark	General fault (OFF1/OFF2)
Bright	Dark	Dark	Bright	Shutdown with overload fault
Bright	Dark	Bright	Dark	Fault shutdown with safe operating stop
Dark	Bright	Dark	Dark	Ready
Dark	Dark	Dark	Bright	Overload operation
Dark	Dark	Bright	Dark	Safe operating stop state (SH) reached
Dark	Dark	Bright	Bright	State – safely-reduced speed has been reached
G1 to G6 (yellow) Flashes		Indicate the assigned safety group of the frequency converter Flashes for the time that the assigned safety function is activated		

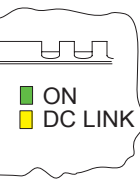
Fig. 8-8 LED state display on the front panel of the ICU24F

Additional state displays for the ICU24F

SF	Flashes (0,5 Hz)	after the firmware has been successfully completed to indicate that a system test is required.
RY	Flashes	while the frequency converter is being commissioned – Quick commissioning
RY	Flashes	if no frequency converter fault is present; if communications to a higher-level control have still not been established – but power is present at the ET 200 S station. Gx is the selected shutdown group, x= 1 to 5
Gx and G6	Bright	
All LEDs	Dark	while uploading and downloading parameters set when the control unit is running-up ICU(F)
	are bright (lit)	while the firmware is being updated.
G1 to G6	Flash (2 Hz)	in synchronism while the safety functions are being commissioned.

IPM25 display of the various states

The state of the power module is displayed using two LEDs.



LED	State	Significance
ON (green)	Bright	Frequency converter output is active (pulse enable)
	Dark	Frequency converter output is not active (pulse enable)
DC LINK (yellow)	Bright	DC voltage connection available
	Dark	DC voltage connection not available

Fig. 8-9 LED to display the states of the converter power module

8.6 System diagnostics

Description

System diagnostics for the complete ET 200S system is realized via the diagnostics channel of PROFIBUS-DP or a higher-level control.

A detailed diagnostics evaluation and program example is provided in the Manual "SIMATIC ET 200S, Distributed I/O System", Section 6.6.

The FB125 S7 blocks are available to evaluate diagnostics data. The S7 blocks and the appropriate descriptive information can be downloaded at no charge from the following address:

<http://www4.ad.siemens.de/WW/view/de/18686824/133100>

An overview of the fault/error types is listed in the following tables.

Diagnostics, power modules

Table 8-6 Fault/error types, power modules

Power module	Fault type	Significance	Counter-measure/remedy
PM-D PM-D FX1 PM-D F Profisafe	01001	A module fault has occurred	Replace the module
	10001	Power supply voltage missing, U1 or U2 not present or too low	<ul style="list-style-type: none"> • Check the process wiring • Check the power supply voltage
	11000	Actuator shutdown, safety relay OFF	Acknowledge using the ON button
	11001	Safety-related shutdown, EMERGENCY STOP has been pressed or there is a cross-circuit fault between the EMERGENCY STOP cables	Remove the cause of the shutdown/trip, e.g. <ul style="list-style-type: none"> • Release the EMERGENCY STOP button • Remove the cross-circuit fault

8.7 Error messages via the user program

8.7 Error messages via the user program

Overview

Communication errors, parameterization errors and drive faults/errors are output via the user program. A detailed description of the individual messages is provided on the following pages.

Communication errors

An SFC_ERR occurs if there is a communications error between the frequency converter and PROFIBUS DP, as a result of a read or write error.

If an SFC error is detected, it is displayed via FB100 in accordance with the information provided in the following error tables:

Table 8-7 Error numbers for SFC_ERR_RD

Error No.	Description
0000	An error has not occurred.
8090	This message is output if one of these errors occurs: <ul style="list-style-type: none"> You have not configured a board/module for the specified logical basis address You have not taken into consideration the restrictions regarding the length of the consistent data, You have not configured a module for the specified logical address or you have ignored the restriction concerning the length of consistent data or you have not entered the start address in the LADDR parameter in hexadecimal format
8092	Type data not equal to BYTE is specified in ANY reference. Only for S7-400
8093	No DP module from which you can read consistent data exists at the logical address specified in LADDR
80A0	Access error detected while the I/O device were being accessed
80B0	Slave failure at an external DP interface module
80B1	The length of the specified destination area is not identical to the user data length configured with STEP 7
80B2	System error for an external DP interface module
80B3	System error for an external DP interface module
80C0	The data was still not read from the module
80C2	System error for an external DP interface module
80Fx	System error for an external DP interface module
87xy	System error for an external DP interface module
808x	System error for an external DP interface module
8xyy	General error information

8.7 Error messages via the user program

Table 8-8 Error number for SFC_ERR_WR

Fault No.	Description
0000	An error has not occurred.
808x	System error for an external DP interface module
8090	This message is output if one of these errors occurs: <ul style="list-style-type: none"> For the specified logical basis address, you have not configured a board/module, You have not taken into consideration the restrictions regarding the length of the consistent data, You have not entered the start address in the LADDR parameter in hexadecimal format
8092	Type data not equal to BYTE is specified in ANY reference. Only for S7-400
8093	No DP module where you can write consistent data exists at the logical address specified in LADDR
80A1	Access error detected while the I/O device was being accessed
80B0	Slave failure at an external DP interface module
80B1	The length of the specified source area is not identical to the user data length configured with STEP 7.
80B2	System error for an external DP interface module
80B3	System error for an external DP interface module
80C1	The data of the previous write task on the module has not yet been processed by the module.
80C2	System error for an external DP interface module
80Fx	System error for an external DP interface module
85xy	System error for an external DP interface module
8xyy	General error information

Parameterization errors

Parameterization errors are output via the "PAR_ERR_NO" output of FB100 if one of the following conditions applies:

- Incorrect parameter number in PAR_ADDRESS
- Incorrect index in PAR_INDEX
- Incorrect value in WRITE_DATA_VALUE
- PAR_ERR remains valid until it is acknowledged via PAR_ERR_ACK.

For fault numbers, refer to the following table:

Note

A new read/write request via FB100 can only be sent if the following conditions are fulfilled:

- PAR_ERR = 0
- PAR_ERR_ACK = 0

8.7 Error messages via the user program

Table 8-9 Parameterization error numbers

Fault/ error No.	Description
0	Invalid parameter number (PNU), when PNU not present. An attempt was made to change a parameter even though this has been inhibited via p0927, bit 0 = 0.
1	Parameter value cannot be changed if the parameter is a monitoring parameter.
2	Lower or upper value limit exceeded
3	Incorrect index
4	No field index
5	Incorrect data type
6	No setting permitted (only resetting possible)
7	Description element cannot be changed under any circumstances
11	Control priority has not been assigned
12	Keyword missing; device parameter: 'access key' and/or 'parameter special access' do not match
17	Request cannot be performed because of the operational status; converter status does not currently permit the request.
30	No communication with PLC within the TIME_OUT_CYCLE time limit. The parameter value p8451 is too small. During the PLC and converter startup phase, or immediately after it, the fault number 30 is okay.
31	Internal communications error
102	Channel width too small; only for short channels; The selected parameterized length of the PKW area is too large because of internal device restrictions. In the T 100 technology module, this fault message can only occur for the USS protocol when this interface accesses the basic device parameters.
104	Invalid parameter value. This fault number is transferred when the parameter value to be transferred has not been assigned a function in the device, or, at the time of the change, cannot be transferred due to internal reasons (even though the value lies within the limits).
106	Request not implemented
107	Incorrect sequence of data transmission from ET200S
108	The control unit does not respond to a read/write task from FB100 within the TIME_OUT_PARA cycle (p8450).

Drive faults

ET 200S FC drive faults are output via the "ERR_NO" output of FB100. ERR_NO contains the value of r0947.

Note

In order to evaluate drive faults and errors for the plant/system control, output "ERR_NO_VALID" of FB100 should be used!

A table with all of the possible drive faults is provided in the Parameter Manual of the ET 200S FC in the Chapter "Alarm and fault messages".

A diagnostics alarm for the particular fault can be programmed using the OB82.

Note

The diagnostic messages that trigger the corresponding diagnostic interrupt on the SIMATIC S7 can be activated or de-activated using parameter p8452 "DIA_LOCK". This will also enable or disable LED displays (SF).

8.8 Diagnostics via the user program

Group fault

If there is a fault in r0947, then a group fault is output on the ICU24(F), the IM 151 and the CPU.

System diagnostics

Note

The diagnostic messages that trigger the corresponding diagnostic interrupt on the SIMATIC S7 can be activated or deactivated using parameter p8452 "DIA_LOCK". This will also enable or disable LED displays (SF).

The user program (e.g., SIMATIC S7) can access the organizational blocks OB82, OB86 and OB122 for the purpose of diagnosing faults on the slave (ET 200S station).

- OB82 for diagnostic interrupts for drive faults
- OB86 for diagnostic interrupts for IM slave (ET 200S station has failed)
- OB122 for diagnostic interrupts for I/O access errors

A specific response to faults can be programmed in this organization block. If the particular OB is not available, the control system - and therefore also the frequency converter - go into STOP status when a fault occurs.

Note

Depending on the CPU used, additional organization blocks for diagnostics can be incorporated.

It is not possible to completely monitor communications using the standard blocks SFC14/SFC15 used in FB100. Diagnostic functions OB82, OB83, etc., should be used to completely monitor communications.

Diagnostics for drive faults

Table 8-10 ET 200S diagnostic messages

Fault No.	Message	Cause	Associated alarm or fault message
			Fault
1	Short-circuit	Current too high, ground fault	1, 22, r0052[11]*
2	Undervoltage	Faulty power supply	3
3	Overvoltage	<ul style="list-style-type: none"> Supply voltage too high Ramp-down time too short Required braking power too high DC link overvoltage 	2
4	Overload	<ul style="list-style-type: none"> Converter overtemperature Overcurrent Converter overload 	4, 5, 27, 28, 453, r0052[15]*
5	Overtemperature		
6	Line breakage	<ul style="list-style-type: none"> Motor not connected Motor cable breakage Sensor cable breakage, encoder fault 	20, 23, 26, 60
7	Upper limit value overshoot		
8	Lower limit value undershoot		
9	Fault	Internal fault: EPROM fault, RAM fault, watchdog, fan fault, deactivated power module, internal communications error.	51, 52, 61, 62, 63, 100, 101
16	Parameterization fault	<ul style="list-style-type: none"> Module has not been parameterized Module contains incorrect parameters Configuration fault (CB) Incorrect data from the PowerStack 	35, 41, 42, 452, 396, 397, 398, 399
17	Encoder or load voltage missing		
18	Fuse defective		
20	Ground fault		
21	Reference channel fault		
22	Process alarm lost		
23	Actuator alarm		
24	Actuator disconnection	<ul style="list-style-type: none"> Motor overtemperature (also produced from the I²t calculation) Communication to the CB is disturbed 	11, 15, 70, 71, 72, r0052[13]*
25	Safety-related disconnection	Safe standstill initiated (storing because of the fault condition)	1600, 1610, 1611, 1612, 1613, 1614, 1630, 1649, 1650, 1655, 1659, 1660,
26	External fault		85
27	Fault not clear		25, 499

Table footnote: * r0052 is status word 1

8.8 Diagnostics via the user program

General Technical Data

9

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9.1 Technical data, ambient operating conditions, Standards and Certificates

Technical Data

General Technical Data is provided in the "SIMATIC ET 200S Distributed I/O System" Manual.

Note

Deviating from the general Technical Data, the following applies for ET 200s components:

Free fall (in the original packaging) ≤ 0.35 m.

Technical Data for ET 200S FC components is provided in the applicable Sections of Chapter 2.

Ambient operating conditions

Please refer to the "SIMATIC ET 200S Distributed I/O System" Manual for data and information on the mechanical and climatic ambient operating conditions in which the ET 200S system can be used.

Special ambient operating conditions for the ET 200S FC frequency inverter are described in the appropriate Sections of Chapter 2.

Standards and Certificates

The Standards applicable for the ET 200S System are listed in the "SIMATIC ET 200S Distributed I/O System" Manual.

The deviations that apply to ET 200S FC frequency inverters are also described there.

9.2 General ambient operating conditions for the ET 200S FC

The following points should be carefully observed when installing an ET 200S FC frequency inverter:

Shock and vibration

Neither drop an ET 200S FC nor subject it to sudden shock.

Do not install an ET 200S FC inverter in an environment where it is continually subject to vibration.

Atmospheric pollution

Do not install an ET 200S FC inverter in an environment that contains polluted air such as air containing dust, corrosive gases etc.

Water

Ensure that the ET 200S FC inverter is installed in a location where it cannot be damaged by water. For example, do not install an ET 200S FC inverter under pipes where moisture condensation may occur. Avoid installing an ET 200S FC inverter where excessive humidity and condensation may occur.

Installation and cooling

Please ensure that the cooling airflow from the fans is not restricted. Devices may not be mounted in the cooling airflow that can either restrict or influence this cooling airflow.

A 35 mm clearance to other devices or components must be maintained above and below the ET 200S FC inverter to ensure that the air circulation is not restricted.

9.3 Electromagnetic compatibility (EMC)

9.3 Electromagnetic compatibility (EMC)

Definition

Electromagnetic compatibility is the capability of an electrical device to function satisfactorily in an electromagnetic environment without interfering with this environment.

9.3.1 EMC Directive

All manufacturers/assemblers of electrical equipment/apparatus that performs a complete intrinsic function and is placed on the market as a single unit intended for the end user must comply with the EMC Directive EEC/89/336.

Compliance with this EMC Directive can be demonstrated by applying the appropriate EMC Standards, e.g. EN 61800-3 (CE Marking that has been self-certified). In this case, the specifications in the Product Standard have priority over Generic Standards. The EMC Product Standard of the end product must be applied when mounting/installing a product in an end product for which there is a special EMC Product Standard.

Generally, a frequency converter/inverter is considered to be a component of a complete plant/system, similar to a motor, control system etc. This means that the manufacturer of the drive converter/inverter is not responsible in certifying that the equipment is in compliance with the EMC Directive. The body responsible for marketing the complete plant/system is responsible in ensuring compliance with the EMC Directive - i.e. in compliance with the appropriate EMC Standards.

Note

ET 200S FC frequency converters are devices that are intended for specific applications by users who are knowledgeable about EMC. These devices are not intended to be used by persons without the appropriate level of EMC knowledge.

As manufacturer of this device, we provide sufficient information and data in the Operating Instructions so that the end user, by applying his specialist knowledge, can guarantee the electromagnetic compatibility.

9.3.1.1 EMC Directive - compliance with harmonic current requirements

Since the 1st of January 2001, all electrical equipment, that falls under the EMC Directive must fulfill EN 61000-3-2 "Limit values for harmonic currents (input current of the device ≤ 16 A per phase)".

All of the Siemens ET 200S FC frequency converters that are classified as "Professional applications" in the sense of the Standard, fulfill the requirements of the Standard.

There are special issues related to 750 W frequency converters that are used in non-industrial applications. For drive units in this power range, the following warning information applies:

"Before this drive unit is connected to the public line supply, authorization is required from the electrical utility company."

For drive units that are connected to industrial line supplies¹⁾, authorization is not required (refer to EN 61800-3, Section 6.1.2.2).

The permissible harmonic currents for "Equipment for professional applications" (in the sense of the Standard EN 61000-3-2) with an input power > 1 kW have not been finally defined.

This is the reason that all electrical equipment and devices, that contain the above mentioned drives and have an input power > 1 kW, do not require authorization prior to being connected to the line supply.

As an alternative, by installing input reactors, it is no longer necessary to apply for authorization. These input reactors are recommended in the appropriate Catalog.

For more detailed information please refer to Draft EN 61000-3-12, Sections 5.3 and 6.4.

The harmonic currents emitted from the ET 200S FC frequency converter depend on the line supply conditions. The harmonics are significantly lower than for DC link voltage converters with line reactor.

The following formula can be used to estimate the percentage of harmonics with respect to the basic fundamental frequency (50/60Hz):

$$\text{Percentage} = \frac{1 \cdot 100}{\text{Order No. of the harmonic}}$$

$$\text{e.g. 5th harmonic: } \frac{1 \cdot 100}{5} = 20 \% .$$

1) Industrial line supplies are defined as those supplies that are not used to supply residential buildings.

9.3 Electromagnetic compatibility (EMC)

9.3.2 ET 200S FC frequency converters in industrial environments

ET 200S FC frequency converters, when equipped with Class A filter and when the permissible cable lengths are maintained, are designed for use in industrial environments.

Table 9-1 Industrial applications

Application	Requirements placed on	
	Emission	Immunity
Industrial	EN61000-6-4, with Class A filter	EN61000-6-2

Mounting guidelines for ET 200S FC frequency converters with EMC filter

- Operation with EMC filter is only permitted with TN line supplies.
- The EMC Class A filter is located directly in front of the power bus supply in the line feeder cable of the ET 200S FC frequency converter.
- The frequency converter must be mounted on a panel grounded through a large surface area.
- Only shielded cables are permissible after the EMC filter.
- For frequency converters with safety-relevant functions, shielded cables must always be used.
- The power bus for the frequency converter must be routed separately away from other power buses.
- The complete ET 200S system with frequency converters must be installed in a metallic electrical cabinet.
- The maximum length of the motor cables is 350 meters. In this case, all of the motor feeder cables of all of the drive converters that are connected to a common power bus must be added.
- The maximum length of shielded motor cable per frequency converter is 50 m.
- Connection cross-sections
 - 25 A : 4 mm² (AWG 11)
 - 50 A : 10 mm² (AWG 7)

9.3 Electromagnetic compatibility (EMC)

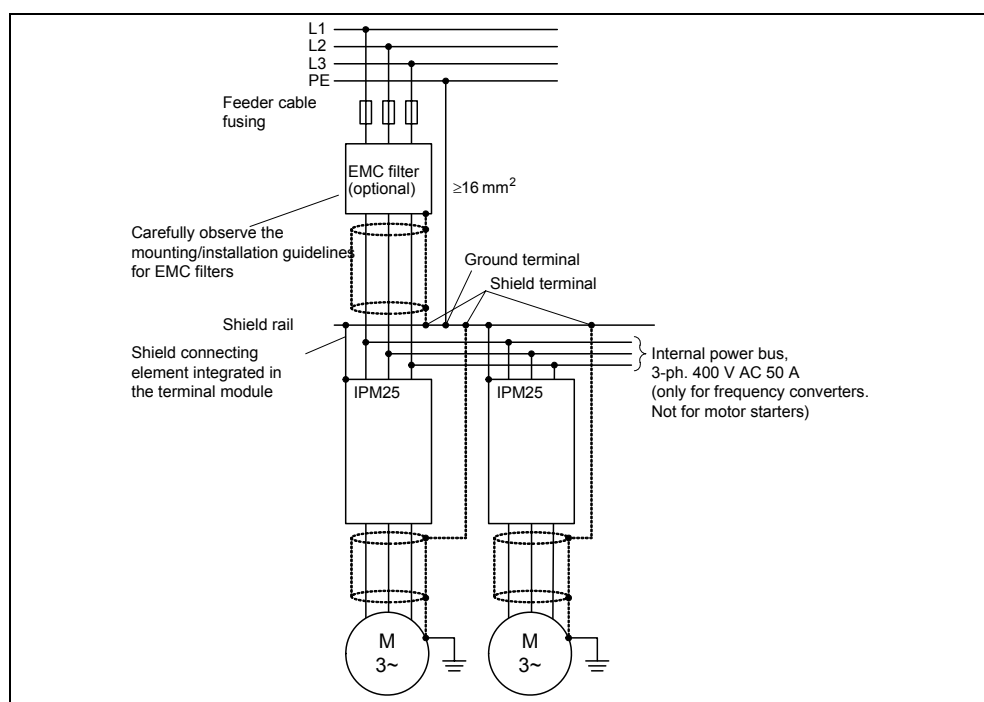


Fig. 9-1 ET 200S FC frequency converter with EMC filter

9.3.2.1 ET 200S FC frequency converter in a drive system according to EN 61800-3

Information regarding EN 61800-3 +A11

The EN 61800-3+A11 Product Standard for "Adjustable-speed electric drives, Part 3: EMC Product Standard including special test procedures" specifies limit values for emission and immunity. The EMC Product Standard EN 61800-3+A11 does not directly refer to a frequency converter/inverter but to a complete power drive system (PDS). In addition to the converter/inverter, this drive system includes the complete circuitry as well as the motor and cables.

Limit values for maintaining EN 61800-3 according to Category C3

The most important limit values that have to be maintained to comply with EN 61800-3 for equipment with **limited availability** in the commercial marketplace are included in the following table. This data also applies to drive systems according to Category , i.e. **for use in the second environment** (industrial

¹ Category C3: Drive system (PDS) with a rated voltage < 1000V. For use in the 2nd environment.

9.3 Electromagnetic compatibility (EMC)

environment) which are to be commissioned and installed by personnel with extensive EMC knowledge.

Table 9-2 Limit values for emissions for a drive system according to Category C3

EMC phenomenon	Basic Standard for the test technique	Limit value
Radiated emission	EN 55011	Class A, Group 1
Conducted emission	EN 55011	Class A, Group 2

Table 9-3 Limit values for immunity for a drive system according to Category C3

EMC phenomenon	Basic Standard for the test technique	Level	Evaluation criterium	
Power/voltage dips	EN 61800-3-A11	30 %, 10 ms ¹⁾	B	
		60 %, 100 ms ¹⁾	C	
		95 %, 5 s ³⁾	C	
Power/voltage interruptions	EN 61800-3-A11	100 %, 230 ms ³⁾	C	
		100 %, 120 ms (regenerative feedback) ²⁾	C	
Harmonics under nominal load conditions Regenerative feedback	EN 61800-3-A11	5.	-	
		7.		
		11.		
		13		
		22.7 %		
		20.7 %		
		9.6 %		
		9.7 %		
		19.2 %		
		14.7 %		
		12.9 %		
		11.6 %		
Electrostatic discharge	EN 61000-4-2	8 kV, air discharge (housing)	B	
Interference	Burst	EN 61000-4-4	2 kV / 5 kHz (power cable)	B
	Surge voltage	EN 61000-4-5	2 kV, phase – ground (power cable) 1 kV, phase – phase (power cable)	B B
Radio frequency electromagnetic field, amplitude-modulated	EN 61000-4-3	80 MHz – 1000 MHz, 10 V/m, 80 % AM	A	
Ground leakage current	EN 61800-5-1	Refer to Table 9-4 and Table 9-5		

- 1) Reduce the motor speed
- 2) Shutdown with fault F0002 "Overvoltage"
- 3) Shutdown with fault F0003 "Undervoltage"

The requirements of the Product Standard for a Category 3 drive system are fulfilled with the exception of the conducted emissions. An external filter is required in order that these requirements are also fulfilled.

An unfiltered ET 200S FC frequency converter can only be used in a drive system corresponding to Category C3 if the complete drive system is equipped with additional line filters on the supply side.

9.3 Electromagnetic compatibility (EMC)

Table 9-4 Ground leakage currents (mA) acc. to EN 61800-5-1 with 50 m CY shielded cable

Converter power module IPM25	Output frequency	Ground leakage currents (mA) at pulse frequency			
		2 kHz	4 kHz	8 kHz	16 kHz
FSA, 0.75 kW	50 Hz	8.21	7.87	7.39	7.22
	20 Hz	12.63	10.69	8.04	6.72
	10 Hz	13.79	11.58	8.57	6.88
	5 Hz	14.21	11.85	8.76	6.95
	Ready	5.01			
FSB, 2.2 kW	50 Hz	9.92	9.12	8.04	7.80
	20 Hz	16.44	13.46	9.66	7.18
	10 Hz	18.10	14.76	10.32	7.46
	5 Hz	18.64	15.08	10.50	7.60
	Ready	4.97			
FSB, 4.0 kW	50 Hz	11.03	9.68	8.42	8.32
	20 Hz	18.36	14.25	10.32	7.79
	10 Hz	20.21	15.58	11.09	8.00
	5 Hz	20.72	16.63	11.43	8.27
	Ready	5.05			
FSB, 4.0 kW with external filter	50 Hz	1.94	2.06	2.02	2.08
	20 Hz	2.06	2.00	1.98	1.96
	10 Hz	2.10	1.98	1.92	1.92
	5 Hz	2.10	1.98	1.92	1.88
	Ready	1.84			

Table 9-5 Ground leakage currents (mA) acc. to EN 61800-5-1 with 3 m YY non-shielded cables

Converter power module IPM25	Output frequency	Ground leakage currents (mA) at pulse frequency			
		2 kHz	4 kHz	8 kHz	16 kHz
FSA, 0.75 kW	50 Hz	5.12	5.12	5.12	5.09
	20 Hz	5.09	5.07	2.97	5.05
	10 Hz	5.12	5.09	5.07	5.05
	5 Hz	5.12	5.09	5.08	5.05
	Ready	5.03			
FSB, 2.2 kW	50 Hz	5.16	5.25	5.36	5.39
	20 Hz	5.47	5.46	5.36	5.32
	10 Hz	5.56	5.48	5.38	5.12
	5 Hz	5.68	5.49	5.38	5.18
	Ready	5.02			
FSB, 4.0 kW	50 Hz	5.26	5.37	5.35	5.33
	20 Hz	5.56	5.47	5.31	5.22
	10 Hz	5.68	5.52	5.33	5.22
	5 Hz	5.71	5.54	5.33	5.22
	Ready	5.05			
FSB, 4.0 kW with external filter	50 Hz	1.76	1.90	1.90	1.88
	20 Hz	1.78	1.86	1.88	1.88
	10 Hz	1.84	1.84	1.86	1.88
	5 Hz	1.78	1.84	1.86	1.86
	Ready	1.86			

9.3 Electromagnetic compatibility (EMC)

9.3.2.2 ET 200S FC frequency converters in general industrial applications

Information on general industrial applications

With this level of EMC performance, the manufacturer/installation company may themselves certify (self-certification procedure) their device regarding compliance with the EMC Directive for industrial environments. The limit values correspond to the Generic Standards EN 61000-6-4 for generic emissions and EN 61000-6-2 noise immunity in the second environment (industrial environment).

Limit values for general industrial applications

The following table contains the most important limit values in order to be compliant with the Generic Standards.

Table 9-6 Limit values for emissions for general industrial applications according to EN 61000-6-4

EMC phenomenon	Basic Standard for the test technique	Limit value
Radiated emission	EN 55011	Class A, Group 1
Conducted emission	EN 55011	Class A, Group 1

Table 9-7 Limit values for immunity for general industrial applications according to EN 61000-6-2

EMC phenomenon	Basic Standard for the test technique	Level	Evaluation criterium
Voltage dips	EN 61000-4-11	30 % reduction, 0.5 periods	B
Voltage interruptions	EN 61000-4-11	> 95 % reduction, 250 periods	C
Electrostatic discharge	EN 61000-4-2	8 kV, air discharge 4 kV, contact discharge	B B
Interference	Burst	EN 61000-4-4 2 kV power cable 1 kV control cable	B B
	Surge voltage	EN 61000-4-5 2 kV power cable (phase-ground) 1 kV power cable (phase-phase) 1 kV control cable (cable-ground)	B B B
Radio frequency electromagnetic field, amplitude-modulated	EN 61000-4-3	80 MHz – 1000 MHz, 10 V/m, 80 % AM	A

The requirements of the Generic Standards regarding immunity are fulfilled. The required emission levels are fulfilled when an external EMC Class A filter is used and when the devices are installed in compliance with the EMC design guidelines.

Non-filtered ET 200S FC frequency converters can only be used in general industrial applications if the complete drive system is equipped with additional line filters on the supply side.

Appendix

A

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*A.1 Dimension drawings***A.1 Dimension drawings****A.1.1 ET 200S modules**

Dimension drawings for the following ET 200S modules are provided in the "SIMATIC ET 200S Distributed I/O System" Manual:

- Power module PM-D
- Power module PM-D F
- Brake control module xB1 and xB2
- Distance module DM-V15

A.1.2 ET 200S FC frequency inverters

ICU24(F) control unit

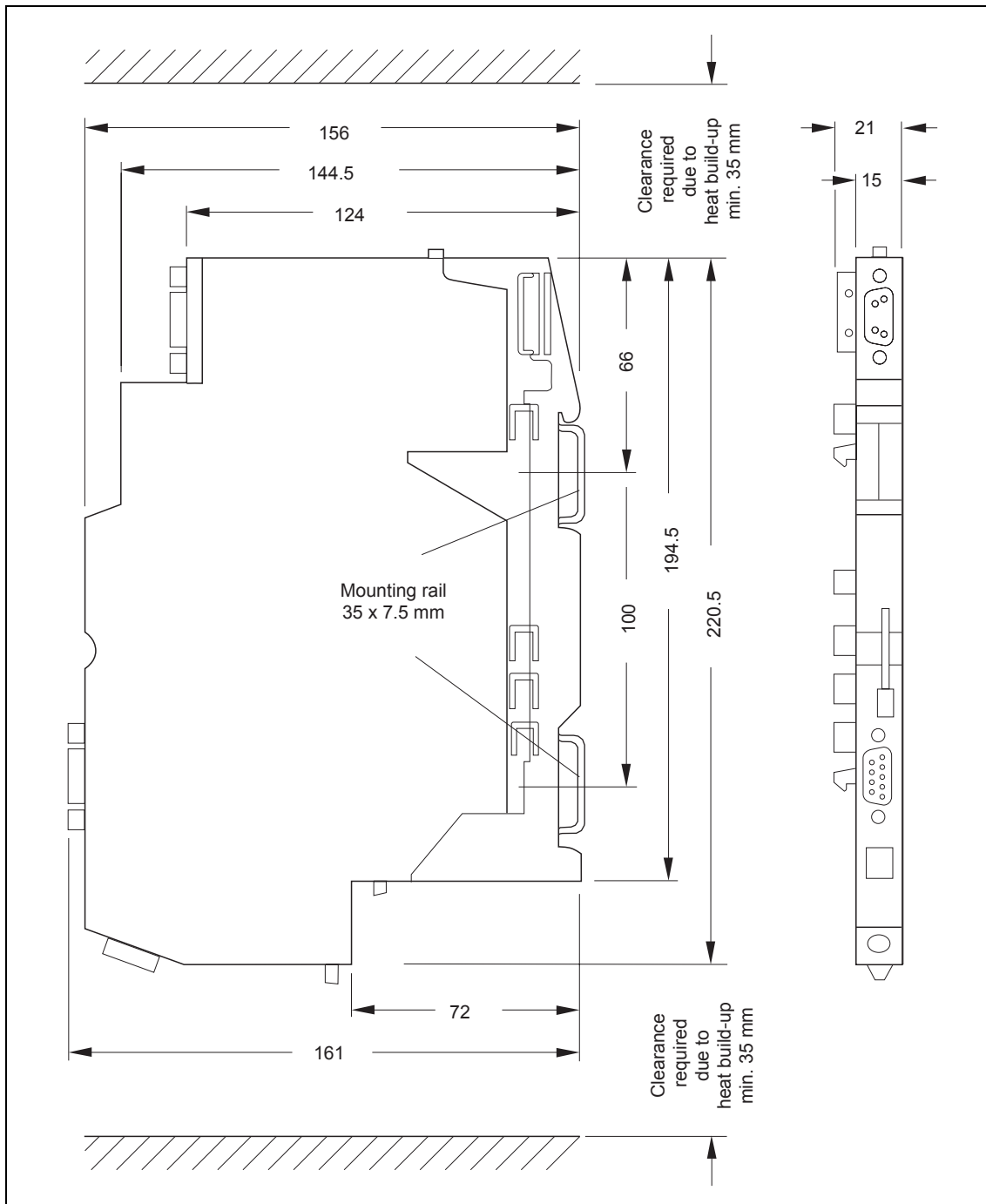


Fig. A-1 Dimension drawing ICU24(F) with terminal module

A.1 Dimension drawings

IPM25 FSA power module

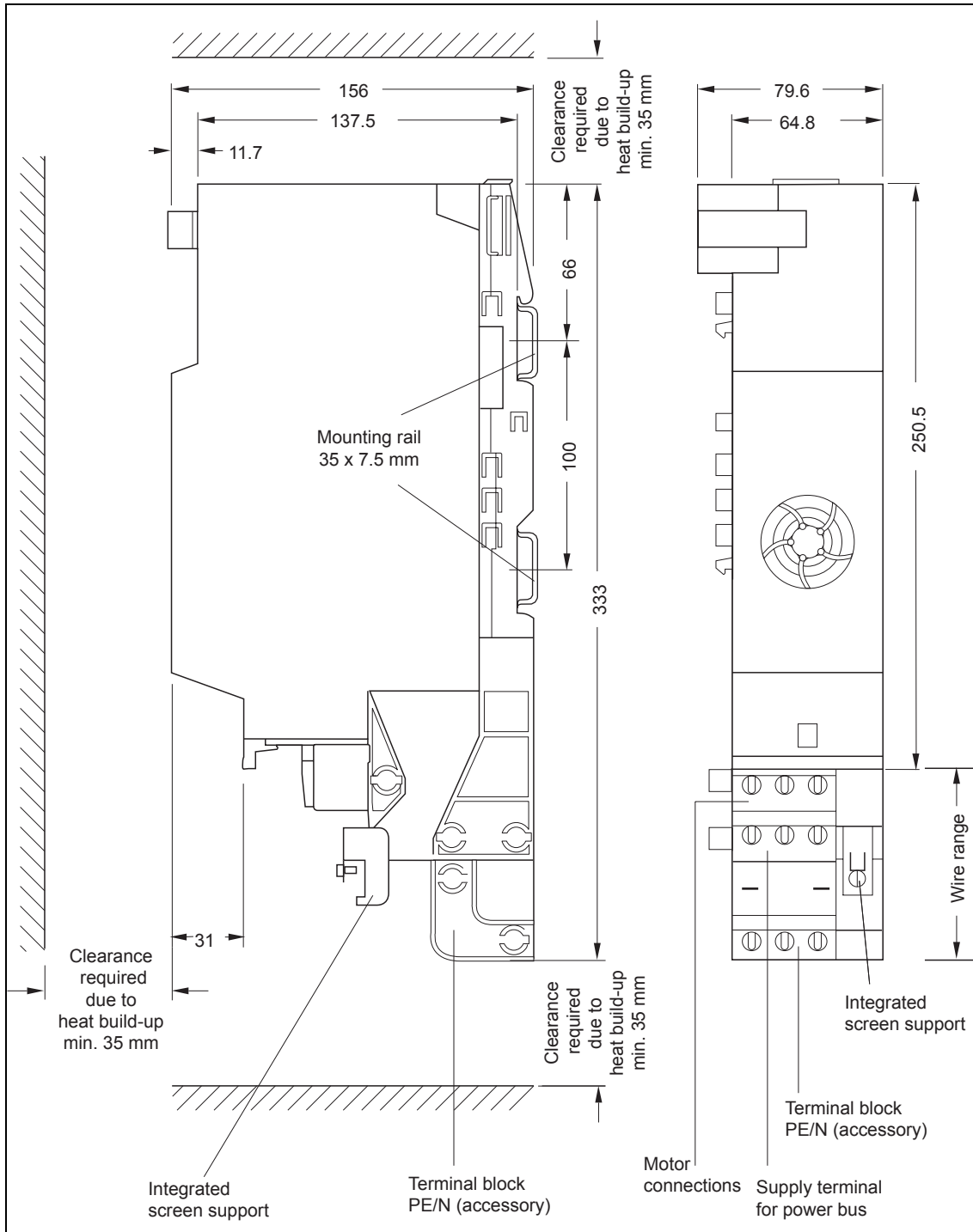


Fig. A-2 Dimension drawing IPM25 FSA with terminal module

IPM25 FSB power module

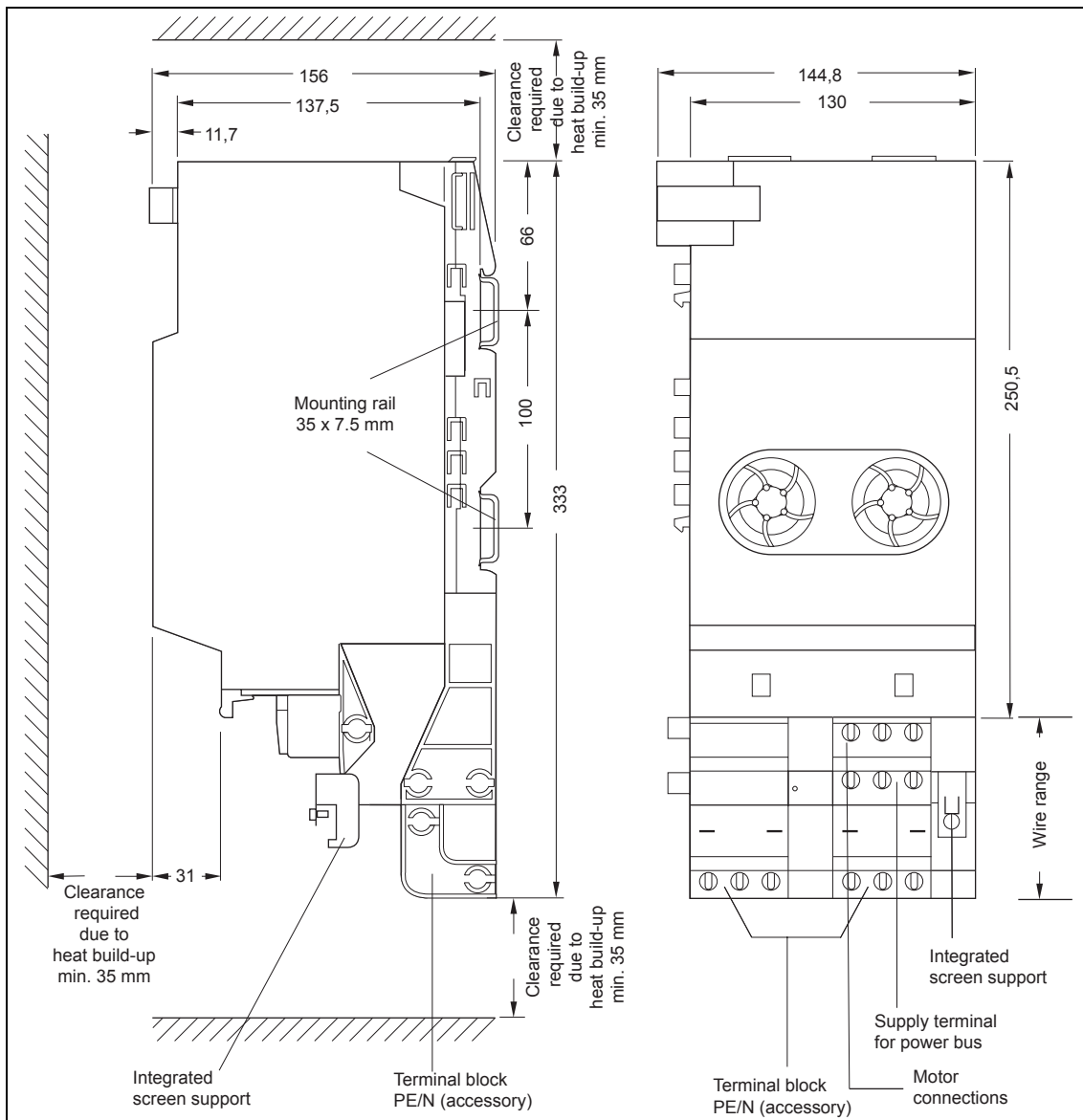


Fig. A-3 Dimension drawing IPM25 FSB with terminal module

A.1 Dimension drawings

A.1.3 EMC filter (option)

EMC filter (25 A)

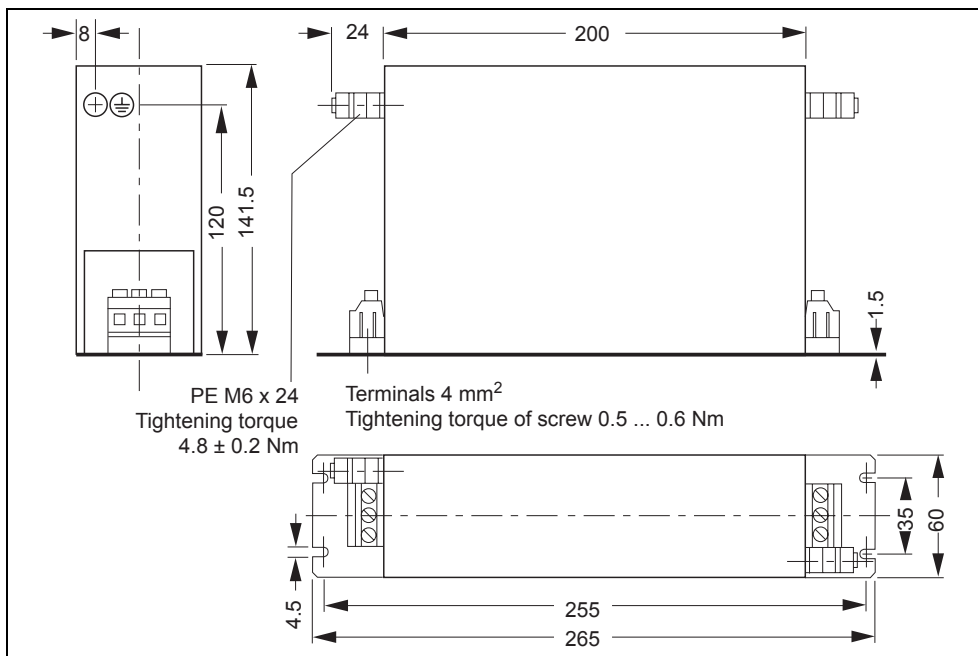


Fig. A-4 Dimension drawing EMC filter (25 A)

EMC filter (50 A)

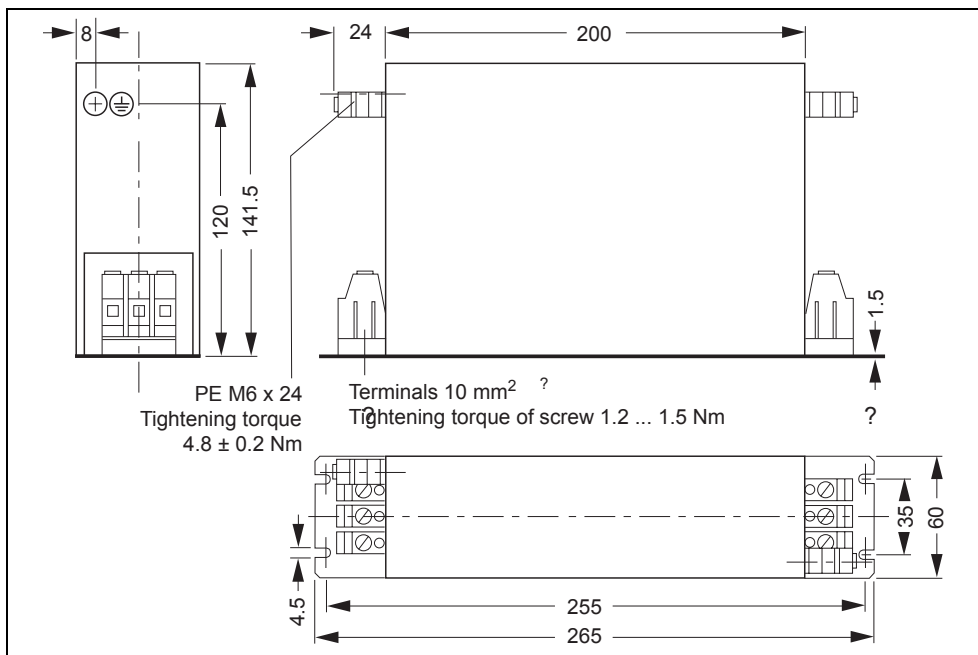


Fig. A-5 Dimension drawing EMC filter (50 A)

A.2 Abbreviations

AC	AC current	EEPROM	Electrically erasable programmable ready only memory (non-volatile memory)
AD	Analog-digital converter	ELCB	Earth-Leakage Circuit Breaker
ADC	Analog-digital converter	EMC	Electromagnetic compatibility (EMC)
ADR	Address	EMF	Electromagnetic force (EMF)
AFM	Frequency modification (modulation)	EMI	Electromagnetic interference
AG	Automation device	ESB	Equivalent circuit diagram
AIN	Analog input	FAQ	Frequently asked questions
AOUT	Analog output	FB	Function block
ASIC	Application-Specific IC	FCC	Flux current control
ASP	Analog setpoint	FCL	Fast current limiting
ASVM	Asymmetrical space Vector modulation	FF	Fixed frequency
BCC	Block check character	FFB	Free function block
BCD	Binary-coded decimal code	FOC	Field-orientated closed-loop control
BI	Binector input	FSA	Frame size A
BICO	Binector / connector	GSG	First steps
BIST	Test program	GUI ID	Global ID
BO	Binector output	HIW	Main actual value
BOP	Operator unit with numerical display	HSW	Main setpoint
C	Commissioning	HTL	Logic with higher noise threshold
CB	Communications module	I/O	Input / output
CCW	Left, counter-clockwise	IBN	Commissioning
CDS	Command data set	IGBT	Insulated Gate Bipolar Transistor
CI	Connector input	IND	Sub index
CM	Configuration management	JOG	Jogging
CMD	Command	KIB	Kinetic buffering
CMM	Combimaster	KTY	Thermistor
CO	Connector output	LCD	Liquid crystal display
CO/BO	Connector output / binector output	LED	Light emitting diode
COM	Common	LGE	Length
COM-Link	Communications interface	MHB	Motor holding brake
CT	Commissioning, ready	MM4	MICROMASTER 4
CT	Constant torque	MOP	Motorized potentiometer
CUT	Commissioning, run, ready	NC	NC contact
CW	Right, clockwise	NO	NO contact
DA	Digital-analog converter	NPN	Negative positive negative
DAC	Digital-analog converter	OPI	Operating Instructions
DC	DC current	PDS	Drive system
DDS	Drive data set	PID	PID controller (proportional, integral, differential component)
DIN	Digital input	PKE	Parameter ID
DIP	DIP switch	PKW	Parameter ID value
DOUT	Digital output	PLC	Programmable logic controller
DP	Distributed I/O	PLI	Parameter list
DS	Drive state	PNP	Positive negative positive
EEC	European Economic Community	POT	Potentiometer

A.2 Abbreviations

PPO	Parameter process data objects	SCL	Scaling
PTC	PTC thermistor (positive temperature coefficient)	SDP	Status display unit
PWE	Parameter value	SLVC	Sensorless closed-loop Vector control
PWM	Pulse-width modulation	STW	Control word
PX	Power extension	STX	Start text
PZD	Process data	SVM	Space Vector modulation
QC	Quick commissioning	TTL	Transistor-transistor logic
RAM	Random Access Memory	USS	Universal serial interface
RCCB	Fault current protective switch	VC	Vector control
RCD	Residual current operated switch	Vdc	DC link voltage
RFG	Ramp function generator	VT	Variable torque
RFI	Radio frequency interference	ZSW	Status word
RPM	Revolutions per minute (RPM)	ZUSW	Supplementary setpoint
RTOS	Real-time operating system		

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Operating Instructions for the frequency converter ET 200S FC

Have you come across any errors when reading these Operating Instructions?

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We are grateful for any suggestions and recommendations for improvement.

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