Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth Bosch Group

Rexroth IndraDrive Fc
Drive Controllers
Frequency Converters FCS01

R911310845
Edition 01

Operating Instructions

Title
Rexroth IndraDrive Fc
Drive Controllers
Frequency Converters FCS01

Type of Documentation
Operating Instructions

Document Typecode
DOK-INDRV*-FCS01*****-IB01-EN-P

Internal File Reference
Document Number, 120-2400-B323-01-EN

Purpose of Documentation
This documentation provides information on:

- the mechanical and electrical assembly
- the conditions of connection
- the commissioning of the devices
- the basic parameterization of the devices
- the error messages with information on causes and remedies

Record of Revisions

Description	Release Date	Notes
DOK-INDRV*-FCS01******-IB01-EN-P	Feb.06	First Edition

Validity
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Note
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Contents

1 Introduction

1.1 About this Documentation

WARNING

Personal injury and property damage caused by incorrect project planning for applications, machines and installations!

⇒ Take contents of the listed reference documentations into account.

Purpose of Documentation

This documentation provides information on ...

- … a presentation of the documentations on the drive system Rexroth IndraDrive Fc
- … help for selecting the system components of the drive system Rexroth IndraDrive Fc

Content of this documentation

These Operating Instructions comprise information on

- Assembly and installation
- Technical data of the individual components (as far as relevant for the operation).
- Current, voltage and performance data
- Dimensions and weights, and
- Pin assignment

This documentation contains safety regulations, technical data and operating instructions for the drive system Rexroth IndraDrive Fc. The individual chapters have the following main focuses:

Main focuses of the Chapters

Chapter	Title	Contents
1	Introduction	General **information**
2	Safety Instructions for Electric Drives and Controls	**Safety**
3	Important Directions for Use	
4	Brief Description	**Product description** (for those doing project planning)
5	Delivery	
6	Certifications and Types	
7	Mounting	
8	Installation	
9	Display and Operation of the Function Modules	**Practical application** (for operators and maintenance staff)
10	Commissioning	
11	Parameterization	
12	Error Messages	
13	Technical Data	
14	Additional Information	
15	Control Communication - Field Busses and Protocols	
16	Disposal and Environmental Protection	General **Information**

Fig. 1-1: Main focuses of the Chapters

1.2 Abbreviations Used

This documentation uses the following abbreviations:

Abbr.	Significance	Contents
FC	Frequency converter	
PPO	Parameter process data object	
PIDV	Parameter ID value	
PCD	Process data	
PID	Parameter ID	
IND	Index	
PV	Parameter value	
CTW	Control word	
STW	Status word	
CV1..3	Setpoint value 1-3	
AV1..3	Actual value 1-3	

Fig. 1-2: Abbreviations used

Reference Documentations - Overview

Title	Kind of documentation	Document typecode[1)]
Rexroth IndraDrive Additional Components	System Configuration	DOK-INDRV*-ADDCOMP****-PRxx-EN-P
Rexroth Connection Cables	Selection Data	DOK-CONNEC-CABLE*STAND-AUxx-EN-P
Third-party motors	Project Planning and Commissioning Manual	DOK-DRIVE*-3RDPART*MOT-AWxx-EN-P
safety instructions for electric drives and controls	Safety Guidelines	DOK-GENERAL-DRIVE******-SVSx-MS-P

1) In the documentation types, "xx" is a wildcard for the current version status of the documentation (example: PR01 stands for the first version of a system configuration)

Fig. 1-3: Documentations - overview

Standards

German, European and international technical standards are mentioned in this documentation. Standard documents and sheets are subject to copyright protection and Rexroth mustn't pass them on.

If required, contact the authorized sales agencies; in Germany directly contact:

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Dept. BRC/EDY

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D-97816 Lohr, Germany

1.3 Introducing the System

Drive System, Definition of Term

The Rexroth IndraDrive Fc drive system comprises the individual components (the system elements) which are required for application and utilization in the respective case:

- FCS01 frequency converter
- FCC01 function module
- FWA-INDRV*-FCB firmware
- Standard asynchronous motor
- Power transformer as an optional component
- Mains filter as an optional components
- Mains choke as optional components
- Braking resistor as additional component

System Elements - Components of the System

The drive system Rexroth IndraDrive Fc consists of the following system elements:

System elements	Types	Characteristics	Requirement
transformer	autotransformer	DST	optional
	isolating transformer	DLT	optional
mains filter	1-phase	NFE	optional
	3-phase	NFD03.1; HNF01.1;	optional
mains choke	standard	FNL01.1E	optional
Frequency converter	single-axis	FCS01.1	standard
firmware		FCB01	standard
Function module	control panels	FCC01.1T	optional
	Field bus module	FCC01.1F	optional
Braking resistor		FLR01.1	optional
Output throttle		FML01	optional
Motor cable	shielded	RKL	standard
	unshielded	RKL	optional
Motor	Standard asyn-chronous motor		standard

Fig. 1-4: System elements Rexroth IndraDrive

Rexroth IndraDrive C and Rexroth IndraDrive Fc

Differences

Compared to the units HCS02 and HCS03 of the IndraDrive C product family, the FCS01 units of the IndraDrive FC product family display a narrower power range, and their functionality scalability is smaller than that of the former. Primarily the FCS01 unit specialize in OpenLoop operation.

Compatibility

It is not possible to couple the FCS01 units via a shared DC bus to the HCS02 units.

2 Safety Instructions for Electric Drives and Controls

2.1 General Information

Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.

If the device is resold, rented and/or passed on to others in any other form, then these safety instructions must be delivered with the device.

WARNING

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

Instructions for Use

- Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.
- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations:
  - Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.

- The devices have been designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded.
  Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturer must

  - make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  - make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only permitted if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
- The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.

Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:

Warning symbol with signal word	Degree of hazard seriousness according to ANSI Z 535
 **DANGER**	Death or severe bodily harm will occur.
 **WARNING**	Death or severe bodily harm may occur.
 **CAUTION**	Bodily harm or material damage may occur.

Fig. 2-1: Hazard classification (according to ANSI Z 535)

2.2 Hazards by Improper Use

DANGER

High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!

DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

WARNING

High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

CAUTION

Hot surfaces on device housing! Danger of injury! Danger of burns!

CAUTION

Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting, or improper handling of pressurized lines!

CAUTION

Risk of injury by improper handling of batteries!

2.3 Instructions with Regard to Specific Dangers

Protection Against Contact with Electrical Parts

Note: This section only concerns devices and drive components with voltages of more than 50 Volt.

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

DANGER

High electrical voltage! Danger to life, electric shock and severe bodily injury!

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.

⇒ Follow general construction and safety regulations when working on electrical power installations.

⇒ Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.

⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.

⇒ Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard to prevent reconnection.

⇒ With electrical drive and filter components, observe the following:

Wait 30 minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.

⇒ A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.

⇒ Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.

European countries: according to EN 50178/ 1998, section 5.3.2.3.

USA: See National Electrical Code (NEC), National Electrical Manufacturers' Association (NEMA), as well as local engineering regulations. The operator must observe all the above regulations at any time.

With electrical drive and filter components, observe the following:

DANGER

High housing voltage and large leakage current! Risk of death or bodily injury by electric shock!

⇒ Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.

⇒ The equipment grounding conductor of the electrical equipment and the units must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.

⇒ Over the total length, use copper wire of a cross section of a minimum of 10 mm^2 for this equipment grounding connection!

⇒ Before start-up, also in trial runs, always attach the equipment grounding conductor or connect with the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

2.4 Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 5 and 50 Volt at Rexroth products are protective extra-low voltage systems which are provided with touch guard according to the product standards.

WARNING

High electric voltage by incorrect connection!
Risk of death or bodily injury by electric shock!

⇒ To all connections and terminals with voltages between 0 and 50 Volt, only devices, electrical components, and conductors may be connected which are equipped with a PELV (Protective Extra-Low Voltage) system.

⇒ Connect only voltages and circuits which are safely isolated from dangerous voltages. Safe isolation is achieved for example by isolating transformers, safe optocouplers or battery operation without mains connection.

2.5 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

DANGER

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

⇒ For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation.

They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

⇒ Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:

- - use safety fences
- - use safety guards
- - use protective coverings
- - install light curtains or light barriers

⇒ Fences and coverings must be strong enough to resist maximum possible momentum.

⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the device if the emergency stop is not working.

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

⇒ Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example:

- mechanically securing the vertical axes,
- adding an external braking/ arrester/ clamping mechanism or
- ensuring sufficient equilibration of the vertical axes.

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!

⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

2.6 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⇒ Persons with heart pacemakers and metal implants are not permitted to enter following areas:
- Areas in which electrical equipment and parts are mounted, being operated or commissioned.
- Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.

⇒ If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.

⇒ Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

2.7 Protection Against Contact with Hot Parts

CAUTION

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

⇒ Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!

⇒ Do not touch housing surfaces of motors! Danger of burns!

⇒ According to operating conditions, temperatures can be **higher than 60 °C, 140 °F** during or after operation.

⇒ Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes**! Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.

⇒ After switching drive controllers or chokes off, wait 15 minutes to allow them to cool down before touching them.

⇒ Wear safety gloves or do not work at hot surfaces.

⇒ For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.

2.8 Protection During Handling and Mounting

In unfavorable conditions, handling and assembling certain parts and components in an improper way can cause injuries.

CAUTION

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!

- ⇒ Observe the general construction and safety regulations on handling and assembly.
- ⇒ Use suitable devices for assembly and transport.
- ⇒ Avoid jamming and bruising by appropriate measures.
- ⇒ Always use suitable tools. Use special tools if specified.
- ⇒ Use lifting equipment and tools in the correct manner.
- ⇒ If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- ⇒ Do not stand under hanging loads.
- ⇒ Immediately clean up any spilled liquids because of the danger of skidding.

2.9 Battery Safety

Batteries consist of active chemicals enclosed in a solid housing. Therefore, improper handling can cause injury or damages.

CAUTION

Risk of injury by improper handling!

- ⇒ Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
- ⇒ Do not recharge the batteries as this may cause leakage or explosion.
- ⇒ Do not throw batteries into open flames.
- ⇒ Do not dismantle batteries.
- ⇒ Do not damage electrical parts installed in the devices.

Note: Environmental protection and disposal! The batteries installed in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separate from other waste. Observe the local regulations in the country of assembly.

2.10 Protection Against Pressurized Systems

According to the information given in the Project Planning Manuals, motors cooled with liquid and compressed air, as well as drive controllers, can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids, and cooling lubricating agents. In these cases, improper handling of external supply systems, supply lines, or connections can cause injuries or damages.

CAUTION

Risk of injury by improper handling of pressurized lines!

⇒ Do not attempt to disconnect, open, or cut pressurized lines (risk of explosion).

⇒ Observe the respective manufacturer's operating instructions.

⇒ Before dismounting lines, relieve pressure and empty medium.

⇒ Use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).

⇒ Immediately clean up any spilled liquids from the floor.

Note: Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separate from other waste. Observe the local regulations in the country of assembly.

3 Important Directions for Use

3.1 Appropriate Use

Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for an appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the products take the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

Areas of Use and Application

Drive controllers made by Bosch Rexroth are designed to control electrical motors and monitor their operation.

Control and monitoring of the motors may require additional sensors and actors.

Note: The drive controllers may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant Functional Descriptions.

Every drive controller has to be programmed before commissioning, making it possible for the motor to execute the specific functions of an application.

The drive controllers have been developed for use in single- and multi-axis drive and control tasks.

To ensure an application-specific use, the drive controllers are available with different drive power and different interfaces.

Typical applications of the drive controllers include:

- handling and mounting systems,
- packaging and food machines,
- printing and paper processing machines and
- machine tools.

The drive controllers may only be operated under the assembly and installation conditions described in this documentation, in the specified position of normal use and under the ambient conditions as described (temperature, degree of protection, humidity, EMC, etc.).

3.2 Inappropriate Use

Using the drive controllers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "inappropriate use".

Drive controllers must not be used, if…

- …they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extremely high maximum temperatures.
- Furthermore, the drive controllers must not be used in applications which have not been expressly authorized by Rexroth.
- Please carefully follow the specifications outlined in the general Safety Instructions!

4 Brief Description

4.1 General Information

The FCS01 units of the IndraDrive Fc product family are characterized by high modularity while simultaneously showing excellent control properties.

The FCS01 units have a sensorless current vector control which, together with the motor model of an asynchronous three-phase motor, guarantees an optimized voltage/frequency ratio at all times. For the drive, this means: highest starting and overload torques with constant speed.

Thanks to its modular function modules, this series of devices can be tailored to individual requirements.

Because of the large number of setting options, all three-phase a.c. motors can be operated.

This manual is based on the FCS01 device firmware FWA-INDRV*-FCB-01V**. Version (01V) and release status (**) can be checked in parameter P707. If your frequency converter is of another version, differences may occur. In this case, download the latest manual and device software from http://www.boschrexroth.com/indradrive.

4.2 FCS01 Properties FCS01

Properties of the basic device FCS01:

- Permitted ambient temperature 0 to 50°C
- Degree of protection IP20 (for installation of control cabinet)
- Can be mounted next to each other without any additional space in-between
- Power range from 0.25 kW to 7.5 kW
  (1/3~ 230V for 0.25kW to 2.2kW, 3~ 400V for 0.55kW to 7.5kW)
- Supply voltages 230 V and 400 V, 1- and 3-phase;
- Integrated EMC mains filter for limit curve A according to EN55011
- High start-up torque and precise motor speed control
- Overload capacity up to 200% over 3.5 s, and 150% over 60 s
- Output frequency 0....400Hz
- Settable pulse frequencies of 3.0…16 kHz
- Integrated brake chopper for 4-quadrant-operation (braking resistor can be connected externally)
- Materials free of asbestos and silicone

Operating Modes

- U/f operation
- Sensorless current vector control (named ISD control in the following)

Functions

- Automatic motor parameter identification
- Four separate parameter records which can be switched in online operation
- PID and process controller
- 32 fixed frequencies
- Motor potentiometer
- Signal recording
- Programmable d.c. braking
- Ramp rounding
- Flying restart circuit
- …

Interfaces

- RS 232 / RS 485
- 5 digital inputs
- 2 analog inputs (can also be used as digital input)
- 1 analog output
- 2 relays AC230V / DC30V, 2A

Cooling Types (Depending on Size)

- Natural cooling
- Forced, temperature-controlled cooling

5 Delivery

Check the unit for transport damages, e.g. deformation or loose parts, **immediately** after receipt/unpacking.

In case of damage, contact the forwarder at once and arrange for a thorough review of the situation.

Note: This is also applicable if the packaging is undamaged.

5.1 Scope of Supply

Standard model

- FCS01 frequency converter, degree of protection IP20
- FCB firmware
- Integrated brake chopper
- Integrated EMC mains filter for limit curve A according to EN55011
- Cover for the function module slot
- Shield clip for control terminals
- Cover for the control terminals
- Operating Instructions

Available accessories:

- FLR01 braking resistor, for applications with energy recovery function;
- FAS01 temperature switch for assembly to FLR01 braking resistors;
- FAS02 optional component for connection of the motor cable shield to the housing of the frequency converter;
- DriveTop Fc software for parameterization and commissioning
- Ask us for any other accessories you may require

Function modules

- FCC01.1T-STD-NNNN, standard control panel, removable control panel, 4-digit 7-segment LED display
- FCC01.1T-CMF-NNNN, comfort control panel, removable control panel, 4-line plain text LCD display
- FCC01.1F-PB1-NNNN, Profibus module DP, 1.5 MBaud, Function module for Profibus communication
- FCC01.1F-PB2-NNNN, Profibus module DP, 12 MBaud; Function module for Profibus communication
- FCC01.1F-CN1-NNNN, CANopen module, Function module for CANopen bus activation
- FCC01.1F-DN1-NNNN, DeviceNet module, Function module for DeviceNet bus activation

6 Certifications and Types

6.1 Certifications

For the latest state of certifications, please refer to http://www.boschrexroth.com/indradrive.

CE Conformity

Low-voltage directive

The conformity of the FCS01 frequency converters with the low-voltage directive is herewith confirmed.

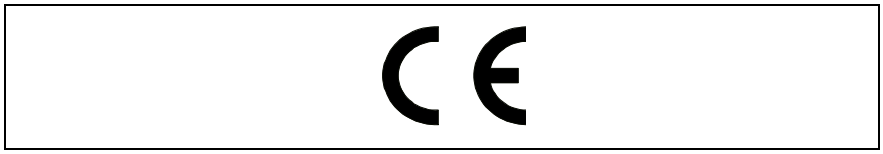


Fig. 6-1: CE label

EMC directive

See Chapter 13.4, Electromagnetic Compatibility (EMC)

UL and cUL Certification

The registration of the FCS01 frequency converter is under preparation.
(application in North America)

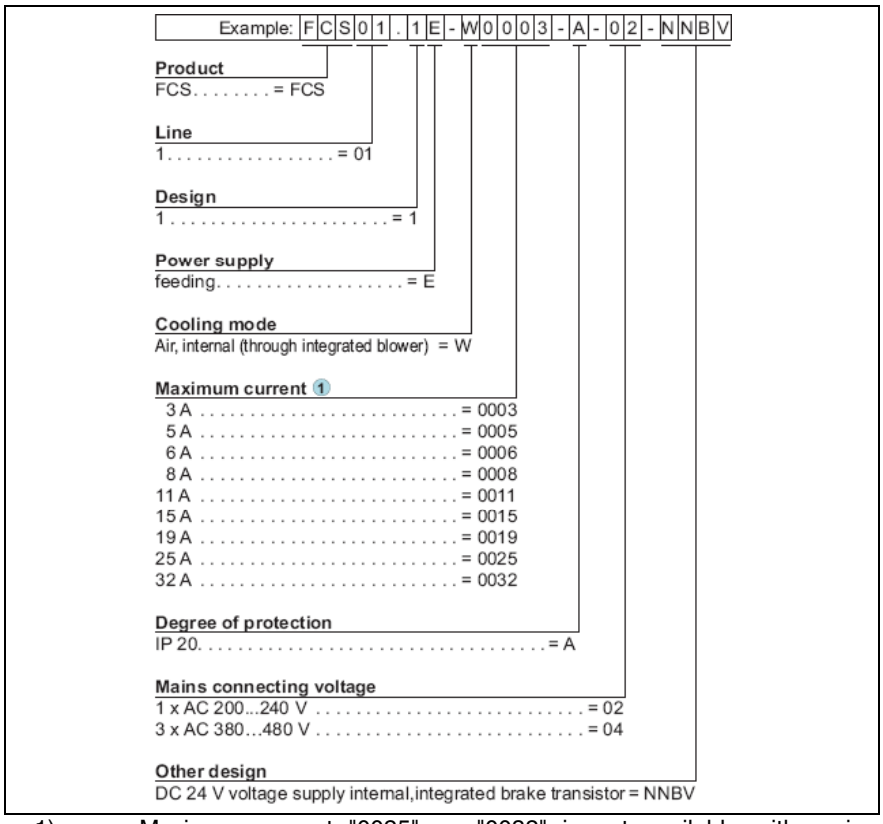
Fig. 6-2: UL and cUL certification

Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 200…240 Volts or 380…480 Volts (three phase) and "when protected by J class fuses" as indicated in Chapter 7.4.

The FCS01 frequency converters of the IndraDrive Fc product family comprise a motor overload protection. For more technical details, please see Chapter 13.3, Electrical Data for UL/cUL Certification.

6.2 Type Codes

Type Code Frequency Converter FCS01



1) Maximum current "0025" an "0032" is not available with mains connecting voltage "02"

Fig. 6-3: Type code FCS01

Type Code FCC01 Function Module

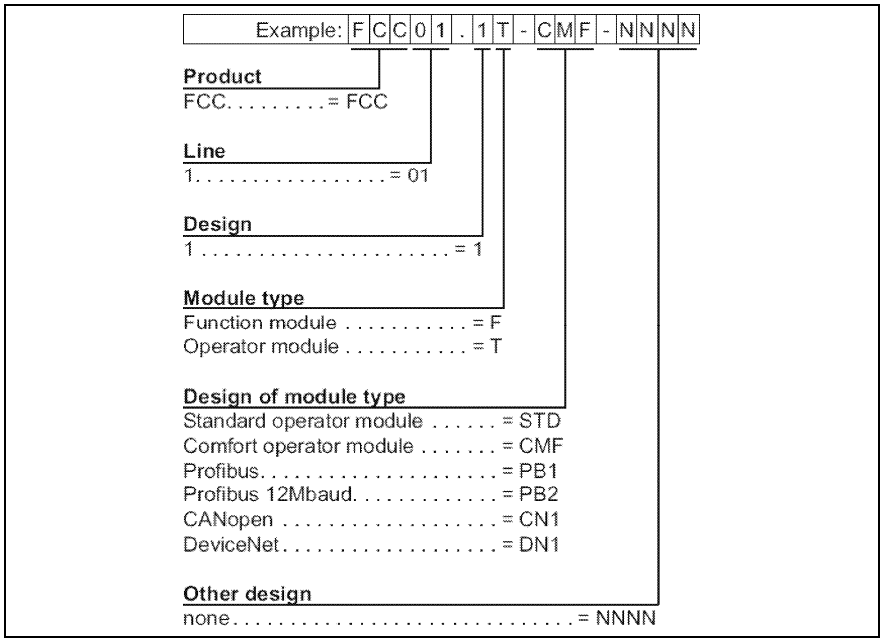


Fig. 6-4: Type code FCS01

Type Code FLR01 Braking Resistor

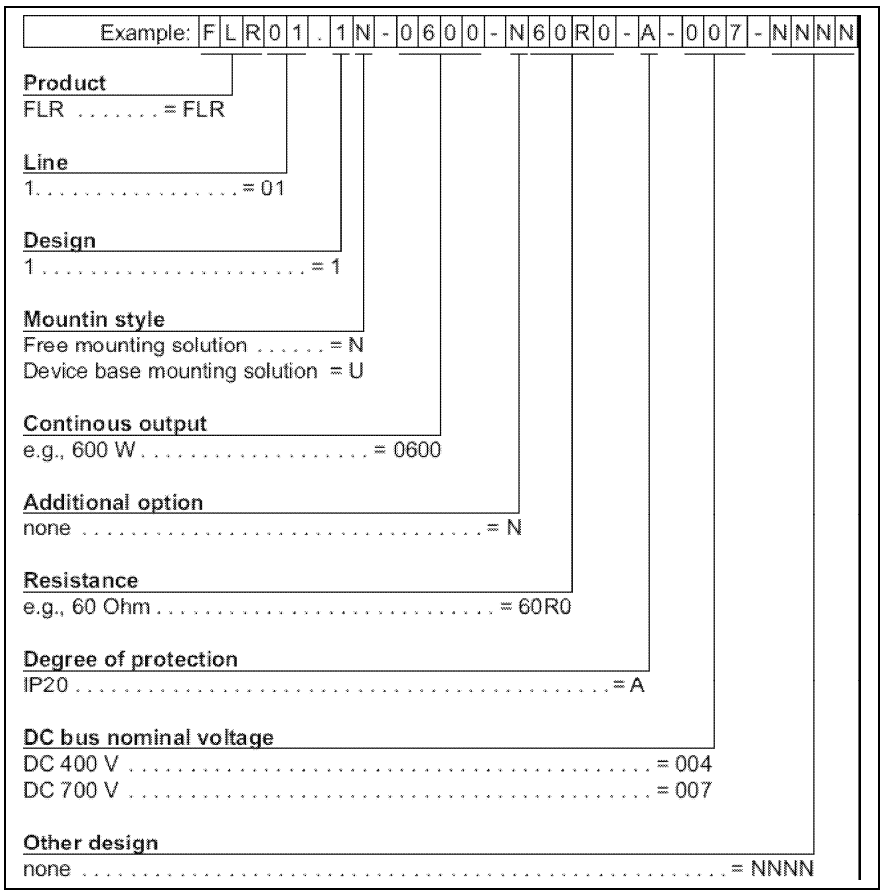


Fig. 6-5: FLR01 type code

Accessories FAS01 Type Code (Temperature Switch)

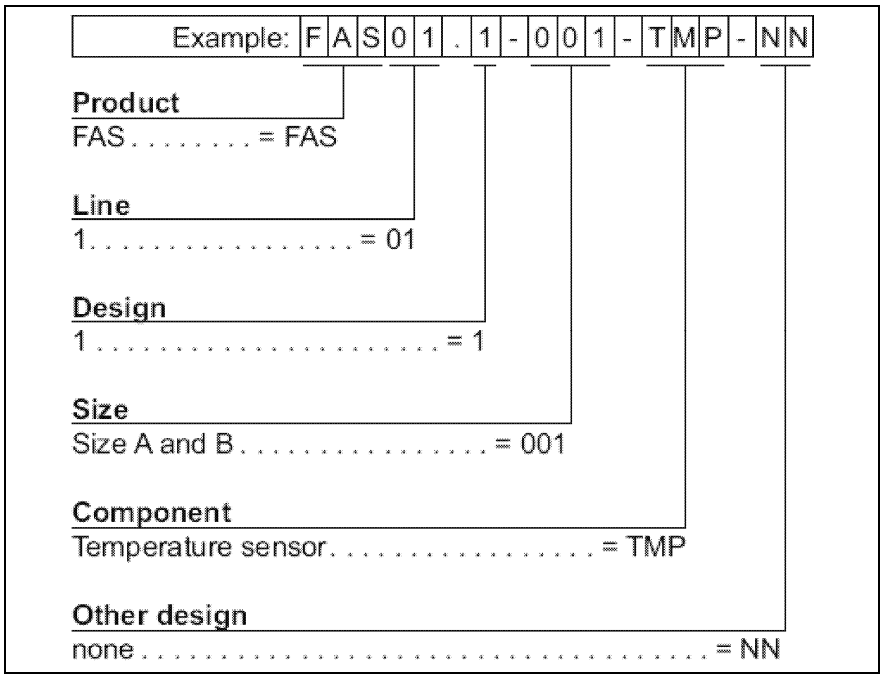


Fig. 6-6: Type code FAS01

Accessories FAS02 Type Code (Shield Connection)

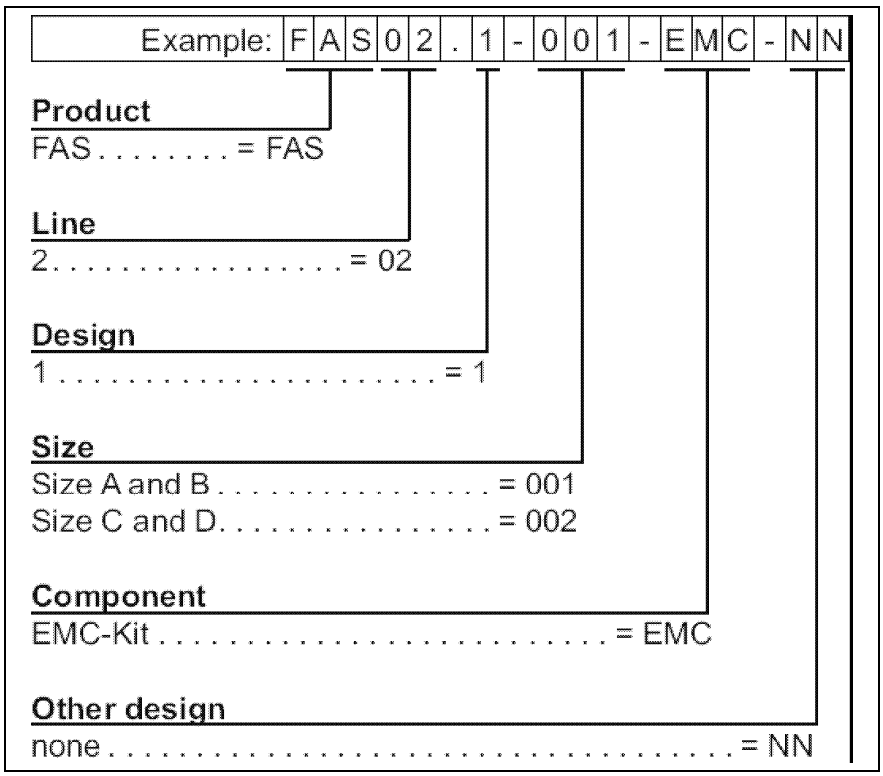


Fig. 6-7: Type code FAS02

6.3 IndraDrive Fc Components

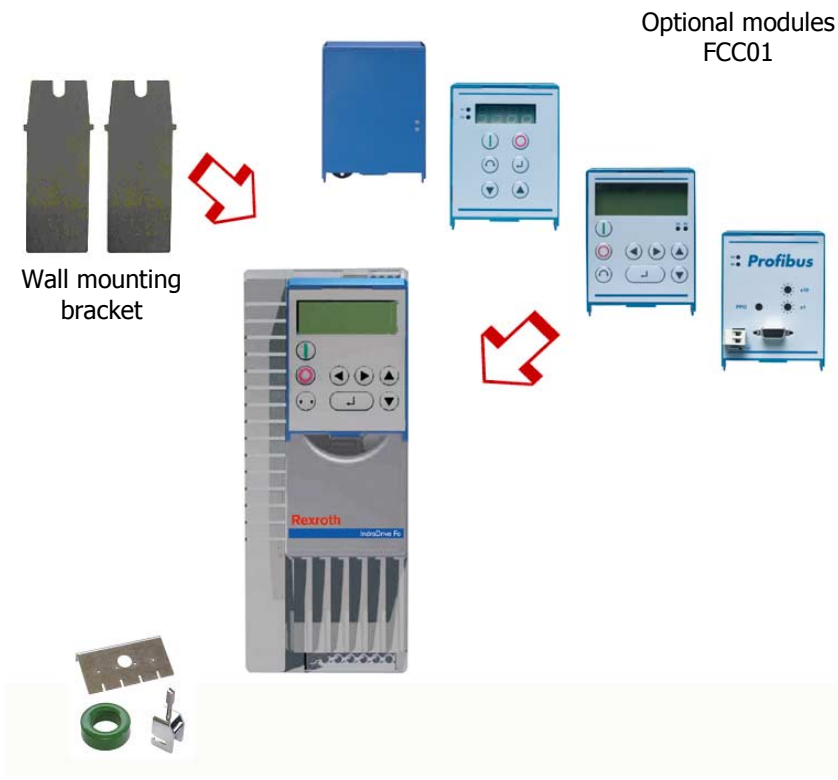


Fig. 6-8: IndraDrive Fc Components

7 Mounting

7.1 Mounting

The FCS01 frequency converters are supplied in different sizes, depending on the power. When mounting your frequency converter, observe the correct installation position.

To be protected from overheating, the devices must be sufficiently ventilated. Here, recommended values apply for minimum distance above and below the frequency converter, and to neighboring components which may disturb the free flow of air.

Note: Mounting without additional lateral space between the frequency converters is permitted. The installation position is always vertical.

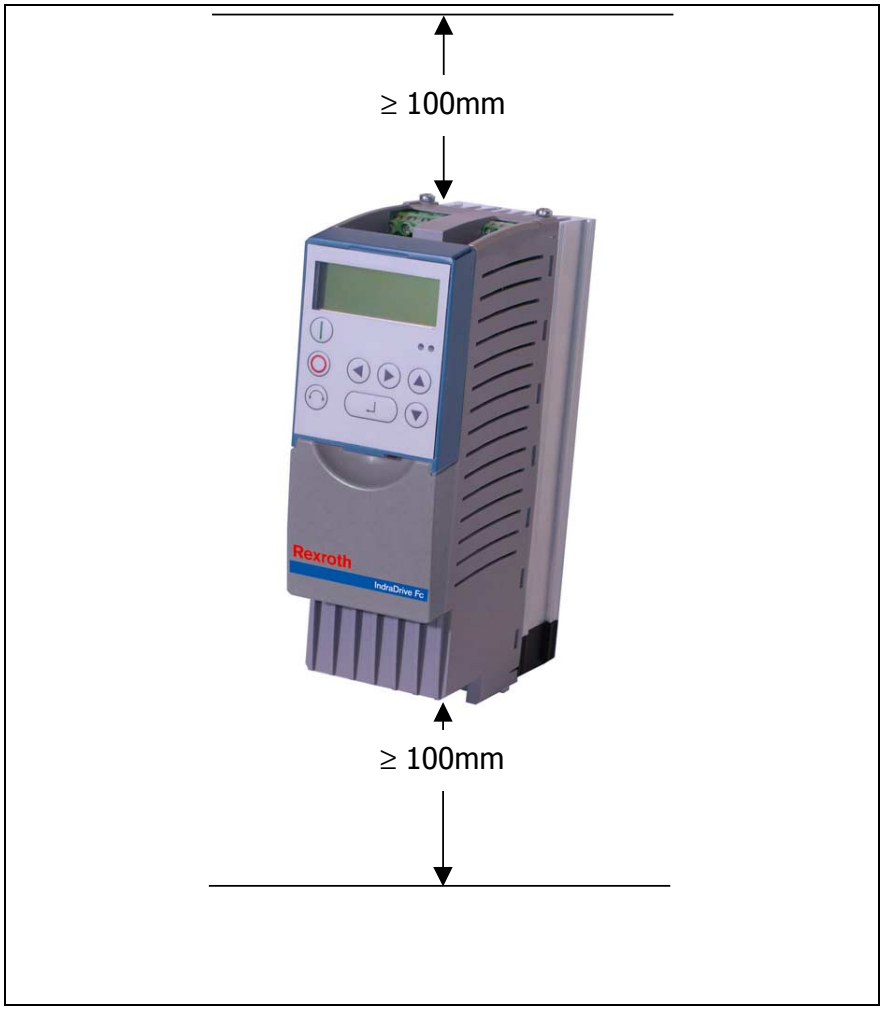


Fig. 7-1: Vertical installation position

Note: Warm air must be carried off above the devices!

If several frequency converters are arranged above one another, make sure that the top limit of air entry temperatures is not exceeded. (also refer to Chapter 13, Technical Data). If the limit is exceeded, we

recommend to mount an "obstacle" (e.g. a cable duct) between the frequency converters which will interrupt the direct air flow (rising warm air).

Efficiency: On installation in a control cabinet, ensure sufficient ventilation. During operation, lost heat in the amount of approx. 5% (depending on unit size and equipment) of the nominal power of the frequency converter will occur.

7.2 Dimensions of the FCS01 Frequency Converter

Device type	Size	Housing dimensions [mm]			Wall mounting bracket mm]	
		L	W	D	L1, approx	Ø
FCS01.1E-W0003-A-02 FCS01.1E-W0005-A-02 FCS01.1E-W0006-A-02 FCS01.1E-W0008-A-02 FCS01.1E-W0003-A-04 FCS01.1E-W0005-A-04	A	186	74	153	220	5.5
FCS01.1E-W0011-A-02 FCS01.1E-W0015-A-02 FCS01.1E-W0019-A-02 FCS01.1E-W0006-A-04 FCS01.1E-W0011-A-04	B	226	73	153	260	5.5
FCS01.1E-W0015-A-04 FCS01.1E-W0019-A-04	C	241	98	178	275	5.5
FCS01.1E-W0025-A-04 FCS01.1E-W0032-A-04	D	286	98	178	320	5.5

Fig. 7-2: Dimensions of the IndraDrive Fc frequency converters

8 Installation

8.1 Wall Mounting Bracket FCS01

2 brackets for wall mounting are comprised in the delivery scope of the FCS01. They are inserted at the heatsink at the rear of the device, as shown in the illustration. No other accessories are required. Alternatively, the wall mounting bracket can be inserted laterally at the heatsink to reduce the installation depth of the device to a minimum, if required.

Note: To ensure trouble-free operation, the device should be mounted vertically to a level surface.

Fig. 8-1: Wall mounting bracket FCS01

8.2 FLR01 Braking Resistors

When a three-phase a.c. motor is braked (when its frequency is reduced), electrical energy is recovered and fed into the frequency converter. To prevent overvoltage deactivation of the frequency converter, an external braking resistor can be used. In this process, the integrated power transistor (brake chopper) discharges the DC bus voltage (switching limit at approx. DC420V or DC720V, depending on type of FCS01) to the braking resistor. Here, the recovered energy is converted to heat.

FCS01 with power ranges of up to 2.2kW

With converters with a power range of up to 2.2 kW, standard substructure resistors **FLR01.1U** can be used. The resistor can additionally be equipped with an optional temperature switch **FAS01** to prevent overloading. The fastening material in the groove on the side is comprised in the delivery range of the FLR01.1N. The braking resistor and the temperature switch are connected via lines.

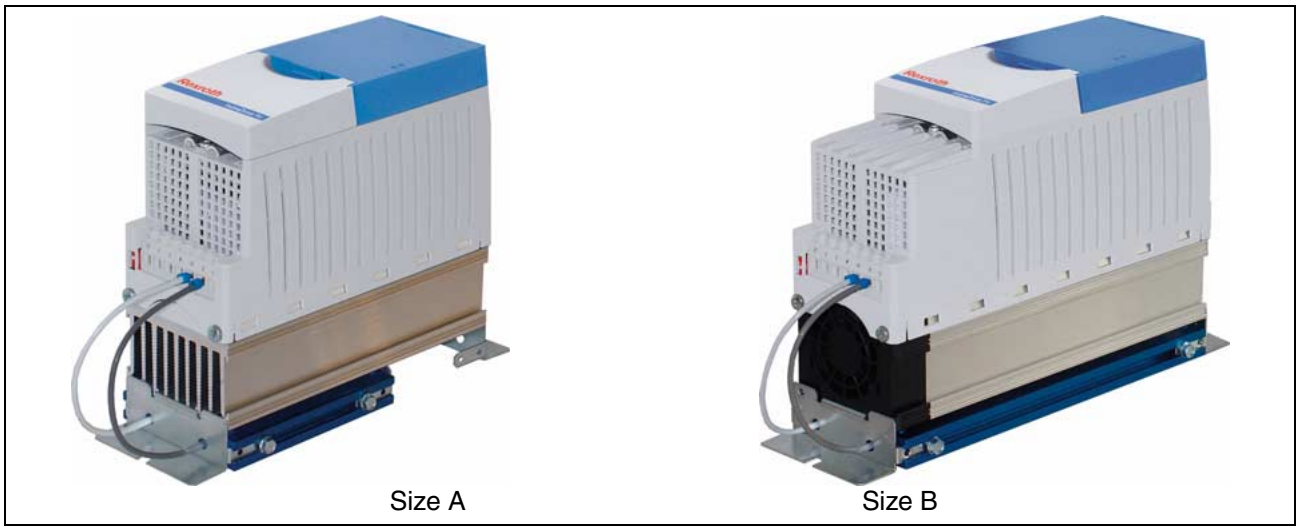


Fig. 8-2: FLR01 substructure type

FCS01 with power ranges from 3kW to 7.5kW

For frequency converters with a power range of 3kW to 7.5kW, resistors **FLR01.1C** can be used for free installation. They should be mounted in the control cabinet close to the frequency converter. Overload protection is provided by a temperature switch at the brake resistor. The resistor and the thermal switch are connected by means of screw type terminals.

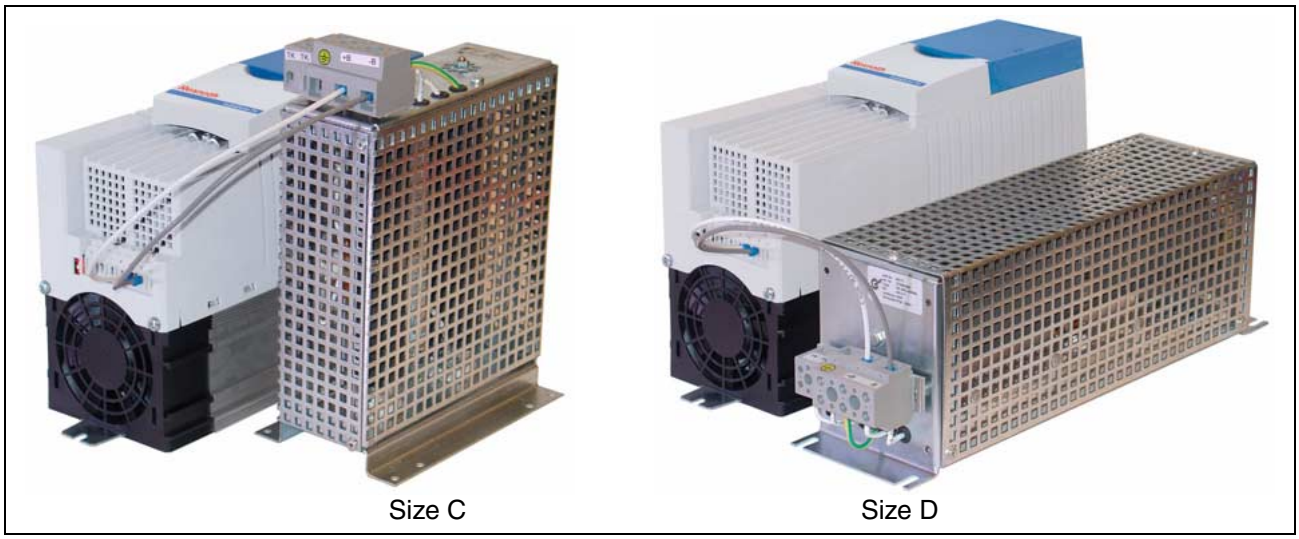


Fig. 8-3: FLR01 'free installation' type

Permitted combinations Braking resistors with converter type

Braking resistor	Converter
FLR01.1U-0100-N240R-A-004-NNNN	FCS01.1E-W0003-A-02-NNBV FCS01.1E-W0005-A-02-NNBV
FLR01.1U-0100-N150R-A-004-NNNN	FCS01.1E-W0006-A-02-NNBV FCS01.1E-W0008-A-02-NNBV
FLR01.1U-0200-N75R0-A-004-NNNN	FCS01.1E-W0011-A-02-NNBV FCS01.1E-W0019-A-02-NNBV
FLR01.1U-0100-N400R-A-007-NNNN	FCS01.1E-W0003-A-04-NNBV FCS01.1E-W0005-A-04-NNBV
FLR01.1U-0200-N220R-A-007-NNNN	FCS01.1E-W0006-A-04-NNBV FCS01.1E-W0011-A-04-NNBV
FLR01.1N-0400-N100R-A-007-NNNN	FCS01.1E-W0015-A-04-NNBV FCS01.1E-W0019-A-04-NNBV
FLR01.1N-0600-N60R0-A-007-NNNN	FCS01.1E-W0025-A-04-NNBV FCS01.1E-W0032-A-04-NNBV

Fig. 8-4: Coordination table FLR01 to FCS01

Technical Data FLR01

Electrical data FLR01

Type of braking resistor	Construction type/size/degree of protection	Resistor	Continuous rating	max. allowed energy uptake	Puls power / max. allowed duty ratio @ T=120s		Connecting line		Connection terminals
					420V	720V	length	cross section	cross section
		[Ω]	[W]	[kWs]	[kW] / [%]	[kW] / [%]	[m]	[mm²] / [AWG]	[mm²] / [AWG]
FLR01.1U-0100-N240R-A-004-NNNN	Substructure/ A /IP40	240	100	1.0	0.7 / 7	--	2*0,5	1,9 / 14	--
FLR01.1U-0100-N150R-A-004-NNNN	Substructure/ A /IP40	150	100	1.0	1.1 / 4	--	2*0,5	1,9 / 14	--
FLR01.1U-0200-N75R0-A-004-NNNN	Substructure/ A /IP40	75	200	4.0	2.3 / 4	--	2*0,5	1,9 / 14	--
FLR01.1U-0100-N400R-A-007-NNNN	Substructure/ B /IP40	400	100	0.75	--	3.8 / 0.5	2*0,5	1,9 / 14	--
FLR01.1U-0200-N220R-A-007-NNNN	Substructure/ B /IP40	220	200	4.0	--	6.7 / 0.5	2*0,5	1,9 / 14	--
FLR01.1N-0400-N100R-A-007-NNNN	Free installation / C/ IP00 [1)]	100	400	6.0	--	15 / 0.5	--	--	2*10
FLR01.1N-0600-N60R0-A-007-NNNN	Free installation / D/ IP00 [2)]	60	600	7.5	--	25 / 0.5	--	--	2*10

1) Terminals IP20
2) IP20 possible, if mounted on a proper mounting surface

Fig. 8-5: FLR01: electrical data

Technical data temperature switch

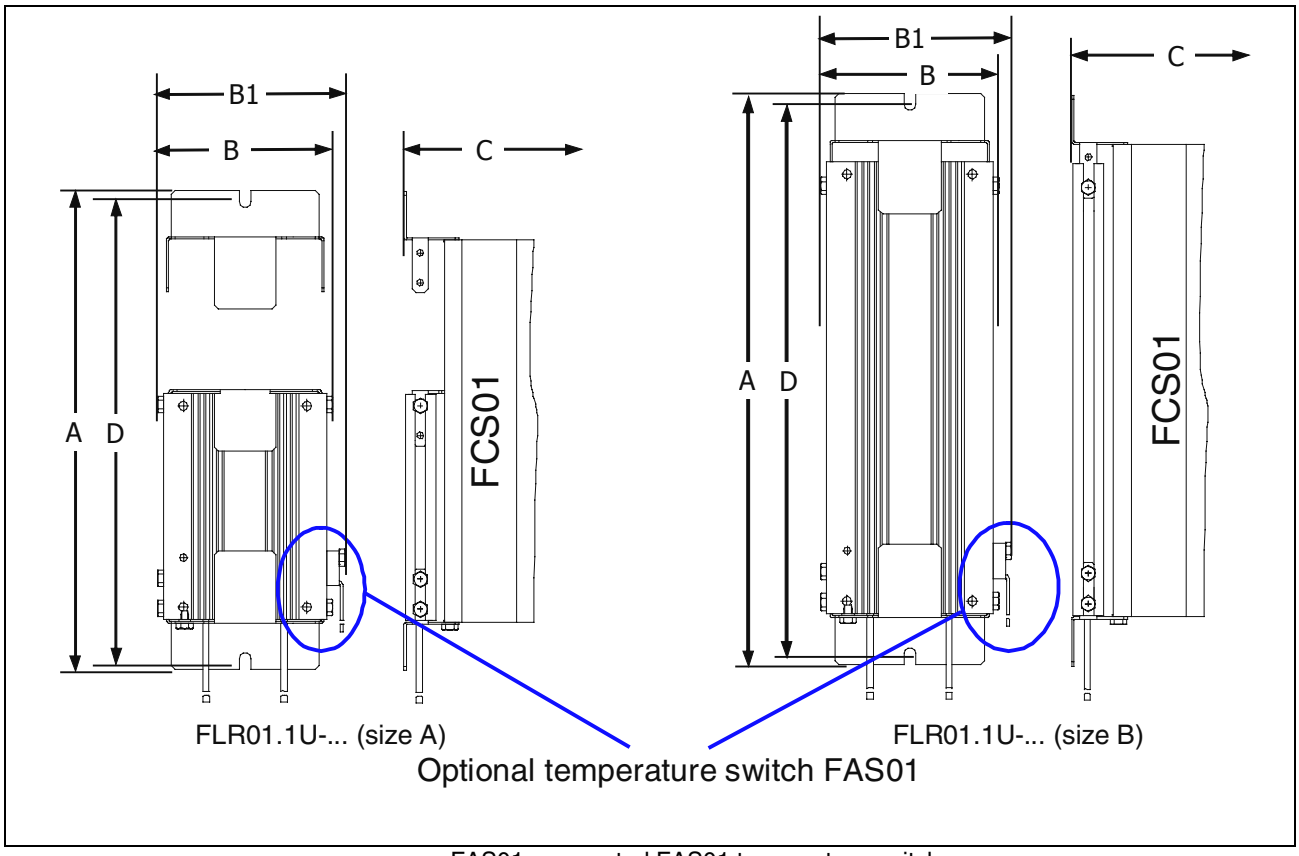
Temperature switch type	Degree of protection	Voltage	Current	Dimensions	Connecting line		Connection terminals	Notes
					length	cross section	Crosssection	
				[mm]	[m]	[mm²] / [AWG]	[mm²] / [AWG]	
FAS01.1-001-TMP-NN	IP40	AC250V	2,5A @ cosPhi=1; 1,6A @ cosPhi=0,6	1) B1= B+10	2*0,5	0,8 / 18	--	Optional equipment for FLR01.1U braking resistors
		AC250V	2A (AC11)					
		DC24V	2A (DC11)					
Integrated in FLR01.1N	IP40	AC250V	2,5A @ cosPhi=1; 1,6A @ cosPhi=0,6	--	--	--	2*4 / --	Integrated in FLR01.1N braking resistors
		AC250V	2A (AC11)					
		DC24V	2A (DC11)					

1) see FLR01.1U dimensions

Fig. 8-6: Technical data temperature switch

Note: The bimetallic contact in temperature switch FAS01 opens at approx. 180°C.

Dimensions of FLR01.1U (type 'substructure')



FAS01 mounted FAS01 temperature switch

Fig. 8-7: Dimensions of FLR01.1U

Type of braking resistor	Size	A	B	C 1)	D	Diameter of fastening
		[mm]	[mm]	[mm]	[mm]	[mm]
FLR01.1U-0100-N240R-A-004-NNNN **FLR01.1U-0100-N150R-A-004-NNNN** **FLR01.1U-0200-N75R0-A-004-NNNN**	A	230	88	175	220	5.5
FLR01.1U-0100-N400R-A-007-NNNN **FLR01.1U-0200-N220R-A-007-NNNN**	B	270	88	175	260	5.5

1) Installation depth of the frequency converter incl. FLR01.1N

Fig. 8-8: Dimensions of FLR01.1N

Dimensions of FLR01.1N (type 'free installation')

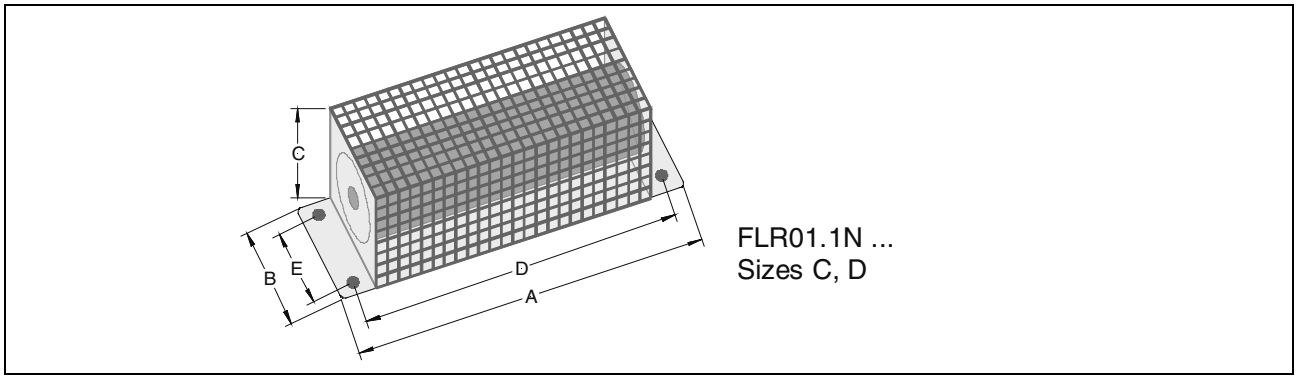


Fig. 8-9: Dimensions of FLR01.1N

Note: The illustration shows the general scale model without proportions. Please also take note of the illustration "FLR01 in 'free installation' type.

Type of braking resistor	Size	A	B	C	D	E	Diameter of fastening
		[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
FLR01.1N-0400-N100R-A-007-NNNN	C	100	170	240	90	150	4,3
FLR01.1N-0600-N60R0-A-007-NNNN	D	350	92	120	325	78	6,5

Fig. 8-10: Dimensions of FLR01.1N

8.3 Wiring Directives

The frequency converters have been developed for operation in an industrial environment. In this environment, the frequency converter may be exposed to high degrees of electromagnetic interferences. Usually, correct installation guarantees smooth operation free of trouble and risks. To ensure that the limits of the EMC directives are kept, the following notes should be observed.

- Make sure that all devices in the control cabinet or in the field are well grounded by means of short grounding lines with large cross-section which are connected to a common grounding point or grounding bar. It is very important that each control unit (e.g. automation device) connected to the frequency converters is linked by means of a short line with a large cross-section to the same grounding point as the converter. Flat lines (e.g. metal U-clamps) are preferable as their impedance with high frequencies is lower.
  If possible, the PE ground of the motor controlled through the frequency converter should be connected directly to the earth connection linked to the heat sink, together with the PE of the power input line of the respective frequency converter. Usually, smooth operation is guaranteed if a central grounding bar is provided and all PEs are connected to this bar. (also see Chapter 13.4, Electromagnetic Compatibility (EMC))
- Use shielded lines for control circuits where possible. The shield should carefully terminated at the end of the line. Make sure that strands do not run unshielded over long sections.
- The shield of the control cables should be grounded only on the frequency converter side.
- Run the control cables separately from the load lines if possible, for example by using separate cable ducts etc. Lay cables at crossing points at 90° angles if possible.
- Make sure that interference suppression has been provided for the contactors in the control cabinets, either - for a.c. contactors - by RC connection or - for d.c. contactors - by "free-wheeling" diodes. **Note that the interference suppressors must be mounted to the contactor coils.** Varistors are also effective for overvoltage limiting. This interference suppression is of special importance if the contactors are controlled by the relays in the converter.
- Use shielded or armoured cables for the load connection (motor cable), und ground the shield/armor at both ends. Grounding should be effected directly on the well conducting mounting plate of the control cabinet or the EMC kit shield angle.

- When the drive is to be operated in an environment sensitive to electromagnetic interference, we recommend the use of interference suppressor filters (note degree of protection) to limit the conducted and emitted interferences of the frequency converter. Mount the filter as close as possible to the converter and ground it well.
- Furthermore, it is imperative to observe the directives for EMC-compatible wiring. (also see Chapter 13.3, Electrical Data for UL/cUL Certification, and Chapter 13.4, Electromagnetic Compatibility (EMC))
- Select the lowest available switching frequency. This reduces the intensity of the electromagnet interference generated by the converter.

Note: It is imperative that the safety regulations are observed when installing the frequency converters!

Note: Control, mains, and motor cables must be run separately. They must never be laid in one common cable pipe/duct.
The test equipment for high voltage insulation must not be used for cables connected to the frequency converter.

Wiring Arrangement and Shielding at Function Modules

Where no EMC measures have been taken, high-frequency interferences primarily caused by switching operations or lightning frequently result in faults in electronic components of the bus nodes; in this cause, trouble-free operation is no longer guaranteed.

Professionally shielded bus cables dampen the potential electrical interferences of an industrial environment. Adopt the following measures to realize optimum shielding properties:

- Keep the connections between bus nodes as short as possible.
- The shielding of the bus cable must be placed on both sides over a large area.
- Avoid connection of field devices to the bus via stubs.
- Avoid extension of bus cables via connectors.

Note: In case of different potentials to ground, a compensating current may flow through the shield connected on both sides which is a potential risk to the electronic components. Equipotential differences must be reduced by sufficient equipotential bonding.

Wiring Recommendations for Power Connections

Note: Place the cable shield on both sides, i.e. at the shield angle of the frequency converter housing and on the motor terminal box.

Observe the other wiring recommendations given in Chapter 8, Wiring Directives.

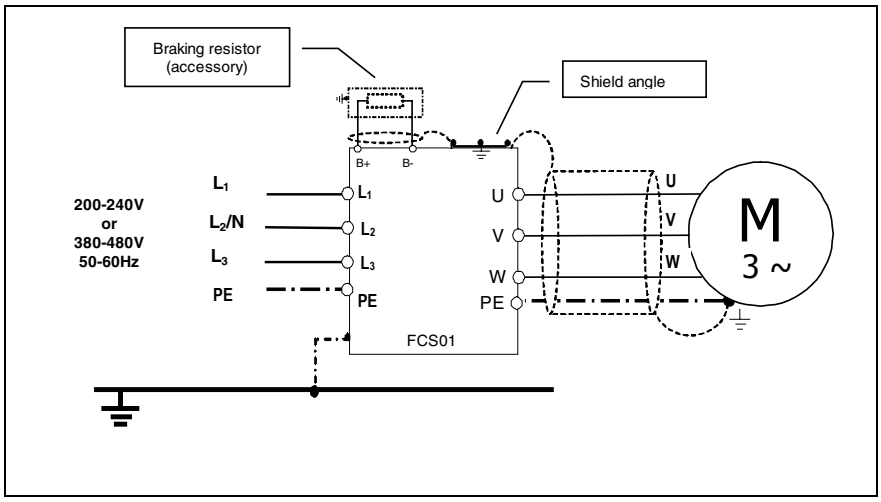


Fig. 8-11: **Wiring**

8.4 Connection of Electrical Power

WARNING

THESE DEVICES MUST BE GROUNDED.

⇒ Professional mounting and commissioning by qualified personnel in accordance with the instructions in this Manual is a precondition for the safe operation of the device.Specifically, the general and regional mounting and safety instructions for working with electrical power installations (e.g. VDE) and the regulations concerning professional utilization of tools and the use of personal safety equipment must be observed.At the power input and the motor terminals, dangerous voltage may be applied even while the converter is deactivated. Always use insulated screwdrivers at these terminal panels.Make sure that the input voltage source is de-energized before making or modifying the connections to the unit.Check that the frequency converter and the motor are dimensioned for the actually existing supply voltage.

The power connection and signal relay terminals are situated on the top of the frequency converter. The motor connection and braking resistor terminals are situated on the bottom of the frequency converter.

The control terminals are situated on the front of the frequency converter. To reach them, push the terminal cover downwards and pull it off. Now, the terminals are accessible from the front.

Re-fit all covers before switching on the supply voltage!

The following has to be taken into account:

- Make sure that the voltage source supplies the correct voltage and is dimensioned for the required current (see Chap. 7, Technical Data). Make sure that suitable power circuit breakers with the specified nominal current range of have been placed between the voltage source and the frequency converter.
- Connect the mains voltage directly to the mains terminals **L_1-L_2/N-L_3-PE**.
- Use a four-core cable to connect the motor. The cable is connected to the motor terminals **PE-U-V-W.**
- If shielded motor cable is used as recommended, place the cable shield over a large area on the metallic mounting surface of the control cabinet.

Note: It is imperative to use shielded cable to observe the specified degree of radio interference suppression.

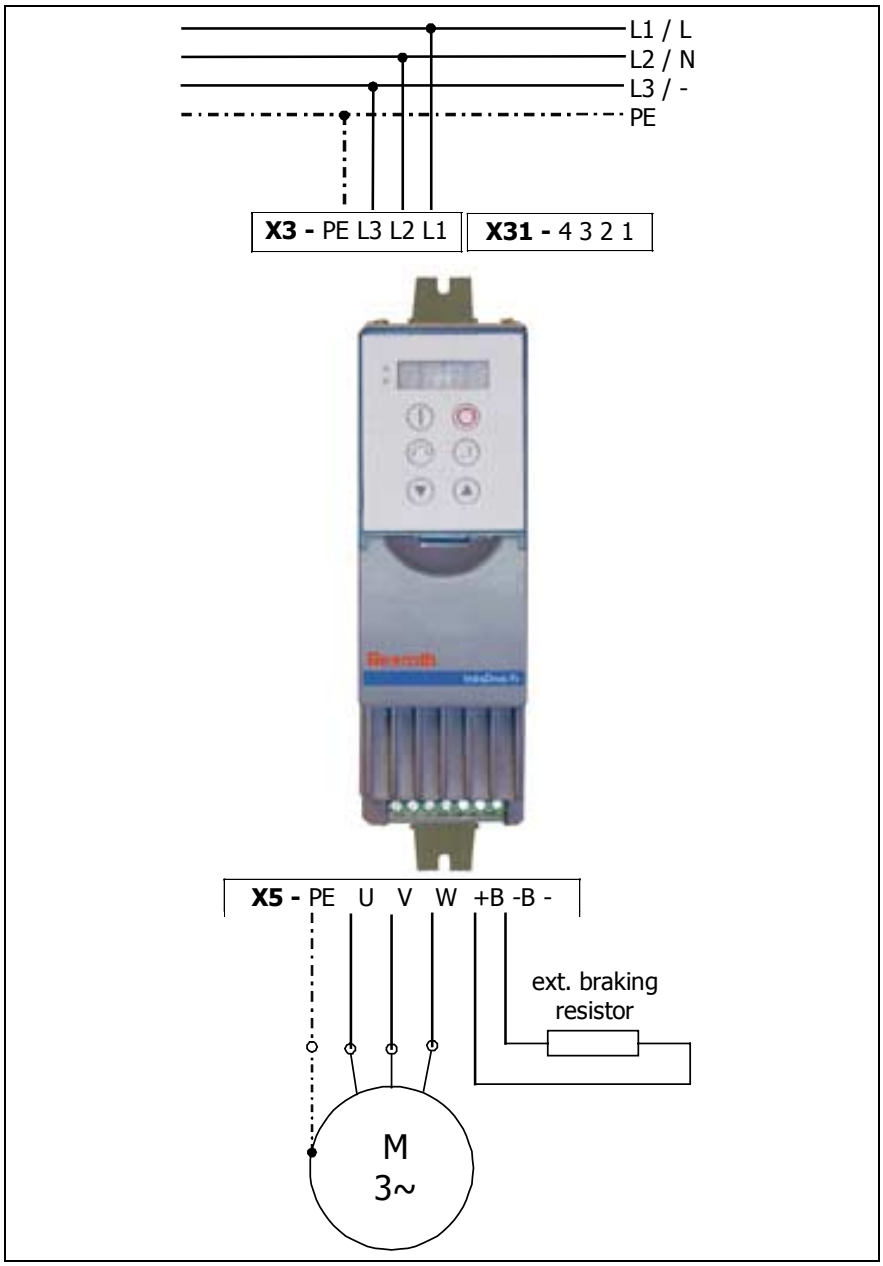


Fig. 8-12: Connection of electrical power

Note: When **connector sleeves** are used, the maximum connectable cable cross-section may be reduced.

Note: When **synchronous machines** or **several motors** are connected to a device in parallel, the frequency converter must be operated with linear voltage/ frequency characteristic P211 = 0 and P212 = 0.

X3, System Connection (PE, L1, L2/N, L3)

The frequency converter does not require any special securing at the power input side. We recommend to use the usual mains fuses (see Technical Data), and a main switch or contactor.

230V devices of up to 2.2kW may either be operated with 1-phase 230V (L/N = L1/L2) or with 3-phase 230V (L1/L2/L3).

All 400V devices and devices ≥ 3kW must only be supplied with 3-phase mains voltage (L1/L2/L3). Please refer to Chapter 13, Technical Data, for a detailed specification.

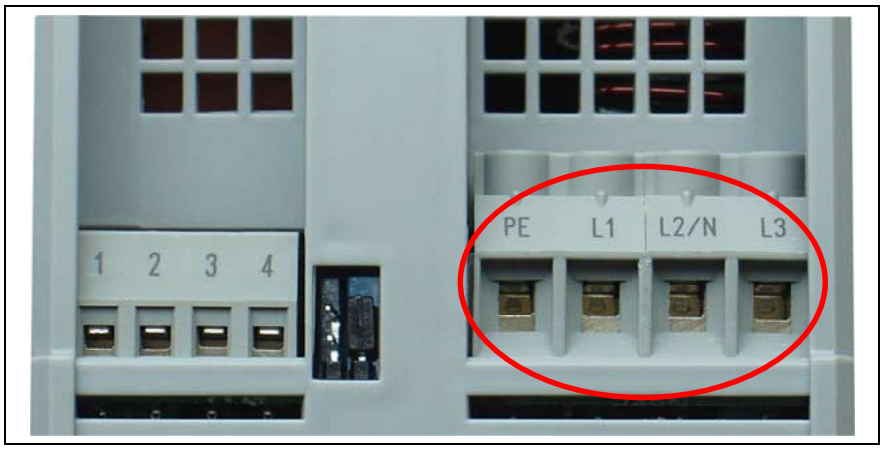


Fig. 8-13: System connection

Operation with earth-leakage circuit breakers

The frequency converter FCS01 are dimensioned for the operation with a 30mA a.c.-d.c. earth-leakage current breaker.

If **several** FCS01 frequency converters are operated at an earth-leakage circuit breaker, the leakage currents must be reduced against PE.

Operation IT Mains

Note: The FCS01 frequency converter can be used with **IT mains** after adjustment by means of jumpers.
Also refer to Chapter 8 Settings to Reduce the Leakage Currents.

X31, Relay 1 (1, 2), Relay 2 (3, 4)

Adjust the function of this relay according to your requirements with the parameters P434 through P443. They may be operated with max. 230V AC/24V DC, 2A.

In factory setting, the closed contact signals the frequency converter's readiness for operation at the terminals 3-4 (relay 2). When an error message is pending or when the frequency converter is de-energized, the contact is open.

The terminals 1-2 (relay 1) can control a mechanical motor brake in factory setting. Only in this way, it releases and is applied again at the right moment. To optimize the temporal sequence, set the respective delay (0.2 - 0.3 s) in parameter P107.

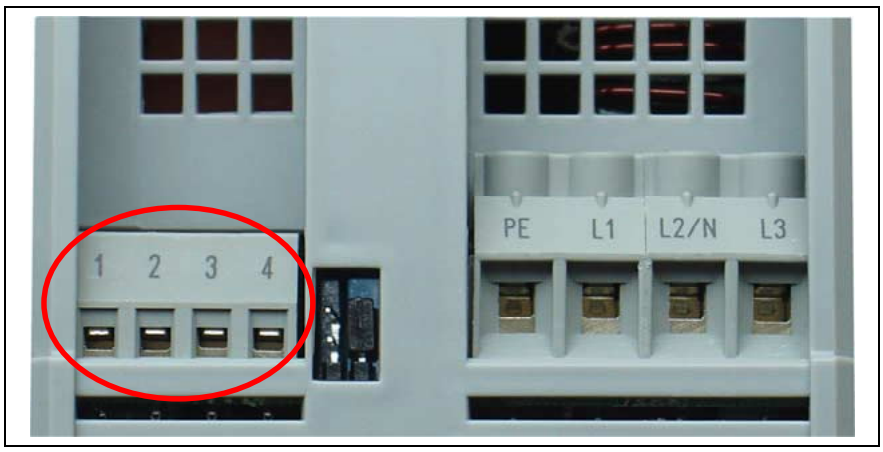


Fig. 8-14: Relay connection

X5, Connection of Motor Cable (PE, U, V, W)

The motor cable can have a **total length of 100 m** if it is a standard unshielded type. If you use a shielded cable run the cable in a well-grounded metallic cable duct, the **total length** should not exceed **30 m**.

With greater cable lengths , use an additional output throttle (accessory)..

Note: Please also take note of Chapter 13.4, Electromagnetic Compatibility (EMC).

Note: For operation with several motors, the total motor cable length is the sum of all individual cable lengths.

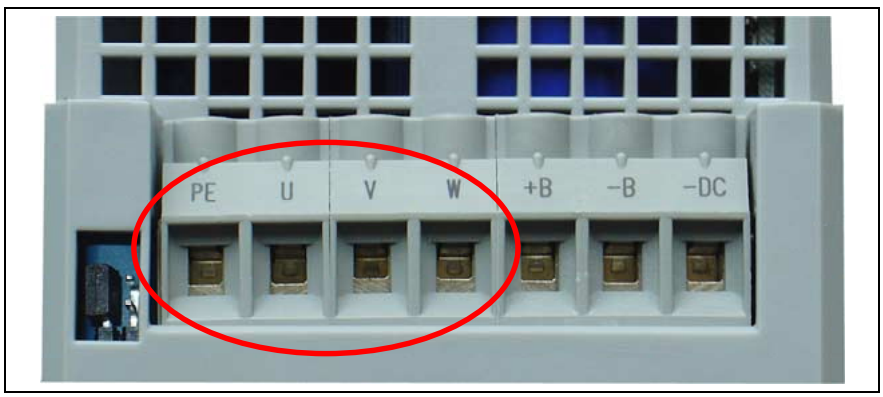


Fig. 8-15: Motor cable

X5, Connection of Braking Resistor (+B, -B)

The terminals +B/-B are provided for connection of a suitable braking resistor. For the connection, select a twisted and shielded link which is as short as possible (**maximum permissible length 2 x 5 m).**

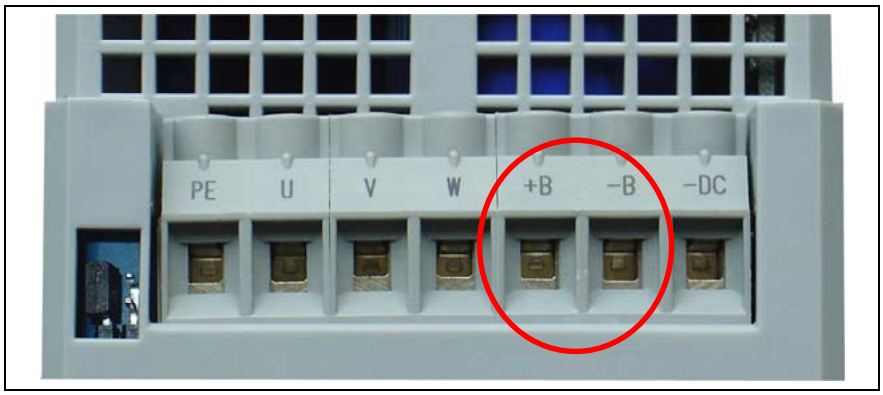


Fig. 8-16: Connection of braking resistor

Note: The braking resistor heats up during operation.

- Place the braking resistor at a sufficient distance from heat-sensitive components.
- Provide sufficient ventilation for the brake resistor.
- The application of the FLR01 is not UL/cUL-certified.

WARNING

Damage to the device due to incorrect connection!

⇒ Connect the braking resistor only between +B and -B. Make sure specifically to avoid short-circuit against ground.

X5, DC Coupling (+B, -DC)

DC coupling with FCS01 makes sense when drives in one system simultaneously work in a motor-driven and a regenerative manner. In this process, the energy from the regenerative drive is supplied back to the motor-driven drive. This is of advantage in view of energy consumption and utilization of braking resistors.

Note the following points:

- Keep the connecting line between +B and -DC as short as possible.
- Make sure that the coupling is not provided before readiness for operation is signaled. Otherwise, there is the risk that the DC bus capacitors of all frequency converters are charged by only one frequency converter.
- Make sure that the coupling is severed if one of the devices is no longer operative.
- With DC Coupling use a braking resistor (possibly of low capacity).
- It is possible to use frequency converters without a mains choke only if devices of identical capacity (identical type) are coupled and identical system impedances are active (identical cable length to mains bar). Otherwise, provide a mains choke in the power input line of each frequency converter.

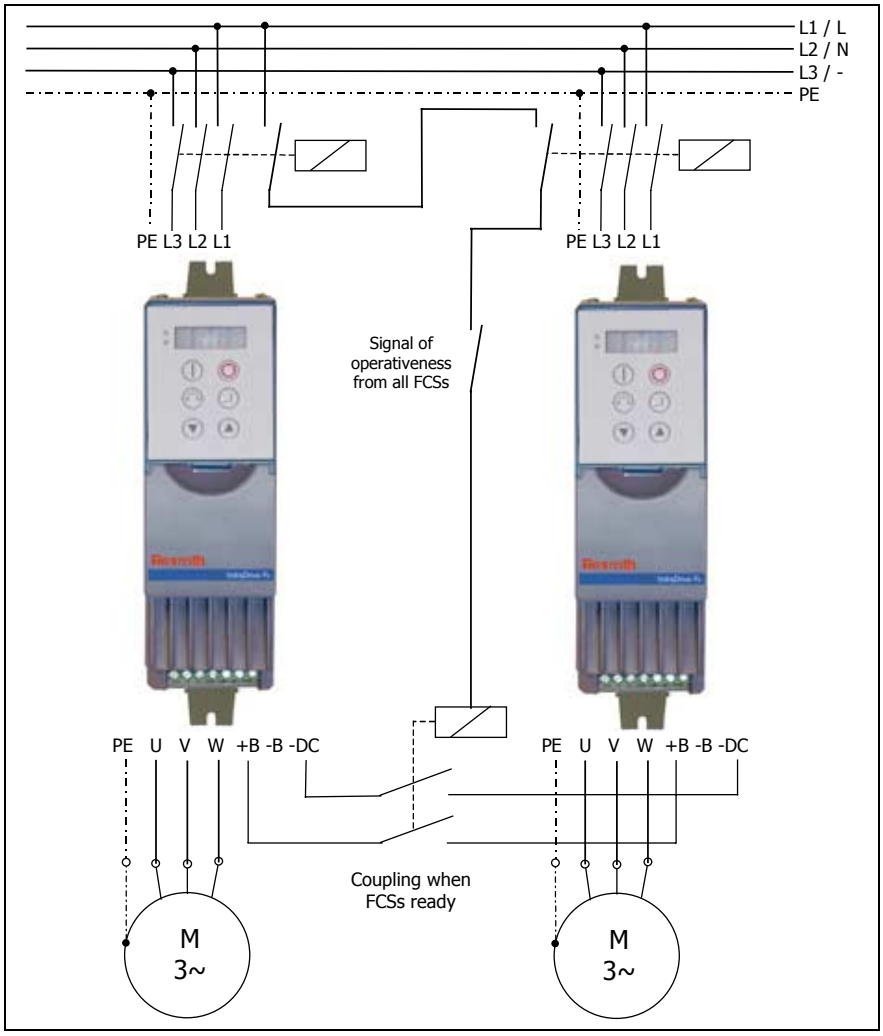


Fig. 8-17: DC coupling

Settings to Reduce the Leakage Currents

Via jumpers at the top and the bottom of the device, the FCS01 frequency converters can for example be adjusted for operation at IT mains and for reduction of leakage currents.

At the top of the device (mains input)

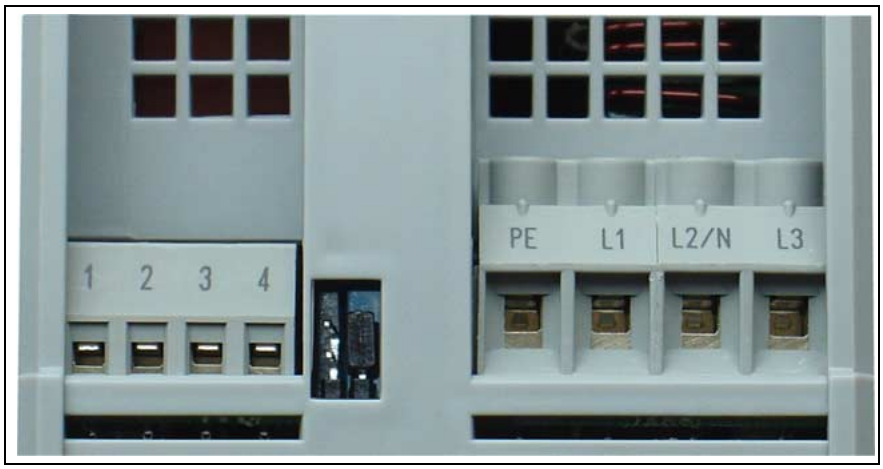


Fig. 8-18: Mains input jumper in position "2"

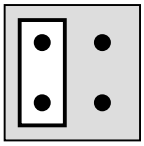
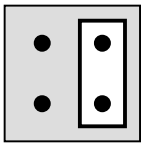
Position	Setting	Effect
	0	Operation at the IT mains
	1	No effect
	2	Standard position (factory setting)

Fig. 8-19: Jumper position top

At the bottom of the device (motor output)

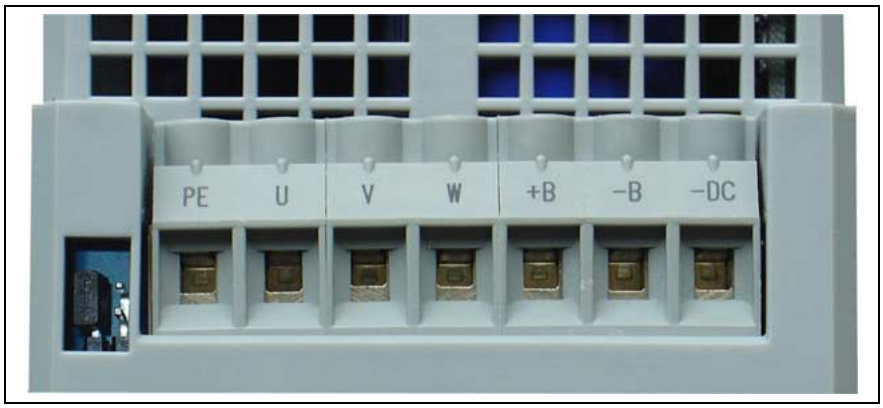


Fig. 8-20: Motor output jumper in position "1"

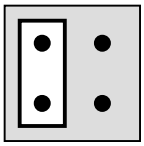
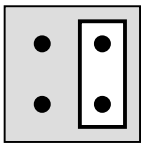
Position	Setting	Effect
	0	Operation at the IT mains
	1	Standard position (factory setting)
	2	Reduced leakage current; operation with earth-leakage circuit breakers

Fig. 8-21: Jumper position bottom

Operation	Setting of jumper at top of device	Setting of jumper at bottom of device	Explanation
IT mains	0	0	
Earth-leakage circuit breaker	0, 1 or 2	2	

Fig. 8-22: Settings

Note: Be aware that the specified degree of radio interference suppression may change with the different settings. For details, please refer to Chapter 13.4, Electromagnetic Compatibility (EMC).

Effect of the settings in the device

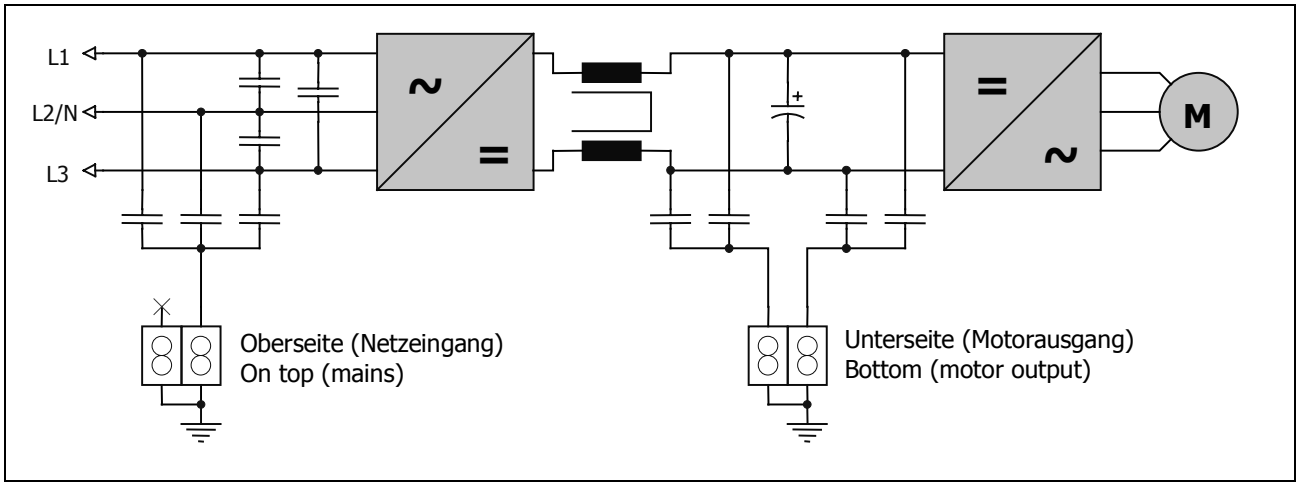


Fig. 8-23: Internal effect of the settings

8.5 Electrical Control Connectors

The control connectors are situated under the terminal cover of the frequency converter.

Terminals:

Plugging or clamping connectors, are opened with a small screwdriver.

Maximum connection cross-section:

1.0mm ^{2} (AWG 26-14)

Relay = 1.5mm ^{2} (AWG 26-16)

Control cables:

run and shield separately from mains/motor cables

Control voltages:

5V ± 20%, max. 250mA

(short-circuit proof) 10V, max. 5mA, reference voltage for an ext. potentiometer

15V ± 20%, max. 150mA, for supplying the dig. inputs

analog output 0…10V, max. 20mA, for an ext. indicator

Note: AGND and DGND are signal common for analog or digital inputs.
If applicable, 5V/15V can be picked off by several terminals. The sum of the picked-off currents must not exceed 250mA/150mA.

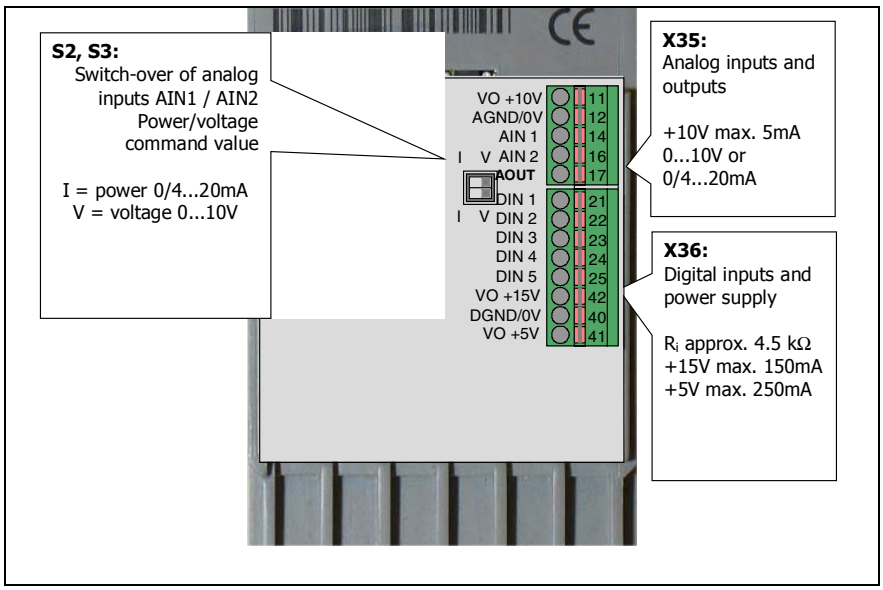


Fig. 8-24: Electrical control connection

Details of the Control Connections

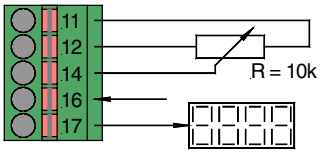
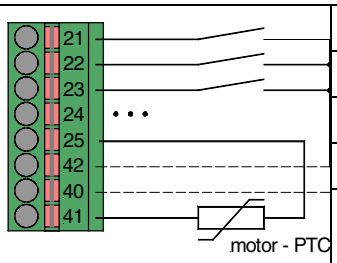
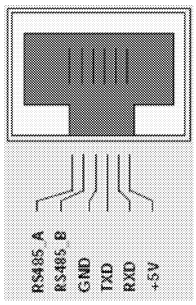
Terminal	Function	Data	Description / suggested wiring	Parameter
Terminal block X31 (at the top of the device)				
1 K1.1 2 K1.2	Relay 1	Make contact230V AC / 24V DC, 2A	Brake control	P434
3 K2.1 4 K2.2	Relay 2		Error / Operative	P441
Terminal block X35 (at the front of the device)				
11 VO +10V	10V reference voltage	10V, 5mA	The analog input controls the output frequency of the frequency converter	
12 AGND/0V	Signal common of the analog signals	0V analog		
14 AIN1	analog input 1	0...10V, R_i=10kΩ, 0/4...20mA, R_i=250Ω, selectable with DIP switch, signal common AGND; when using digital functions: 7,5...24V		P400
16 AIN2	analog input 2			P405
17 AOUT1	analog output	0...10V, 20mA, signal common AGND	Can be used for external indication or further processing in a secondary machine.	P418
Terminal block X36 (at the front of the device)				
21 DIG1	digital input 1	7.5...30V, R_i=6.1kΩ		P420
22 DIG2	digital input 2			P421
23 DIG3	digital input 3			P422
24 DIG4	digital input 4			P423
25 DIG5	digital input 5	2.5...30V, R_i=2.2kΩ, suitable for PTC thermistor evaluation with +5V supply		P424
42 VO +15V	15V- power supply	15V, ± 20%, 150mA		
40 DGND	Signal common of the digital signals	0V digital		
41 VO +5V	5V- power supply	5V, ± 20%, 250mA	Power supply for motor PTC	
Terminal block X2 (RJ12), RS485/RS232 at the top of the device				
1 RS485 A	Data cable RS485	Baud rate 9600...38400 Baud	 RJ12: Pin 1...6	P502...P513
2 RS485 B				
3 GND	Signal common of the bus signals	0V digital		
4 232 TXD	Data cable RS232	Baud rate		
5 232 RXD		9600...38400Baud		
6 +5V	5V- power supply	5V, ± 20%, 250mA		

Fig. 8-25: Control connections

9 Indications and Operation of the Function Modules

9.1 Indicator Elements at the FCS01 Basic Device

In factory setting, there are 2 LEDs (green/red) under the cover. They signal the current status of the device.

The **green LED** signals the application of mains voltage; during operation, it indicates the degree of overload at the frequency converter output by means of an increasingly fast flash code.

The **red LED** signals pending errors by flashing the number of times which corresponds to the numeric code of the error.

9.2 Modules FCC01

By combining various modules for indication, control and parameterization, the FCS01 frequency converter can easily be adjusted to a large variety of requirements.

Use alphanumerical indication and operation modules for easy commissioning. For more complex task, select one of several connection options to PC or automation systems.

As the **function module FCC01** is plugged on to the frequency converters externally, it is easily accessible.

Fig. 9-1: Modules

9.3 Overview over FCC01 Function Modules

Function modules	Description	Data
Standard control panel **FCC01.1T-STD-NNNN**	Used for commissioning, parameterization, configuration and control of the frequency converter.	4-digit, 7-segment LED display, keyboard
Comfort control panel **FCC01.1T-CMF-NNNN**	Used for commissioning, parameterization, configuration and control of the frequency converter.	4-line LCD display, background lighting, keyboard
Profibus module **FCC01.1F-PB1-NNNN**	This function module allows for control of the frequency converter through the serial Profibus DP Port.	Baud rate: 1.5 MBaud Connector: Sub-D9
Profibus module **FCC01.1F-PB2-NNNN**	This function module allows for control of the frequency converter through the serial Profibus DP Port.	Baud rate: 12 MBaud Connector: Sub-D9ext. 24V DC power supply, 2-pole terminal
CANopen module **FCC01.1F-CN1-NNNN**	This function module allows for control of the frequency converter through the serial CANbus port with the CANopen protocol	Baud rate: up to 1MBit/s Connector: Sub-D9
DeviceNet module **FCC01.1F-DN1-NNNN**	This function module allows for control of the frequency converter through the serial DeviceNet port with the CANopen protocol	Baud rate: 500 KBit/s 5-pole screw type terminals

Mounting

For **mounting** the FCC01 function module, follow the steps listed below:

- Switch the mains voltage off, observe the waiting period.
- Push the control terminal cover downwards or take it off.
- Remove the blind cover by unlocking it at the lower edge and twist it off in an upwards movement. Possibly, the fixing screw next to the bolt must be removed.
- Hook the FCC01 function module on at the upper edge and press lightly to snap it home. Check the connector bar for perfect contact and fix with the screw (included) if necessary.
- Re-close the control terminal cover.

Fig. 9-2: Sample for mounting the FCC01 function module

WARNING

⇒ The modules may only be inserted or removed when the system is de-energized. The slots can only be used for the intended modules. It is not possible to mount the FCC01 function modules **away from the frequency converters,** they must be plugged on to **X43** directly at the frequency converter.

Standard Control Panel FCC01.1T-STD-NNNN

This function module is used as an easy-to-operate parameterization, indication, and control tool of the FCS01 frequency converter.

Features

- 4-digit, 7-segment LED display
- Direct control of a frequency converter
- Indication of the active parameter record and operating value
- Storage of a complete converter data record (parameter record 1…4)

Fig. 9-3: Standard Control Panel FCC01.1T-STD-NNNN

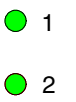
After the standard control panel has been plugged on and the mains voltage has been switched on, horizontal lines will be indicated in the 4-digit, 7-segment display. They signal that the frequency converter is operative. If a jog frequency value is preset in parameter P113, this value will appear in the display.

When release is given for the frequency converter, the display will change automatically to the operating value selected in parameter P001 >Selection of indicator value< (factory setting current frequency).

The parameter record used currently is indicated in binary code by the 2 LEDs to the left of the display.

Note: The factory setting for the digital frequency command value is 0Hz. To check whether the drive is working, enter a frequency command value via the ▲ key, or a jog frequency via the respective parameter P113, >Jog frequency<.
Settings may only be made by qualified personnel under strict observation of the safety instructions and warnings.
ATTENTION!: The drive will possibly start moving immediately after the START key I has been pressed!

Functions of the Standard Control Panel:

	Press this key to switch the frequency converter on. Now, it is released with the set jog frequency (P113), if applicable. A preset minimum frequency (P104), if applicable, will be supplied as a minimum. Parameter >Interface< P509 and P510 must be = 0.
	Press this key to switch the frequency converter off. The output frequency is reduced to the absolute minimum frequency (P505). Below the frequency, the frequency converter will switch off on the output side.
7-segment LED display	Indicates the currently set operating value (selected in P001) or the error codes during operation. During parameterization, the parameter numbers or the parameter value are indicated.
LEDs 	In the status indication (P000), the LEDs signal the current operation parameter record. During parameterization, they indicate the parameter record currently parameterized. This is indicated in binary code. 
	Press this key to change the motor's sense of rotation. "Sense of rotation left" is indicated by a minus sign. Parameter mode: If you do not wish to save a changed value, press the  key to leave the parameter without saving the change. **Caution!** Be careful with pumps, screw conveyors, fans etc. Lock the key by means of parameter P540.
	Press this key to increase the frequency. During parameterization, the parameter number or value is increased.
	Press this key to reduce the frequency. During parameterization, the parameter number or value is reduced.
	Press the "ENTER" key to save a changed parameter value or to go from parameter number to parameter value and back.

Selection of parameter records:

Select the parameter record by means of parameter P100, or via the digital inputs during operation.

Menu structure with standard control panel

All parameters are sequentially arranged in the individual menu groups in a ring structure. This means that forwards and backwards leafing is possible in this area.

Each parameter has a parameter no. **P x x x**. See Chapter 11, Parameterization, for meaning and description of the parameters.

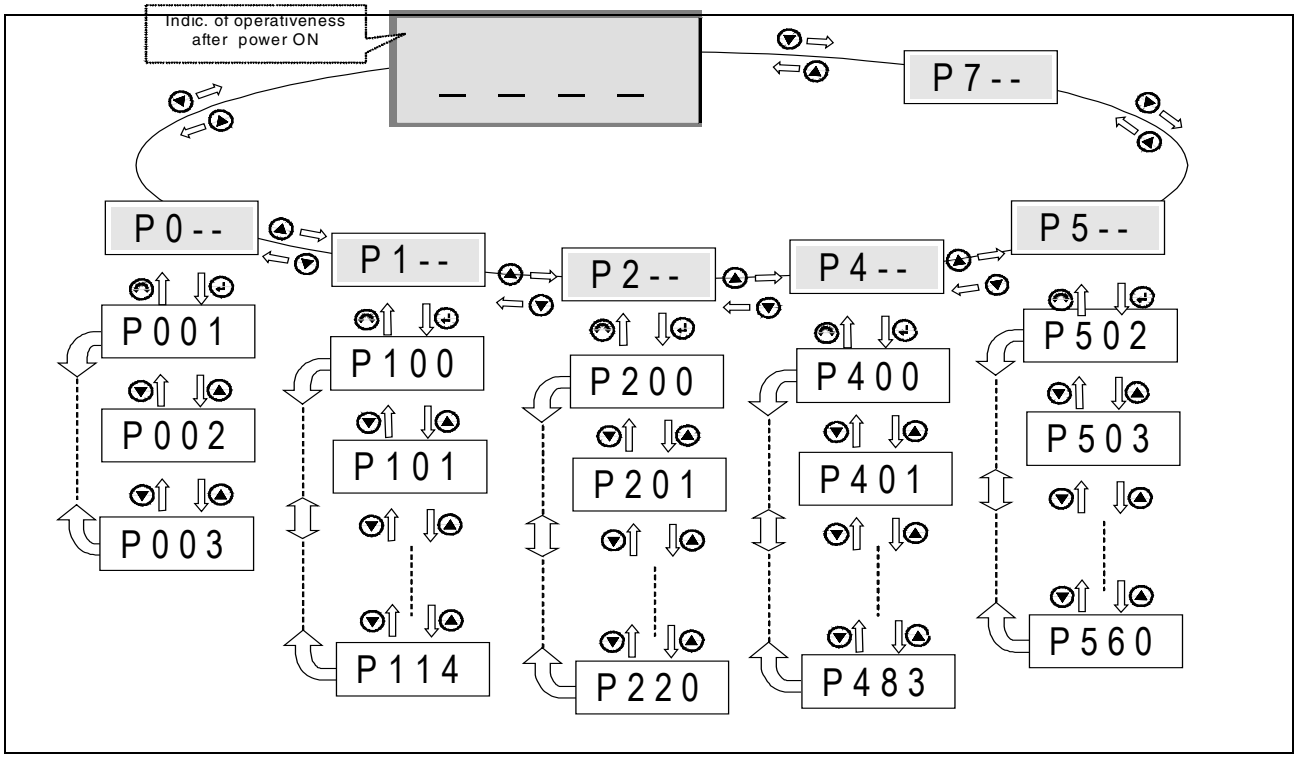


Fig. 9-4: Menu structure

Parameterization with standard control panel

The **parameterization** of the frequency converter can be performed in various operating states. Generally, all parameters can be changed online. Depending on operating state and release source, there are different ways to change to parameter mode.

- When the frequency converter has been released via the standard control panel (START key), go to parameterization mode by simultaneously pressing the START and ENTER keys + .
- Change back into control mode by pressing the START key .
- When no release has been given, or release has been given through the control terminals or a serial interface, change into parameterization mode directly from the operating value indication by pressing the or keys. P0_ _ / P7_ _
- To quit parameterization mode, press the key.
- To **change a parameter value**, press the ENTER key when the respective parameter number is indicated.Effect changes via the or VALUE keys. Press to save and quit the parameter.
  As long as a changed value has not been confirmed with "ENTER", the value indication will flash; this means that the value has not yet been saved in the converter.
  During parameter setting, the indicated values do not flash for better legibility.
  If you do not wish to confirm a change, press the "DIRECTION" key to quit the parameter.

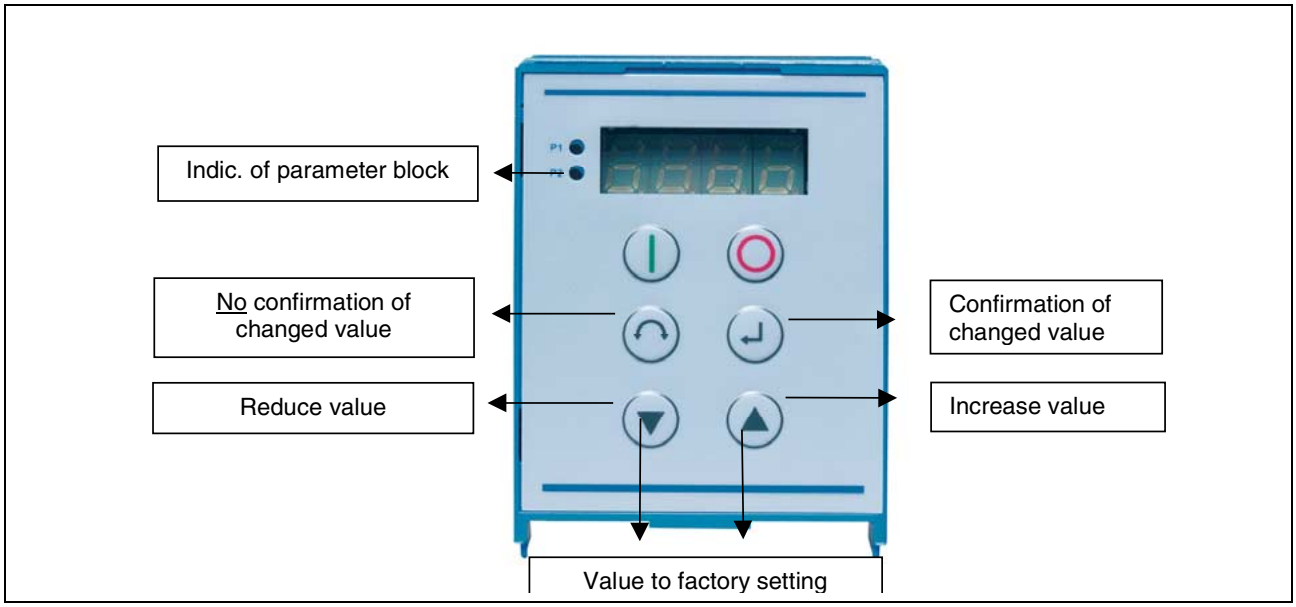


Fig. 9-5: Control panels of the standard control panel

Controlling with the standard control panel

The frequency converter can only be controlled via the standard control panel if it has not been previously released through the control terminals or a serial interface (P509 = 0 and P510 = 0).

Press the "START" key to change the frequency converter to status indication (selection P001). It supplies 0 Hz, or a higher, preset minimal frequency (P104) or jog frequency (P113).

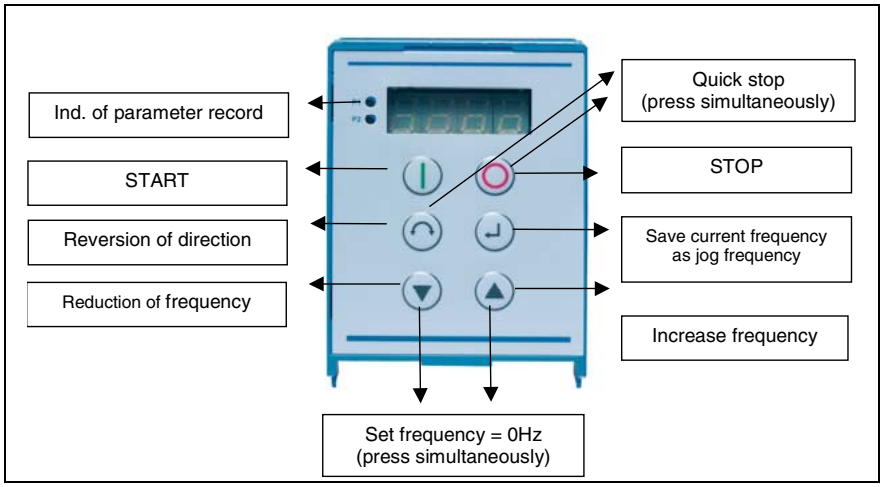


Fig. 9-6: Controlling the frequency converter with the standard control panel

Frequency command value:

The current frequency command value is based on the setting of jog frequency (P113) and minimum frequency (P104) parameters. During operation via keyboard, this value can be changed with the value keys and . Press the ENTER key to permanently save the value in P113 as jog frequency.

Quick stop:

Activate quick stop by simultaneously pressing the STOP key and the "direction reversal" key .

Comfort Control Panel FCC01.1T-CMF-NNNN

This function module is used to comfortably parameterize and control the frequency converter and to indicate current operating values and statuses.

Up to 5 data records (consisting of parameter record 1…4) can be administered and saved in this device. This helps to implement efficient commissioning of serial applications.

Fig. 9-7: Comfort control panel FCC01.1T-CMF-NNNN

Features of the Comfort Control Panel

- Illuminated, high-resolution LCD graphic screen
- Large indication of individual operating parameters
- Display text in 6 languages
- Help texts for trouble shooting.
- 5 complete frequency converter data records can be stored, loaded and edited in the memory.
- Can be used to indicate various operating parameters
- Scaling of individual operating parameters to indicate special system data
- Direct control of a frequency converter

Initial Commissioning

When the frequency converter is switched on for the first time with the plugged-on comfort control panel, the menu language (German, English) is queried. Then, the comfort control panel automatically does a "bus scan" to identify the connected frequency converter. When the frequency converter has been identified, its type, current operating state and current status is indicated.

After release of the frequency converter, the display changes to the three standard operating values (frequency, voltage, power). The indicated current operating values can be selected from a list.

Note: The factory setting for the digital frequency command value is 0Hz. To check whether the drive is working, enter a frequency command value via the ▲ key, or a jog frequency (P113).
Settings may only be made by qualified personnel under strict observation of the safety instructions and warnings.
ATTENTION!: The drive will possibly start moving immediately after the START key I has been pressed!

Functions of the Comfort Control Panel

LCD display	**Background-illuminated LCD display, suitable for graphics, for indication of operating values and parameters of the connected frequency converter and the parameters of the comfort control panel.**	
 	Use the **SELECTION keys** to leaf through the menu levels or the individual menu points. Press the selection keys to quit a parameter without saving a changed value. Press the ◀ and ▶ keys simultaneously to go back to the next higher level.	
 	Use the **VALUE keys** to change the contents of individual parameters. Simultaneously press the ▲ ▼ keys to load the factory value of the selected parameter. When controlling the frequency converter via the keyboard, use the VALUE keys to set the frequency command value.	
	Press the **ENTER key** to change into the selected menu group, or to confirm the changed menu points or parameter values. If the frequency converter is currently controlled via the keyboard (and not the control terminals), the current command frequency can be saved to jog frequency parameter P113 by pressing the ENTER key.	
	**START key** for switching on the frequency converter.	**NOTE:** Only available if this function has been released in parameter P509 or P540.
	**STOP key** for switching off the frequency converter.	
	Press the **DIRECTION key** to change the motor's direction of rotation. "Sense of rotation left" is indicated by a minus sign. **Caution!** Be careful with pumps, screw conveyors, fans etc.	
	The LEDs signal the current status of the comfort control panel. **ON**: The comfort control panel is operative. **ERROR**: An error has occurred in editing the data or in the connected frequency converter.	

LCD Display

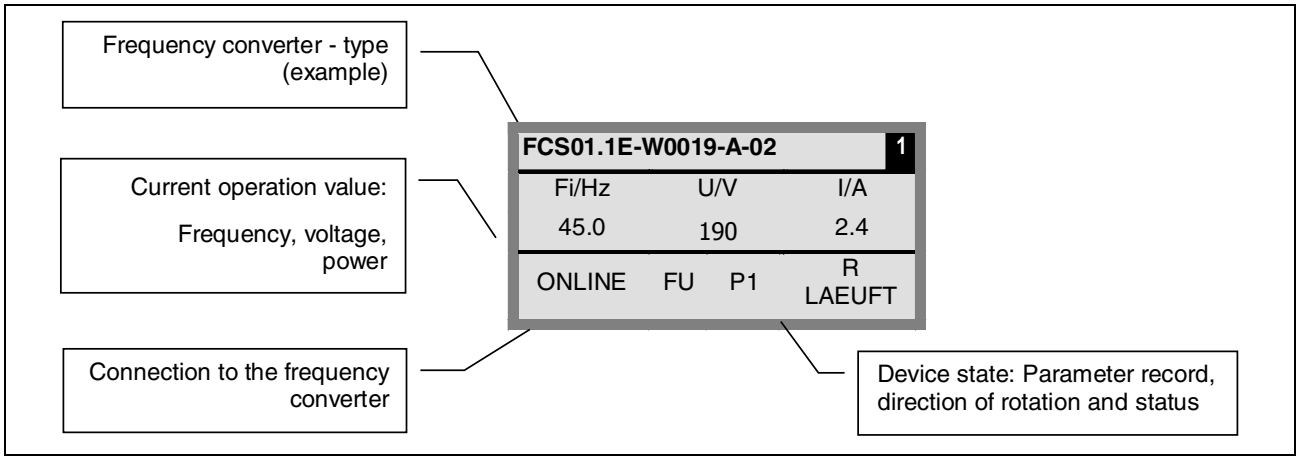


Fig. 9-8: LCD display

Menu Structure

The menu structure comprises various levels, each designed in a ring structure. Press the ENTER key to go to the next level. Go back by simultaneously pressing the SELECTION keys.

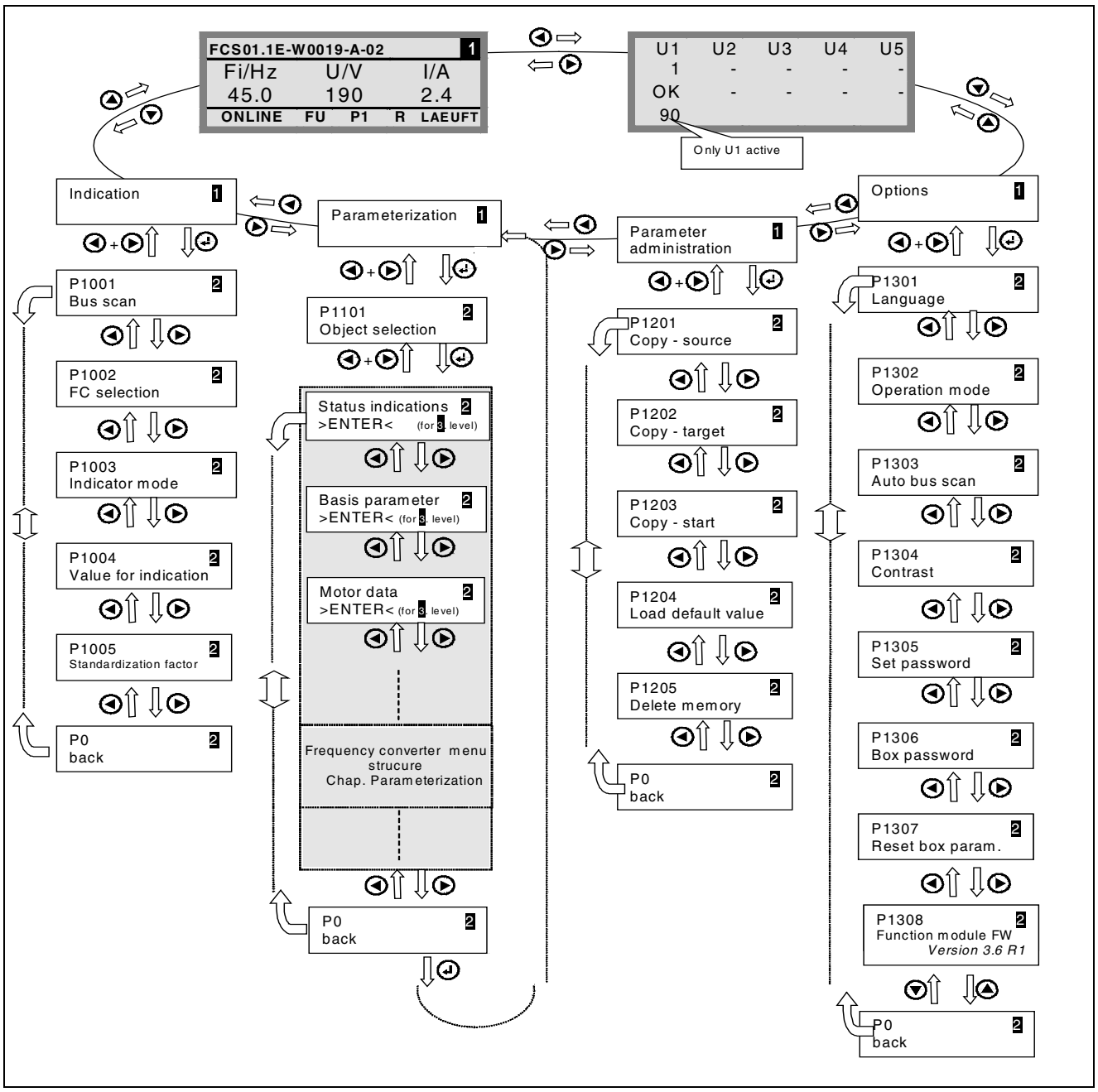


Fig. 9-9: Menu Structure

The menu points >Indication< (P11xx), >Parameter administration< (P12xx) and >Options (P13xx) are only parameters for the comfort control panel. Via the >Parameterization< menu, go to the frequency converter menu structure.

Also refer to Chapter 11, Parameterization.

Language Selection, Brief Description

To change the menu language in the display of the comfort control panel, proceed as follows:

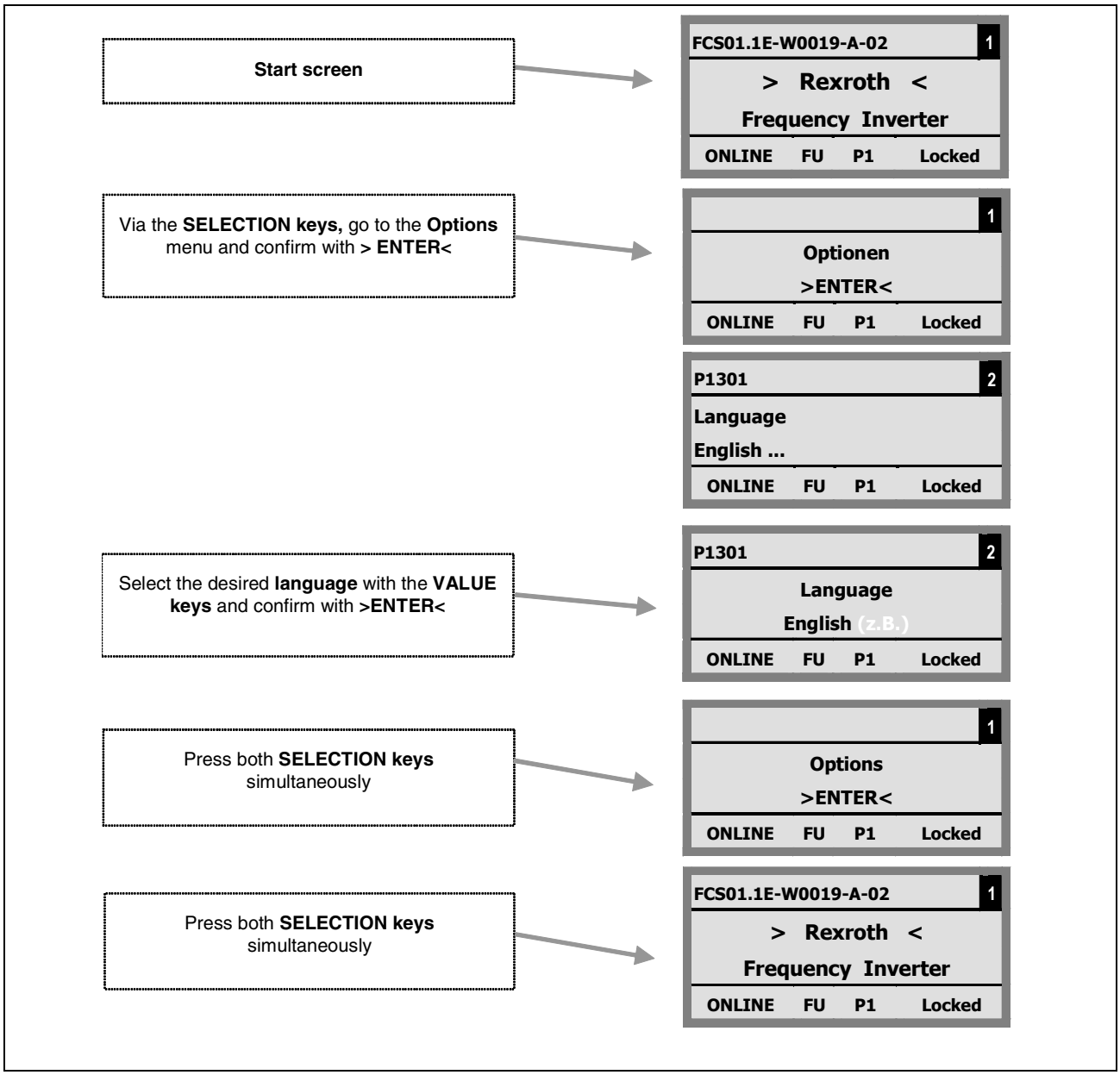


Fig. 9-10: Language selection

Parameterization with the Comfort Control Panel

To get into parameterization mode, select the menu point >Parameterization< in level 1 of the comfort control panel. Press the ENTER key to go to the parameter level of the connected frequency converter.

The following illustrations explains how the operating elements of the comfort control panel are used for parameterization.

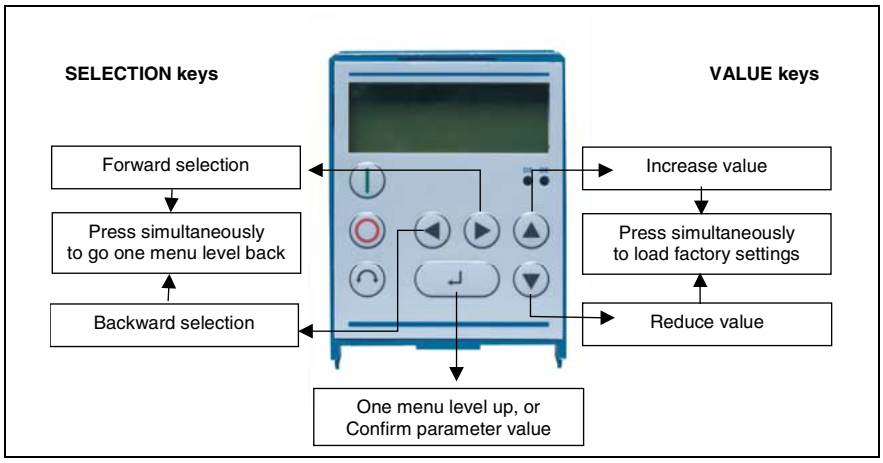


Fig. 9-11: Controlling the frequency converter with the comfort control panel

Screen Layout During Parameterization

If the setting of a parameter is changed, the value will flash until confirmed via the ENTER key. To get the factory settings of the parameter to be edited, press both VALUE keys simultaneously. To change the setting, confirm with the ENTER key.

If you do not wish to confirm the change, press a SELECTION key to call up the value last saved, and press a SELECTION key again to quit the parameter.

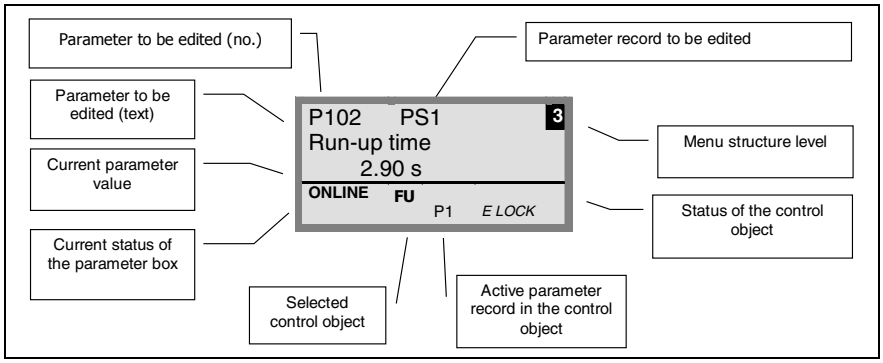


Fig. 9-12: Screen layout during parameterization

Note: The bottom line in the display is used to indicate the current status of the comfort control panel and the frequency converter to be controlled.

Controlling the Frequency Converter with the Comfort Control Panel

The frequency converter can only be fully controlled via the comfort control panel if the >Interface< parameter (P509) is set to the >Keyboard< function (0 = factory setting) and the frequency converter has not been released via the control terminals.

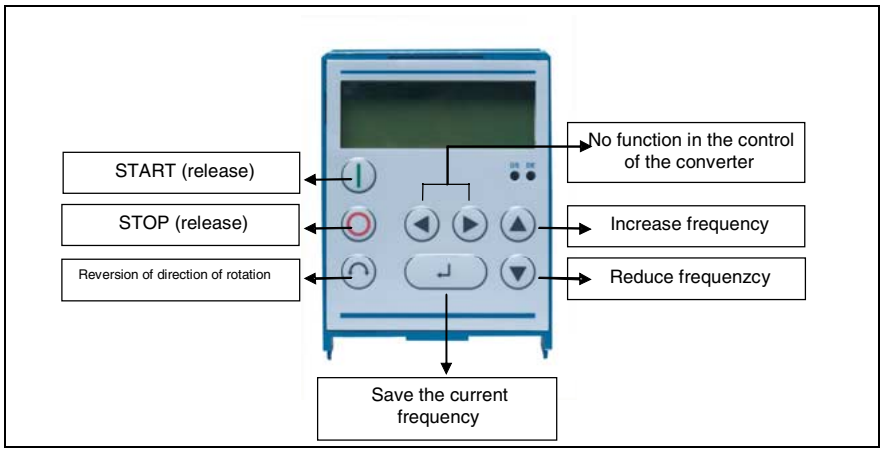


Fig. 9-13: Controlling the frequency converter with the comfort control panel

Note: If the frequency converter is released in this mode, the parameter record selected in parameter P100 is used. To switch to another parameter record during operation, select the new parameter record in P100 and confirm with ENTER.

After removal of release and re-start via the ⏻ key, the frequency converter will run in the parameter record selected last.

Note: After the START command, the frequency converter can immediately start with a previously programmed frequency.

Parameters of the Comfort Control Panel

The following main functions are assigned to the menu groups:

Menu group	No.	Main function
Indication	(P10xx):	Selection of the operating values and the display structure
Parameterization	(P11xx):	Programming of the connected frequency converter and all memory objects
Parameter administration	(P12xx):	Copying and saving of whole parameter records from memory objects
Options	(P13xx):	Setting the functions of the comfort control panel, as well as of all automatic processes

Fig. 9-14: Main functions

Menu Group 'Indication'

Parameter	*Setting value / description / note*
P1001 Bus scan	This parameter starts a bus scan. During the process, a progress bar is shown in the display. After a bus scan, the parameter is on "Off". Depending on the result of this process, the comfort control panel will go to "ONLINE" or "OFFLINE" operating mode.
P1002 FC selection	Selection of the current object for parameterizing/controlling. The subsequent indication and operating measures relate to the selected object. In the frequency converter selection list, only the devices identified during the bus scan are available. The current object is indicated in the status line. Value range: FC, S1 … S5
P1003 Indicator mode	Selection of the operating value indication of the comfort control panel Standard: any 3 values next to each other List: any 3 values with unit, one below the other Large indication: any 1 value with unit
P1004 Value for indication	Selection of an indication value for the actual value indication of the comfort control panel. The selected value is set to the first position of an internal list of indication values. Potential actual values for indication: Actual frequency, Voltage, Current, Speed, Torque current, Command frequency, DC bus voltage, Actual bus value 1
P1005 Standardization factor	The first value of the indication list is multiplied by the standardization factor. If this standardization factor is unequal "1", the unit is hidden in the indication. Value range: -327.67 to +327.67; resolution 0.01

Menu Group 'Parameterization'

Parameter	*Setting value / description / note*
P1101 Object selection	Selection of the object to be parameterized. The subsequent parameterization relates to the selected object. In the displayed selection list, only the devices (frequency converters) identified during the bus scan and the memory objects (S1…S5) are available. **Note:** If only one frequency converter is connected and no memory capacity is taken, this parameter will not appear! Value range: FC, S1 … S5

Menu Group 'Parameter Administration'

Parameter	*Setting value / description / note*
P1201 Copying - source	Selection of the current source object for copying. In the selection list, only the frequency converters identified during the bus scan and the memory objects are available. Value range: FC, S1 … S5
P1202 Copying - target	Selection of the current target object for copying. In the selection list, only the frequency converters identified during the bus scan and the memory objects are available. Value range: FC, S1 … S5
P1203 Copying - start	This parameter starts the copying process selected previously. When data is overwritten, a window will appear requiring confirmation. Data transfer is started after confirmation.
P1204 Loading default values	This parameter writes the factory values to the parameters of the selected object. Value range: FC, S1 … S5
P1205 Deleting the memory	This parameter deletes the data of the selected memory object. Value range: S1 ... S5

Menu Group 'Options'

Parameter	*Setting value / description / note*
P1301 Language	Selection of the language for operation Available languages: German, English, Dutch, French, Spanish, Swedish
P1302 Operating mode	Selection of the operating mode Offline: The comfort control panel is operated independently. The data record of the frequency converter is not accessed. The memory objects of the comfort control panel may be parameterized and organized. Online: There is a frequency at the interface of the comfort control panel. The frequency converter can be parameterized and controlled. When the operating mode is changed to "ONLINE", a bus scan will start automatically.
P1303 Auto bus scan	Defining the activation behavior. Off: No bus scan is performed; the frequency converters connected before deactivation are search when the device is switched on once more. On: A bus scan is performed automatically when the comfort control panel is switched on.
P1304 Contrast	Display contrast setting Value range: 0% ... 100%; resolution 1%
P1305 Setting the password	The user can set a password in this parameter. After setting of a password, parameters cannot be modified.
P1306 Password control panel	If parameters are to be modified while a password is active, the password set in parameter P1305 must be input.
P1307 Reset of control panel parameter	This parameter resets the comfort control panel to factory settings. All settings and the data in the memory objects are deleted.
P1308 Software version	Indicates the software version of the comfort control panel. Please have ready if required.

Error Messages Comfort Control Panel

Indication Failure	Cause • Remedy
Error in the communication system	
200 INVALID PARAMETER NUMBER	These error messages are based on EMC malfunctions or different software versions of the nodes. • Check the software version of the comfort control panel and that of the connected frequency converter. • Check the wiring of all components for EMC faults.
201 PARAMETER VALUE CANNOT BE CHANGED	
202 PARAMETER OUTSIDE OF VALUE RANGE	
203 INCORRECT SUB-INDEX	
204 NO ARRAY PARAMETER	
205 INCORRECT PARAMETER TYPE	
206 INCORRECT REPLAY ID USS INTERFACE	
207 CHECKSUMS ERROR OF THEUSS INTERFACE	The communication between the frequency converter and the comfort control panel is faulty (EMC). Safe operation cannot be guaranteed. • Check the comfort control panel for correct connection to the FC.
208 INCORRECT STATUS ID USS INTERFACE	The communication between the frequency converter and the comfort control panel is faulty (EMC). Safe operation cannot be guaranteed. • Check the comfort control panel for correct connection to the FC.
209_1 CONVERTER DOES NOT REPLY	The comfort control panel is waiting for the connected frequency converter to reply. The waiting period has passed without receipt of a reply. • Check the comfort control panel for correct connection to the FC.

Indication Failure	Cause • Remedy
Identification errors	
220 UNKNOWN DEVICE	The device ID has not been found. The connected frequency converter is not listed in the database of the comfort control panel; communication cannot be started. • Please contact your sales partner.
221 SOFTWARE VERSION UNKNOWN	The software version of the connected frequency converter is not listed in the database of the comfort control panel; communication cannot be started. • Please contact your sales partner.
222 RESERVED	
223 BUS CONFIGURATION HAS CHANGED	When the last bus configuration is restored, another device answers than the saved device. This error can only occur when the parameter >Auto bus scan< is set to OFF, and another device has been connected to the comfort control panel. • Activate the 'auto bus scan' function.
224 DEVICE IS NOT SUPPORTED	The frequency converter type connected to the comfort control panel is not supported.
225 CONNECTION TO THE CONVERTER IS BLOCKED	Access to a device which is not online (previous timeout error). • Do a bus scan by means of parameter P1001.
incorrect operation of the comfort control panel	
226 TARGET AND SOURCE ARE DIFFERENT DEVICES	Copying of parameter records of different FC types is generally not possible.
227 SOURCE IS EMPTY	Copying of data from a deleted (empty) memory object is not possible.
228 THIS COMBINATION IS NOT PERMITTED	Target and source of the copy function are identical The command cannot be executed.
229 THE SELECTED OBJECT IS EMPTY	An empty memory object cannot be loaded into the FC.
230 DIFFERENT SOFTWARE VERSIONS	When memory objects with different software versions are copied, problems may occur when the parameters are transmitted.
231 INVALID PASSWORD	An attempt was made to change a parameter without a valid control panel password (P1306).

Indication Failure	Cause • Remedy
232 BUS SCAN ONLY WITH ONLINE OPERATION	A bus scan (searching for a connected frequency converter) is only possible in "ONLINE" operation.
Warnings	
240 DATA OVERWRITE? YES	These warnings inform about a significant change which requires additional confirmation. • The warning must be confirmed with "ENTER".
241 DELETE DATA? YES	
242 SHIFT SW VERSION? NEXT	
243 SHIFT SERIES? NEXT	
244 DELETE ALL DATA? YES	
Error during converter control	
250 THIS FUNCTION IS NOT RELEASED	The FC is not released for control via keyboard. • Check the inputs in P509 and P510.
251 CONTROL COMMAND WAS UNSUCCESSFUL	The FC could not implement the control command as a superior function has been applied at the control terminals of the FC, as e.g. quick stop or an OFF signal.
252 NO CONTROL POSSIBLE IN OFFLINE MODE	A control function has been called up in offline mode. • Change the operating mode of the comfort control panel to 'online' in P1302 and repeat the action.
253 ERROR CONFIRMATION UNSUCCESSFUL	Failed error confirmation of an error at the frequency converter; the error message is still pending.

9.4 Master Communication Module

Note: Please see Chapter 15-1, Master Communication - Field Busses and Protocols for a detailed description of the bus protocols and their parameterization.

9.5 Profibus Module FCC01.1F-PB1-NNNN / -PB2-NNNN

Profibus enables a great variety of automation devices to exchange data. Accordingly, PLC, PC, operating and monitoring units can communicate with each other in bit-serial fashion through one bus.

The data exchange is specified in DIN 19245, part 1 and 2, and the application-specific supplements in part 3. In the frame of the European standardization of field busses, the Profibus will be integrated into the European field bus standard pr EN 50170.

FCC01.1F-PB1-NNNN

Fig. 9-15: FCC01.1F-PB1-NNNN

FCC01.1F-PB2-NNNN

Power is supplied to this function module via an external 24V connector. Thus, the Profibus node is recognized by the master system even when no power is supplied to the frequency converter. The necessary data is input by means of a rotary encoding switch. The data is confirmed as soon as 24V is applied.

Fig. 9-16: FCC01.1F-PB2-NNNN

Status LEDs	BR (green)	BUS ready; communication w/o problems	
	BE (red)	BUS error, operational fault	

Connection of the supply voltage

Supply voltage is 24V DC ±25%. The 24V connection is effected by means of insulation piercing connecting device. The maximum line cross section is 0.75 sqmm. With flexible lines, use the supplied connector sleeves. (cross section 0.75 sqmm, length 12 mm)

Assignment of the 9-pole D-SUB socket

The assignment of the 9-pole D-SUB socket is identical in the function modules FCC01.1F-PB1 and -PB2.

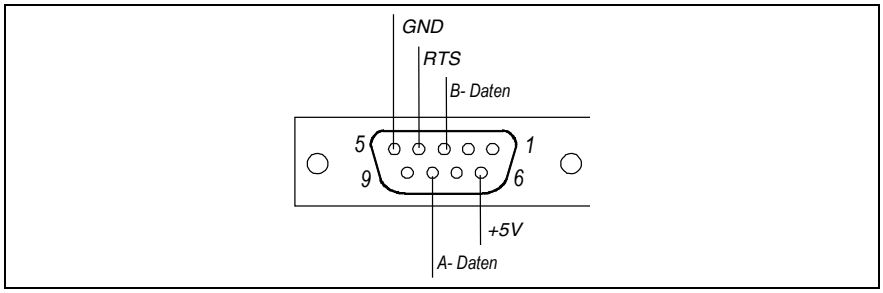


Fig. 9-17: Pin assignment FCC01.1F-PB1 und –PB2

Terminating resistor

The terminating resistor for the last bus node is in the Profibus standard connector; there, it can be activated by means of the switch if required.

Setting of the PPO type

Select the 4 PPO types by means of the rotating encoding switch for the **PPO** type. If set to **PGM**, the value from parameter P507 of the frequency converter is used. Power supply to the frequency converter must be activate.

Setting the Profibus address

Select the Profibus address hexadecimal from 0 to 7F by means of the rotating encoding switches **"x10"** and **"x1"**. Decimally, this equals 0 to 127. If set to **PGM**, the value from parameter P508 of the frequency converter is used. Power supply to the frequency converter must be activate. Setting "+100" (on PPO rotating encoding switches) increases selected address (X10, X1)by "+100".

e.g. Profibus address = 30_{dec} = $1E_{hex}$ -> x10=1, x1=E

e.g. Profibus address = 130_{dec} = $1E_{hex}$ -> x10=1, x1=E; PP0=+100

Note: The settings via the rotating encoding switch are not transmitted into the frequency converter.

Transmission speeds

The use of line type A results in the following lengths of a bus segment:

Transmission speed [kBit / s]	Max. allowed line length [m]
9,6	1200
19,2	1200
45,45	1200
93,75	1200
187,5	1000
500	400
1500	200
3000	100
6000	100
12000	100

Fig. 9-18: Transmission speed

Note: Only when the specified line parameters are observed, the guaranteed transmission speeds or transmission distances can be maintained without any problems.

Bus cable requirements

Cable design	
Cable specification	Line type A acc. To EN 50 170
Cable design	Twisted two-wire line, single-shielded as a minimum (also see specification for RS 485)
Recommended cable type	Surge impedance: 135 ... 165 Ω Capacitance per unit length < 30 pF / m Loop resistance 110 Ω / km Strand diameter 0.64 mm Strand cross-section > 0.34sqmm
Shielding	minimum requirement single-shield; placed on both sides;
Wiring arrangement, distances, shielding	Inside and outside of control cabinets at least 20 cm distance to other lines with voltages > 60V;

Fig. 9-19: Bus cable requirements

Note: The line shield must be connected to the ***functional grounding*** (usually the electrically conducting mounting plate) to avoid EMC damage to the device.

In the FCC01.1F-PBx function module, connect the line shield over a large area with the metal housing of the D-SUB connector and the *functional grounding* in the Profibus connector.

CANopen Module FCC01.1F-CN1-NNNN

The CANopen interface at the FCS01 allows for parameterization and control of the devices in accordance with the CANopen specification.

Up to 127 nodes can be addressed at one bus. An integrated terminating resistor can be applied.

The transmission rate (10kBaud and 500kBaud) and the bus address can be set with the rotating encoding switches or the corresponding parameters.

Fig. 9-20: CANopen module FCC01.1F-CN1-NNNN

CANopen status LEDs	CR (green)	CANopen RUN LED
	CE (red)	CANopen ERROR LED
Modules status LEDs	DR (green)	Module state
	DE (red)	Module error

Setting the ID

Set the node identifiers by means of the rotating switches ID-L and ID-H (1…127).

Example: Node ID = 100 Dec= 64 Hex → ID-H=6, ID-L=4

If ID-H is set to a value greater 7, the value from parameter 515 of the frequency converter is used as a node identifier.

Setting the Baud Rate

Set the Baud rate by means of the rotating switch BAUD (10kBit/s…1Mbit/s). If a value is set in the PGM range, the value from parameter 514 of the frequency converter is used as a Baud rate.

Assignment of the 9-pole D-SUB socket

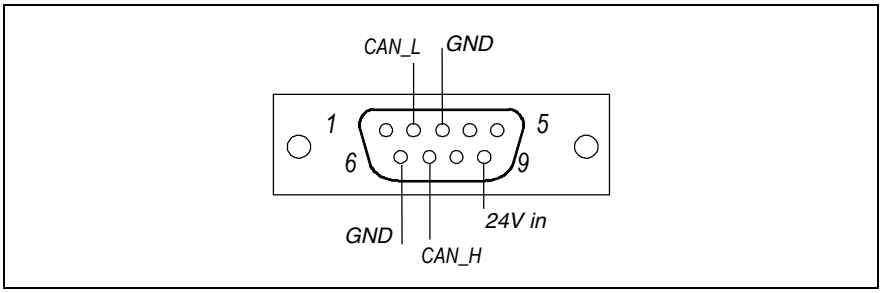


Fig. 9-21: Pin assignment FCC01.1F-CN1

Terminating resistor

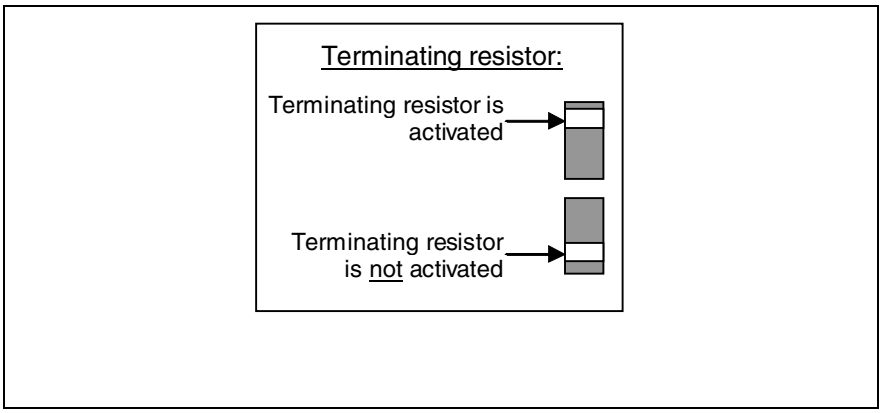


Fig. 9-22: Terminating resistor

Transmission speed

The use of line type A results in the following lengths of a bus segment:

Transmission speed[kBit / s]	Line length[m]	Line resistance[mΩ / m]	Line cross section[sqmm] (AWG)
1000	< 40	70	0.25 ...0.34 / 23, 22
500	40 .. 300	< 60	0.34...0.6 / 22, 20
100	300 .. 600	< 40	0.5...0.6 / 20
50	600 .. 1000	< 26	0.75...0.8 / 18

Fig. 9-23: Transmission speed

Note: Only when the specified line parameters are observed, the guaranteed transmission speeds or transmission distances can be maintained without any problems.

Bus cable requirements

Cable design	
Cable specification	Line type A acc. To EN 50 170
Cable design	Twisted two-wire line, single-shielded as a minimum (also see specification for RS 485)
Recommended cable type	Surge impedance: 135 ... 165 Ω Capacitance per unit length < 30 pF / m Loop resistance 110 Ω / km Strand diameter 0.64 mm Strand cross-section > 0.34sqmm
Shielding	minimum requirement single-shield; placed on both sides;
Wiring arrangement, distances, shielding	Inside and outside of control cabinets at least 20 cm distance to other lines with voltages > 60V;

Fig. 9-24: Bus cable requirements

Note: Shield terminal: Connection of the PE of the frequency converter for suppression of faults on the bus lines

DeviceNet Module FCC01.1F-DN1-NNNN

DeviceNet is an open communication profile for distributed industrial automation system. It is based on the CANbus system.

Up to 64 nodes can be connected at one bus system.

Fig. 9-25: DeviceNet module FCC01.1F-DN1-NNNN

DeviceNet status LEDs	MS (red/green)	Module state
	NS (red/green)	Mains (bus) state
Modules status LEDs	DS (green)	Module state
	DE (red)	Module error

Setting the node ID

Use the rotating switches NA x 1 and NA x 10 to set the node address (0..63):

Example: Node adr= 50 Dec = NA x 1 = 0, NA x 10 = 5

If the node address is set to a value greater 63, the value from parameter 515 of the frequency converter is used as a node address.

Setting the Baud Rate

Set the Baud rate by means of the rotating switch DR (125kBit/s…500kBit/s). If a value is set in the PGM range, the value from parameter 514 of the frequency converter is used as a Baud rate.

Connector pin assignment

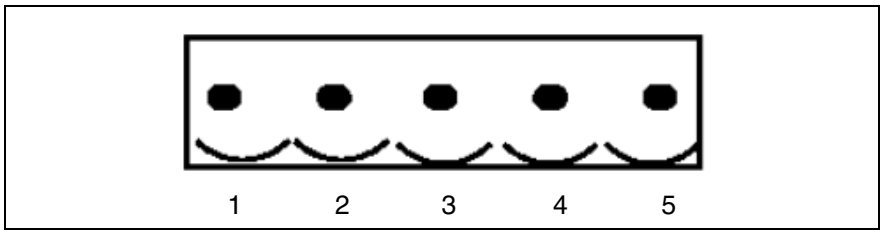


Fig. 9-26: Pin assignment FCC01.1F-DN1

DeviceNet assignment

Pin	Signal	Function
1	VP-	0 V – potential 24 V supply voltage
2	CAN_L	Bi-directional data signal CAN_L
3	Drain/Shield	Shield connection
4	CAN_H	Bi-directional data signal CAN_H
5	VP+	24 V supply voltage - plus

Fig. 9-27: Connector pin assignment FCC01.1-DN1

Transmission speed

The maximum line lengths and thus the maximum distance between the master and the last slave is limited by the line characteristics, the environmental conditions and the transmission rate.

The maximum length of the stubs depends on line material and the selected Baud rate.

Transmission speed [kBit / s]	max. line (bus) lengths[m]
125	up to 500
250	up to 250
500	up to 100

Fig. 9-28: Transmission speed

Note: Only when the specified line parameters are observed, the guaranteed transmission speeds or transmission distances can be maintained without any problems.

Bus cable requirements

Cable design	
Cable specification	Line type A acc. To EN 50 170
Cable design	5-strand line according to DeviceNet specification
Recommended cable type	Surge impedance: 135 ... 165 Ω Capacitance per unit length < 30 pF / m Loop resistance 110 Ω / km Strand diameter 0.64 mm Strand cross-section > 0.34sqmm
Shielding	minimum requirement single-shield; placed on both sides;
Wiring arrangement, distances, shielding	Inside and outside of control cabinets at least 20 cm distance to other lines with voltages > 60V;

Fig. 9-29: Bus cable requirements

Note: Shield terminal: Connection of the PE of the frequency converter for suppression of faults on the bus lines

10 Commissioning

The motor may only be started by a release signal after it the parameters have been successfully set by qualified personnel.

WARNING

⇒ The frequency converter does not have a mains switch. Thus, it is always energized when connected to mains voltage. Accordingly, voltage may be applied to a connected motor.

1.1 Basic Settings

All frequency converters supplied by Bosch Rexroth are pre-programmed by default for standard applications with 4-pole DS standard motors (of identical power and voltage). When motors of other power ratings or pole numbers are used, the information on the motor's type label must be input in the P201...P207 parameters of the menu group >Motor data<.

Note: All motor data can be set by means of the parameter P200. After completed utilization of this function the parameter is reset to *0 = no change*! The data is once loaded automatically into the parameter P201…P209. Here, it can be compared again to the data of the motor type label.

RECOMMENDATION:

To ensure smooth operation of the drive unit, it is necessary to set the motor data as accurately as possible in accordance with the type label. We specifically recommend automatic stator resistance measurement via parameter P220.

To determine the stator resistance automatically, P220 must be set to = 1 and then confirmed with "ENTER". The value converted to the phase resistance (in dependence on P207) is saved to parameter P208.

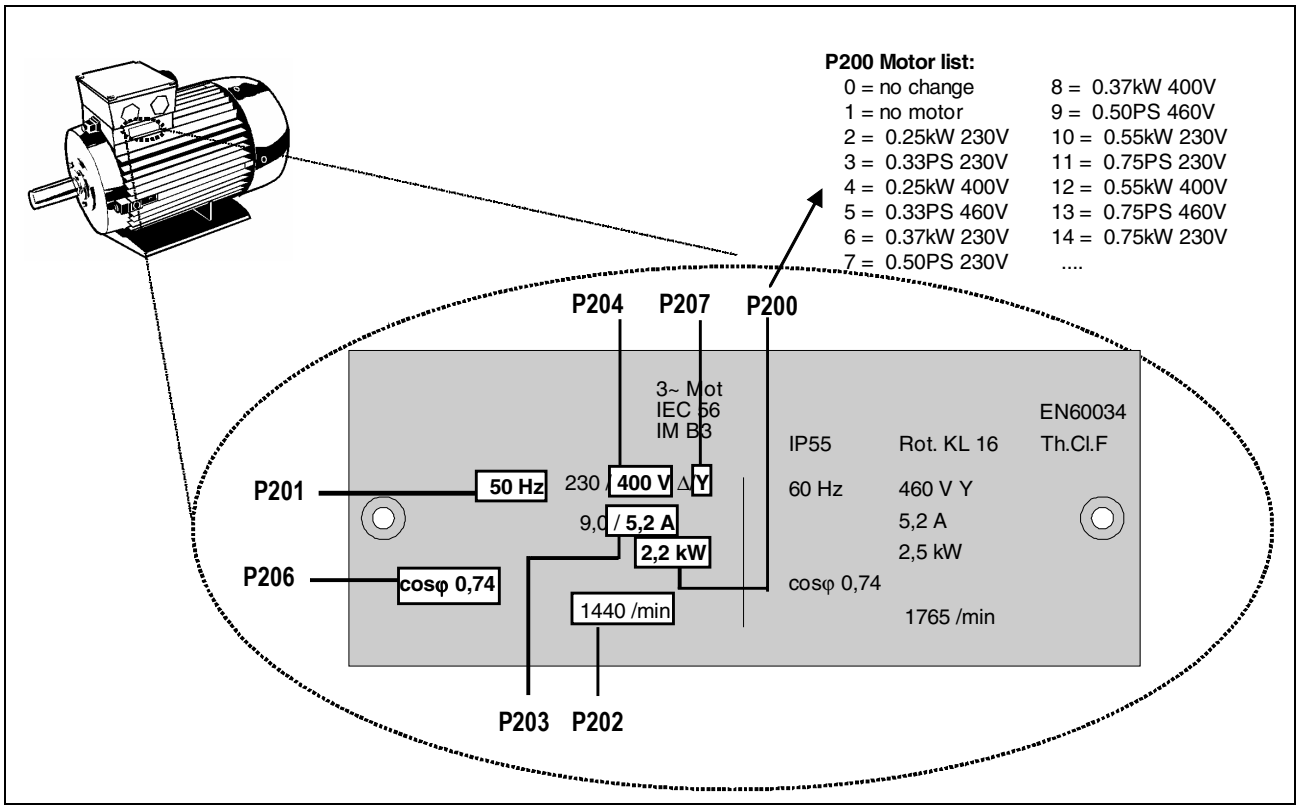


Fig. 10-1: Basic settings

When other motors are used, the data on the motor's type label must be manually input to the parameters P201...P208.

For automatically determination s. recommendation above.

1.2 Minimum Configuration of the Control Connections

If the frequency converter is to be controlled via the digital and analog inputs, the device can be used immediately as supplied in factory setting . Initially, no settings must be made.

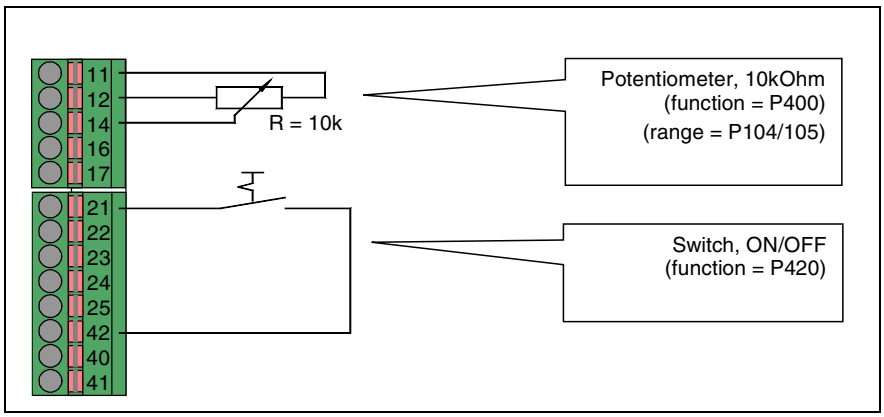


Fig. 10-2: Minimum connection

Basic parameter

If you do not know the current setting of the frequency converter, we recommend loading of the factory data P523 = 1. In this constellation, the frequency converter is pre-parameterized for standard applications.

If required, the standard control panel can be used to adjust the following parameters.

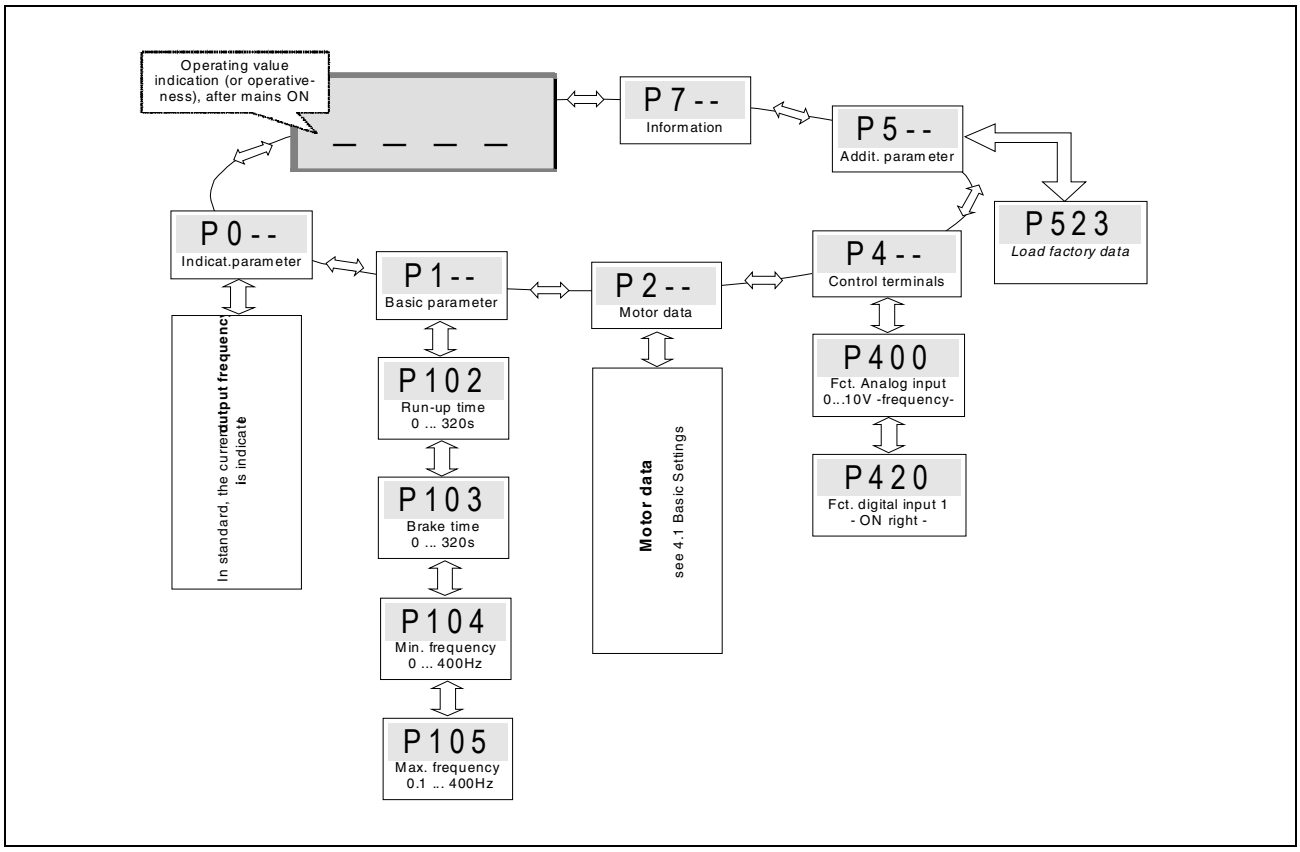


Fig. 10-3: Basic parameter

11 Parameterization

There exist four parameter records. During operation, it is possible to switch between them. All parameters are visible in factory setting but can be partially hidden with parameter P003. All parameters can be changed "online".

Note: As there are dependencies among the parameters, temporary invalidity of data and thus malfunctioning may occur. For this reason, only the inactive parameter record or non-critical settings should be edited during operation.

The individual parameters are classified in different groups. The first digit of the parameter number identifies the classification with one **menu group**:

Menu group no.	**Main function**
Status indication (P0--):	Used to select the physical unit of the indication value.
Basic parameters (P1--):	Comprise basic settings of the frequency converter, e.g. activation and deactivation behavior; together with the motor data, they are sufficient for standard applications.
Motor / characteristics parameters (P2--):	Setting of motor-specific data; important for ISD current regulation and selection of the characteristic, as well as the setting of dynamic and static boost.
Control terminals (P4--):	Scaling of the analog inputs and outputs, definition of the function of the digital inputs and relay outputs, as well as PID control parameters.
Additional parameters (P5--):	These are functions concerning the interface, pulse frequency, or error confirmation.
Information (P7--):	For indicating for example current operating values, old error messages, device status messages, or the software version.
Array parameters - 01 ... -xx	Some parameters can additionally be programmed or read out in several levels (arrays). After selecting the parameter, the array level must be selected additionally.

Fig. 11-1: Groups

Note: Via parameter P523, the factory setting of all parameters can be loaded at any time. This may for example be helpful when commissioning a frequency converter whose parameters no longer confirm with the factory settings.

CAUTION

⇒ All current parameter setting will be lost if P523 = 1 is set and confirmed with "ENTER". To save current settings, they can be transferred to the memory of the control panels.

Availability of Parameters

Depending on the respective configurations, the parameters are subject to certain conditions. In the following table pages (from Chapter 11.1 Status Indication), all parameters are listed with the respective information.

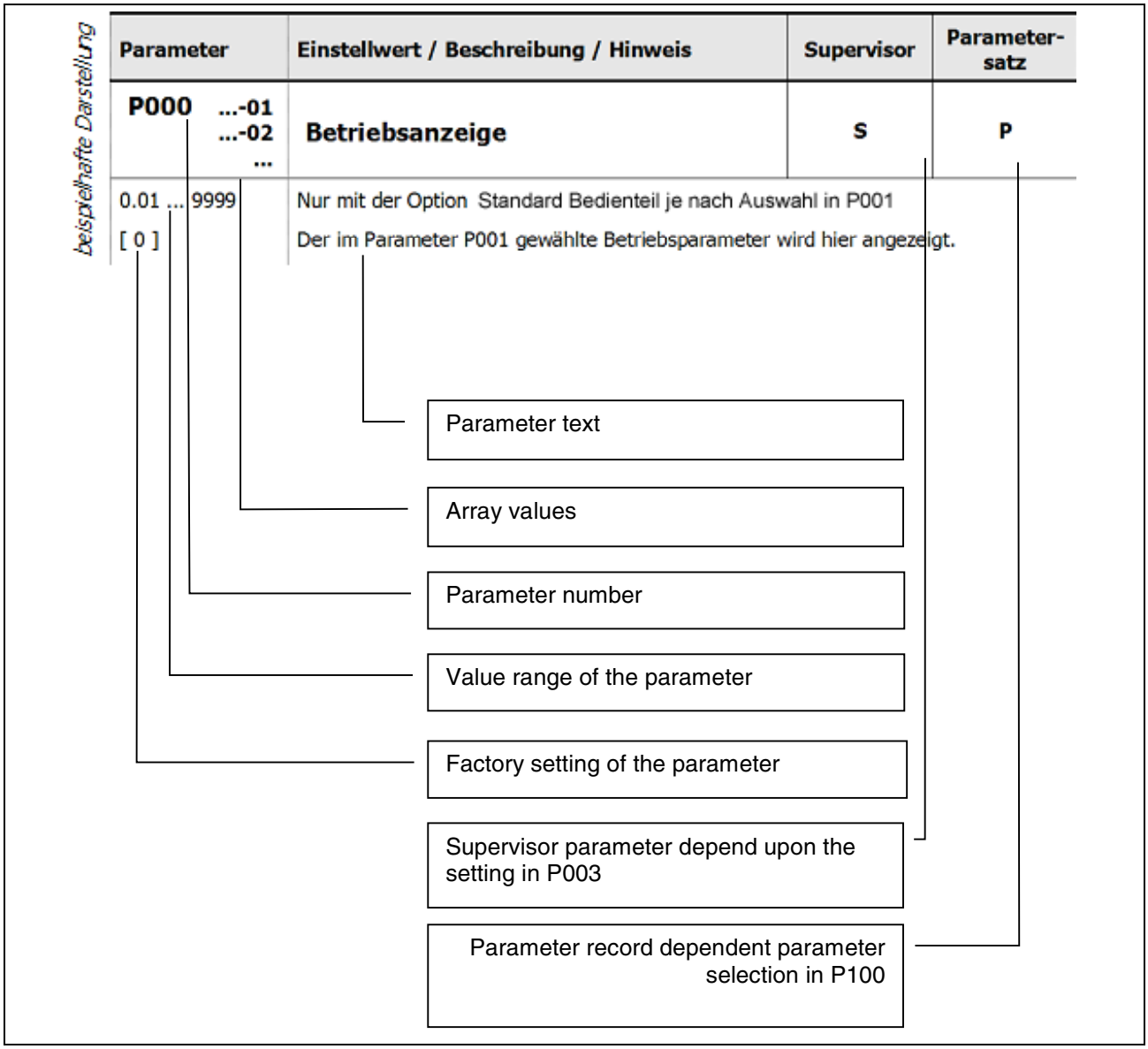


Fig. 11-2: Availability of parameters

Array Parameters Indication

The parameters P502, P701 through 706, P707, P718, P741/742 and P745/746 are capable of mapping settings or views in several levels (‚array'). To this end, the array level is indicated after selection of one of these parameters. Then, this array level must be selected.

With the standard control panel, the array level is indicated by P - 0 x; with the comfort control panel, the selection options of the array level are shown in the top right corner of the display.

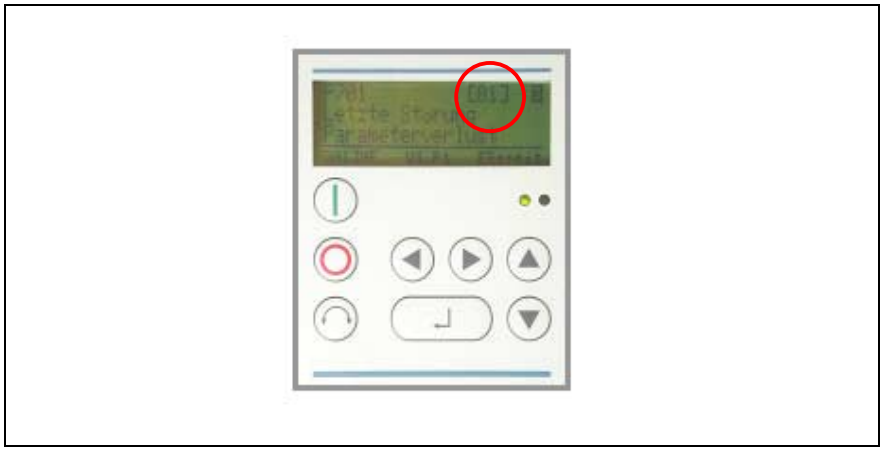


Fig. 11-3: Array parameters indication (comfort control panel)

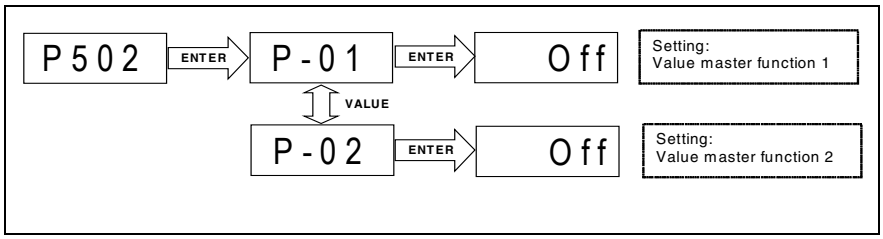


Fig. 11-4: Array parameters indication (standard control panel)

11.1 Status Indication

In the following, the frequency converter is referred to by the abbreviation **FC**.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P000	**Status Indication**			
0.01 ... 9999	In the display of the standard control panel, the operating value selected in parameter P001 is indicated *online*. Depending on what is required, important information on the drive's operating state can be read out.			
P001	**Selection of indicator value**			
0 ... 63 [0]	**0 =** **Actual frequency [Hz]**; this is the output frequency currently supplied by the FC. **1 =** **Speed [1/min]**; this is the actual speed calculated by the FC. **2 =** **Setpoint frequency [Hz]**; this is the output frequency corresponding to the applied setpoint value. It does not have to correspond to the current output frequency. **3 =** **Power [A]**; this is the current output power measured by the FC. **4 =** **Torque current [A]**; this is the torque-forming output current of the FC. **5 =** **Output voltage [V AC]**; this is current AC voltage supplied by the FC at the output. **6 =** **DC bus voltage [V DC]**; this is the internal DC voltage of the FC. This is dependent, among other factors, on the value of the mains voltage **7 =** **cos φ;** this is the currently calculated value of the power factor. **8 =** **Apparent power [kVA]**; this is the current apparent power calculated by the FC. **9 =** **Active power [kW]**; this is the current active power calculated by the FC. **10 =** **Torque [%]**; this is the current torque calculated by the FC. **11 =** **Field [%]**; this is the current field in the motor calculated by the FC. **12 =** **Operating hours**; time in which mains voltage is applied at the FC. **13 =** **Operating hours release;** time in which the FC is released. **14 =** **Analog input 1 [%];** this is the current value applied at analog input 1 of the FC. **15 =** **Analog input 2 [%];** this is the current value applied at analog input 2 of the FC. **16 =** reserved **17 =** reserved **18 =** reserved **19 =** **Heat sink temperature (°C);** current temperature of the FC heat sink. **20 =** **Motor capacity utilization [%];** average motor capacity utilization, based on the known motor data (P201…P209). **21 =** **Brake resistor capacity utilization [%];** average brake resistor capacity utilization, based on the known resistor data (P556…P557). **22 =** … 63 reserved			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P002	**Indication of scaling factor**		S	
0.01 ... 999.99 [1.00]	The operating value selected in parameter P001 >Selection of indicator value< is multiplied by the scaling factor and indicated in P000. Thus, it is possible to indicate system-specific operating values.			
P003	**Supervisor code**			
0 ... 9999 [1]	**0 =** **All parameters** except the supervisor parameters are visible **1 =** **All parameters** are visible **2 =** **Only menu group 0** (P001 ... P003) is visible **3 =** ... 9999, same as setting value 2.			

11.2 Basic Parameters

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P100	**Parameter record**		S	

0 ... 3

[0]

Selection of the parameter record to be parameterized. 4 parameter records are available. All parameters depending upon a parameter record are marked with **P**.

The operation parameter record is selected via a digital input or the BUS control. This can be switched during operation (online).

Setting	**Digital inputfunction [8]**	**Digital inputfunction [17]**	**LEDs Comfort control panel**
0 = Parameter record 1	LOW	LOW	1 ● 2 ●
1 = Parameter record 2	HIGH	LOW	1 ☼ 2 ●
2 = Parameter record 3	LOW	HIGH	1 ● 2 ☼
3 = Parameter record 4	HIGH	HIGH	1 ☼ 2 ☼

When released via the keyboard of a control panel, the operation parameter record follows the setting in P100.

P101	**Copy parameter record**		S	

0 ... 4

[0]

After confirmation with the ENTER key, the active parameter record (P100) is copied into the selectable parameter record 1...4.

0 = Does not trigger any action.

1 = Copies the current parameter record to parameter record 1

2 = Copies the current parameter record to parameter record 2

3 = Copies the current parameter record to parameter record 3

4 = Copies the current parameter record to parameter record 4

P102	**Run-up time**			P

0 ... 320.00 s

[2.00]

Run-up time is the time which corresponds to the linear frequency increase of 0Hz up to the set maximum frequency (P105). When a current setpoint value <100% is used, the run-up time is calculated according to the following formula:

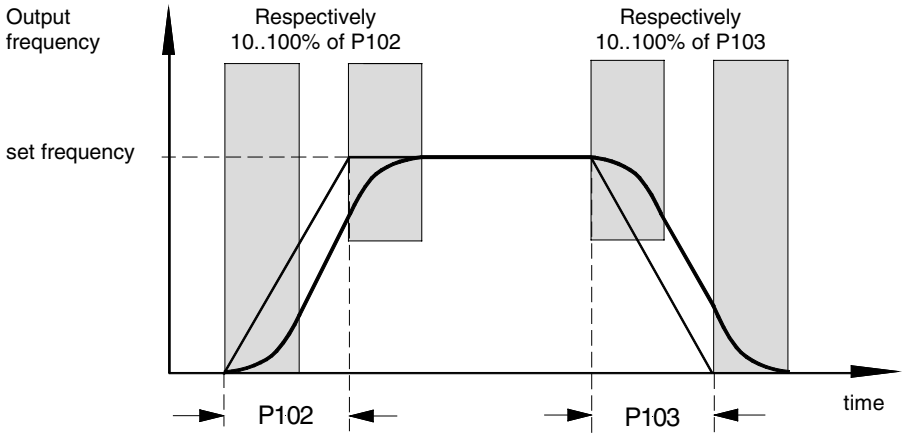
$$\frac{\text{Setpoint}[Hz]}{P105[Hz]} \times P102$$

Fig. 11-5: Run-up time

The run-up time can be extended under certain circumstances, e.g. FC overload, setpoint delay, rounding, or reaching of the current limit.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P103	**Braking time**			P
0 ... 320.00 s [2.00]	Braking time is the time which corresponds to the linear frequency reduction from the set maximum frequency (P105) to 0Hz. When a current setpoint value <100% is used, the braking time is calculated according to the following formula: $\frac{\text{Setpoint}[Hz]}{P105[Hz]} \times P103$ Fig. 11-6: Braking time Under certain circumstances, the braking time can be changed, for example by the selected >Deactivation mode< (P108) or the >Ramp rounding< (P106).			
P104	**Minimum frequency**			P
0.0 ... 400.0 Hz [0.0]	Minimum frequency is the frequency supplied by the FC as soon as it is released, provided no additional setpoint is applied. In combination with other setpoint values (e.g. analog setpoint value or fixed frequencies), they are added to the set minimum frequency. The value falls below this frequency if • the motor is accelerated when the drive is at standstill; • the FC is blocked. Then, the frequency is reduced to the absolute minimum frequency (P505) before the FC switches off at the output side. • the FC reverses. Cyclic reversal takes place at the absolute minimum frequency (P505). The value may permanently be below this frequency if the "Hold frequency" function (function°digital input°=°9) has been executed during acceleration or braking.			
P105	**Maximum frequency**			P
0.1 ... 400.0 Hz [50.0]	This is the maximum frequency available at the FC output. This frequency can be exceeded by means of the slip compensation (P212) or the "Hold frequency" function (function digital input = 9).			
P106	**Ramp rounding**		S	P
0 ... 100 % [0]	This parameter is used for rounding the run-up and the braking ramp. Thus, smooth but still dynamic speed changes can be realized. Rounding is executed with each setpoint change. The value to be set is based on the preset run-up and braking time, with values <10% having no effect. When ramp rounding is active, the run-up or braking time is calculated as follows: $t_{ges\ \ RUN\text{-}UP} = t_{P102} + t_{P102} \cdot \frac{P106[\%]}{100\%}$ $t_{ges\ \ BRAKING\ TIME} = t_{P103} + t_{P103} \cdot \frac{P106[\%]}{100\%}$			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record



	Brake application time			P

0 ... 2.50 s

[0.00]

Electromagnetic brakes have a physically caused delayed reaction time on application. This may result in sinking of load with lifting gear operations; the brake takes over the load with a delay.

This application time of the brake can be taken into consideration by parameter P107 (brake control).

Within this application time, the FC will supply the absolute minimum frequency (P505) and prevents sinking of load on stop.

In this context, also refer to parameter >Release time< P114

Note: To control electromagnetic brakes (above all with lifting gear), an internal relay should be used (function 1, external brake). The value should not fall under 2.0Hz as an absolute minimum frequency (P505).

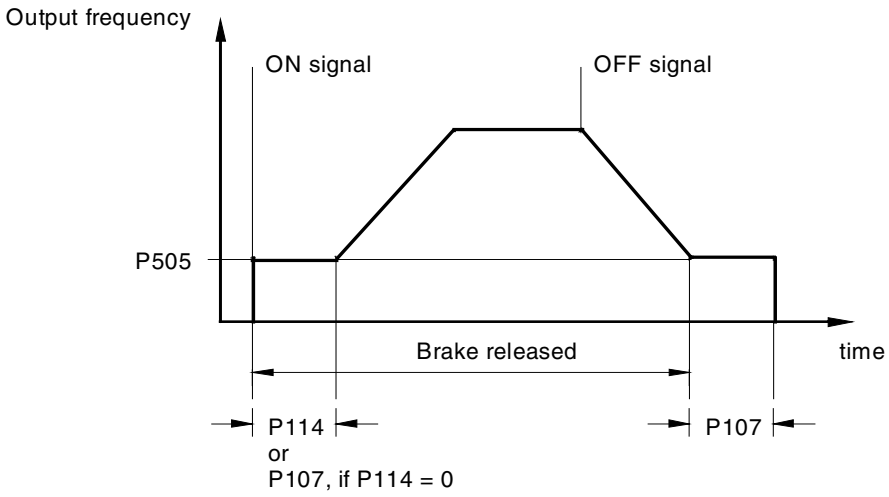
Sample setting: Lifting gear with brake

P114 = 0.2...0.3sec.

P107 = 0.2...0.3sec.

P434 = 1

P505 = 2...4Hz



Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P108	**Switch-off mode**		S	P

0 ... 12

[1]

This parameter specifies the manner in which the output frequency is reduced after "locking" (controller enable → low).

0 = **Voltage disable:** The output signal is switched off without delay. The FC does not supply any output frequency. In this case, the motor is braked only by mechanic friction. Immediate re-activation of the FC may cause an error message.

1 = **Ramp:** The current output frequency is reduced analog to the remaining braking time, from P103/P105.

2 = **Ramp with delay:** same as function1, but with regenerative operation, the braking ramp is extended; with static operation, it is increased. Under certain conditions, this function can suppress overvoltage deactivation or reduce the power dissipation at the braking resistor.

Note: This function may not be programmed when defined braking is required, for example with lifting gear.

3 = **Immediate DC braking:** The FC immediately switches to the preselected DC current (P109). This DC current is supplied analog for the remaining time >Time DC brake< (P110). Depending on the ratio of current output frequency to max. frequency (P105), >Time DC brake< is reduced. The motor stops in a time which is dependent upon the application. This is also in dependence upon the load's mass moment of inertia, friction, and the set DC current (P109).With this type of braking, no energy is recovered into the FC; heat loss occurs primarily in the rotor of the motor.

4 = **Constant stopping distance:** The braking ramp starts at a delay if not operated at maximum output frequency (P105). This results in a roughly identical stopping distance from various current frequencies.

NOTE: This function cannot be used as a positioning function. This function should not be combined with a ramp rounding (P106).

5 = **Combined braking (only with linear characteristic):** Depending on the current DC bus voltage, a high-frequency voltage is applied to the first harmonic. If possible the braking time (P103) is observed ⇒ additional heating in the motor.

6 = **Square ramp:** The braking ramp has no linear course but decreases to the second power.

7 = **Square ramp with delay:** Combination of function 2 and 6.

8 = **Braking combined to the second power:** Combination of function 5 and 6.

9 = **Constant acceleration power (only in field-weakening range):** With constant electric power, the drive is accelerated further, or it is braked. The course of the ramps depends on the load.

10 = **Path calculator:** constant path between the current frequency / speed and the set minimum output frequency (P104).

11 = **Constant performance power with delay:** Combination of functions 2 and 9

12 = **Constant acceleration power with delay** (as in 11) **with additional chopper relief**

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P109	**DC current - brake**		S	P
0 ... 250 % [100]	Current setting for the functions DC current braking (P108 = 3) and combined braking (P108 = 5). The correct setting value depends upon the mechanic load and the desired stop time. A high setting value can stop large loads faster. The 100% setting corresponds to a current value identical to that stored in the >Nominal current< parameter P203.			
P110	**Time DC brake on**		S	P
0.00 ... 60.00 s [2.00]	This is the time in which the current selected in the parameter >DC current - brake< is applied to the motor when the functions (P108 = 3, P108 = 5) are active. Depending on the ratio of current output frequency to max. frequency (P105), >Time DC brake< is reduced. The time starts to run when release is deactivated and can be aborted by a new release.			
P111	**P factor torque limit**		S	P
25 ... 400 % [100]	Acts directly on the behavior of the drive at the torque limit. For most drive jobs, the basic setting of 100% is sufficient. With excessively high values, the drive tends to oscillate when reaching the torque limit. If values are too low, the programmed torque limit may be exceeded.			
P112	**Torque current limit**		S	P
25 ... 400 / 401 % [401]	This parameter is used to set a limit for the torque-producing current. This may prevent mechanical overload of the drive. However, it cannot protect from mechanic block (traversing to the block). There is no replacement for protection in form of a slip clutch. The torque current limit can also be continuously adjusted via an analog input. Then, the maximum setpoint value (compare 100% adjustment, P403/P408) corresponds to the set value in P112. The value cannot fall below the limit value of 20% torque current, not even when a lower analog setpoint value (?400/405 = 2) has been set. **401% = OFF** stands for deactivation of the motor current limit! This is also the basic setting of the frequency converter.			
P113	**Jog frequency**		S	P
-400.0 ... 400.0 Hz [0.0]	When the FC is controlled by means of a **control panel**, the jog frequency is the initial value after release has been given. When the FC is controlled via the control terminals, jog frequency can be activated through one of the digital inputs. The jog frequency can be set directly via this parameter, or - if the FC is released via keyboard control - by pressing ENTER. In this case, the current output frequency is taken over into the parameter P113. It will be available at restart.			

Note: Setpoints specified via the control terminals, e.g. jog frequency, fixed frequencies or analog setpoint value, are generally added with the correct sign. Here, the value cannot exceed the set maximum frequency (P105) or fall below the minimum frequency (P104).

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P114	**Brake release time**		S	P
0 ... 2.50 s [0.00]	Electromagnetic brakes have a physically caused delayed reaction time on release. As a result, the motor may start while the brake is still applied, causing the FC to fail and indicate an overcurrent error. This release time can be taken into consideration by parameter P114 (brake control). During release time, the FC supplies the absolute minimum frequency (P505), thus preventing starting of the motor with the brake still applied. Also refer to the parameter >Brake application time< P107 (sample setting). **Note:** If the brake release time is set to "0", P107 also applies as brake release and application time.			

11.3 Motor Data / Characteristics Parameter

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P200	**Motor list**			P

0 ... 53

[0]

This parameter is used to modify the preset motor data. The factory setting provides for a 4-pole (corresponding to 2 pole pairs) standard DS motor with nominal power of the frequency converter.

By selecting one of the available figures and pressing the ENTER key, all the following motor parameters (P201 to P209) are preset. The motor data is based on 4-pole standard DS motors.

0 = No data change

1 = No motor: In this setting, the FC works without current control, slippage compensation and pre-magnetizing time; accordingly, the setting is not recommended for motor applications. Possible applications include induction furnaces or other applications with coils or transformers. The following motor data is preset: 50.0Hz / 1500rpm / 15.0A / 400V / 0.00kW / cos φ=0.90 / star / stator resistance 0.01Ω / I_{EMPTY} 6.5A

2 =	0.25kW 230V	**14 =**	0.75kW 230V	**26 =**	2.2 kW 230V	**40 =**	reserved
3 =	0.33PS 230V	**15 =**	1.0 PS 230V	**27 =**	3.0 PS 230V	**41 =**	reserved
4 =	0.25kW 400V	**16 =**	0.75kW 400V	**28 =**	2.2 kW 400V	**42 =**	7.5 kW 400V
5 =	0.33PS 460V	**17 =**	1.0 PS 460V	**29 =**	3.0 PS 460V	**43 =**	10.0 PS 460V
6 =	0.37kW 230V	**18 =**	1.1 kW 230V	**30 =**	3.0 kW 230V	**44 =**	11.0 kW 400V
7 =	0.50PS 230V	**19 =**	1.5 PS 230V	**31 =**	3.0 kW 400V	**45 =**	15.0 PS 460V
8 =	0.37kW 400V	**20 =**	1.1 kW 400V	**32 =**	reserved	**46 =**	reserved
9 =	0.50PS 460V	**21 =**	1.5 PS 460V	**33 =**	reserved	**47 =**	reserved
10 =	0.55kW 230V	**22 =**	1.5 kW 230V	**34 =**	4.0 kW 400V	**48 =**	reserved
11 =	0.75PS 230V	**23 =**	2.0 PS 230V	**35 =**	5.0 PS 460V	**49 =**	reserved
12 =	0.55kW 400V	**24 =**	1.5 kW 400V	**36 =**	reserved	**50 =**	reserved
13 =	0.75PS 460V	**25 =**	2.0 PS 460V	**37 =**	reserved	**51 =**	reserved
				38 =	5.5 kW 400V	**52 =**	reserved
				39 =	7.5 PS 460V	**53 =**	reserved

Note: As P200 is reset to = 0 after confirmation, it is possible to control the set motor via parameter P205.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P201	**Rated frequency**		S	P
10.0 ... 399.9 Hz [***]	The rated motor frequency defines the U/f salient point at which the FC supplies the rated voltage (P204) at the output.			
P202	**Rated speed**		S	P
150 ... 24000 rpm [***]	The rated motor speed is relevant for correct calculation and regulation of motor slippage and speed indication (P001 = 1).			
P203	**Rated current**		S	P
0.1 ... 300.0 A [***]	The rated motor current is a significant parameter for current vector regulation.			
P204	**Rated voltage**		S	P
100 ... 800 V [***]	Via parameter P204, the rated motor voltage can be input and read out. In connection with the rated frequency, the voltage/frequency characteristic is determined.			
P205	**Rated power**		--	P
0.00 ... 150.00 kW [***]	The rated motor power is used to monitor the motor set via P200.			
P206	**cos φ**		S	P
0.50 ... 0.90 [***]	The motor cos φ is a significant parameter for current vector regulation.			
P207	**Motor connection**		S	P
0 ... 1 [***]	**0 =** star **1 =** delta The motor connection specifies the stator resistance measurement, and thus current vector regulation.			
P208	**Stator resistance**		S	P
0.00 ... 300.00 Ω [***]	Motor - stator resistance ⇒ resistance of a phase in the DS motor! Directly influences the current control of the FC. An excessively high[1] value may potentially cause an overcurrent, an excessively low value a low motor torque. For easy measuring, parameter P220 can be used. Parameter P208 can be used for manual setting, or to provide information on the result of the automatic measurement.			

Note: For correct function of the current vector control, the stator resistance must be measured automatically by the FC.

*** *These settings depend upon the selection in parameter P200.*

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P209	**No-load current**		S	P
0.1 ... 300.0 A [******]	This value is always calculated automatically from the motor data when parameter >cos φ< P206 and parameter >Rated current< P203 are modified.			

Note: For direct input of the value, it must be set as the last value of the motor data. This is the only way to ensure that the value will not be overwritten.

P210	**Increase of static boost**		S	P
0 ... 400 % [100]	The static boost influences the current which determines the magnetic field. It corresponds the no-load current of the motor in question, i.e. it is load-independent. For typical applications, the factory setting of 100% is sufficient.			
P211	**Increase of dynamic boost**		S	P
0 ... 150 % [100]	The dynamic boost influences the current which determines the torque. This is a load-depending factor. Here, too, the factory setting of 100% is considered sufficient for typical applications. An excessively high value can result in overcurrent at the FC. Then, the output voltage is increased excessively under load. An excessively low value results in an excessively low torque.			
P212	**Slip compensation**		S	P
0 ... 150 % [100]	Slip compensation increases - in dependence on the load - the output frequency to keep the speed of an asynchronous DS motor more or less constant. When asynchronous DS motors are used and the motor data is set correctly, the factory setting of 100% is optimum. When several motors (of different loads or powers) are operated at one FC, slip compensation P212 should be set =0%. This excludes the possibility of a negative influence. This also applies for synchronous motors whose design precludes any slip.			
P213	**Amplification of ISD control**		S	P
25 ... 400 % [100]	This parameter influences the control dynamics of the current vector control (ISD control) of the FC. High settings make the controller fast, low settings make it slow. Depending on the type of application, this parameter must be adjusted, for example to prevent instable operation.			
P214	**Rate-action torque**		S	P
-200 ... 200 % [0]	This function allows for teaching the current controller a value for the torque requirement to be expected. This function can be used for lifting gears to provide better load transfer during startup.			

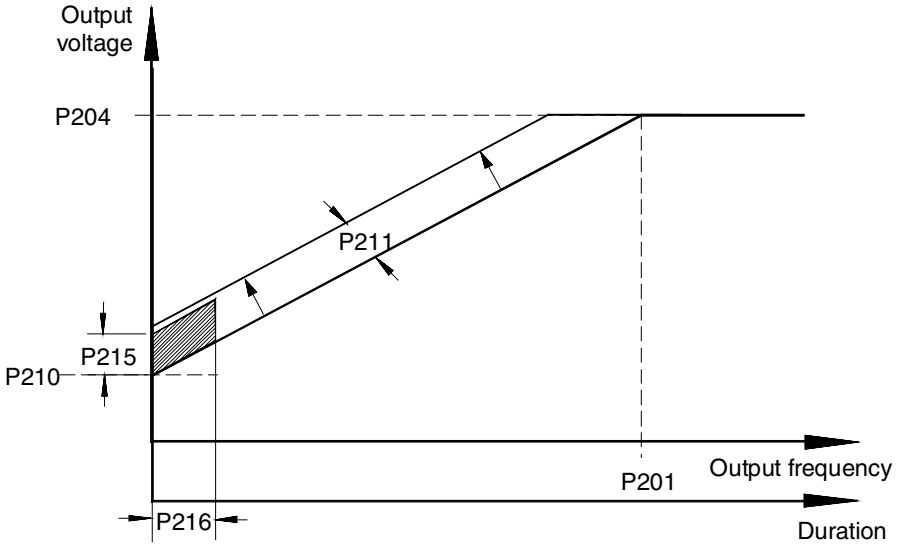
Note: With phase sequence right, motor-driven torques are entered with positive signs, and regenerative torques are marked with negative signs. With phase sequence left, it is vice versa.

[***] *These settings depend upon the selection in parameter P200.*

P215	Rate-action boost		S	P
0 ... 200 %	Only with linear characteristic (P211 = 0% und P212 = 0%).			
[0]	For drives requiring high startup torque, this parameter offers the option to supply an additionally current during the startup phase. The duration is limited; it can be selected in parameter >Time rate-action boost< P216.			

P216	Time rate-action boost		S	P
0.0 ... 10.0 s	Only with linear characteristic (P211 = 0% und P212 = 0%).			
[0]	Duration for which the increased startup current is effective (P115).			

P2xx Control parameter



Note: "typical" setting for the ...

Current vector control (factory setting)

P201 to P208 = Motor data

P210 = 100%

P211 = 100%

P212 = 100%

P213 = 100%

P214 = 0%

P215 = insignificant

P216 = insignificant

Linear U/f characteristic

P201 to P208 = Motor data

P210 = 100% (static boost)

P211 = 0%

P212 = 0%

P213 = 100% (insignificant)

P214 = 0% (insignificant)

P215 = 0% (dynamic boost)

P216 = 0s (duration dyn. boost)

P220	Parameter identification			

... up to 240 s

The FC automatically determines the motor data via this parameter. In the vast majority of cases, this results in a significantly improved drive behavior as the asynchronous DS motor is subject to certain manufacturing tolerances not documented on the type label.

The identification of all parameter will take some time. Do not switch off mains voltage. Should you find an unfavorable operating behavior, select a suitable motor in P200 or set the parameters P201…P208 manually.

0 = No identification

1 = Parameter identification R_S: Only stator resistance P208 is determined.

2 = Parameter identification motor parameter: the parameters P201…P209 are determined.

Procedure:

- Motor data identification must take place with the motor **cold and at standstill** and without release having been given for the FC. The heating of the motor is constantly taken into consideration during operation.
- The motor rating must be not more than one rating class larger or 3 rating classes smaller than the rated power of the FC. Motor cable length should not exceed 20 m.
- The motor data should be preset in accordance with the type label or P200. As a minimum, however, the rated frequency (P201), rated speed (P202), voltage (P204), power (P205) and motor connection (P207) must be known.
- If the identification cannot be terminated successfully, error message E019 is generated. Also refer to Chapter 12, Error Messages.

Note: After parameter identification, P220 will be = 0 again.

11.4 Control Terminals

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P400	**Function analog input 1**			P
0 ... 82 [1]	The analog input of the FC can be used for different functions. Please note that only one of the functions described below can be used at a time. If, for example, actual frequency PID has been selected, the frequency setpoint cannot be an analog signal. The setpoint value can be specified for example by means of a fixed frequency. **Analog functions:** **0 =** **Off**, the analog input is without function. After release of the FC via the control terminals it will supply the minimum frequency if set (P104) **1 =** **Setpoint frequency;** the specified analog range (P402/P403) varies the output frequency between the set minimum and maximum frequency (P104/P105). **2 =** **Torque current limit**; based on the set torque current limit (P112) it can be modified via an analog value. Here, 100% setpoint value correspond to the set torque current limit P112. The value cannot fall below 20% **3 =** **Actual frequency PID***; is needed to establish a control loop. The analog input (actual value) is compared to the setpoint value (e.g. fixed frequency). The output frequency is adjusted as far as possible until the actual value has approached the setpoint. (see controlled variables P413 - P415). **4 =** **Frequency addition ****; the supplied frequency value is added to the setpoint value. **5 =** **Frequency subtraction ****; the supplied frequency value is subtracted from the setpoint value. **6 =** **Current limit**; based on the set current limit (P536) it can be modified via the analog input. **7 =** **Maximum frequency;** the maximum frequency of the FC is varied. 100% corresponds to the setting in parameter P411. 0% corresponds to the setting in parameter P410. The value cannot fall below the values for the min./max. output frequency (P104/P105) or exceed them. **8 =** **Actual frequency PID limited ***; same as function 3, but the output frequency cannot fall below the programmed value for minimum frequency in parameter P104. (no rotation direction reversal) **9 =** **Actual frequency PID monitored ***; same as function 3, but the FC switches off the output frequency when the minimum frequency P104 has been reached. **10 =** **reserved** **11 =** **Rate-action torque;** this function allows for teaching the controller in advance a value for the torque requirement (feedforward control). In lifting gears with separate load sensing function, this function can be used to ensure better load transfer. **12 =** **reserved** **13 =** **Multiplication;** the setpoint value is multiplied with the specified analog value. The analog value adjusted to 100% corresponds to a multiplication factor of 1.			

... Continued on the following page

Parameter	Setting value / description / note	Device	Supervisor	Parameter record

14 = **Actual value process controller *;** activates the process controller, and the analog input 1 is connected with the actual value encoder (dancer, pressure box, flow meter,…). The mode (0-10V or 0/4-20mA) is set in P401.

15 = **Setpoint process controller ***, same as function 14, but the setpoint (e.g. of a potentiometer) is preset. The actual value must be preset via another input.

16 = **Rate-action process controller ***, adds an additional settable setpoint value after the process controller.

*) for more details on the process controller, please refer to Chapter 12.4, Additional Information.

**) The limits of these values are determined by the parameter >Minimum frequency secondary setpoints< P410 and the parameter >Maximum frequency secondary setpoints< P411.

Digital functions:

21 = Release right

22 = Release left

23 = Reversal of rotation direction

24 = Fixed frequency 1

25 = Fixed frequency 2

26 = Fixed frequency 3

27 = Fixed frequency 4

28 = reserved

29 = Hold frequency

30 = Voltage disable

31 = Quick stop

32 = Error confirmation

33 = PC thermistor input

34 = Remote control

35 = Jog frequency

36 = Hold frequency motor potentiometer

37 = reserved

38 = Watchdog

39 = Setpoint 1 on / off

40 = Setpoint 2 on / off

41 = Fixed frequency 5

42 = ... 49 reserved

50 = PID controller on / off

51 = Disable release right

52 = Disable release left

53 = ... 66 reserved

67 = Increase motor potentiometer jog frequency

68 = Reduce motor potentiometer jog frequency

69 = reserved

70 = Bit 0 fixed frequency array

71 = Bit 1 fixed frequency array

72 = Bit 2 fixed frequency array

73 = Bit 3 fixed frequency array

74 = Bit 4 fixed frequency array

75 = ... 82 reserved

A more detailed description of the digital functions follows after the explanation of parameters P420…P424. The functions of the digital inputs coincide with the digital functions of the analog inputs.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P401	**Mode analog input 1**		S	

0 ... 3

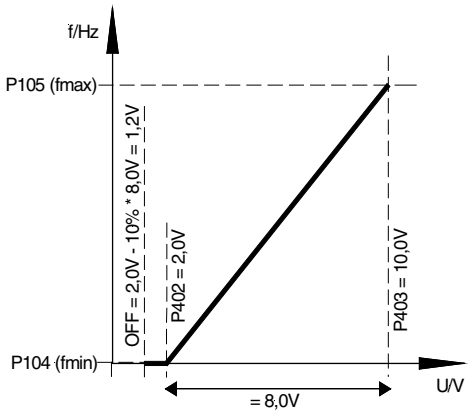
[0]

0 = **0 – 10V limited:** An analog setpoint which is smaller than the programmed adjustment 0% (P402) does not result in reversal of rotation direction.

1 = **0 – 10V:** An analog setpoint which is smaller than the programmed adjustment 0% (P402) will result in reversal of rotation direction. In this way, a reversal of rotation direction can be realized with a simple voltage source and a potentiometer.
e.g. internal setpoint value with reversal of rotation direction:
P402 = 5V, P104 = 0Hz, potentiometer 0–10V ⇒ reversal of rotation direction will occur while potentiometer is within the 0 to 5v range.

2 = **0 – 10V monitored:** If the value falls below the minimum adjusted setpoint value (P402) by 10% of the difference of P403 and P402, the FC output will be deactivated. As soon as the setpoint is higher once more [*P402 - (10% * (P403 - P402))*], it will again supply an output signal.

e.g. setpoint 4-20mA:
P402: Adjustment 0% = 2V; P403: Adjustment 100% = 10V; -10% corresponds to -0.8V; i.e. 2...10V (4...20mA) normal operating range, 1.2...2V = minimum frequency setpoint, the output is switched off if the value falls below 1.2V (2.4mA).



3 = **- 10V – 10V:** An analog setpoint which is smaller than the programmed adjustment 0% (P402) will result in reversal of rotation direction. In this way, a reversal of rotation direction can be realized with a simple voltage source and a potentiometer.
e.g. internal setpoint value with reversal of rotation direction:
P402 = 5V, P104 = 0Hz, potentiometer 0–10V ⇒ reversal of rotation direction will occur while potentiometer is within the 0 to 5v range.

Note:
At the moment of reversal (hysteresis = ± P505), the drive will stand still if the minimum frequency (P104) is smaller than the absolute minimum frequency (P505). A brake controlled by the FC will not be applied in the range of the hysteresis.

If the minimum frequency (P104) is greater than the absolute minimum frequency (P505), the drive will reverse on reaching minimum frequency. In the hysteresis range ± P104, the FC will supply the minimum frequency (P104), a brake controlled by the FC will not be applied.

P402:	**Adjustment analog input 1 0%**		S	

-50.00 ... 50.00 V

[0.00]

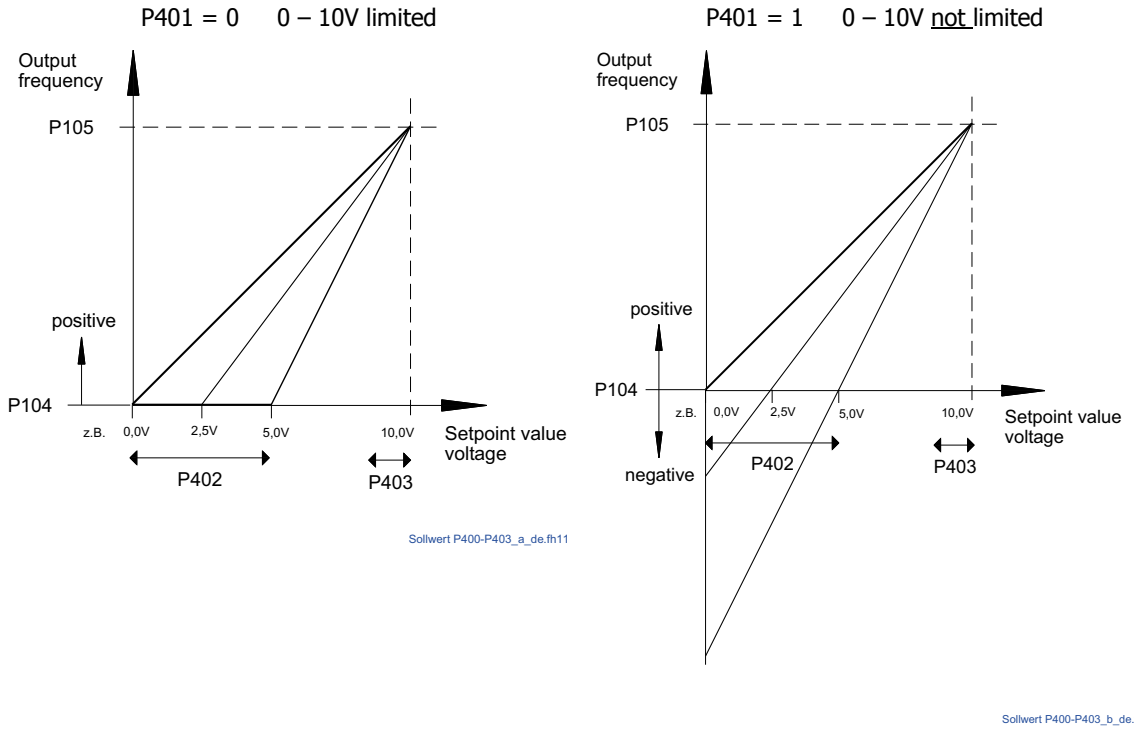
This parameter is used to set the voltage corresponding to the minimum value of the selected function of analog input 1. In factory setting (setpoint), this value corresponds to the setpoint set via P104 Minimum frequency.

Typical setpoint values and corresponding settings.

0 – 10 V	0.00 V
2 – 10 V	2.00 V (monitored with the function 0-10V)
0 – 20 mA	0.00 V (internal resistance approx. 250Ω)
4 – 20 mA	1.00 V (internal resistance approx. 250Ω)

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P403	**Adjustment analog input 1 100%**		S	
-50.00 ... 50.00 V [10.00]	This parameter is used to set the voltage corresponding to the maximum value of the selected function of analog input 1. In factory setting (setpoint), this value corresponds to the setpoint set via P105 Maximum frequency. Typical setpoint values and corresponding settings. 0 – 10 V 10.00 V 2 – 10 V 10.00 V (monitored with the function 0-10V) 0 – 20 mA 5.00 V (internal resistance approx. 250Ω) 4 – 20 mA 5.00 V (internal resistance approx. 250Ω)			

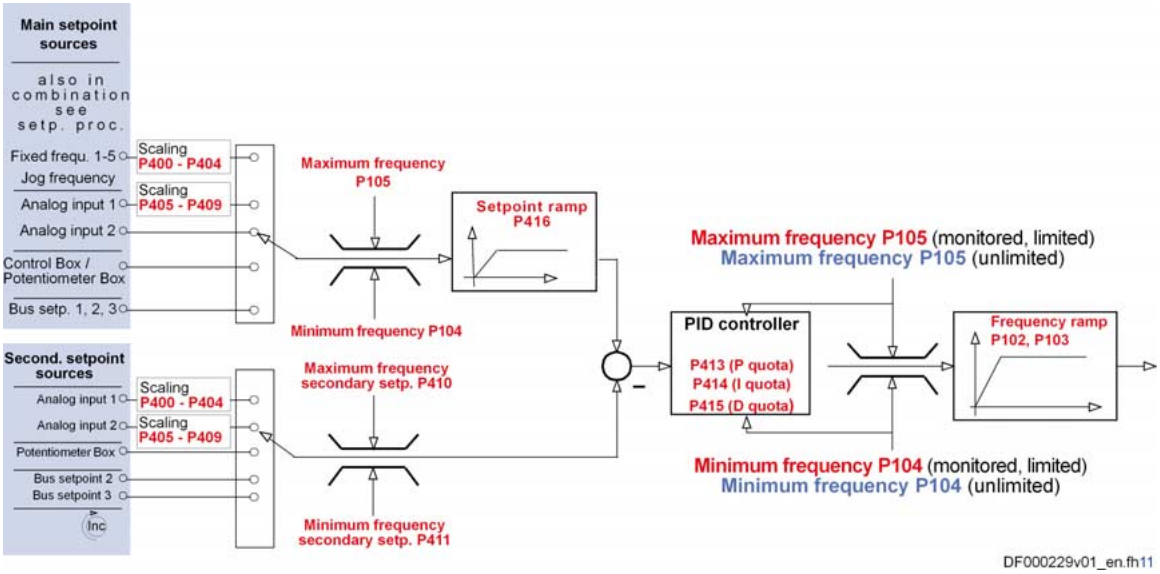
P400 ... P403



P404	**Filter analog input 1**		S	
1 ... 400 ms [100]	Settable digital low-pass filter for the analog signal. The spurious peaks are hidden and reaction time extended.			
P405	**Function analog input 2**			P
0 ... 82 [0]	Parameter P405 is identical with P400.			
P406	**Mode analog input 2**		S	
0 ... 3 [0]	This parameter is identical with P401.			
P407	**Adjustment analog input 2 0%**		S	

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
-50.00 ... 50.00 V [0.00]	This parameter is identical with P402.			
P408	**Adjustment analog input 2 100%**		S	
-50.00 ... 50.00 V [10.00]	This parameter is identical with P403.			
P409	**Filter analog input 2**		S	
1 ... 400 ms [100]	This parameter is identical with P404.			
P410	**Minimum frequency secondary setpoint values**			P
-400.0 ... 400.0 Hz [0.0]	This is the minimum frequency which can act upon the setpoint via the secondary setpoint values. Secondary setpoints are all frequencies which are additionally supplied to the FC for further functions. Actual frequency PID — Frequency addition Frequency subtraction — Secondary setpoints via BUS Process controller min. frequency via analog setpoint (potentiometer)			
P411	**Maximum frequency secondary setpoint values**			P
-400.0 ... 400.0 Hz [50.0]	This is the maximum frequency which can act upon the setpoint via the secondary setpoint values. Secondary setpoints are all frequencies which are additionally supplied to the FC for further functions. Actual frequency PID — Frequency addition Frequency subtraction — Secondary setpoints via BUS Process controller max. frequency via analog setpoint (potentiometer)			
P412	**Setpoint process controller**		S	P
-10.0 ... 10.0 V [5.0]	To specify a fixed setpoint value for the process controller which is to be modified only rarely. Only with P400 = 14 ... 16 (process controller). For more details, please refer to Chapter 14.2, Process Controller.			
P413	**P quota PID controller**		S	P
0.0 ... 400.0 % [10.0]	Only effective if the function actual frequency PID has been selected. The P quota of the PID controller defines the frequency jump in case of a deviation in respect of the controller difference. Example: In case of a setting of P413 = 10% and a deviation of 50%, 5% is added to the current setpoint value.			
P414	**I quota PID controller**		S	P
0.0 ... 300.00 %/ms [1.00]	Only effective if the function actual frequency PID has been selected. In case of a deviation, the I quota of the PID controller will define the frequency modification in dependence on the time.			
P415	**D quota PID controller**		S	P

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
0 ... 400.0 %ms	Only effective if the function actual frequency PID has been selected.			
[1.0]	In case of a deviation, the D quota of the PID controller will define the frequency modification multiplied by time.			
P416	**Ramp PID controller**		S	P
0.00 ... 99.99s	Only effective if the function actual frequency PID has been selected.			
[2.00]	Ramp for the setpoint PID			



P417	Offset analog output		S	P
-10.0 ... 10.0 V [0.0]	In the analog output function, an offset can be set to simplify processing of the analog signal in several devices. if the analog output is programmed with a digital function, the difference between activation point and deactivation point (hysteresis) can be set in this parameter.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P418	**Function analog output**			P

0 ... 52

[0]

Analog functions:

An analog (0 … +10 volt) voltage can be picked off at the control terminals (max. 5 mA). Different functions are available, and the following generally applies: 0 volt analog voltage always correspond to 0% of the selected value. 10 volt corresponds to the respective nominal motor value (unless specified differently), multiplied by the factor of the scaling P419, e.g.:

$$\Rightarrow 10\text{Volt} = \frac{\text{Nominal motor value} \cdot \text{P419}}{100\%}$$

0 = **no function,** no output signal at the terminals.

1 = **actual frequency,** the analog voltage is proportional to the FC output frequency.

2 = **Actual speed;** this is the synchronous speed determined by the FC, based on the applied setpoint value. Load-dependent speed fluctuations are disregarded.

3 = **Current;** this is the effective value of the output current supplied by the FC.

4 = **Torque current;** this indicates the motor load torque calculated by the FC. (100% = P112)

5 = **Voltage;** this is the output voltage supplied by the FC.

6 = **DC bus voltage;** this is the DC voltage in the FC. This is not based on the nominal motor data. 10V with scaling of 100% corresponds to 450V DC (230V) or 850 volt DC (480V)!

7 = **Value of P542**; the analog output can be set via parameter P542 independent of the current operating state of the FC. For example with bus addressing (parameter order), this function can supply an analog value from the control.

8 = **Apparent power**; this is the current apparent motor power.

9 = **Active power**; this is the current active power calculated by the FC.

10 = **Torque [%]**; this is the current torque calculated by the FC.

11 = **Field [%]**; this is the current field in the motor calculated by the FC.

12 = **Output frequency ±**; the analog voltage is proportional to the output frequency of the FC, zero being shifted to 5V. With rotation direction right, the values 5V to 10V are output, and with rotation direction left, values 5V to 0V.

13 = **Actual speed ±;** this is the synchronous speed determined by the FC, based on the applied setpoint value. With rotation direction right, the values 5V to 10V are output, and with rotation direction left, values 5V to 0V.

14 = **Torque [%] ±**; the current torque calculated by the FC, zero being shifted to 5V. With motor-driven torques, values from 5V to 10V are output, and with regenerative torques, values from 5V to 0V.

30 = **Setpoint frequencies of frequency ramp;** this indicates the frequency resulting from any upstream controllers (ISD, PID, …). Then, this is the setpoint frequency for the rating class after it has been adjusted via the run-up or the brake ramp (P102, P103).

31 = **Value via BUS;** the analog output is controlled via a bus system. The process data are transmitted directly (P546, P547, P548).

Digital functions:

All relay functions described in parameter >Function relay 1< P434 can also be transmitted via the analog output. If a condition is met, 10V will be applied at the output terminals. A negation of this function can be specified in parameter >Scaling of analog output< P419.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
	15 = External brake		**28 =** **... 29** reserved	
	16 = Converter is running		**34 =** **... 43** reserved	
	17 = Current limit		**44 =** Bus in bit 0	
	18 = Torque current limit		**45 =** Bus in bit 1	
	19 = Frequency limit		**46 =** Bus in bit 2	
	20 = Setpoint value reached		**47 =** Bus in bit 3	
	21 = Failure		**48 =** Bus in bit 4	
	22 = Warning		**49 =** Bus in bit 5	
	23 = Overcurrent warning		**50 =** Bus in bit 6	
	24 = Overtemperature warning motor		**51 =** Bus in bit 7	
	25 = Torque current limit active		**52 =** Output via bus	
	26 = Value of P541, external control			
	27 = Regenerative torque current limit			

P419	**Scaling of analog output**			P
-500 ... 500 %	**analog functions P418 (= 0...14, 30, 31)**			
[100]	This parameter is used to adjust analog output to the desired operation range. The maximum analog output (10V) corresponds to the scaling value of the respective selection.			
	With a constant operating point, it follows that if this parameter is increased from 100% to 200%, the analog output voltage is reduced by half. Then, 10 volt output signal correspond to double the nominal value.			
	With negative values, the logic is reversed. Then, a setpoint value of 0% is rendered at the output with 10V, and -100% with 0V.			
	digital functions P418 (= 15...27, 44... 52)			
	With the function current limit (= 17), torque current limit (= 18) and frequency limit (= 19), this parameter can be used to set the switching threshold. The 100% value refers to the corresponding nominal motor value (also see P435).			
	With a negative value, the output function is rendered negativated (0/1 → 1/0).			

P420	**Function digital input 1**			
0 ... 62	**Release right** as factory setting			
[1]	Various functions may be programmed. Please refer to the following table.			

P421	**Function digital input 2**			
0 ... 62	**Release left** as factory setting			
[2]	Various functions may be programmed. Please refer to the following table.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P422	**Function digital input 3**			
0 ... 62	**Parameter record switch bit 0** as factory setting			
[8]	Various functions may be programmed. Please refer to the following table.			
P423	**Function digital input 4**			
0 ... 62	**Fixed frequency 1** (P429) as factory setting			
[4]	Various functions may be programmed. Please refer to the following table.			
P424	**Function digital input 5**			
0 ... 62	**No function** as factory setting			
[0]	Various functions may be programmed. Please refer to the following table.			

List of potential functions of the digital inputs P420…P424

Value	Function	Description	Signal
00	no function	Input is switched off.	---
01	Release right	FC supplies the output signal, phase sequence right (with positive setpoint value) 0 → 1 edge (P428 = 0)	high
02	Release left	FC supplies the output signal, phase sequence left (with positive setpoint value) 0 → 1 edge (P428 = 0)	high
	If automatic startup is active (P428 = 1), a high level is sufficient. If the functions 'release right' and 'release left' are addressed simultaneously, the FC will be blocked.		
03	Reversal of rotation direction	Results in reversal of phase sequence in connection with release right or left	high
04	Fixed frequency 1 [1]	The frequency of P429 is added to the current setpoint value.	high
05	Fixed frequency 2 [1]	The frequency of P430 is added to the current setpoint value.	high
06	Fixed frequency 3 [1]	The frequency of P431 is added to the current setpoint value.	high
07	Fixed frequency 4 [1]	The frequency of P432 is added to the current setpoint value.	high
	If several fixed frequencies are addressed simultaneously, they are added with the right signs. Furthermore, the analog setpoint value (P400) and if applicable the minimum frequency (P104) are added.		
08	Switch of parameter record bit 0	Selection of the active parameter record 1…4 (100)	high
09	Hold frequency	During startup or braking phase, a low level caused a "holding" of the current output frequency. A high level allows the ramp to continue.	low
10	Block voltage [2]	The FC output voltage is switched off, the motor runs down freely	low
11	Quick stop [2]	The FC reduces the frequency with the programmed quick stop time of P426.	low
12	Confirmation of failure [2]	Confirmation of failure with an external signal.	0→1 edge
13	PTC thermistor input [2]	Analog evaluation of the applied signal. Switching threshold approx. 2.5 volt. Switch-off delay = 2sec, warning after 1 sec.	analog
14	Remote control [2]	With control via bus system, the system switches to control via control terminals in case of low level.	high
15	Jog frequency [1]	Fixed frequency value that can be set via the UP / Down and the ENTER keys (P113).	high
16	Hold frequency motor potentiometer	Same as setting value 09, but below minimum frequency P104 and above max. frequency P105, the frequency is not held.	low
17	Parameter record switch bit 1	Selection of the active parameter record 1…4 (100)	high
18	Watchdog [2]	The input must cyclically (P460) see a high edge; otherwise, the system switches off with error E012.l The function starts with the 1. high edge.	0→1 edge

Value	Function	Description	Signal
19	Setpoint 1 on / off	Switching the analog input on and off 1/2 (high=ON). The low signal sets the analog input to 0%, which does not result in deactivation with a minimum frequency (P104) > the absolute minimum frequency (P505).	high
20	Setpoint 2 on / off		
21	Fixed frequency 5 [1)]	The frequency of P433 is added to the current setpoint value.	high
22…25	reserved		
26…29	**Pulse functions:** See the description on the next page.		
30	PID controller on / off	Switching the PID controller/process controller function on and off; high = ON	high
31	Disable release right	Disables the >Right/left release< via a digital input or bus address. Does not relate to the motor's actual sense of rotation (e.g. after negativated setpoint value).	low
32	Disable release left		low
33…42	**Pulse functions:** See the description on the next page.		
43…46	reserved		analog
47	Increase frequency	In combination with R/L release, the output frequency can be continuously adjusted. By activating both inputs (higher and lower), the current value can be saved for both in P113 for 0.5 s. With the next release with the same direction preselection, this value is the initial value; otherwise, start will be at f_{MIN}.	high
48	Reduce frequency		high
49	reserved		
50	Bit 0 fixed frequency array	Binary-coded digital inputs for generation of fixed frequencies. (P465)	high
51	Bit 1 fixed frequency array		high
52	Bit 2 fixed frequency array		high
53	Bit 3 fixed frequency array		high
54	Bit 4 fixed frequency array		high
55…62	reserved		

[1] If none of the digital inputs is programmed for right or left release, the addressing of a fixed frequency or the jog frequency will result in release of the frequency converter. The phase sequence depends upon the sign of the setpoint value.

[2] This also applies in case of control via BUS (RS232, RS485, CANopen, DeviceNet, Profibus,)

Functions pulse input: 2...22kHz (only for DIG 2 and DIG 3)

For these functions, the respective inputs evaluates the applied pulse frequency. The frequency range 2kHz to 22kHz covers the value range 0 to 100%. The inputs act up to a maximum pulse frequency of 32kHz. The voltage level may be between 15V and 24V and the duty-cycle between 50% and 80%.

Value	Function	Description	Signal
26	Torque current limit [2]	Adjustable load limit; when it is reached, the output frequency is reduced. → P112	Pulses
27	Actual frequency PID[2 3]	Potential actual value feedback for PID controller	Pulses
28	Frequency addition [2 3]	Addition to other frequency setpoint values	Pulses
29	Frequency subtraction [2 3]	Subtraction from other frequency setpoint values	Pulses
33	Current limit [2]	based on the set current limit (P536), it can be modified via the digital/analog input.	Pulses
34	Maximum frequency [2]	In analog range, the maximum frequency of the FU is set. 100% corresponds to the setting in parameter P411. 0% corresponds to the setting in parameter P410. The value cannot fall below the values for the min./max. output frequency (P104/P105) or exceed them.	Pulses
35	Actual frequency PID controller limited [2 3]	is needed to establish a control loop. The analog input (actual value) is compared to the setpoint value (e.g. another analog input, or fixed frequency). The output frequency is adjusted as far as possible until the actual value has approached the setpoint. (see controlled variables P413 - P416). The output frequency cannot fall below the programmed value of the minimum frequency in parameter P104. (no rotation direction reversal)	Pulses
36	Actual frequency PID controller monitored [2 3]	same as function 35 >Actual frequency PID<, but the FC will switch off the output frequency when the >minimum frequency< P104 has been reached.	Pulses
37	reserved		Pulses
38	Rate-action torque [2]	this function allows for teaching the controller in advance a value for the torque requirement (feedforward control). In lifting gears with separate load sensing function, this function can be used to ensure better load transfer. → P214	Pulses
39	Multiplication [3]	This factor multiplies the main setpoint value.	Pulses
40	PI actual value process controller	same as P400 = 14-16 For more details on the process controller, also see Chapter 14.2, Process Controller.	Pulses
41	PI setpoint value process controller		Pulses
42	PI rate-action process controller		Pulses

[2] This also applies in case of control via BUS (RS232, RS485, CANopen, DeviceNet, Profibus,)

[3] The limits of these values are determined by the parameter >Minimum frequency secondary setpoints< P410 and the parameter >Maximum frequency secondary setpoints< P411.

Value Function	Description			Signal
Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P426	**Quick-stop time**			P
0 ... 320.00 s [0.10]	Setting the braking time for the quick stop function which can be activated via a digital input, the bus control, the keyboard, or automatically in case of error. Quick-stop time is the time which corresponds to the linear frequency reduction from the set maximum frequency (P105) to 0Hz. When a current setpoint value <100% is used, the braking time is reduced accordingly.			
P427	**Quick-stop in case of failure**		S	
0 ... 3 [0]	Activation of automatic quick-stop in case of error **0 = OFF:** Automatic quick-stop in case of failure is deactivated **1 = Mains failure:** Automatic quick-stop in case of mains failure **2 = Error:** Automatic quick-stop in case of error **3 = Mains failure and error:** Automatic quick-stop in case of mains failure and error			
P428	**Automatic startup**		S	P
0 ... 1 [0]	In standard setting (P428 = **0** → **Off**), the FC requires for release an edge (signal change from "low → high") at the respective digital input. In the position **On** → **1**, the FC reacts to an applied high level. This function is only available if the FC is controlled via the digital inputs. (see P509=0/1) In some cases, the FC must start directly with the mains activation. For this, P428 = **1** → **On** can be set. If the release signal is permanently activated or equipped with a wire jumper, the FC will start up directly.			
P429	**Fixed frequency 1**			P
-400 ... 400 Hz [0]	The fixed frequency is used as setpoint value after addressing via a digital input and the release of the FC (right or left). A negative setting value causes reversal of sense of rotation in respect of the release sense of rotation P420…P425. If several fixed frequencies are addressed at the same time, the individual values will be added with the correct signs. This also applies to the combination with the jog frequency (P113), the analog setpoint value (P400 = 1) or the minimum frequency (P104). The values cannot remain under or exceed the frequency limits (P104 = f_{min}, P105 = f_{max}). If none of the digital inputs is programmed for (right or left) release, the simple fixed frequency signal will cause release. Then, a positive fixed frequency corresponds to release on the right side and a negative one to a release on the left side.			
P430	**Fixed frequency 2**			P
-400 ... 400 Hz [0]	Function description of the parameter, see **P429 >Fixed frequency 1<**			
P431	**Fixed frequency 3**			P
-400 ... 400 Hz [0]	Function description of the parameter, see **P429 >Fixed frequency 1<**			
P432	**Fixed frequency 4**			P
-400 ... 400 Hz [0]	Function description of the parameter, see **P429 >Fixed frequency 1<**			

Value	Function	Description			Signal
P433	**Fixed frequency 5**				P
-400 ... 400 Hz [0]	Function description of the parameter, see **P429 >Fixed frequency 1<**				
P434	**Function relay 1**				P
0 ... 38 [1]	The settings 3 to 5 work with a 10% hysteresis; this means that the relay contact closes (function 11 opens) when the limit value is reached, and opens (function 11 closes) when the value falls below a value which is lower by 10%.				

Setting / function	Relay contact... with limit value or function
0 = no function	open
1 = external brake, for controlling a mechanical brake at the motor. The relay switches at the programmed absolute minimum frequency. For typical brakes, a setpoint value delay of 0.2...0.3 s (also see P170) should be programmed. A mechanical brake may be connected directly at the AC current side. (Please observe the technical specification of the relay contact).	closes
2 = Converter is running, the closed relay contact signals voltage at the converter output (U - V - W).	closes
3 = Current limit, based on the setting of the nominal motor current in P203. This value can be adjusted via scaling (P435).	closes
4 = Torque current limit, based on the setting of the motor data in P203 and P206. Signals a corresponding torque load at the motor. This value can be adjusted via scaling (P435).	closes
5 = Frequency limit, based on the setting of the nominal motor frequency in P204. This value can be adjusted via scaling (P435).	closes
6 = Setpoint value reached, indicates that the FC has completed the frequency increase or reduction. Setpoint frequency = actual frequency! From a difference of 1 Hz *Setpoint not reached - contact opens.*	closes
7 = Failure, total failure message, failure is active or not yet confirmed. *Operative - closes*	opens
8 = Warning, total warning; a limit value has been reached which may cause subsequent deactivation of the FC.	opens
9 = Overcurrent warning, at least 130% nominal converter current for 30 sec.	opens
10 = Motor overtemperature warning: The motor temperature is evaluated via a digital input. motor is too hot. The warning is displayed immediately, the overtemperature deactivation follows after 2 seconds.	opens
11 = Torque current limit/current limit active (warning), Limit value in P112 or P536 has been reached. P435 is insignificant. Hysteresis = 10%.	opens
12 = Relay through P541 - external control, the relay can be controlled via parameter 541 (bit 0) independent of the FC's current operating status.	closes

Value	Function	Description	Signal
		13 = Torque value regeneratively active: The limit value in P112 has been reached in regenerative range. Hysteresis = 10%	closes
		14 = ... 29 reserved	---
		30 = Bus IO in bit 0 / bus in bit 0 (AS1 option)	closes
		31 = Bus IO in bit 1 / bus in bit 1 (AS1 option)	closes
		32 = Bus IO in bit 2 / bus in bit 2 (AS1 option)	closes
		33 = Bus IO in bit 3 / bus in bit 3 (AS1 option)	closes
		34 = Bus IO in bit 4 / bus in bit 4 (AS1 option)	closes
		35 = Bus IO in bit 5 / bus in bit 5 (AS1 option)	closes
		36 = Bus IO in bit 6 / bus in bit 6 (AS1 option)	closes
		37 = Bus IO in bit 7 / bus in bit 7 (AS1 option)	closes
		38 = Output via bus	closes

P435	**Scaling relay 1**			P
-400 ... 400 % [100]	Adjustment of the limit value of the relay function. With positive setting values, the relay contact closes, and with negative setting values it opens when the limit value is reached. Current limit = x [%] · P203 >Nominal motor current Torque current limit = x [%] · P203 · P206 (calculated nominal motor torque) Frequency limit = x [%] · P201 >Nominal motor frequency< Values in the range of +/- 20% are internally limited to 20%.			

P436	**Hysteresis relay 1**		S	P
1 ... 100 % [10]	Difference between activation and deactivation point to prevent oscillation of the output signal.			

P441	**Function relay 2**			P
0 ... 38 [7]	The functions are identical with P434!			

P442	**Scaling relay 2**			P
-400 ... 400 % [100]	The functions are identical with P435!			

P443	**Hysteresis relay 2**			P
1 ... 100 % [10]	The functions are identical with P436!			

P460	**Time watchdog**		S	
0.0 / 0.1 ... 250.0 s [10.0]	**0.1 ... 250.0** = The time interval between the expected watchdog signals (programmable function of the digital inputs P420 - P425). If this time interval elapses without registration of a pulse, the FC switches off with error message E012. **0.0 = Customer error**, as soon as a low-high edge is registered at the input, the FC will switch off with error E012.			

Value	Function	Description			Signal
P465	**... - 01 ... ... - 31**	**Fixed frequency field**			
-400.0 ... 400.0 Hz [0]	In the array levels, up to 31 different fixed frequencies can be set; these frequencies can be selected with the functions 50...54 for the digital inputs.				
P466		**Minimum frequency process controller**			P
-400.0 ... 400.0 Hz [0.0]	By means of the minimum frequency process controller, the controller quota can be retained to a minimum quota, also with a reference value of "zero", for example to provide for alignment of the dancer. More details in P400.				
P475	**... - 01 ... ... - 09**	**Activation/ deactivation delay**		S	
-30.000 ... 30,000 s [0.000]	Adjustable activation and deactivation delay for the digital inputs and the digital functions of the analog inputs. Utilization as activation filter or simple process control is possible. **[00] =** digital input 1 **[01] =** digital input 2 **[02] =** digital input 3 **[03] =** digital input 4 **[04] =** digital input 5 **[05] =** reserved **[06] =** reserved **[07] =** digital function analog input 1 **[08] =** digital function analog input 2 **Positive values** = activation delayed **Negative values** = deactivation delayed				
P480	**... - 01 ... ... - 12**	**Function bus I/O in bits**		S	
0 ... 62 [12]	The bus I/O in bits are regarded as digital inputs. They can be set to the same functions (P420...425) **[01] =** Bus I/O in bit 1 **[02] =** Bus I/O in bit 2 **[03] =** Bus I/O in bit 3 **[04] =** Bus I/O in bit 4 **[05] =** Bus I/O initiator 1 **[06] =** Bus I/O initiator 2 **[07] =** Bus I/O initiator 3 **[08] =** Bus I/O initiator 4 **[09] =** Marker 1 **[10] =** Marker 2 **[11] =** Bit 8 BUS control word **[12] =** Bit 9 BUS control word For the potential functions for the BUS in bits, please see the table of the functions of digital inputs P420...P425.				

Value	Function	Description			Signal
P481	**... - 01 ... ... - 10**	**Function bus I/O out bits**		S	

0 ... 38

[10]

The bus I/O in bits are regarded as multi-function relay outputs. They can be set to the same functions (P434...443)

[01] =	Bus I/O out bit 1	**[06] =**	Bus I/O actuator 2
[02] =	Bus I/O out bit 2	**[07] =**	Marker 1
[03] =	Bus I/O out bit 3	**[08] =**	Marker 2
[04] =	Bus I/O out bit 4	**[09] =**	Bit 10 BUS status word
[05] =	Bus I/O actuator 1	**[10] =**	Bit 13 BUS status word

For the potential functions for the BUS out bits, please see the table of the functions of relays P434.

P482	**... - 01 ... ... - 08**	**Scaling bus I/O out bit**		S	

-400 … 400 %

[100]

Adjustment of the limit values of the relay functions / bus out bits. With a negative value, the output function is rendered negativated.

With positive setting values, the relay contact closes, and with negative setting values it opens.

P483	**... - 01 ... ... - 08**	**Hysteresis bus I/O out bit**		S	

1 … 100 %

[10]

Difference between activation and deactivation time to prevent oscillation of the output signal.

11.5 Additional Parameter

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P502	**... - Value reference function ... -**		S	P

0 ... 21

[0]

Selection of up to 3 reference values:

[01] = reference value 1 **[02] =** reference value 2 **[03] =** reference value 3

Selection of the available setting values for the reference values:

0 = off
1 = Actual frequency
2 = actual speed
3 = Current
4 = Torque current
5 = status digital inputs and multi-function relay
6 = reserved
7 = reserved
8 = Setpoint frequency
9 = Error Message
10 = reserved
11 = reserved
12 = Digital out bit's 0...7
13 = reserved
14 = reserved
15 = reserved
16 = reserved
17 = Value analog input 1
18 = Value analog input 2
19 = Setpoint frequency reference value
20 = Setpoint frequency after ramp reference value
21 = Actual frequency without slippage reference value

P503	**Reference function output**		S	

0 ... 2

[0]

To use the reference function output, select the source of the converter control in P509. In parameter P502, the reference value to be transferred through the BUS interface is determined.

0 = off **1 = USS** **2 = CAN** (up to 250kBaud)

P504	**Pulse frequency**		S	

3.0 ... 16.0 kHz

[6.0]

With this parameter, the internal pulse frequency for control of the power section can be modified. A high setting value results in a motor noise reduction, but also to increased EMC radiation and reduction of possible motor torque.

Note: When the setting 6.0kHz is chosen, the degree of radio interference limit curve A 1 is observed. As a precondition, the wiring guidelines must be met. For more details, please refer to Chapter 13.4, Electromagnetic Compatibility (EMC).

Note: An increase of the pulse frequency causes a reduction of the available output current in dependence on the time (I^2t characteristic). For more details, see Chapter 13.2, Derating of Electrical Data.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P505	**Absolute minimum frequency**		S	P
0.0 ... 10.0 Hz [2.0]	Specifies the frequency value below that the FC cannot fall below. If the setpoint value falls under the absolute minimum frequency, the FC will switch off or change to 0.0Hz. At absolute minimum frequency, brake control (P434 or P441) and setpoint value delay (P107) is executed. If the setting value "zero" is selected, the brake relay will not switch at reversing. With lifting gear controls, this value should be set to 2Hz as a minimum. The current control of the FC works from 2Hz, and a connected motor can generate sufficient torque. **Note:** Output frequencies < 2Hz result in a current limitation. For more details, see Chapter 13.2, Derating of Electrical Data.			
P506	**Automatic error confirmation**		S	
0 ... 7 [0]	Alternative to the manual error confirmation, also automatic confirmation can be selected. **0 = No automatic** error confirmation. **1...5 = Number** of the permissible automatic error confirmations within one mains-on-cycle. After mains switch-off and switch-on, the full number is available once more. **6 = Always,** an error confirmation is always confirmed automatically when the error cause is no longer pending. **7 = ENTER key,** confirmation is only possible with the Enter key or mains switch-off. Confirmation is not executed by removing the release!			
P507	**PPO Type**			
1 ... 4 [1]	With the function modules FCC01.1F-xxx			
P508	**Profibus address**			
1 ... 126 [1]	With the function modules FCC01.1F-PB1 and –PB2 Also refer to Chapter 15, Master Communication - Field Busses and Protocols.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P509	**Source control word**			

0 ... 9

[0]

Selection of the interface through which the FC is controlled.

0 = **Control terminals or keyboard control** ** with the standard control panel and the Comfort control panel, when P510 = 0, or via bus I/O bits.

1 = **Only control terminals** *; controlling the FC is possible only via the digital and analog inputs, or via BUS I/O bits.

2 = **USS** control word *; the control signals (release, sense of rotation, ...) are transferred via the RS485 interface, and the setpoint value via the analog input or the fixed frequencies.

3 = reserved

4 = **Profibus** control word *

5 = reserved

6 = **CANopen** control word *

7 = **DeviceNet** control word *

8 = reserved

9 = **CAN Broadcast** *

*) Keyboard control via the operating elements is blocked, continued parameterization is possible.

**) If communication is faulty in case of control via keyboard (time out 0.5s),the FC will block without error message.

P510	**... - ... -**	**Source setpoint values**		S	

0 ... 8

[0]

Selection of the setpoint value source to be parameterized:

[01] = Source **main setpoint value** **[02] =** Source **secondary setpoint value**

Selection of the interface through which the FC receives its setpoint values.

0 = **Auto:** The source of the secondary setpoint value is automatically derived from the setting of parameter P509 >interface<.

1 = **Control terminals,** digital and analog inputs control the frequency, also fixed frequencies.

2 = **USS**

3 = reserved

4 = **Profibus**

5 = reserved

6 = **CANopen**

7 = **DeviceNet**

8 = reserved

P511	**USS Baud rate**		S	

0 ... 3

[3]

Setting of the transmission rate (transmission speed) via the interface RS485. All bus nodes must have the same Baud rate setting.

0 = 4800 baud **2 =** 19200 baud

1 = 9600 baud **3 =** 38400 baud

P512	**USS address**			

0 ... 30

[0]

Setting of the FC bus address.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P513	**Telegram downtime**		S	
0.0 / 0.1 ... 100.0 s [0.0]	Monitoring function of the respectively active bus interface. After receipt of a valid telegram, the next telegram must arrive within the preset time. If not, the FC will signal an error and switches off with the error message E010 >Bus time out<. With the setting value *0.0 = off*, monitoring is switched off.			
P514	**CAN Baud rate**			
0 ... 7 [4]	Setting of the transmission rate (transmission speed) via the CANbus interface. All bus nodes must have the same Baud rate setting. Also refer to Chapter 15, Master Communication - Field Busses and Protocols. **0 =** 10kBaud **3 =** 100kBaud **6 =** 500kBaud **1 =** 20kBaud **4 =** 125kbaud **7 =** 1Mbaud * (only for test purposes) **2 =** 50kBaud **5 =** 250kBaud *) safe operation is not guaranteed			
P515	**CAN address**			
0 ... 255 [50]	Setting of the CANbus address			
P516	**Hiding frequency 1**		S	P
0.0 ... 400.0 Hz [0.0]	Setting the hiding frequency (also see P517). This range is traversed with the set braking and run-up ramps; it cannot be permanently supplied at the output. Frequencies below the absolute minimum frequency should not be set. **0 =** Hiding frequency inactive			
P517	**Hiding range 1**		S	P
0.0 ... 50.0 Hz [2.0]	Hiding range for the >Hiding frequency 1< -516. This frequency is not added to and subtracted from the hiding frequency. Value range: (P516 - P517) < hiding range 1 < (P516 + P517)			
P518	**Hiding frequency 2**		S	P
0.0 ... 400.0 Hz [0.0]	Function as P516			
P519	**Hiding range 2**		S	P
0.0 ... 50.0 Hz [2.0]	Function as P517			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P520	**Flying restart circuit**		S	P
0 ... 4	Suitable only fro motor frequencies < 100Hz.			
[0]	This function is needed to lock on the FC to already rotating motors, e.g. with fan drives.			
	0 = Switched off, no flying restart circuit.			
	1 = Both directions, the FC searches a speed in both directions.			
	2 = In direction of the setpoint value, the FC searches only in the direction of the applied setpoint value.			
	3 = Both directions, only after mains failure and error			
	4 = In direction of the setpoint value, only after mains failure and error			
P521	**Flying restart circuit resolution**		S	P
0.02... 2.50 Hz [0.05]	With this parameter, the increment used for searching the flying restart circuit can be modified. Excessively high values are detrimental to the accuracy and cause FC failure with overcurrent message. Excessively small values greatly prolong searching time.			
P522	**Flying restart circuit offset**		S	P
-10.0 ... 10.0 Hz [0.0]	A frequency value which can be added to the found frequency value, for example to get into the motor-driven range, to avoid the chopper range.			
P523	**Factory setting**			
0 ... 2 [0]	By addressing the corresponding value and confirmation with the Enter key, the selected parameter range is set to factory setting. After the setting has been made, the value of the parameter automatically changes back to 0.			
	0 = No change. Does not change the parameterization.			
	1 = Load factory setting: All parameterization of the FC is reset to factory setting. All parameterized data is lost.			
	2 = Factory setting without bus: All parameters of the FC, but not the bus parameters are reset to factory setting.			
P535	**I^2t motor**		S	
0 ... 1 [0]	The motor temperature is calculated in dependence on the output current, the time and the output frequency (cooling). Reaching of the temperature limit results in deactivation and error message E002 (overtemperature motor). Here, environmental conditions cannot be taken into consideration.			
	0 = switched off			
	1 = switched on			
P536	**Current limit**		S	
0.1 ... 2.0 / 2.1	The FC output current is limited to the set value. If this limit is reached, the FC reduces the current output frequency.			
[1.5]	Multiplier with the nominal FC current; makes up the limit value			
	Current limit value = P536 x nominal $current_{FC}$			
	2.1 = OFF stands for deactivation of this limit value. This is also the basic setting of this parameter.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P537	**Pulse deactivation**		S	

10...200%/201

[150]

This function is used to prevent quick deactivation of the FC when a corresponding load is applied. With pulse deactivation activated, the output current is limited to the set value. This limitation is realized by temporary deactivation of individual output transistors. The current output frequency is retained.

10...200% = limit value in respect of the nominal FC current

201% = function is deactivated

Note: A smaller value in P536 may fall below the value set here.
With small output frequencies (< 4.5 Hz) or high pulse frequencies (> 6 kHz), the power reduction (also see Chapter 13.2, Derating of Electrical Data) may fall below the pulse deactivation.

Note: When pulse deactivation is switched off (P537=201) and a high pulse frequency is selected in parameter P504, the frequency converter will automatically reduce the pulse frequency on reaching of power limits. When the frequency converter is relieved again, the pulse frequency will return to its original higher value.

P538	**Monitoring of mains voltage**		S	

0 ... 4

[3]

For safe operation of the frequency converter, the power supply must meet certain quality criteria. If a phase is temporarily interrupted, or if the supply voltage falls below a certain limit, the converter will signal a failure.

Under certain circumstances, it may be necessary to suppress this error message. In this case, input monitoring can be adjusted.

0 = Switched off: no monitoring of the supply voltage.

1 = Only phase error: only phase errors cause an error message.

2 = Only undervoltage: only undervoltages cause an error message.

3 = Phase error and undervoltage: undervoltages and phase errors cause an error message.

4 = DC supply: In case of direct supply with DC voltage the input voltage is fixedly received at 480 V. Phase error and mains undervoltage monitoring is deactivated.

Note: The FC may be destroyed if operated with an impermissible mains voltage!

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P539	**Output monitoring**		S	P

0 ... 3

[0]

This safety function is used to monitor the output current at the terminals U-V-W and to check it for plausibility. In case of failure, error message E016 is output.

0 = **Switched off:** No monitoring takes place.

1 = **Only motor phase error:** The output current is measured and checked for symmetry. If there is an asymmetry, the FC will switch off and signals error E016.

2 = **Only magnetization monitoring:** In the moment of FC activation, the amount of magnetization current (field current) is checked. If there is not enough magnetization current, the FC will switch off with error message E016. This happens independent of the parameters P107/P114; no motor brake is released.

3 = **Motor phase and magnetization monitoring**

Note: This function is recommended as an additional safety function for lifting gear applications, but is impermissible as a sole measure for protection of individuals.

P540	**Rotation direction mode**		S	P

0 ... 7

[0]

This parameter can be used to prevent for safety reasons a reversal of rotation direction, and thus incorrect rotation.

0 = **No limitation of the rotation direction**

1 = **Block reversal of rotation direction;** the rotation direction key of the comfort control panel is blocked.

2 = **Only clockwise rotation***; only phase sequence right is possible. Selection of the "incorrect" sense of rotation results in output of 0Hz.

3 = **Only anti-clockwise rotation***; only phase sequence left is possible. Selection of the "incorrect" sense of rotation results in output of 0Hz.

4 = **Only release direction;** sense of rotation is possible only in accordance with the release signal; otherwise, 0Hz is supplied.

5 = **Only clockwise rotation monitored***; only phase sequence right is possible. Selection of the "incorrect" sense of rotation results in FC deactivation.

6 = **Only anti-clockwise rotation monitoring***; only phase sequence left is possible. Selection of the "incorrect" sense of rotation results in FC deactivation.

7 = **Only release direction monitored;** sense of rotation is only possible according to the release signal; otherwise, the FC is deactivated.

*) is applicable for control via keyboard and control terminals, and the direction key of the standard control panel is blocked.

P541	**Set relay**		S	

0000 ... 3F1F (hex)

[0000]

This function offers the possibility to control the relays and the digital outputs independent of the frequency converter status. To this end, the output in question must be set to the function "external control".

This function can be used manually or in connection with a bus address.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record

Bit 0 = relay 1
Bit 1 = relay 2
Bit 2 = relay 3 (DOUT1)
Bit 3 = relay 4 (DOUT2)
Bit 4 = Dig AOut 1 (analog output 1)
Bit 5...7 = reserved
Bit 8 = Bus out bit 0
Bit 9 = Bus out bit 1
Bit 10 = Bus out bit 2
Bit 11 = Bus out bit 3
Bit 12 = Bus out bit 4
Bit 13 = Bus out bit 5

	Bit 13-12	Bit 11-8	Bit 7-4	Bit 3-0	
Min. value	00	0000	0000	0000	binary
	0	**0**	**0**	**0**	**hex**
Max. value	11	1111	0001	1111	binary
	3	**F**	**1**	**F**	**hex**

BUS: The corresponding hex value is written into the parameter, and thus the relays and/or digital outputs are set.

Standard control panel: When the standard control panel is used, directly enter the hexadecimal code.

Comfort control panel: Each individual output can be separately called up into the plain text and activated.

P542 Set analog output

S

0.0 ... 10.0 V

[0.0]

With this function, the FC's analog output can be set independent of its current operating status. To this end, the analog output in question must be set to the function "external control" (P418 = 7).

This function can be used manually or in connection with a bus address. The value set here is output after confirmation at the analog output.

P543 Actual bus value 1

S P

0 ... 21

[1]

In this parameter, the return value 1 can be selected when the bus is addressed.

NOTE: For more details, please refer to the respective BUS operating instructions or the description on P400.

0 = off
1 = Actual frequency
2 = actual speed
3 = Current
4 = torque current (100% = P112)
5 = *see status digital inputs & relay
6 = **... 7** reserved
8 = setpoint frequency
9 = error Number
10 = **... 11** reserved
12 = Bus out bit 0...7
13 = **... 16** reserved
17 = value analog input 1 (P400)
18 = value analog input 2 (P405)
19 = setpoint frequency reference value (P503)
20 = Setpoint frequency after ramp reference value
21 = Actual frequency without slippage reference value

*see status digital inputs & relay

Bit 0 = DigIn 1
Bit 1 = DigIn 2
Bit 2 = DigIn 3
Bit 3 = DigIn 4
Bit 4 = DigIn 5
Bit 5 = reserved
Bit 6 = reserved
Bit 7 = reserved
Bit 8 = reserved
Bit 9 = reserved
Bit 10 = reserved
Bit 11 = reserved
Bit 12 = Rel 1
Bit 13 = Rel 2
Bit 14 = reserved
Bit 15 = reserved

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P544	**Actual bus value 2**	S		P
0 ... 21	This parameter is identical with P543			
[0]	Condition is PPO 2 or PPO 4 type (P507).			
P545	**Actual bus value 3**		S	P
0 ... 21	This parameter is identical with P543			
[0]	Condition is PPO 2 or PPO 4 type (P507).			
P546	**Function bus - Setpoint value 1**		S	P
0 ... 24 [1]	In this parameter, the supplied setpoint value 1 is assigned a function in case of bus address.			

Note: For more details, please refer to Chapter 15, Master Communication - Field Busses and Protocols.

0 = off
1 = setpoint frequency (16 bit)
2 = torque current limit (P112)
3 = actual frequency PID
4 = frequency addition
5 = frequency subtraction
6 = current limit (P536)
7 = maximum frequency (P105)
8 = actual frequency PID limited
9 = actual frequency PID monitored
10 = torque
11 = rate-action torque (P214)
12 = reserved
13 = multiplication
14 = PI actual value process controller
15 = PI setpoint value process controller
16 = PI rate-action process controller
17 = digital in bit's 0...0.7
18 = reserved
19 = status relay (P541)
20 = value analog output (P542)
21 = ... 24 reserved

P547	**Bus - setpoint 2**		S	P
0 ... 24 [0]	This parameter is identical with P546.			
P548	**Bus - setpoint 3**		S	P
0 ... 24 [0]	This parameter is identical with P546.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P549	**Function potentiometer box**		S	
0 ... 16 [1]	reserved			
P550	**ParameterBoxJobs**			
0 ... 3 [0]	Only available with standard control panel. Within the standard control panel, a data record can be saved which consists of parameter record 1 to 4 of the connected FC. The data record is written within the operating panel into an E²PROM. Thus, it can be transferred to other FCs with the same database version (P742). 0 = no function 1 = FC -> Standard control panel, the FC writes the data record into the E^2PROM of the control panel; any existing data is overwritten. 2 = Standard control panel -> FC, the control panel writes the data record into the FC 3 = FC <--> Standard control panel, the FC's data record is exchanged for that of the control panel. No data is lost here. Accordingly, data can be changed back again.			

Note: Procedure in case of different firmware versions of the FC: To ensure that enough capacity is reserved in the memory of the standard control panel, the control panel must first be written with the parameters of the current firmware version (P707) (P550 = 1).Then, the parameters to be transferred must be loaded into the box from an older firmware version and then written into the new FC.

P551	**Drive profile**		S	
On / off [0 = off]	This parameter is used to activate the CANopen profile DS401.			
P554	**Min. application point chopper**		S	
65 ... 100 % [65]	This parameter is used to influence the switching threshold of the brake chopper. In factory setting, an optimized value for many applications is set. For applications where energy is supplied back in oscillating fashion (crank drive), this parameter value can be increased to minimize the power dissipation at the braking resistor. An increase of this setting results in faster overvoltage switch-off of the FC.			
P555	**Power limitation chopper**		S	
5 ... 100 % [100]	This parameter is used to program a manual (peak) power limitation for the braking resistor. The ON time (modulation degree) of the brake chopper can increase up to the specified limit. When the value is reached, the FC will de-energize the resistor independently of the amount of the DC bus voltage. In consequence, the overvoltage deactivation of the FC would follow.			
P556	**Braking resistor**		S	
20 ... 400 Ω [120]	The value of the braking resistor for the calculation of the maximum braking power to protect the resistor. If the maximum continuous power (P557) is reached, the error I^2t limit (E003) is triggered.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P557	**Power braking resistor**		S	
0.00 ... 20.00 kW [^{0}.00]	Continuous power (nominal power) of the resistor for calculating the maximum braking power. **0.00 =** monitoring deactivated			
P558	**Magnetization time**		S	P
0 / 1 / 2 ... 500 ms [1]	The ISD control can only work properly if there is a magnetic field in the motor. For this reason, DC current is applied to the motor before the start. The duration depends upon the motor dimension and is automatically set in the FC factory setting. For time-critical applications, magnetization time can be set or deactivated. **0 =** switched off **1 =** automatic calculation **2 ... 500 =** correspondingly set time in [ms] **Note:** Excessively small values can reduce dynamics and torque development on start-up.			
P559	**DC lag time**		S	P
0.00 ... 2.50 s [0.50]	After a stop signal and expiry of the brake ramp, a DC current is temporarily applied to the motor in order to completely deactivate the drive. Depending on mass inertia, the time of current application can be set via this parameter. The amount of current depends on the previous braking process (current vector control) or on the static boost (linear characteristic).			
P560	**Save to EEPROM**		S	
0 ... 1 [0]	**0 =** Changes of the parameter settings are lost when the FC is disconnected from the mains. **1 =** All parameter settings are automatically written into the EEPOM. Thus, they are retained when the FU is disconnected from the mains. **Note:** When the USS protocol is used to modify parameters, please ensure that the maximum number of write cycles to the EEPROM (100.000 x) is not exceeded.			

11.6 Information

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P700	**Current error**			
0.0 ... 21.4	Currently pending error. For more details, see Chapter 12, Error Messages. **Standard control panel:** The description of the individual error numbers can be found under 'Error Messages'. **Comfort control panel:** The errors are indicated in plain text. For more information, see under 'Error Messages'.			
P701 ... - 01 ... ... - 05	**Last error 1...5**			
0.0 ... 21.4	This parameter saves the last 5 errors. For more details, see Chapter 12, Error Messages. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored error code. **Note:** The current error is always saved to array "-01.			
P702 ... - 01 ... ... - 05	**Freq. last error 1...5**		S	
-400.0 ... 400.0 Hz	This parameter saves the output frequency that was supplied at the moment of error. The values of the last 5 errors are saved. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored value.			
P703 ... - 01 ... ... - 05	**Current last error 1...5**		S	
0.0 ... 999.9 A	This parameter saves the output current that was supplied at the moment of error. The values of the last 5 errors are saved. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored value.			
P704 ... - 01 ... ... - 05	**Voltage last error 1...5**		S	
0 ... 500 V AC	This parameter saves the output voltage that was supplied at the moment of error. The values of the last 5 errors are saved. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored value.			

Parameter		Setting value / description / note	Device	Supervisor	Parameter record
P705	**... - 01 ... ... - 05**	**DC bus volt. last error 1...5**		S	
0 ... 1000 V DC		This parameter saves the DC bus voltage that was supplied at the moment of error. The values of the last 5 errors are saved. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored value.			
P706	**... - 01 ... ... - 05**	**Parameter record last error 1...5**		S	
0 ... 3		This parameter saves the parameter record identification that was active at the moment of error. The data of the last 5 errors is saved. With the standard control panel, the corresponding memory location 1...5 (array parameter) must be addressed and confirmed with the ENTER key to read the stored error code.			
P707	**... - 01 ... - 02**	**Software-Version/ - Revision**			
0.0 ... 9999.9		Contains the software version of the FC, cannot be modified.		**... - 01 =** version number (1.1) **... - 02 =** revision number (2)	
P708		**Status digital inputs**			
000000000 ... 111111111 (binary) *or* 0000 ... 01FF (hexadecimal)		Indicates the status of the digital inputs in binary/hexadecimal code. This indication can be used to check the input signals. **Bit 0 =** digital input 1 **Bit 1 =** digital input 2 **Bit 2 =** digital input 3 **Bit 3 =** digital input 4 **Bit 4 =** digital input 5 **Bit 5** = reserved **Bit 6** = reserved **Bit 7 =** digital function analog input 1 **Bit 8 =** digital function analog input 2			

	Bit 11-8	Bit 7-4	Bit 3-0	
Minimum value	0000	0000	0000	binary
	0	**0**	**0**	**hex**
Maximum value	0001	1111	1111	binary
	1	**F**	**F**	**hex**

Standard control panel: the binary bits are indicated as a hexadecimal value.

Comfort control panel: the bits are indicated from right to left in ascending order (binary).

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P709	**Voltage analog input 1**			
0.00 ... 10.00 V	Indicates the value least measured of analog input 1.			
P710	**Voltage analog output**			
0.0 ... 10.0 V	Indicates the value least rendered of analog output 1. (0.0 ... 10.0V)			
P711	**Status multi-function relay**			
0000 ... 01FF (hex)	Indicates the current status of the pilot relay. **Bit 0 =** Relay 1 **Bit 1 =** Relay 2 **Bit 2** = reserved **Bit 3** = reserved			
P712	**Voltage analog input 2**			
0.00 ... 10.00 V	See parameter P709.			
P714	**Operating hours**			
0.10 ... 9999.99 h	This parameter indicates how long the mains voltage has been applied to the FC.			
P715	**Release hours**			
0.00 ... 9999.99 h	This parameter indicates how long the FU has been released.			
P716	**Current frequency**			
-400.0 ... 400.0 Hz	Indicates the current output frequency.			
P717	**Current speed**			
-9999 ... 9999 rpm	Indicates the motor speed calculated by the FC.			
P718 **... - 01** **... - 02** **... - 03**	**Current setpoint frequency**			
-400.0 ... 400.0 Hz	Indicates the frequency specified by the setpoint value (also refer to Chapter 14.1, Setpoint Processing in FSC01). **... - 01 =** current setpoint frequency from the setpoint source **... - 02 =** current setpoint frequency after processing in the FC status machine **... - 03 =** current setpoint frequency after frequency ramp			
P719	**Current power**			
0.0 ... 999.9 A	Indicates the current output current.			
P720	**Current torque current**			
-999.9 ... 999.9 A	Indicates the currently calculated torque-determining output current (active current). negative values = regenerative, positive values = motor-driven			
P721	**Current field power**			
-999.9 ... 999.9 A	Indicates the currently calculated field current (reactive current).			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P722	**Current voltage**			
0 ... 500 V	Indicates the AC voltage currently supplied at the FC output.			
P723	**Current voltage component Ud**			
0 ... 500 V	Indicates the current field voltage component.			
P724	**Current voltage component Uq**			
0 ... 500 V	Indicates the current torque voltage component.			
P725	**Current cosφ**			
0.00 ... 1.00	Indicates the currently calculated cos φ of the drive.			
P726	**Apparent power**			
0.00 ... 99.99 kVA	Indicates the currently calculated apparent power.			
P727	**Mechanical power**			
-99.99 ... 99.99 kW	Indicates the currently calculated active power at the motor.			
P728	**Mains voltage**			
0 ... 1000 V	Indicates the mains voltage currently applied at the FC.			
P729	**Torque**			
0 ... 400 %	Indicates the currently calculated torque.			
P730	**Field**			
0 ... 400 %	Indicates the field in the motor currently calculated by the FC.			
P731	**Current parameter record**			
0 ... 3	Indicates the current parameter record. **0 =** Parameter record 1 **1 =** Parameter record 2 **2 =** Parameter record 3 **3 =** Parameter record 4			
P732	**Current phase U**		S	
0.0 ... 999.9 A	Indicates the current of phase U. **NOTE:** By reason of the measuring method with symmetric output currents, this value may deviate from the value in P719.			
P733	**Current phase V**		S	
0.0 ... 999.9 A	Indicates the current of phase V. **NOTE:** By reason of the measuring method with symmetric output currents, this value may deviate from the value in P719.			
P734	**Current phase W**		S	
0.0 ... 999.9 A	Indicates the current of phase W. **NOTE:** By reason of the measuring method with symmetric output currents, this value may deviate from the value in P719.			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P736	**DC bus voltage**			
0 ... 1000 V DC	Indicates the current DC bus voltage.			
P737	**Current capacity utilization braking resistor**			
0 ... 1000 %	This parameter informs on the current capacity utilization of the braking resistor in regenerative operation when the parameters P556 and P557 have been set correctly. If P556 = 0 and P557 = 0 are set, this parameter informs on the control factor of the brake chopper in FC.			
P738	**Current capacity utilization motor**			
0 ... 1000 %	Indicates the current motor capacity utilization. Calculation of motor data based on P201…P209.			
P739	**Current temperature heat sink**			
0 ... 100 °C	Indicates the current temperature of the FC heat sink.			
P740 **... - 01** **...** **... - 13**	**Process data bus in**		S	
0000 ... FFFF (hex)	This parameter informs about the current control word and the setpoint values which are transmitted through the bus systems.	**... - 01 =** control word		control word, source from P509.
		... - 02 = setpoint value 1 **... - 03 =** setpoint value 2 **... - 04 =** setpoint value 3		setpoint data of the main setpoint value P510 -01.
		... - 05 = Bus I/O in bits (P480)		The indicated value represents all "bus in bit sources" logically OR linked.
		... - 06 = parameter data in 1 **... - 07 =** parameter data in 2 **... - 08 =** parameter data in 3 **... - 09 =** parameter data in 4 **... - 10 =** parameter data in 5		Data with parameter transmission.
		... - 11 = setpoint value 1 **... -12 =** setpoint value 2 **... -13 =** setpoint value 3		Setpoint value data of secondary setpoint value P510 -02.

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P741 **... - 01** **...** **... - 13**	**Process data bus out**		S	

0000 ... FFFF (hex)	This parameter informs about the current status word and the actual values which are transmitted through the bus systems.	**... - 01 =** status word	Status word, source from P509.
		... - 02 = actual value 1 (P543) **... - 03 =** actual value 2 (P544) **... - 04 =** actual value 3 (P545)	
		... - 05 = Bus I/O out bits (P481)	The indicated value represents all "bus in bit sources" logically OR linked.
		... - 06 = parameter data out 1 **... - 07 =** parameter data out 2 **... - 08 =** parameter data out 3 **... - 09 =** parameter data out 4 **... - 10 =** parameter data out 5	Data with parameter transmission.
		... - 11 = actual value 1 reference function **... -12 =** actual value 2 reference function **... -13 =** actual value 3 reference function	Actual value of the reference function P502 / P503.

P742	**Database version**		S	
0 ... 9999	Indication of the internal database version of the FC.			

P743	**Converter type**			
0.25 ... 11.00	Indication of the converter power in kW, e.g. "1.50" ⇒ FC with 1.5kW nominal power.			

P744	**Expansion option**			
0000 ... FFFF (hex)	This parameter displays the internal FC expansion option. With the standard control panel, the indication is in hexadecimal code, and with the comfort control panel in plain text. Standard = xx00 Bit 0 and bit 1 (00) indicate the expansion option. Bit 2 and Bit 3 (xx) are irrelevant. **Standard = xx00**			

P745	**Modules version**			
0.0 ... 999.9	Software version of the integrated modules, but only if there is an independent processor.			

P746	**Modules status**		S	
0000 ... FFFF (hex)	Status of the integrated function modules (if active).			

P747	**Converter voltage range**			
0 ... 2	Indicates the mains voltage range for which this device is specified. **0 =** 100....120V **1 =** 200....240V **2 =** 380....480V			

Parameter	Setting value / description / note	Device	Supervisor	Parameter record
P750	**Statistics overcurrent**		S	
0 ... 9999	Number of overcurrent messages during operating hours.			
P751	**Statistics overvoltage**		S	
0 ... 9999	Number of overvoltage messages during operating hours.			
P752	**Statistic mains error**		S	
0 ... 9999	Number of mains errors during operating hours.			
P753	**Statistic overtemperature**		S	
0 ... 9999	Number of overtemperature errors during operating hours.			
P754	**Statistics parameter loss**		S	
0 ... 9999	Number of parameter losses during operating hours.			
P755	**Statistics system error**		S	
0 ... 9999	Number of system errors during operating hours.			
P756	**Statistics time-out**		S	
0 ... 9999	Number of time-out errors during operating hours.			
P757	**Statistics customer error**		S	
0 ... 9999	Number of customer watchdog errors during operating hours.			
P799 ... - 01 ... ... - 05	**Operating hours last error 1...5**			
0.1 ... 9999.99	Mirrors the parameter P714 (operating hours) at the time of the respective error.			

11.7 Pertinent Parameters, User Settings

(P) ⇒ dependent upon parameter record, these parameters can be variously set in 4 parameter records.

Parameter no.		Designation	Factory setting	Super visor	Setting after commissioning			
					P 1	P 2	P 3	P 4
STATUS INDICATIONS								
P000		Status Indication						
P001		Selection of indicator value	0					
P002		Display factor	1.00	S				
P003		Supervisor code	1					
BASIC PARAMETER								
P100		Parameter record	0	S				
P101		Param. record copied	0	S				
P102	(P)	run-up time [s]	2.0					
P103	(P)	braking time [s]	2.0					
P104	(P)	Minimum frequency [Hz]	0.0					
P105	(P)	Maximum frequency [Hz]	50.0					
P106	(P)	Ramp rounding [%]	0	S				
P107	(P)	Brake application time [s]	0.00					
P108	(P)	Switch-off mode	1	S				
P109	(P)	DC current - brake [%]	100	S				
P110	(P)	Time DC brake on [%]	2.0	S				
P111	(P)	P factor torque limit [%]	100	S				
P112	(P)	Torque current limit [%]	401 (off)	S				
P113	(P)	Jog frequency [Hz]	0.0	S				
P114	(P)	Brake application time [s]	0.00	S				
MOTOR DATA / CHARACTERISTIC PARAMETER								
P200	(P)	Motor list	0					
P201	(P)	Nominal motor frequency [Hz]	*50.0 **	S				
P202	(P)	Nominal motor speed [rpm]	*1385 **	S				
P203	(P)	Nominal motor current [A]	*4.8 **	S				
P204	(P)	Nominal motor voltage [V]	*230 **	S				
P205	(P)	Nominal motor power [kW]	*1.10 **					
P206	(P)	Motor cos phi	*0.78 **	S				
P207	(P)	Motor connection [star=0/delta=1]	*1 **	S				
P208	(P)	Stator resistance [Ω]	*6.28**	S				
P209	(P)	No-load current [A]	*3.0 **	S				

Parameter no.		Designation	Factory setting	Super visor	Setting after commissioning			
					P 1	P 2	P 3	P 4
P210	(P)	Static boost [%]	100	S				
P211	(P)	Dynamic boost [%]	100	S				
P212	(P)	Slip compensation [%]	100	S				
P213	(P)	Hidden ISD control [%]	100	S				
P214	(P)	Rate-action torque [%]	0	S				
P215	(P)	Rate-action boost [%]	0	S				
P216	(P)	Time rate-action boost [%]	0.0	S				
P220		Parameter identification	0					
			*) dependent upon the FC power or P200 / P220					
CONTROL TERMINALS								
P400		Function Analog input 1	1					
P401		Analog mode on 1	0	S				
P402:		Adjustment 1: 0% [V]	0.0	S				
P403		Adjustment 1: 100% [V]	10.0	S				
P404		Filter analog on 1 [ms]	100	S				
P405		Function Analog input 2	1					
P406		Analog mode on 2	0	S				
P407		Adjustment 2: 0% [V]	0.0	S				
P408		Adjustment 2: 100% [V]	10.0	S				
P409		Filter analog on 2 [ms]	100	S				
P410	(P)	Min. freq. secondary setpoint value [Hz]	0.0					
P411	(P)	Max. freq. secondary setpoint value [Hz]	50.0					
P412	(P)	Setpoint process controller [V]	5.0	S				
P413	(P)	P quota PID controller [%]	10.0	S				
P414	(P)	I quota PID controller [%/ms]	1.0	S				
P415	(P)	D quota PID controller [%ms]	1.0	S				
P416	(P)	Ramp time PI setpoint [s]	2.0	S				
P417	(P)	Offset analog output [V]	0.0	S				
P418	(P)	Function analog output	0					
P419	(P)	Scaled analog output [%]	100					
P420		digital input 1	1					
P421		digital input 2	2					
P422		digital input 3	8					
P423		digital input 4	4					
P424		digital input 5	0					

Parameter no.		Designation	Factory setting	Super visor	Setting after commissioning			
					P 1	P 2	P 3	P 4
P426	(P)	Quick-stop time [s]	0.10					
P427		Quick-stop Failure	0	S				
P428	(P)	Automatic start-up [Off°/°On]	0	S				
P429	(P)	Fixed frequency 1 [Hz]	0.0					
P430	(P)	Fixed frequency 2 [Hz]	0.0					
P431	(P)	Fixed frequency 3 [Hz]	0.0					
P432	(P)	Fixed frequency 4 [Hz]	0.0					
P433	(P)	Fixed frequency 5 [Hz]	0.0					
P434	(P)	Function relay 1	1					
P435	(P)	Scaling relay 1 [%]	100					
P436	(P)	Hysteresis relay 1 [%]	10	S				
P441	(P)	Function relay 2	7					
P442	(P)	Scaling relay 2 [%]	100					
P443	(P)	Hysteresis relay 2 [%]	10	S				
P450	(P)	Function relay 3	0					
P451	(P)	Scaling relay 3 [%]	100					
P452	(P)	Hysteresis relay 3 [%]	10	S				
P455	(P)	Function relay 4	0					
P456	(P)	Scaling relay 4 [%]	100					
P457	(P)	Hysteresis relay 4 [%]	10	S				
P460		Watchdog time [s]	10.0	S				
P465		Fixed frequency field [-01…-31]	0					
P466	(P)	Minimum frequency process controller	0.0					
P475		Activation/ deactivation delay	0.000	S				
P480		Function Bus I/O in bits	12	S				
P481		Function Bus I/O out bits	10	S				
P482		Scaled bus I/O out bits [%]	100	S				
P483		Hysteresis Bus I/O out bits [%]	10	S				
ADDITIONAL PARAMETERS								
P502		Value reference function	0	S				
P503		Reference function output	0	S				
P504		Pulse frequency [kHz]	6.0	S				
P505	(P)	Absolute minimum frequency [Hz]	2.0	S				
P506		Automatic error confirmation	0	S				

Parameter no.		Designation	Factory setting	Super visor	Setting after commissioning			
					P 1	P 2	P 3	P 4
P507		PPO Type	1					
P508		Profibus address	0					
P509		Source control word	0					
P510		Source setpoint value	0 (auto)	S				
P511		USS Baud rate	3	S				
P512		USS address	0					
P513		telegram downtime [s]	0.0	S				
P514		CAN Baud rate	4					
P515		CAN address	50					
P516	(P)	Hidden frequency 1 [Hz]	0.0	S				
P517	(P)	Hidden range 1 [Hz]	2.0	S				
P518	(P)	Hidden frequency 2 [Hz]	0.0	S				
P519	(P)	Hidden range 2 [Hz]	2.0	S				
P520	(P)	Flying restart circuit	0	S				
P521	(P)	Flying restart circuit resolution [Hz]	0.05	S				
P522	(P)	Flying restart circuit Offset [Hz]	0.0	S				
P523		Factory setting	0					
P535		I^2t motor	0	S				
P536		Current limit	1.5	S				
P537		Pulse deactivation [%]	150	S				
P538		Mains voltage monitoring	3	S				
P539	(P)	Output monitoring	0	S				
P540		Rotation direction mode	0	S				
P541		Set relay	0000 (hex)	S				
P542		Set analog output [V]	0.0	S				
P543	(P)	Actual bus value 1	1	S				
P544	(P)	Actual bus value 2	0	S				
P545	(P)	Actual bus value 3	0	S				
P546	(P)	Function setpoint bus value 1	1	S				
P547	(P)	Function setpoint bus value 2	0	S				
P548	(P)	Function setpoint bus value 3	0	S				
P550		ParameterBoxJobs	0					
P551		drive profile	0	S				
P554		Min. application point chopper	65	S				

Parameter no.		Designation	Factory setting	Super visor	Setting after commissioning			
					P 1	P 2	P 3	P 4
P555		P limit chopper [%]	100	S				
P556		Braking resistance [Ω]	120	S				
P557		Power braking resistor [kW]	0	S				
P558	(P)	Magnetization time [ms]	1	S				
P559	(P)	DC lag time [s]	0.50	S				
P560		Save to EEPROM	1	S				

Parameter no.	Designation	Current state or indicated values				
INFORMATION						
P700 (P)	current error					
P701	last error 1…5					
P702	Freq. last error 1…5					
P703	Current last error 1…5					
P704	Voltage last error 1…5					
P705	DC bus volt. last error 1…5					
P706	P-record last error 1...5					
P707	Software version (/-revision)					
P708	Status digital input (bin/hex)					
P709	Voltage analog in. 1 [V]					
P710	Voltage analog out. [V]					
P711	Status relay [hex]					
P712	Voltage analog in. 2 [V]					
P714	Operating hours [h]					
P715	Release hours [h]					
P716	Current frequency [Hz]					
P717	Current speed [1/min]					
P718	Current setpoint frequ. 1..3 [Hz]					
P719	Current power [A]					
P720	Current torque power [A]					
P721	Current field power [A]					
P722	Current voltage [V]					
P723	Voltage-d [V]					
P724	Voltage-q [V]					
P725	Current cos phi					
P726	Apparent power [kVA]					
P727	Mechanic power [kW]					
P728	Input voltage [V]					
P729	Torque [%]					
P730	Field [%]					
P731	Parameter record					
P732	Current phase U [A]					
P733	Current phase V [A]					
P734	Current phase W [A]					
P735	Speed rotary encoder [rpm]					
P736	DC bus voltage [V]					
P737	Capacity utilization braking resistor [%]					

Parameter no.	Designation	Current state or indicated values				
INFORMATION						
P738	Capacity utilization motor [%]					
P739	Temperature heat sink [°C]					
P740	Process data bus in [hex]					
P741	Process data bus out [hex]					
P742	Database version					
P743	Converter type					
P744	Expansion option					
P745	Modules version					
P746	Modules status					
P747	Converter voltage range 230/400V					
P750	Stat. overcurrent					
P751	Stat. overvoltage					
P752	Stat. mains error					
P753	Stat. overtemperature					
P754	Stat. param. loss					
P755	Stat. system error					
P756	Stat. time-out					
P757	Stat. customer error					
P799	Failure duration 1...5					

12 Error Messages

Errors can cause deactivation of the frequency converters.

There are the following options for reset of an error (error confirmation):

- by mains deactivation and re-activation,
- by a correspondingly programmed digital input (P420… P424 = function 12),
- by removing the "release" at the frequency converter (when no digital input has been programmed for confirming),
- by a bus confirmation, or
- by P506, the automatic error confirmation.

12.1 Indicator Elements at the FCS01 Basic Device

In factory setting, there are 2 LEDs (green/red) under the cover. They signal the current status of the device.

The **green LED** signals the application of mains voltage; during operation, it indicates the degree of overload at the frequency converter output by means of an increasingly fast flash code.

The **red LED** signals pending errors by flashing the number of times which corresponds to the numeric code of the error.

12.2 Indication in the Function Modules FCC01.1T-xxx

The standard control panel indicates an error with the respective error number, preceded by an "E". Additionally, the current error can be viewed in parameter P700. The last error messages are saved in parameter P701. For more information on the frequency converter status at the moment of error, refer to parameters P702 to P706.

If the error cause does not exist any more, the error indication at the standard control panel will flash. Then, the error can be confirmed by pressing the Enter key.

Available error messages

Indication at the standard control panel		Indication at the comfort control panel	Cause • Remedy
Group	Detail in P700 / P701		
E001	**1.0**	**Overtemperature converter**	Error signal from the output stage module (static) • Lowering of the environmental temperature (<50°C or <40°C, also see Chap. 13, Technical Data) • Check control cabinet ventilation
E002	**2.0**	**Overtemperature motor** (PTC thermistor) Only when a digital input (function 13) has been programmed.	The motor temperature feeler has triggered • reduce motor load • increase motor speed • use forced ventilation of the motor
	2.1	**Overtemperature motor** (I^2t) Only when I^2t motor (P535) has been programmed.	I^2t motor has responded • reduce motor load • increase motor speed
E003	**3.0**	**Overcurrent inverter**	I^2t limit has responded, e.g. > 1,5 x I_n for 60s (please also note P504) • Avoid permanent overload at the frequency converter output.
	3.1	**Overcurrent chopper**	U^2t limit for the brake chopper has responded (please also note P555, P556, P557) • Avoid overload at the braking resistor
	3.2	**Overcurrent derating monitoring 125%**	Derating (power reduction) with f < 2 Hz • 125% OC level for 50 ms
	3.3	**Overcurrent derating monitoring 150%**	Derating (power reduction) with f < 2 Hz • 150% OC level
E004	**4.0**	**Overcurrent module**	(Temporary) error signal from the module • Localize short circuit or ground fault at the frequency converter output. • Use external output throttle (motor cable is too long)
	4.1	**Overcurrent module** from current measuring	Output current exceeds the measuring range • Localize short circuit or ground fault at the frequency converter output. • Use external output throttle (motor cable is too long)
E005	**5.0**	**Overvoltage DC bus**	The frequency converter DC bus voltage is too high. • Reduce the recovered energy by means of a braking resistor. • Prolong braking time (P103). • Possibly, set the switch-off mode (P108) with a delay (not for lifting gear) • Prolong the quick-stop time (P426)
	5.1	**Overvoltage mains**	Mains voltage too high. • Please check 380V-20%...480V+10% / 200...240V ± 10%

Indication at the standard control panel		Indication at the comfort control panel	Cause • Remedy
Group	Detail in P700 / P701		
E006	**6.0**	**Undervoltage DC bus** (charging error)	Frequency converter - mains/DC bus voltage too low • Check mains voltage 380V-20% ... 480V+10%, or 200...240V ± 10%
	6.1	**Undervoltage mains**	
E007	**7.0**	**Phase failure mains**	One of the three mains input phases was or is interrupted. • Check mains phases 380V-20% to 480V+10%, or 200...240V ± 10%, possibly too low? • Check the mains phases for symmetry.
OFF		OFF is indicated in the display when the three mains phases are reduced uniformly.	
E008	**8.0**	**Parameter loss EEPROM** (maximum value exceeded)	Error in the EEPROM data • Check the software version of the stored data record and the software version of the frequency converter for compatibility • **Note:** Incorrect parameters are automatically re-loaded (factory data). • EMC measures (also see E020).
	8.1	**Invalid converter type**	• see 8.3
	8.2	**Reproduction error external EEPROM**	• Check function module for correct installation and fit. • Check entry in parameter P550.
	8.3	**Incorrect identification of customer interface**	
	8.4	**Incorrect database version**	No identification of FC expansion option. • Switch the device off and on.
	8.7	**Difference between original and mirror**	
E009	**---**	**ControlBox error**	SPI bus failure, the function module is not addressed. • Check function module for correct installation and fit. • Switch mains voltage off and on again.
E010	**10.0**	**Telegram downtime** (P513)	Faulty telegram transmission. • Check external connection
	10.2	**Telegram downtime external bus module**	• Check the program sequence of the bus protocol. • Check the bus master.
	10.4	**Initialization error external bus module**	• Check P746. • Bus module is not plugged in correctly. • Check power supply to the bus module.
	10.1	**System error external bus module**	For more details, also refer to Chapter 15, Master Communication - Field Busses and Protocols.
	10.3		
	10.5		
	10.6		
	10.7		

Indication at the standard control panel		Indication at the comfort control panel	Cause • Remedy
Group	Detail in P700 / P701		
	10.8	**Communication error external module**	Connection error / malfunction of the external module
E011	**11.0**	**Error ADU customer interface**	Error of reference voltage of customer interface (10V / 15V) Is only indicated when control is effected through the control terminals (P509 = 0/1). • Check connection of the terminals for short-circuit.
E012	**12.0**	**Watchdog customer** / customer error	The watchdog function has been selected on a digital input, and the impulse on the respective digital input fails for longer than the period specified in parameter P460 >Time watchdog<.
E013	**13.0**	reserved	
	13.1	reserved	
	13.2	**Following error break monitoring function**	"Safe stop" has been executed. • Torque limit (P112) has been reached.
E016	**16.0**	**Phase error motor**	No motor phase is connected. • Check P539
	16.1	**Motor current monitoring function**	The required magnetizing current has not been reached. • Check motor connection
E019	**19.0**	**Parameter identification error**	Automatic identification of the connected motor has failed • Check motor connection • Check motor data (P201…P209)
	19.1	**Incorrect star / delta wiring of motor**	
E020	**20.0**	reserved	System error in program execution, triggered by EMC errors. • Please refer to Chapter 8.3, Wiring Guidelines. • Installation of an additional external mains filter, also refer to Chapter 13.4, Electromagnetic Compatibility (EMC) • Check the frequency converter for correct grounding.
	20.1	**Watchdog**	
	20.2	**Stack Overflow**	
	20.3	**Stack Underflow**	
	20.4	**Undefined Opcode**	
	20.5	**Protected Instruction**	
	20.6	**Illegal Word Access**	
	20.7	**Illegal Instruction Access**	
	20.8	**EPROM error**	
	20.9	reserved	
	21.0	reserved	
	21.1	**PLL** error	
	21.2	**ADU** Overrun	
	21.3	**PMI** Access Error	

13 Technical Data

13.1 General Data FCS01

Function		Specification	
output frequency		0.0 ... 400.0Hz	
Pulse frequency fs		3.0 ... 16.0kHz; Standard setting: 6kHz Derating with 230V devices from fs > 8 kHz Derating with 400V devices from fs > 6 kHz	
typ. overload capacity		150% for 60s, 200% for 3,5s	
Protection against		Overtemperature of the frequency converter over- and undervoltage short circuit, ground fault overload, idling mode	
Adjustment and control		sensorless current vector control (ISD), linear U/f characteristic	
Setpoint value input analog / PID input		2x 0...10V, 0/4...20mA, scaleable	
Setpoint value resolution analog		10-bit related to measuring range	
Analog output		0 ... 10V scaleable	
Setpoint value constancy		analog < 1% digital < 0.02%	
Motor temperature monitoring		I^2t motor (UL/cUL suitable), PTC / bimetal switch (not UL/cUL)	
Digital input		5 * 7,5...30V (2,5V); Ri = 6,1 kOhm (2,2 kOhm); cycle time = 1...2 ms	
Galvanic isolation		Control terminal of the digital and analog inputs	
Ramp times		0 ... 320.0s	
Control outputs		2x relay 28V DC / 230V AC, 2A	
Interfaces		Standard: RS 485 (USS) RS 232 (single slave) Optional: Profibus-DP CANopen DeviceNet	
Frequency converter efficiency		approx. 95%	
ambient temperature		0°C .. +40°C (S1-100% ED), 0°C ... +50°C (S3-75% ED 10 min)	
Storage and transport temperature		-25°C .. +70°C	
Long-term storage		The frequency converter should be connected to mains voltage for a period of 60 minutes after expiry of one year at the latest. This cycle must be maintained over the whole storage period.	
Degree of protection		IP20 (for installation of control cabinet)	
Max. installation height / power reduction		up to 1000°m above sea level: none 1000…4000°m above sea level: 1% / 100 m	
Overvoltage category		up to 2000°m: overvoltage category 3 2000...4000°m overvoltage category 2, external overvoltage protection required at the mains input	
Waiting period between two mains activation cycles		60 sec for all devices in normal operation cycle	
Terminals	Mains/motor/brake resistor	0,2 .. 4 mm^2 multiwire with connector sleeves, 0,2 .. 6 mm^2 single-wire AWG 24 .. 10	
	Control Section	0,4 .. 1.5 mm^2 single- or multiwire with connector sleeves, AWG 26 .. 16	Tightening torque: 0.5..0.6 Nm

Function		Specification
	Relay	0,14 .. 1.5 mm² multiwire with connector sleeves, 0,14 .. 2.5 mm² single-wire AWG 26 .. 14
	RS485 / RS232	1x RJ12 (6-pole)
	CANbus	--

13.2 Electrical Data

Electrical Data of the 230 V Devices

Size		A			
Type of device:	FCS01.1E	-W0003-A-02	-W0005-A-02	-W0006-A-02	-W0008-A-02
Rated motor power	230V	0.25 kW	0.37 kW	0.55 kW	0.75 kW
(4-pole standard motor)	240V	1/3 hp	½ hp	¾ hp	1 hp
Mains phases	Number	1 / 3 AC			
Mains voltage		200 ... 240V, ± 10%, 47 ... 63 Hz			
System impedance		min. 100µH per strand			
output voltage		3 AC (0V up to mains voltage)			
Rated output current	rms [A]	1.7	2.2	3.0	4.0
min. braking resistance	Accessories	240 Ω	190 Ω	140 Ω	100 Ω
typ. input current 1/3 AC	rms [A]	3.7 / 2.4	4.8 / 3.1	6.5 / 4.2	8.7 / 5.6
recom. mains fuse 1/3 AC	slow [A]	10 / 10	10 / 10	16 / 10	16 / 10
Type of ventilation		free convection			
Weight	approx. [kg]	1,4			

Size		B		
Type of device:	FCS01.1E	W0011-A-02	W0015-A-02	W0019-A-02
Rated motor power	230V	1.1 kW	1.5 kW	2.2 kW
(4-pole standard motor)	240V	1½ hp	2 hp	3 hp
Mains phases	Number	1 / 3 AC		
Mains voltage		200 ... 240V, ± 10%, 47 ... 63 Hz		
System impedance		min. 100µH per strand		
output voltage		3 AC (0V up to mains voltage)		
Rated output current	rms [A]	5.5	7.0	9.0 (9.5)
min. braking resistance	Accessories	75 Ω	62 Ω	43 Ω
typ. input current 1/3 AC	rms [A]	12.0 / 7.7	15.2 / 9.8	19.6 / 13.3
recom. mains fuse 1/3 AC	slow [A]	16 / 16	20 / 16	25 / 20
Type of ventilation		fan cooling, temperature-controlled		

Weight	approx. [kg]	1,8

Electrical Data of the 400 V Devices

Size		A / B			
Type of device:	FCS01.1E	W0003-A-04	W0005-A-04	W0006-A-04	W0008-A-04
Rated motor power	400V	0.55 kW	0.75 kW	1.1 kW	1.5 kW
(4-pole standard motor)	480V	¾ hp	1 hp	1½ hp	2 hp
Mains phases	Number	3 AC			
Mains voltage		380 ... 480V, -20% / +10%, 47 ... 63 Hz			
System impedance		min. 50µH per strand			
output voltage		3 AC (0V up to mains voltage)			
Rated output current	rms [A]	1.7	2.3	3.1	4.0
min. braking resistance	Accessories	390 Ω	300 Ω	220 Ω	180 Ω
Typ. input current	rms [A]	2.4	3.2	4.3	5.6
recom. Mains fuse	slow [A]	10	10	10	10
Type of ventilation		free convection			
Weight	approx. [kg]	1,4		1,8	

Size		B / C / D				
Type of device:	FCS01.1E	W0011-A-04	W0015-A-04	W0019-A-04	W0025-A-04	W0032-A-04
Rated motor power	400V	2.2 kW	3.0 kW	4.0 kW	5.5 kW	7.5 kW
(4-pole standard motor)	480V	3 hp	4 hp	5 hp	7½ hp	10 hp
Mains phases	Number	3 AC				
Mains voltage		380 ... 480V, -20% / +10%, 47 ... 63 Hz				
System impedance		min. 50µH per strand				
output voltage		3 AC (0V up to mains voltage)				
Rated output current	rms [A]	5.5	7.5	9.5	12.5	16.0
min. braking resistance	Accessories	130 Ω	91 Ω	75 Ω	56 Ω	43 Ω
Typ. input current	rms [A]	7.7	10.5	13.3	17.5	22.4
recom. Mains fuse	slow [A]	10	16	16	20	25
Type of ventilation		fan cooling, temperature-controlled				
Weight	approx. [kg]	1,8	2,7		3,1	

Derating of the electrical data

The frequency converters FCS01 are dimensioned for certain operating statuses. Other deviating operating status are possible with derating of the electrical data. Derating of the output current is executed in dependence on pulse frequency, output frequency and mains voltage.

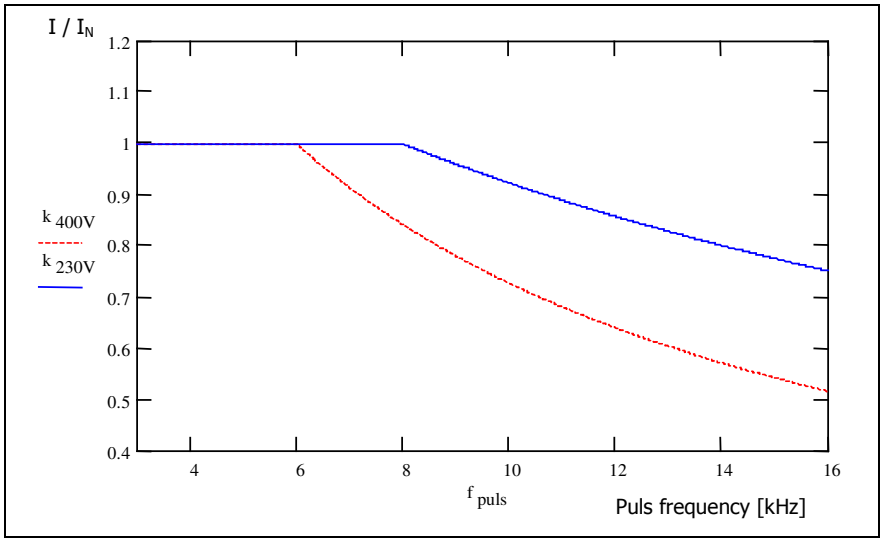
Reduction of the output current is effected in case of

- pulse frequency fs > 6 kHz (400V device); 8 kHz (230V device)
- output frequency < 2Hz and DC voltages
- system voltage > 400 V

Refer to the paragraphs below for the resulting electrical data.

Derating of the output current depending on the pulse frequency

This illustration shows the current reduction based on the pulse frequency for 230V and 400V devices. With 400V devices, reduction starts with a pulse frequency of 6kHz. With 230V devices, it starts with a pulse frequency of 8 kHz. In case of higher pulse frequency, the current is reduced insofar that the power dissipation in the power section remains more or less constant.



I: permissible overcurrent
I_N: Rated current

Fig. 13-1: Derating output current vs. fs

Derating overload capacity depending on overload duration

Depending on the duration of an overload, the available overload capacity changes. When the overload capacity limit is reached, the frequency converter must be operated with lower capacity utilization before it is overloaded once more.

230V devices

Pulse frequency [kHz]	Duration of overload [s]					
	Continuous operation	**60**	**30**	**20**	**10**	**3,5**
3...8	**110%**	**150%**	**170%**	**180%**	**180%**	**200%**
10	**103%**	**140%**	**155%**	**165%**	**165%**	**180%**
12	**96%**	**130%**	**145%**	**155%**	**155%**	**160%**
14	**90%**	**120%**	**135%**	**145%**	**145%**	**150%**
16	**82%**	**110%**	**125%**	**135%**	**135%**	**140%**

Fig. 13-2: Overload capacity 230V devices

400V devices

Pulse frequency [kHz]	Duration of overload [s]					
	Continuous operation	**60**	**30**	**20**	**10**	**3,5**
3...6	**110%**	**150%**	**170%**	**180%**	**180%**	**200%**
8	**100%**	**135%**	**150%**	**160%**	**160%**	**165%**
10	**90%**	**120%**	**135%**	**145%**	**145%**	**150%**
12	**78%**	**105%**	**120%**	**125%**	**125%**	**130%**
14	**67%**	**92%**	**104%**	**110%**	**110%**	**115%**
16	**57%**	**77%**	**87%**	**92%**	**92%**	**100%**

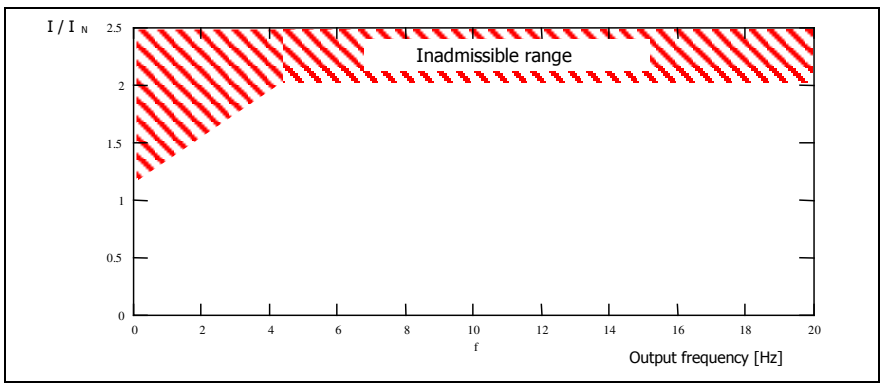
Fig. 13-3: Overload capacity 400V devices

Derating of the permissible overcurrent, depending on the output frequency

To protect the power section in case of small output frequencies, the output current is limited by means of pulse deactivation (P537).

At standstill and at fs=6°kHz, the current is limited to the rated current multiplied by 1.1.

The diagram illustrates the correlation between the maximum output current and the output frequency with a pulse frequency (fs) of 3…8 kHz (230V devices) or 3…6 kHz (400V devices). The maximum output current can be withdrawn for a period of 3.5°s.



I: permissible overcurrent
I_N: Rated current

Fig. 13-4: Derating of the output current

For the upper limits of the pulse deactivation dependent on pulse and output frequency, consult the following tables.
In any case, the value that can be set in parameter P537 (10…200%) is limited to the value indicated in the tables, depending on the pulse frequency. Values below the limit can be set in any way.

230V devices

Pulse frequency [kHz]	Output frequency [Hz]						
	4.5	**3.0**	**2.0**	**1.5**	**1.0**	**0.5**	**0**
3...8	**200%**	**170%**	**150%**	**140%**	**130%**	**120%**	**110%**
10	**180%**	**153%**	**135%**	**126%**	**117%**	**108%**	**100%**
12	**160%**	**136%**	**120%**	**112%**	**104%**	**96%**	**95%**
14	**150%**	**127%**	**112%**	**105%**	**97%**	**90%**	**90%**
16	**140%**	**119%**	**105%**	**98%**	**91%**	**84%**	**85%**

Fig. 13-5: Overload capacity 230V devices

400V devices

Pulse frequency [kHz]	Output frequency [Hz]						
	4.5	**3.0**	**2.0**	**1.5**	**1.0**	**0.5**	**0**
3...6	**200%**	**170%**	**150%**	**140%**	**130%**	**120%**	**110%**
8	**165%**	**140%**	**123%**	**115%**	**107%**	**99%**	**90%**
10	**150%**	**127%**	**112%**	**105%**	**97%**	**90%**	**82%**
12	**130%**	**110%**	**97%**	**91%**	**84%**	**78%**	**71%**
14	**115%**	**97%**	**86%**	**80%**	**74%**	**69%**	**63%**
16	**100%**	**85%**	**75%**	**70%**	**65%**	**60%**	**55%**

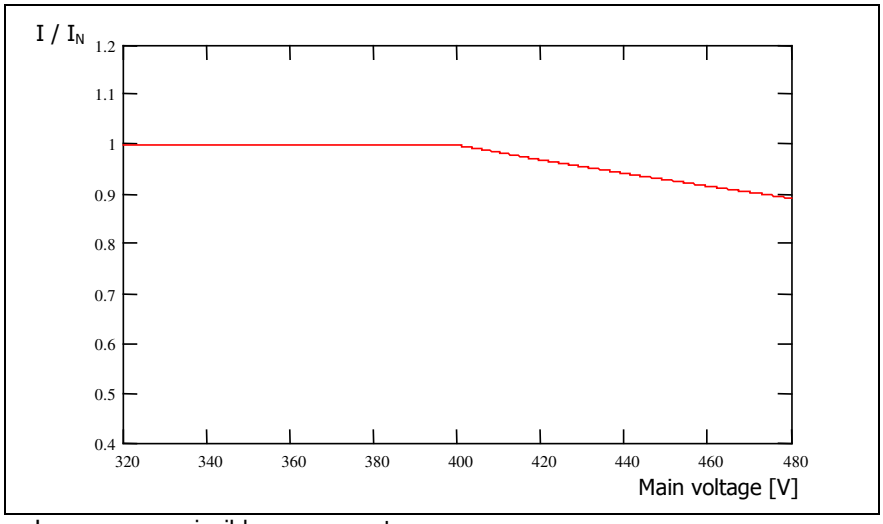
Fig. 13-6: Overload capacity 400V devices

The percentages relate to the output current that the FC can supply for a duration of 3.5°s.

Reduced overcurrent based on mains voltage

The FCS01 devices are thermally dimensioned for the rated currents. This rated current is available with the specified rated voltage. With deviating rated voltages in the permissible range, please note the following:

- **Umains<Urated**: With mains voltages below the rated voltage, no higher currents may be withdrawn to ensure that the dissipated power remains current.
- **Umains>Urated**: With mains voltages greater than the rated voltage, a reduction of the permissible output permanent currents takes place to compensate for the increased switching losses.



I: permissible overcurrent
I_N: Rated current

Fig. 13-7: Derating vs. U mains

13.3 Electrical Data for UL/cUL Certification

The data specified in this paragraph should be considered to observe the regulations on UL/cUL certification.

Size A - 230 V mains					
Type of device:	FCS01.1E	-W0003-A-02	-W0005-A-02	-W0006-A-02	-W0008-A-02
Rated motor power	**220V**	**0.25 kW**	**0.37 kW**	**0.55 kW**	**0.75 kW**
(4-pole standard motor)	**240V**	**$^1/_3$ hp**	**½ hp**	**¾ hp**	**1 hp**
FLA 1/3 AC	**[A]**	**4 / 3**	**5 / 4**	**7 / 5**	**9 / 6**
recom. Mains fuse	**J Class Fuse**	**LPJ 10A**	**LPJ 10A**	**LPJ 16A / 10A**	**LPJ 16A / 10A**

Size A - 230 V mains				
Type of device:	FCS01.1E	W0011-A-02	W0015-A-02	W0019-A-02
Rated motor power	**220V**	**1.1 kW**	**1.5 kW**	**2.2 kW**
(4-pole standard motor)	**240V**	**1½ hp**	**2 hp**	**3 hp**
FLA 1/3 AC	**[A]**	**11 / 8**	**14 / 10**	**19 / 13**
recom. Mains fuse	**J Class Fuse**	**LPJ 16A**	**LPJ 16A**	**LPJ 20A**

Size A / B - 400 V mains		A		B		
Type of device:	FCS01.1E	W0003-A-04	W0005-A-04	W0006-A-04	W0008-A-04	W0011-A-04
Rated motor power	**380V**	**0.55 kW**	**0.75 kW**	**1.1 kW**	**1.5 kW**	**2.2 kW**
(4-pole standard motor)	**460...480V**	**¾ hp**	**1 hp**	**1½ hp**	**2 hp**	**3 hp**
FLA 1/3 AC	**[A]**	**4**	**4**	**5**	**6**	**8**
recom. Mains fuse	**J Class Fuse**	**LPJ 10A**	**LPJ 10A**	**LPJ 10A**	**LPJ 10A**	**LPJ 10A**

Size C / D - 400V mains		C		D	
Type of device:	FCS01.1E	W0015-A-04	W0019-A-04	W0025-A-04	W0032-A-04
Rated motor power	**380V**	**3.0 kW**	**4.0 kW**	**5.5 kW**	**7.5 kW**
(4-pole standard motor)	**460...480V**	**4 hp**	**5 hp**	**7½ hp**	**10 hp**
FLA 1/3 AC	**[A]**	**11**	**13**	**17**	**21**
recom. Mains fuse	**J Class Fuse**	**LPJ 16A**	**LPJ 16A**	**LPJ 20A**	**LPJ 25A**

13.4 Electromagnetic Compatibility (EMC)

Regarding conformity, we distinguish the following cases:

- Supply of drive components
- Acceptance test of a machine or installation with the installed drive components.

Supply of drive components

According to the regulations, there are two options for drive components which are used for further processing:

- Supply without conformity to the EMC regulations. Conformity of the final product is determined by the end product's manufacturer with the installed drive component. Here, the CE sign at the drive component exclusively relates to the low-voltage directive.
- Supply with conformity according to the EMC regulation according to product standard EN 61800-3. In this case, the examination is executed in a test setup which is typical for the system. Conformity of the final product is derived by the end product's manufacturer or determined directly at the final product.

  Conformity according to the EMC regulation for the IndraDrive Fc is under preparation.

Acceptance test of a machine or installation with the installed drive components.

The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In the last years, some new product standards were created for certain machine types and some are being created at present. These new product standards contain references to the product standard EN 61800-3 for drives or specify higher-level requirements demanding increased filter and installation efforts. When the machine manufacturer wants to put the machine/installation into circulation, the product standard relevant to his machine/installation has to be complied with for his end product "machine/installation". The authorities and test laboratories responsible for EMC normally refer to this product standard.

The EMC performance which can be realized in a machine or system with a drive system consisting of standard components is under preparation. Here, the conditions are specified which must be met to reach the specified EMC performance.

Note: FCS01 frequency converters are intended **exclusively for commercial applications.** Thus, they are not subject to the requirements of standard EN 61000-3-2 for transmission of harmonics.

Realizable EMC Limit Value Classes (in preparation)

The following limit value classes can be realized when the following conditions are met:

Device type	Jumper setting s. Chapter 7 "Settings"		max. perm. motor cable length (shielded) for limit observation [m]	
	mains input	**motor output**	**class A1**	**class B1**
FCS01.1E- W0003-A-02-NNBV up to W..... FCS01.1E- W0019-A-02-NNBV	**2**	**1**	**tbd**	**tbd**
	2	**2**	**tbd**	**tbd**
FCS01.1E- W0003-A-04-NNBV up to W..... FCS01.1E- W0032-A-04-NNBV	**2**	**1**	**tbd**	**tbd**
	2	**2**	**tbd**	**tbd**

Fig. 13-8: limit value classes to be achieved

Interference immunity

According to the product standard for drive systems: EN 61800-3

Type of emission	Standard	Limit value class
ESD	**EN61000-4-2**	**6 kV (CD); 8 kV (AD)**
EMF	**EN61000-4-3**	**10V/m; 26...1000MHz**
Burt on control cables	**EN61000-4-4**	**1kV**
Burst on mains and motor cables	**EN61000-4-4**	**2kV**
Surge (phase-phase / ground)	**EN61000-4-5**	**1kV / 2kV**
Conducted disturbance by high-frequency fields	**EN61000-4-6**	**10V, 0,15...80 MHz**
Voltage fluctuations and collapses	**EN61000-2-1**	**+10%, -15%; 90%**
Voltage asymmetries and frequency changes	**EN61000-2-4**	**3%; 2%**

Fig. 13-9: Interference immunity

14 Additional Information

14.1 Setpoint Processing in FCS01

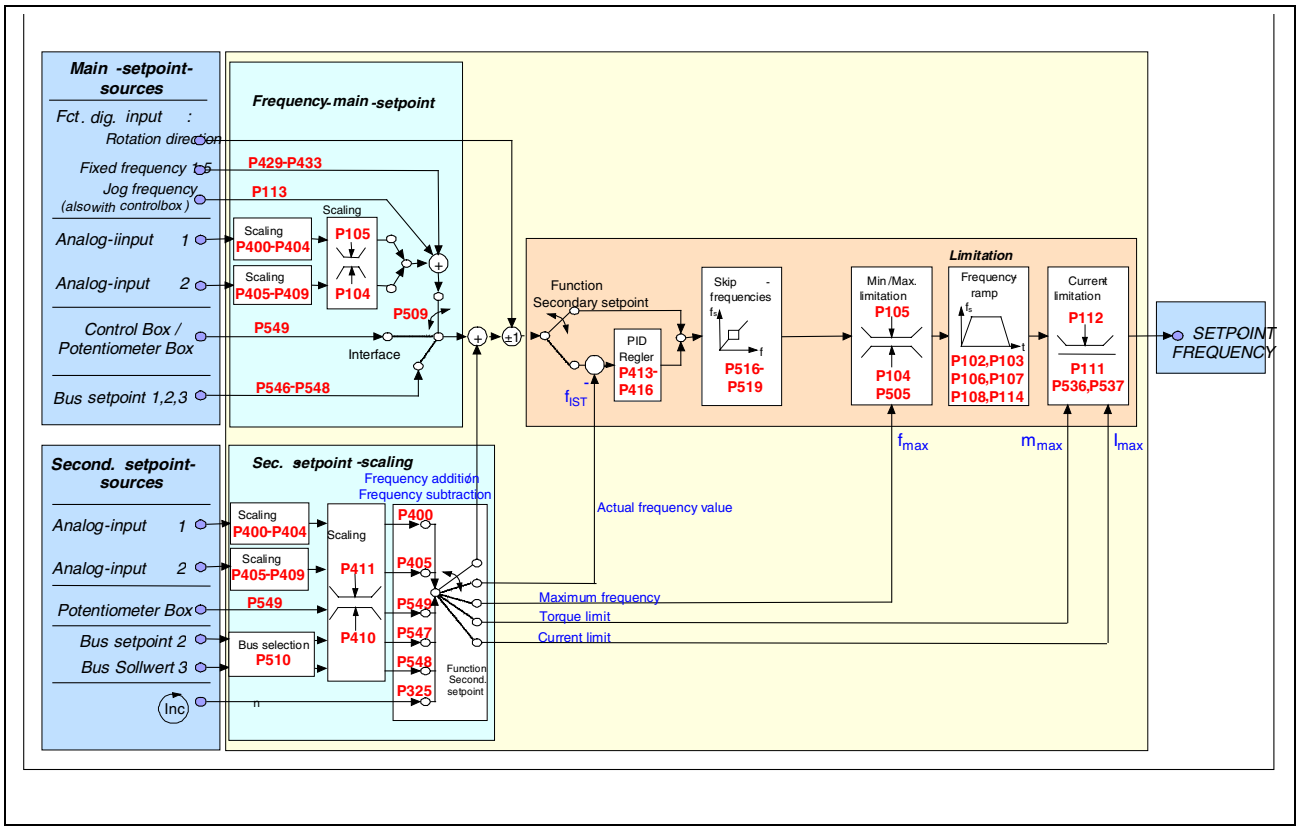


Fig. 14-1: Setpoint processing

14.2 Process Controller

The process controller is a PI controller which allows for limitation of the controller output. Additionally, the output is scaled in per cent to a reference input variable. In this way, it is possible to control an existing downstream drive with the reference input variable and to correct it with the PI controller.

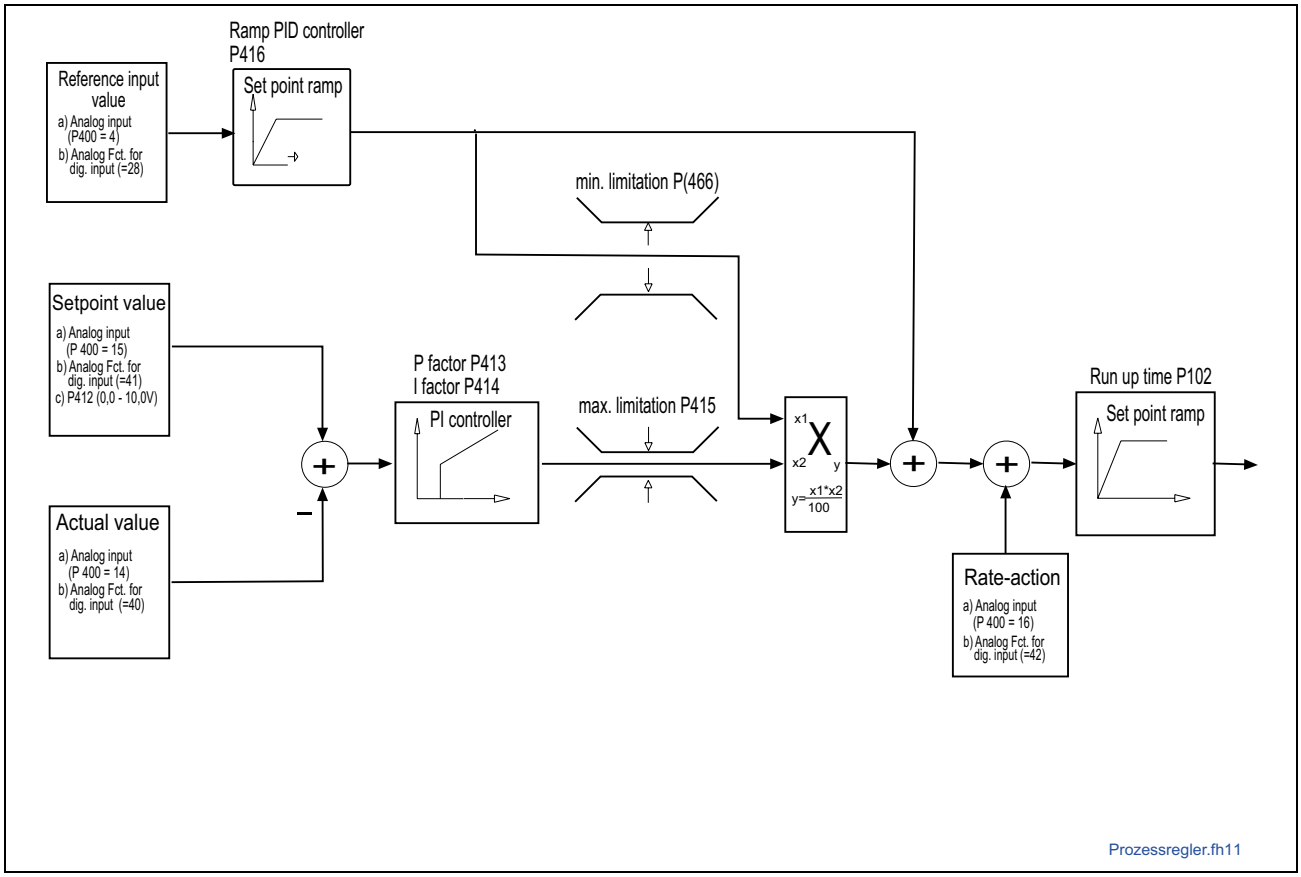


Fig. 14-2: Process controller

Sample application process controller

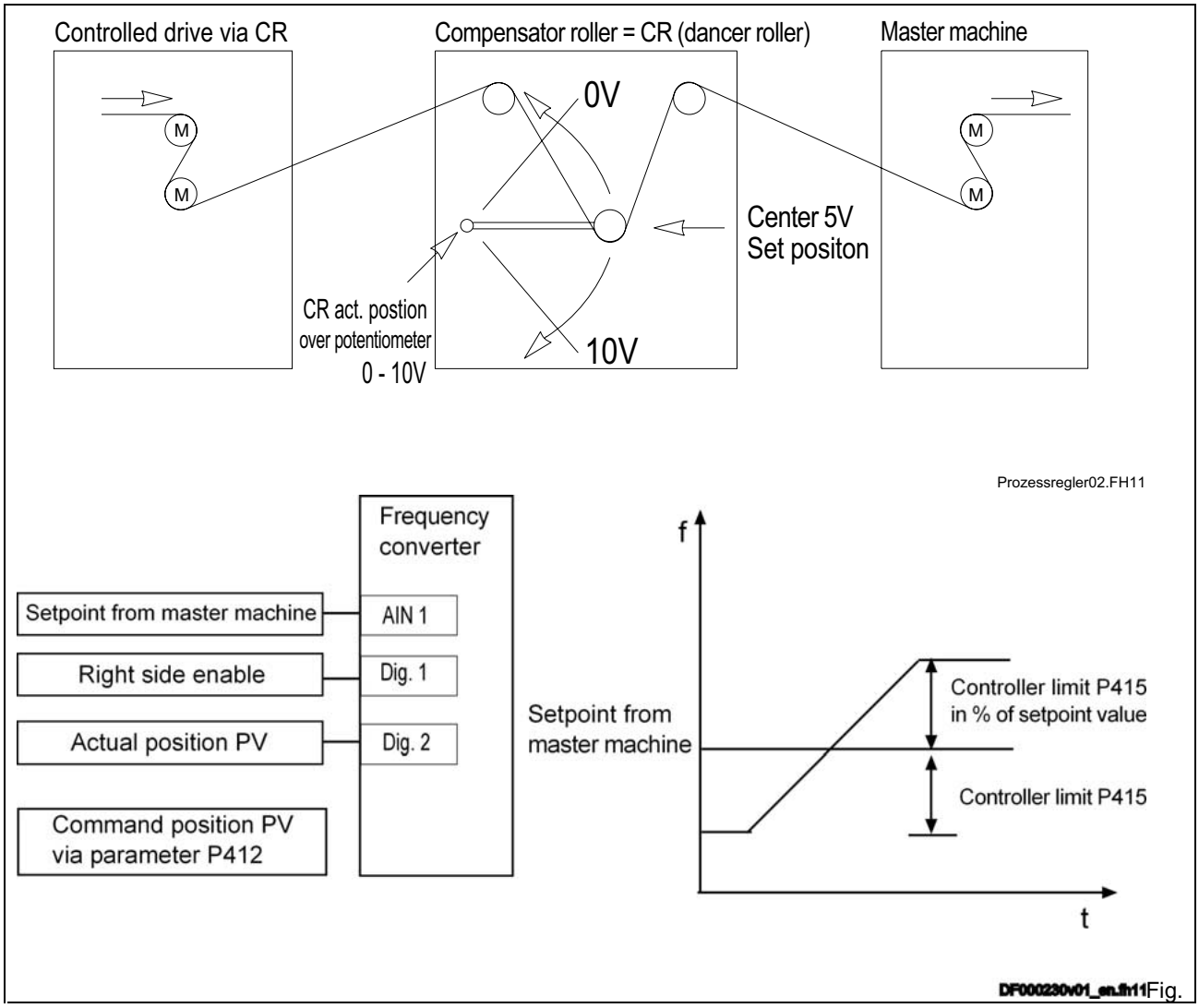


Fig. 14-3: Sample application process controller

Process Controller Parameter Settings

(Example: setpoint frequency: 50 Hz, control limits: +/- 25%)

P105 (maximum frequency) [Hz]:

$$\geq Setp.frq.[Hz] + \left(\frac{Setp.frq.[Hz] \times P415[\%]}{100\%} \right)$$

: Example: $\geq 50Hz + \frac{50Hz \times 25\%}{100\%} =$ **62.5 Hz**

P400 (Fct. analog input)**:** "**4"** (frequency addition)

P411 (setpoint frequency) [Hz]:
setpoint frequency at 10V at analog input1: Example **50 Hz**

P412 (setpoint process controller):
medium setting PW / factory setting **5 V** (adjust if necessary)

P413 (P controller) [%]: factory setting **10%** (adjust if necessary)

P414 (I controller) [% / ms]: recommended **0,1** $\%/ms$

P415 (limitation +/-) [%]: controller limitation (see above) Example **25%** of the setpoint value

P416 (ramp before controller) [s]**:** factory setting **2s**
(adjust to control behavior if applicable)

P420 (Fct. digital input 1): **"1"** release right

P421 (Fct. digital input 2): **"40"** actual value PID process controller

15 Control Communication - Field Busses and Protocols

15.1 Overview

Reference communication	Standards	Main features	Required accessories
Profibus-DP	**EN 50170DIN 19245 parts 1, 2 and 3**	**Transmission rate up to 1.5°Mbaud Electrically isolated bus interface Status indication with 2 LEDs Programming of all frequency convert parameters via Profibus DP Controlling of the output frequency via Profibus connection Up to 126 converters at one bus**	**FCC01.1F-PB1-NNNN**
		Transmission rate up to 12°Mbaud Electrically isolated bus interface Status indication with 2 LEDs Programming of all frequency convert parameters via Profibus DP Controlling of the output frequency via Profibus connection Up to 126 converters at one bus	**FCC01.1F-PB2-NNNN und External 24V supply**
CANopen	**DS-301 and DS-402 of CiA**	**Open communication profile Electrically isolated bus interfaceStandard transmission rate up to 1 Mbit/s Status indication with 4 LEDs Programming of all frequency convert parameters via CANopen Communication profile DS-301 Drive profile DS-402 Dynamic mapping (4 TPDOs and 4 RPDOs) Heartbeat and node guarding**	**FCC01.1F-CN1-NNNN and external 24V supply**
DeviceNet		**Electrically isolated bus interface Standard transmission rate up to 500 kBit/s Easy connection to the converter via a 5-pole open style connector Status indication with 4 LEDs 24V supply of the bus drivers Programming of all frequency convert parameters via DeviceNet Support of the communication profile DeviceNet Specification Release 2.0 and the drive profile AC-Drive Group 2 Only Slave (support of Predefined Master/ Slave Connection Set)**	**FCC01.1F-DN1-NNNN and external 24V supply**
USIP protocol		**Support of a multi-point-capable coupling, e.ge. EIA RS 485-hardware or a point-to-point-coupling, e.g. EIA RS 232. master-slave access methodSingle master system Maxum of 32 nodes (31 slaves maximum) Simple, safe telegram frameBus physics identical to that of PROFIBUS (DIN 19245 part 1) Data interface to the basic device after PROFILE Variable-speed drives. This means that the information on the drive are transmitted via USIP in the same way as with PROFIBUS DP. Suitable for start-up, service and automation Service tool DriveTop Fc on PC Easy implementation in customer-specific systems**	**none: Operation at the RS 485 interface at FCS01**

Fig. 15-1: Overview

Configuration files

The required configuration files:

for Profibus, the device master file (*.gsd), and for DeviceNet, CanOpen the Electronic Data Sheet (*.eds) are to be found under www.boschrexroth.com/indradrive.

Abbreviations used

PIDV	Parameter ID value
PCD:	Process data
PPO:	Parameter process data object
PID:	Parameter ID
IND	Index
PV:	Parameter value
CTW:	Control word
STW:	Status word
SP:	Setpoint value
AV:	Actual value
PNU:	Parameter numbers
JID/RID:	Job ID, response ID
SPM:	Spontaneous message

15.2 Profibus DP

Use and Application

Profibus enables a great variety of automation devices to exchange data. PLC, PC, operating and monitoring units can communicate with each other in bit-serial fashion through one bus. The speed-optimized Profibus variant PROFIBUS DP is primarily used in the field of sensor and actuator communication where short system reactions are vital. PROFIBUS DP is suitable as a replacement for the cost-intensive parallel signal transmission with 24V and the transmission of measured values.

Profibus Protocol

The protocol is described in the following according to the OSI 7-layer reference model.

Transmission layer

In layer 2 of the ISO/OSI model, the following is to be found among other features:

- the general format of telegrams for data transmission
- the mechanisms of bus access
- the storing mechanisms
- the time periods to be observed
- and the available transmission services.

The user does not have much influence on the dimensioning of layer 2, as almost all services are comprised in the available PROFIBUS ASICs.

For the PROFIBUS DP, the following transmission services are defined:

Transmission service	Description
SDR	**Send and request data** with acknowledge**.** **In a message cycle, the master transmits output data to a slave and receives back the input data in the same cycle.**
SDN	**Send data** with no acknowledge **allows for transmission of broadcast telegrams (unacknowledged telegrams).**

Fig. 15-2: Transmission services

Profibus Master

PROFIBUS Master are field devices which take the initiative for data exchange with field services acting as slaves. A master has the sole access rights to the slaves on a bus (in case of several masters, the respective master must have access right).

All data a PROFIBUS Master needs for exchanging data with the slaves (e.g. I/O area) must be generated before system start and loaded into the master (→ GSD file).

The master primarily has the following tasks:

- data exchange with the projected slaves
- coordination of bus access
- anticipation of error handling
- making slave data available to the user.

The PROFIBUS DP Master is avaible as

- module within a PLC
- CPU module with integrated PLC
- standard PC modules
- stand-alone-boards

Profibus Bus Description

Bus structure

Elements		Description / data
Bus elements	**Topology**	**serial bus system**
	Nodes	**max. 126 nodes in the exchange of user data**
	Segments	**max. 32 nodes per segment**
	Repeater	**Required for 33 nodes or more to connect segments.Recommendation: Do not connect more than 3 repeaters in series.**
	Interface	**Via serial interface RS 485**
	Bus terminator	**At both ends with 120Ω resistors between RS485 + and RS485 -**

Abb. 15-3: Bus structure

Note: The reaction time will increase with increasing number of nodes.

Parameterization of the Profibus

Pertinent Parameters

The following parameters are pertinent to communication via Profibus:

Group	Parameter	Parameter name
Bus parameter	**P507**	**PPO type**
	P508	**Profibus address**
	P509	**Source control word**
	P510	**Source setpoint value**
	P513	**Telegram downtime**
	P543	**Actual bus value 1**
	P544	**Actual bus value 2**
	P545	**Actual bus value 3**
	P546	**Bus setpoint value 1**
	P547	**Bus setpoint value 2**
	P548	**Bus setpoint value 3**
Information parameter	**P745**	**Module version**
	P746	**Module status**

Fig. 15-4: Profibus - pertinent parameters

Preset Values - Activation of Profibus DP

To operate the converter with the Profibus protocol, the bus must be connected to the master, and a number of settings must be made at the converter.

In the Profibus protocol, the converter parameters are mapped into the range 1000 to 1999, i.e. when parameterizing via the bus, the parameter numbers must be added to the value of 1000 (e.g. P508 → P1508).

The Profibus address is set in **P508**, and the PPO type in **P507** in correspondence with the control configuration. The converter can be parameterized at all times. Control of the converter via PROFIBUS DP can be activated by setting the parameter **P509** to the value 4. The telegram downtime **P513** can be selected in dependence on the Profibus system.

Note: After activation, the functions **Disable voltage, quick-stop, remote control**, and **error confirmation** are generally available at the control terminals (locally). To operate the drive in this case, a high signal must be applied at the used digital inputs before the drive can be released.

Profibus Error Monitoring and Indication

Monitored Functions

- Connection to the master: Error for example by disconnecting the bus cable.
- Baud rate identification
- Receipt of process data from the PROFIBUS
  After receipt of a valid telegram, the next telegram must arrive within the time set in the converter parameter "USIP timeout".
- Receipt of process data from the converter: If the connection to the converter is interrupted, an error message is indicated in the PROFIBUS telegram in the extended diagnosis (2 bytes: 0x02 0x04).

In parameter **P746**, the status of the PROFIBUS module can be read out. With FCS01 devices, this can be done by means of a function module FCC01.0F-PBx. There are 2 diagnosis LEDs at the function module.

Parameter **P746** is a sub-index parameter: The status of the function module FCC01.1F-PBx is indicated in sub-index 0.

LED Indication at the Function Module FCC01.1F-PB1

The two integrated LEDs signal the status of the function module:

Status Green LED	Status Red LED	Significance
ON	**OFF**	**Bus Ready: Regular operation; cyclic data transmission via PROFIBUS.**
slowly flashing	**OFF**	**No process data has been received since activation** **→ e.g.: No connection to master**
slowly flashing	**one short flash**	**Initialization of the PROFIBUS module (on switching on, or on changing of a Profibus parameter at the converter)**
slowly flashing	**ON**	**Bus Error: Timeout in receipt of process data: the watchdog time parameterized by the Profibus master has elapsed without receipt of new process data (maximum 3 seconds) (e.g.: Baud rate not identified, cable interruption)**
slowly flashing	**slowly flashing**	**Timeout in receipt of process data: the time set in P513 has elapsed without receipt of new process data**
slowly flashing	**fast flashing**	**The communication between converter and PROFIBUS module is interrupted.**

Fig. 15-5: LED Indication at the Function Module FCC01.1F-PB1

Profibus - Structure of the Useful Data

Structure of the Useful Data

The structure of the useful data for cyclic data transfer between the master and the converter is divided into two areas:

Abbr.	Significance	Purpose
PIDV	**Parameterization;** **Parameter** ID **value**	**Select the parameter; change values**
PCD	**Process data**	**Transfer of actual and setpoint values**

Fig. 15-6: Structure of useful data

Parameter values can be read and written through the PIDV area of the useful data. All tasks executed via the PIDV interface are mainly tasks for configuration, observation and diagnosis.

The PIDV area is used to control the frequency converter. In the process data, the control word or status word as well as the actual and setpoint values are transmitted.

One access always comprises job and response telegram. In the job telegram, the useful data is transmitted from master to slave. In the response telegram, the useful data is transmitted from slave to master. The structure of both telegrams is identical.

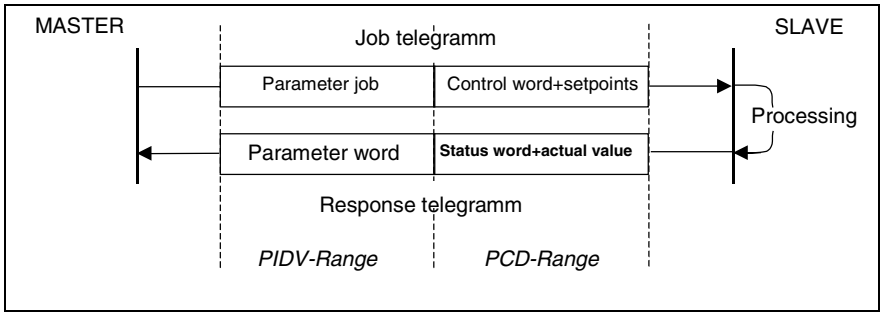


Fig. 15-7: Telegram transfer / structure of the useful data area

In the frequency converter, processing the process data takes place immediately (high priority) to allow for fast reaction to control commands and for change status change messages to be transmitted to the master without any delay.

On the contrary, the priority of the processing speed of the PIDV data is low so that it may take significantly longer to edit.

Types of Parameter Process Objects (PPO Types)

For cyclic data transfer, the parameter process data object (PPO) is defined which is used to transfer process data (PCD) and parameters (PIDV) from the master to the converter. The converter can handle PPO types 1, 2, 3 or 4.

Type	Task
PPO1	**extended parameter telegram with 32 bit parameter value and process data**
PPO2	**telegram with extended process data (main and two secondary command values) and 32 bit parameter value**
PPO3	**process data telegram with main command value without parameter data**
PPO4	**extended process data telegram with main and secondary command values without parameter data**

Fig. 15-8: Parameter process data object (PPO)

PPO 3 and PPO 4 are pure process data objects for applications which can do without cyclic parameter editing.

The following graphic shows an overview of the supported PPO types.

	PIDV				PCD			
	PID	**IND**	**PV**	**PV**	**PCD1**	**PCD2**	**PCD3**	**PCD4**
					CTW	**SP1**	**SP3**	**SP2**
					STW	**AV1**	**AV3**	**AV2**
	1. word	**2. word**	**3. word**	**4. word**	**5. word**	**6. word**	**7. word**	**8. word**
PPO 1								
PPO 2								
					1. word	**2. word**	**3. word**	**4. word**
PPO3								
PPO4								

Fig. 15-9: supported PPO types

Note: For the PPO types 2 and 4, 6 words each must be reserved for the address section of the process data (PCD) by reason of the protocol definition. The last two words are not used for the process data telegrams; they are only reserve sections.

Note: Usually, a PLC can only consistently transmit double words by I/O memory access. With longer data formats (PIDV channel generally / PCD with PPO2 or PPO4), system functions must be used (e.g. SFC14/15).

Profibus Telegram Structure

PCD Useful Data Section (PCD)

In process data section PCD, control words and command values are transmitted from the master to the converter, and status words and actual values are sent from the converter to the master. The structure of the PCD section is always identical in the sequence of its elements (words), but is designated in different ways depending on the direction of data flow master ⇒ converter / converter ⇒ master.

The structure of the process data section of the useful data is as follows:

Payload	Abbr.	Length [bit]	Significance	Contents
Control word	**CTW**	**16**	**Job telegram**	**contains control bits (e.g. release, quick-stop, error confirmation)**
Status word	**STW**	**16**	**Response telegram**	**contains status bits (e.g. FC is running, error)**
Command values (max. 3 available)	**CV1..3**	**16 or 32**	**Job telegram**	**e.g. frequence setpoint, position setpoint, torque setpoint**
Actual values (max. 3 available)	**AV1..3**	**16 or 32**	**Response telegram**	**e.g. actual frequency value, actual position value, actual torque value**

Fig. 15-10: Process data section of the useful data

	1. word	2. word	3. word	4. word	
PCD section with 1x16 bit setpoint	**CTW STW**	**SP1 AV1**			**PPO type 1,3**
PCD section with up to 3 16 bit setpoints	**CTW STW**	**SP1 AV1**	**SP3 AV3**	**SP2 AV2**	**PPO type 2.4**
PCD section with 1x32 bit setpoint value and 1x16 bit	**CTW STW**	**SP1 AV1**	**SP2 AV2**	**PPO type 2.4**	

Fig. 15-11: Structure and sequence of the process data section

The control word (CTW)

In the **job telegram**, the control word (CTW) is transmitted as the first word to the converter in the section of the process data.

PCD1	PCD 2	PCD 3	PCD 4
CTW	**SP1**	**SP3**	**SP2**

Fig. 15-12: Control word

Bit	Value	Significance	Notes
0	**0**	**OFF 1**	**Return motion with the brake ramp, with f = 0 Hz voltage release**
	1	**ON**	Ready for operation
1	**0**	**OFF 2**	**Disable voltage; the converter output voltage is deactivated; the FC goes to** activation disable **state.**
	1	**Operating condition**	**OFF 2 is cancelled**
2	**0**	**OFF 3**	**Quick-stop with programmed quick-stop time; with f=0Hz voltage release; the FU goes to** activation block **status.**
	1	**Operating condition**	**OFF 3 is cancelled**
3	**0**	**Disable operation**	**Disable voltage; the converter output voltage is deactivated; the FC goes to** ready for activation **state.**
	1	**Enable operation**	**Enabling of output voltage; run-up to applied setpoint value**
4	**0**	**Disable run-up encoder**	**Run-up encoder is set to zero, with f=0Hz no voltage release; FC remains in** Operation enable **state.**
	1	**Operating condition**	**Run-up encoder is enabled**
5	**0**	**Stop run-up encoder**	**Freezing of the setpoint value currently set by the run-up encoder (hold frequency).**
	1	**Enable run-up encoder**	**Enable setpoint value at the run-up encoder.**
6	**0**	**Disable setpoint value**	**Addressed setpoint value is set to zero at the run-up encoder.**
	1	**Enable setpoint value**	**The addressed setpoint value is activated at the run-up encoder.**
7	**0**		
	1	**Confirming**	**On changing from 0 to 1, errors which are no longer active are confirmed.** **Note: When a digital input is programmed for the function "Stoer.Quit" ("Confirm error"), this bit must not be permanently set to 1 via the bus (otherwise, flank evaluation would be prevented).**
8	**0/1**		**reserved**
9	**0/1**		**reserved**
10	**0**	**PCD invalid**	**The transmitted process data is invalid.**

Bit	Value	Significance	Notes
	1	**PCD valid**	**Valid process data is transmitted by the master.** Note: **When only setpoint values are transmitted via the bus (setting: interface), this bit must be set to validate the transmitted setpoint.**
11	**0**		
	1	**Clockwise rotation**	**Clockwise rotation on**
12	**0**		
	1	**Counterclockwise rotation**	**Counterclockwise rotation on**
13	**0/1**		**reserved**
14	**0/1**	**Parameter record switching bit 0**	**00 parameter record 1** **01 parameter record 2** **10 parameter record 3** **11 parameter record 4**
15	**0/1**	**Parameter record switching bit 1**	

Fig. 15-13: Meaning of the bits in control word CTW

The status word (STW)

In the converter **response telegram**, the status word (STW) is transmitted as the first word to the master in the section of the process data.

PCD 1	PCD 2	PCD 3	PCD 4
STW	**AV1**	**AV3**	**AV2**

Fig. 15-14: Status word

Bit	Value	Significance	Notes
0	**0**	**Not ready for activation**	
	1	**Ready for activation**	**Initialization completed, charging relay in, output voltage disabled**
1	**0**	**Not ready for operation**	**Causes: ON command is not applied, error is applied, ON2 or ON3 are applied,** activation disable **status is applied**
	1	**Ready for operation**	**ON command is applied, no error is applied. The converter can start with the command ENABLE OPERATION**
2	**0**	**Disable operation**	
	1	**Operation enabled**	**Enabling of output voltage; run-up to applied setpoint value**
3	**0**	**Free of failure**	
	1	**Failure**	**Error at drive, and consequently drive out of operation; after successful confirmation, drive goes to** activation disable **state**
4	**0**	**OFF2**	**OFF 2 command is applied**
	1	**no OFF2**	
5	**0**	**OFF3**	**OFF3 command is applied**
	1	**no OFF2**	
6	**0**	**No activation disable**	
	1	**Activation disable**	**Through OFF1, goes to** ready for activation **state**
7	**0**	**No warning**	
	1	**Warning**	**Drive in continued operation, no confirmation required**
8	**0**	**Actual value not ok**	**Actual value does not correspond to setpoint**
	1	**Actual value ok**	**Actual value corresponds to desired setpoint (setpoint reached)**
9	**0**	**Local control**	**Control locally active at the device**
	1	**Control requested**	**The master is requested to take over control**
10	**0**	**Value has fallen below comparison value MFR 1**	**Programmed function of the MFR 1 is not met, or actual value < programmed comparison value**

Bit	Value	Significance	Notes
	1	**Comparison value MFR 1 reached**	**Programmed function of the MFR 1 met, or** **actual value > programmed comparison value**
11	**0**		
	1	**Clockwise rotation**	**The motor defaults to clockwise type revolving field**
12	**0**		
	1	**Counterclockwise rotation**	**The motor defaults to counterclockwise type revolving field**
13	**0**		**reserved**
	1		**reserved**
14	**0/1**	**Current active parameter record 0**	**00 parameter record 1** **01 parameter record 2** **10 parameter record 3** **11 parameter record 4**
15	**0/1**	**Current active parameter record 1**	

Fig. 15-15: Bit significance STW - status word

The setpoint 1 (SP1)

In parameter P546, the function of the 1. setpoint is set. The following possibilities are available:

command frequency (16 bit)

By default, the command frequency is transmitted as a 16 bit value in setpoint 1. Setpoint 1 is transmitted to the converter in the job telegram in the process data section as the second word.

PCD 1	PCD 2	PCD 3	PCD 4
CTW	SP1	**SP3**	**SP2**

Fig. 15-16: Setpoint 1

The setpoint is transmitted as an integer figure with the value range -32768 to 32767 (8000 hex to 7FFF hex). The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%. A setpoint value of 100% corresponds to the parameter **maximum frequency** (parameter P105) set in the same parameter record.

Second and third setpoint (SP2/3)

If PPO type 2 or 4 is used, a 2. setpoint can be transmitted in word PCD4, and a 3. setpoint in PCD3, both in addition to setpoint 1.

PCD1	PCD2	PCD3	PCD4
CTW	SP1	SP3	SP2

A third setpoint can only be transmitted if no 32 bit setpoint is transmitted in the first setpoint.

PCD1	PCD2	PCD3	PCD4
CTW	SP1		SP2

The second and third setpoint is always 16 bits wide. The function of the second and third setpoint can be set in the converter under the parameter P547 *'Function setpoint 2'* or P548 *'Function setpoint 3'*.

The first two setpoints are transmitted as integer figures in the range (-32768 to 32767). The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%; thus, no setpoints in the range -200% to +200% can be transmitted. Here, a setpoint of 100% corresponds to the respective rated quantity:

Setting	100% correspond
off	
Command frequency, actual frequency PID, actual frequency PID limited, actual frequency PID monitored, frequency addition, frequency subtraction, maximum frequency	**Maximum frequency**
Torque current limit	**torque current limit (P112)**
Current limit	**Rated converter current**
Rate-action torque	**rate-action torque (P214)**

Fig. 15-17: Relation of the setpoint values

The actual value 1 (AV1)

By default, the actual frequency - i.e. the actual output frequency of the converter- is transferred as a 16 bit value in actual value 1. In the converter response telegram, the actual value 1 is transmitted as the second word to the master in the section of the process data.

PCD 1	PCD 2	PCD 3	PCD 4
STW	AV1	**AV3**	**AV2**

Fig. 15-18: Actual value

Actual value 1 is transmitted as integer figures in the range (-32768 to 32767). In addition to the actual frequency, other current converter values can be transmitted. The setting is made in P543, *'Function actual value 1'*.

The settings 'Actual frequency', 'Actual speed', 'Current' and 'Torque current' are transmitted as a percentage of the respective rated quantity. The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%. Actual values in the range -200% to +200% can be transmitted.

The setting "Status digital I/O" (P543 = 5) transmits the status of the control terminals and the relays (multi-function relays:

Bit	Status
Bit 0-4	**Digital input 1-5**
Bit 5-11	**reserved**
Bit 12-13	**Relays 1 and 2**
Bit 14-15	**reserved**

Fig. 15-19: Status digital I/O

PCd1	PCD2	PCD3	PCD4
STW	AV1		AV2

Actual value 2 and actual value 3 (AV2/3)

When PPO type 2 or 4 is used in a transmission, two more actual values can be transmitted to the control.

Actual value 2 (AV2) is sent in PCD4. The value to be transmitted can be selected in P544 (actual bus value 2). The actual value 3 (AV3) can be sent in PCD3 if actual value 1 is **not** a 32bit value. The value to be transmitted can be selected in P545 (actual bus value 3). The scalings correspond to those of actual value 1.

Useful Data Section PIDV (Parameter ID Value)

The PIDV mechanism can be used to perform parameter editing in cyclic data traffic. In this context, the master formulates a job, and the converter formulates the respective response. The parameter section is only used in a transmission with the PPO type 1 and the PPO type 2.

Generally, the parameter sections comprises a **parameter identification** in which the job type (write, read, etc.) and the respective parameter is specified. By means of the **index**, individual parameter records or array elements can be addressed. The **parameter value** contains the value to be written or the read value.

Note: A parameter job must be repeated until the converter reacts with by transmitting the respective response telegram.

Parameter identification (PID)

In parameter identification **(PID)**, job or response and the appurtenant parameter are coded.

1	2	3	4
PID	**IND**	**PV 1**	**PV 2**

Fig. 15-20: Telegram for parameter editing

PID															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
JID/RID:				**SPM**	**PNU:**										

Fig. 15-21: PID structure

Parameter identification **(PID)** is always a 16 bit value.

PNU: The bits 0 to 10 contain the number of the requested parameter (**PNU)**, or in the converter's response telegram the number of the current parameter.

Note: Please see Chapter 11, Parameterization, for the parameter numbers **(PNU)** for the converter of FCS01 series.

In the Profibus protocol, the converter parameters are mapped into the range 1000 to 1999, i.e. when parameterizing via the bus, the parameter numbers must be added to the value of 1000 (e.g. P508 → PNU=P1508).

SPM: Bit 11 is the toggle bit for spontaneous messages. This function is **not**supported!

JID/RID: The bits 12 to 15 contain the job or response identification.

Job and Response Identification

All jobs that can be transmitted from the master to the converter are listed in the following table. The right column shows the response transmitted in normal case (°response ID positive°). Depending on the job identification, only specific response identifications are available. In error case (°JID/RID negative°), the converter always transmits to the master the value 7 in job identification (JID).

JID/ RID:	Function	Response ID positive
0	**no job**	**0**
1	**Request parameter value**	**1 / 2**
2	**Change parameter value (word)**	**1**
3	**Change parameter value (double word)**	**2**
4	**reserved (request description element)**	**-**
5	**reserved (change description element)**	**-**
6	**Request parameter value (array)**	**4 / 5**
7	**Change parameter value (array word)**	**4**
8	**Change parameter value (array double word)**	**5**
9	**Request number of array elements**	**6**
10	**reserved**	**-**
11	**Change parameter value (array double word) without writing into the EEPROM**	**5**
12	**Change parameter value (array word) without writing into the EEPROM**	**4**
13	**Change parameter value (double word) without writing into the EEPROM**	**2**
14	**Change parameter value (word) without writing into the EEPROM**	**1**

Fig. 15-22: Response identification

Significance of the values transmitted in response identification:

JID/ RID:	Function
0	**no response**
1	**Transmit parameter value (word)**
2	**Transmit parameter value (double word)**
4	**Parameter value transmitted (array word)**
5	**Transmit parameter value (array double word)**
7	**Job cannot be executed (with error numbers in PV2)**

*Only with PPO type 2 and PPO type 4

Fig. 15-23: Response identification

Before a job execution is completed, the converter will supply the response of the last job. Thus, the master must always check whether the received response corresponds to the transmitted job. **For plausibility check, the value in the response identification (RID), the received parameter number (PNU) with the corresponding index (IND) and the current parameter value (PV) for writing of parameters can be used.**

Error messages in case of non-executable jobs

If the response identification is "Job cannot be executed" (RID = 7), the parameter value (**PV2)** of the converter response is additionally extended by an error message. See the following table for the significance of the transmitted values.

No.	Statement
0	Invalid parameter number
1	Parameter value not alterable
2	Lower or upper value limit exceeded
3	Faulty sub-index
4	No array
5	Impermissible data type
6	Can only be reset (only 0 may be written)
7	Write element not alterable
9	Write data does not exist
201	Invalid job element in the job received last
202	Internal response ID cannot be mirrored

Fig. 15-24: Error Messages

Sub-index (IND)

1	2	3	4
PID	IND	**PV 1**	**PV 2**

Fig. 15-25: Telegram for parameter editing

IND															
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
						P1-P4		**no information, each bit=0**							
Array 1-64						**P1-P4**									
Sub-index															

Fig. 15-26: PID structure

The structure and function of the parameter index (IND) depend upon the type of parameter to be transmitted.

With parameter record-dependent values, the parameter record can be selected via bits 8 and 9 of the indices (IND) (0 = parameter record 1, 1 = parameter record 2, ….).

If the parameter to be edited is furthermore an array parameter, the sub-index of the requested parameter can furthermore be addressed through bit 10 to bit 15 (0 = array element 1, 1 = array element 2, ….).

Array element	Parameter record	Index
5 (000101 $_{BIN}$)	**2 (01$_{BIN}$)**	**15$_{HEX}$ = 0001 0101 $_{BIN}$**
21 (010101 $_{BIN}$)	**4 (11 $_{BIN}$)**	**57 $_{HEX}$ = 0101 0111 $_{BIN}$**

Fig. 15-27: Example: Array element / parameter record

For non-parameter record-dependent parameters, bit 8 - 15 is used for the sub-index.

Please see the operating instructions for the structure of the individual parameters and the values that can be called via the sub-indices.

Note: When using the sub-index, 6, 7, 8, or 11, 12 must be used as job identification number for the sub-index to become effective.

Parameter value (PV)

Depending on PPO type or parameter, the parameter value (PV) is always transmitted as word (16 bit) or double word (32 bit). Generally, only one parameter value can be transmitted in a telegram.

A 32 bit parameter value is made up of PV1 (more significant word) and PV2 (less significant word, 4th word).

A 16 bit parameter value in PPO 1 and PPO 2 is transmitted in PV2. With negative values, the high word must be set to FFFF hex.

Note: 32 bit parameter values are not supported by FCS01.

The parameter value is transmitted as an integer value. In case of parameters with the resolutions 0.1 or 0.01, the parameter value must be multiplied by the reciprocal value of the resolution.

Example: A run-up time of 99.99 seconds should be set.

99.99s $\rightarrow$ 99.99 * 1/0.01 = 99.99 * 100 = 9999. It follows that the value 9999 $_{dez}$ = 270F $_{hex}$ must be transmitted.

Profibus Data Transfer - Sample Telegrams

In the following, the control and parameterization of the converter via the Profibus is illustrated by way of several sample telegrams.

Activation Disable → Ready for Activation

A frequency converter is to be switched from the "activation disable" state (CTW bit 0 = 0), which is active after the device has been switched on, into the "ready for activation" state (CTW bit 0 = 1). Parameter record 1 is valid. Only the PCD channel is taken into consideration.

Procedure:

- Check status word (STW 0B 70)
- Generate control word (STW 04 7E)
- Check response telegram (STW 0A 31)

Details:

Converter status word → converter is in *Activation disable* state

9	**10**	11	12
STW	**STW**	AV1	AV1
0B	**70**	00	00

Bit	Value	Value $_{HEX}$	Significance
15	**0**	**0**	**Parameter record bit 1 off**
14	**0**		**Parameter record bit 0 off**
13	**0**		**reserved**
12	**0**		**Counterclockwise rotation off**
11	**1**	**B**	**Clockwise rotation on**
10	**0**		**Value has fallen below comparison value**
9	**1**		**Bus control**
8	**1**		**Setpoint value = actual value**
7	**0**	**7**	**No warning**
6	**1**		**Activation disable**
5	**1**		**No quick-stop**
4	**1**		**Voltage disabled**
3	**0**	**0**	**Free of failure**
2	**0**		**Disable operation**
1	**0**		**Not ready for operation**
0	**0**		**Not ready for activation**

Fig. 15-28: Example telegram

To switch the converter into *Ready for activation* status, the following telegram must be transmitted:

9	10	11	12
CTW	**CTW**	SP1	SP1
04	**7E**	00	00

When the converter has switched to *Ready for activation* state, it will transmit the following response telegram:

9	10	11	12
STW	**STW**	AV1	AV1
0B	**31**	00	00

Note: The control telegram must be transmitted cyclically as it cannot be guaranteed that the converter goes to the desired state within the response time of a telegram.

Enable with 50% setpoint value

A frequency converter which is in "Ready for activation" state is to be enabled with 50% setpoint value in clockwise rotation. The control has received a last response telegram as follows.

Procedure:

- Check status word (STW 0B 31)
- Generate control word (STW 04 7F)
- Check response telegram (STW 0F 37)

Details:

Precondition (status word of the converter)

9	10	11	12
STW	**STW**	AV1	AV1
0B	**31**	00	00

The following telegram must be sent to the converter:

9	10	11	12
CTW	**CTW**	**SP1**	**SP1**
04	**7F**	**20**	**00**

The converter accelerates the motor at the ramp. When the converter has reached 50% setpoint value, it will respond by transmitting the following telegram:

9	10	11	12
STW	**STW**	AV1	AV1
0F	**37**	20	00

Note: In bit 10 of the response telegram, the status of MFR 1 is signaled. Depending on the programmed function and state, the status word may change.

Writing a Parameter

When transmitting parameter jobs, please note that the slave will not directly respond to the job in the parameter channel of the master telegram but that the positive response may be delayed by one or several communication cycles. For this reason, the master must repeat the requested job until it has received the corresponding response from the slave.

The run-up time parameter (USIP no. = 102_{dez} / 66_{hex}) of a frequency converter should be set to the vlaue 10sec in parameter record 3. Only the PIDV channel is taken into consideration.

As the run-up time has a converter-internal resolution of 0.01s, a parameter value of 10 / 0.01 = 1000 ($3E8_{hex}$) must be transmitted for a period of 10s.

Procedure:

- Select parameter ($P102_{dez}$ + 1000 = P1102 = P $44E_{hex}$)
- Select parameter record 3 (IND = 02)
- Set parameter word (200_{dez} / $C8_{HEX}$)
- Check response telegram

In hexadecimal notation, the telegram is made up as follows:

	3	4	5	6	7	8	9	10
Parameter	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	**PV**	**PV**
Value	**24**	**4E**	**02**	**00**	**00**	**00**	**00**	**C8**

Fig. 15-29: Job telegram

When the converter has completed the job, it responds with

	3	4	5	6	7	8	9	10
Parameter	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	**PV**	**PV**
Value	**14**	**4E**	**02**	**00**	**00**	**00**	**00**	**C8**

Fig. 15-30: Response telegram

Profibus Data Transfer - Status Machine

Description of the Status Machine

The frequency converter runs through a status machine. The transitions between different statuses are triggered by corresponding control commands in the control word of the process data. The current status is returned in the status word of the process data.

After activation, the converter is in **Activation disable** state. The state can only be quitted by transmission of the command "Standstill (off 1)".

Usually, the response to a master telegram does not contain the reaction to a received control command. The control must check the slave's responses for execution of the control command.

The following bits indicate the status of the converter:

Status	Bit6 Activation disable	Bit5 Quick stop	Bit4 Voltage disable	Bit3 Failure	Bit2 Operation enabled	Bit1 Ready for operation	Bit0 Ready for activation
Not ready for activation	**0**	**X**	**X**	**0**	**0**	**0**	**0**
Activation disable	**1**	**X**	**X**	**0**	**0**	**0**	**0**
Ready for activation	**0**	**1**	**1**	**0**	**0**	**0**	**1**
Activated	**0**	**1**	**1**	**0**	**0**	**1**	**1**
Operation enabled	**0**	**1**	**1**	**0**	**1**	**1**	**1**
Failure	**0**	**X**	**X**	**1**	**0**	**0**	**0**
Failure active	**0**	**X**	**X**	**1**	**1**	**1**	**1**
Quick-stop active	**0**	**0**	**1**	**0**	**1**	**1**	**1**

Fig. 15-31: Converter status

Representation of the Status Machine

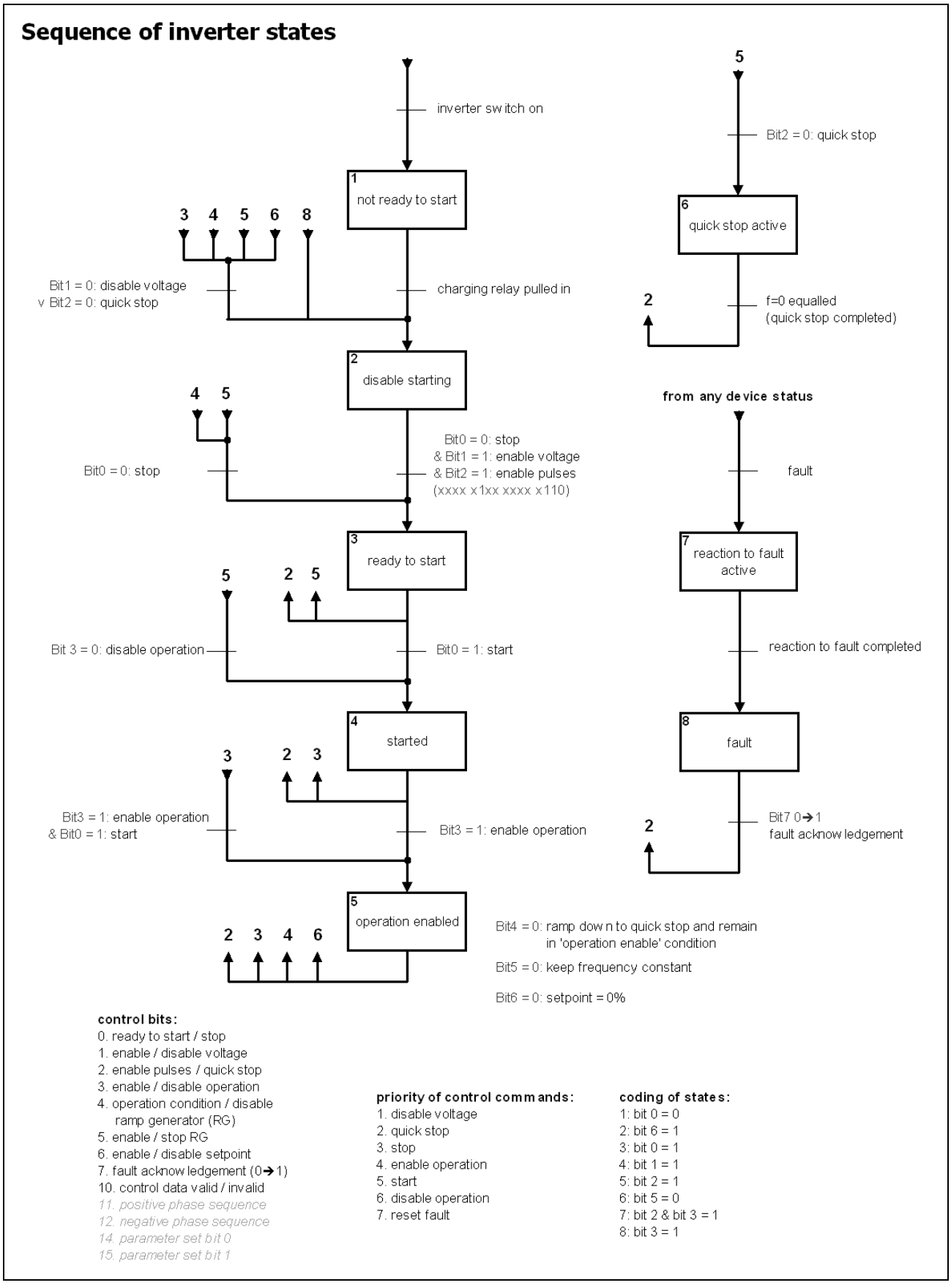


Fig. 15-32: Internal status machine

PROFIDRIVE Standard Parameter

The following parameters defined by the PROFIBUS profile are realized in the PROFIBUS module:

PNU	Explanation
918	**Node address**
927	**Control sovereignty PIDV (always 1, i.e. PROFIBUS interface)**
947	**Error number:** **The current error number is stored in this parameter.**
965	**Profile number (3.0)**
967	**Control word**
968	**Status word**
970	**Load data record** **When the parameter is set to the value 1, a factory setting is made and all change bits are set to 0.**
971	**Integration into the non-volatile memory** **(is always done automatically)**

Fig. 15-33: PROFIBUS module

These parameter numbers are not mapped.

Consistent Data Transmission

Usually, a PLC can only consistently transmit double words by I/O memory access. With longer data formats (PIDV channel generally / PCD with PPO2 or PPO4), system functions must be used (e.g. SFC14/15).

15.3 CANopen

Use and Application

In their basic version, the basic devices do not have components for parameterization or control. To establish a communication via CANopen, a **technology module CANopen** must be used.

The CANopen specification DS-301 and DS-402 of CiA is supported.

CANopen Protocol

Overview

<table>
<tr><th>Element</th><th>Description</th></tr>
<tr><td>Object directory (OD)</td><td>The OD contains all objects of the device. Objects mirror the visible functionality. They contain data, parameters or functions. They are accessed via SDOs. An object is addressed via the index (16 bit) and the sub-index (8 bit). The OD is subdivided into the following sections:
- 0000h...1FFFh: Communication-specific objects
- 2000h...5FFFh: Manufacturer-specific objects
- 6000h...9FFFh: Standardized device profile objects
- A000h...FFFFh: reserved</td></tr>
<tr><td>Service Data Obj. (SDO)</td><td>Via SDOs, confirmed transfer of data of any length between two nodes takes place: Here, the SDO client is the initiating node and has direct access to the OD entries of the SDO server (read or write). Usually, the SDO transfer is used for parameterization and for service purposes.</td></tr>
<tr><td>Process Data Obj. (PDO)</td><td>PDOs are used to transmit process data. The process data can comprise 8 byte as a maximum. They are transmitted unconfirmed. The significance of the transmitted data is specified by the identifier and the set PDO mapping. A PDO generally has one producer (sender). It can have several consumers (receivers), however.</td></tr>
<tr><td>PDO mapping</td><td>In the objects 1600h-1603h or 1A00h..1A03h, it can be specified which objects (setpoint/actual values) are transmitted in the PDO telegrams.</td></tr>
<tr><td>Identifier</td><td>Each CAN message has an 11 bit identifier. Via this identifier, addressing and priority allocation take place.
CANopen defines a preset identifier allocation which provides for communication between an upstream device with up to 127 other devices. The 11 bit identifier is divided as follows:
<table>
<tr><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">Function code</td><td colspan="7">Node identifier (0[all], 1-127)</td></tr>
</table>
<table>
<tr><th>Object</th><th>Function code</th><th>Resulting COB-ID</th><th>Index OD entry</th></tr>
<tr><td>NMT</td><td>0000</td><td>0</td><td></td></tr>
<tr><td>SYNC</td><td>0001</td><td>80h</td><td>1005h-1007h</td></tr>
<tr><td>Time stamp</td><td>0010</td><td>100h</td><td>1012h, 1013h</td></tr>
<tr><td>Emergency</td><td>0001</td><td>81h – FFh</td><td>1014h, 1015h</td></tr>
<tr><td>PDO1 (Tx)</td><td>0011</td><td>181h – 1FFh</td><td>1800h, 1A00h</td></tr>
<tr><td>PDO1 (Rx)</td><td>0100</td><td>201h – 27Fh</td><td>1400h, 1600h</td></tr>
<tr><td>PDO2 (Tx)</td><td>0101</td><td>281h – 2FFh</td><td>1801h, 1A01h</td></tr>
<tr><td>PDO2 (Rx)</td><td>0110</td><td>301h – 37Fh</td><td>1401h, 1601h</td></tr>
<tr><td>PDO3 (Tx)</td><td>0111</td><td>381h – 3FFh</td><td>1802h, 1A02h</td></tr>
<tr><td>PDO3 (Rx)</td><td>1000</td><td>401h – 47Fh</td><td>1403h, 1602h</td></tr>
<tr><td>PDO4 (Tx)</td><td>1001</td><td>481h – 4FFh</td><td>1803h, 1A03h</td></tr>
<tr><td>PDO4 (Rx)</td><td>1010</td><td>501h – 57Fh</td><td>1403h, 1603h</td></tr>
<tr><td>SDO (Tx)</td><td>1011</td><td>581h – 5FFh</td><td>1200h</td></tr>
<tr><td>SDO (Rx)</td><td>1100</td><td>601h – 67Fh</td><td>1200h</td></tr>
<tr><td>NMT Error Control</td><td>1110</td><td>701h – 77Fh</td><td>1016h, 1017h</td></tr>
</table></td></tr>
</table>

Fig. 15-34: Protocol elements

CANopen Bus Description

Bus structure

Elements		Description / data
Bus elements	**Topology**	**linear (serial bus system)**
	Nodes	**max. 128 nodes, depending on the driver modules used; standard drivers can drive approx. 100 nodes;**
	Segments	**max. 32 nodes per segment**
	Repeater	**Used for 33 nodes or more**
	Interface	**Via serial interface RS 485**
	Bus terminator	**With resistors at both ends**

Fig. 15-35: Bus structure

Note: The reaction time will increase with increasing number of nodes.

CANopen Parameterization

Pertinent Parameters

The following parameters are pertinent to communication via CANopen:

Group	Parameter	Parameter name
Bus parameter	**P509**	**Source control word**
	P510	**Source setpoint value**
	P513	**Telegram downtime**
	P514	**CAN bus Baud rate**
	P515	**CAN bus address**
	P543	**Actual bus value 1**
	P544	**Actual bus value 2**
	P545	**Actual bus value 3**
	P546	**Bus setpoint value 1**
	P547	**Bus setpoint value 2**
	P548	**Bus setpoint value 3**
	P551	**Drive profile**
Information parameter	**P745**	**Modules version**
	P746	**Module status**

Fig. 15-36: CANopen - pertinent parameters

Note: For detailed description of the pertinent parameters, please refer to Chapter 11, Parameterization.

Preset Values - Activation of CANopen

To operate the converter with the CANopen protocol, the bus must be connected to the master, and a number of settings must be made at the converter.

In the CANopen protocol, the converter parameters are mapped in the range 2000_{hex} tos $23E7_{hex}$ = 8192_{dez} to 9191_{dez}, i.e. when parameterizing via the bus, the value 2000_{hex} must be added to the parameter numbers (e.g. P508 $\rightarrow$ obj $21FC_{hex}$).

The converter can be parameterized at all times. Control of the converter via CANopen can be activated by setting the parameter **P509** to the value 6.

Note: After activation, the functions **Block voltage, quick-stop, remote control**, and **error confirmation** are generally available at the control terminals (locally). To operate the drive in this case, a high signal must be applied at the used digital inputs before the drive can be released.

CANopen Error Monitoring and Indication

LED Indication at the Function Module FCC01.1F-CN

4 LEDs indicate the status at the function module FCC01.1F-CN:

- CR / CE for the status of the CAN bus
- DR / DE for the status of the module

LED CR (green)	LED CE(red)	LED DR (green)	LED DE (red)	Significance
OFF				**CANopen status STOPPED**
Flashing				**CANopen status PRE-OPERATIONAL**
ON				**CANopen status OPERATIONAL**
	OFF			**no error**
	Flashing			**Bus warning, error counter of the CAN controller has reached or exceeded warning limit** • **Check wiring / shield / terminating resistor** • **No other node exists**
	ON			**Bus off, CAN controller has de-coupled from the bus because a severe error has occurred, e.g.:** • **wiring error** • **wrong Baud rate set**
		OFF		**No power supply**
		Flashing		**Initialisation (init phase)**
		ON		**Module OK**
			OFF	**no error**
			Flashing 5 Hz	**Initialisation (init phase)**
			Flashing 2 Hz	**Timeout error**
			Single flash	**Converter error**
			ON	**System error, e.g. plug-in contact incorrect**

Fig. 15-37: Diagnosis LED CANopen

CANopen Data Transfer - Process Data Objects PDO

Control via PDOs

Process data are transmitted via PDOs: The frequency converter sends its status data via transmit-PDOs and receives control data via receive-PDOs. With FCS01 frequency converters, 4 transmit- and 4 receive-PDOs are available characterized by different identifiers.

PDOs are transmitted unconfirmed. The significance of the transmitted data is specified by the CAN identifier used and the PDO mapping. A maximum of 8 bytes of data are transmitted.

PDO Operating Modes (Transmission Type)

Via "transmission type", it is specified when a transmit-PDO is sent, or when the data of a receive-PDO are processed. These settings are made in the objects 1400-1403 and 1800-1803. With FCS01 frequency converters, the following settings are available:

Transmit PDO: Transmission type	Value
0	**PDO is transmitted when a SYNC command has been received and the data (status) have changed since the last SYNC command.**
1-240	**PDO is transmitted when 1..240 SYNC commands have been received, irrespective of whether the data (status) has changed.**
252-253	**reserved**
254,255	**PDO is sent immediately when the data (status) has changed** **(standard setting)**

Fig. 15-38: Send PDO

Receive PDO: Transmission type	Value
0-240	**Data from the receive-PDO is only processed when the next SYNC command is received.**
252-253	**reserved**
254,255	**Data from the receive-PDO is processed immediately** **(standard setting)**

Fig. 15-39: Receive-PDO

PDO Mapping

Under PDO mapping (objects 1600-1603 or 1A00-1A03), the arrangement of the process data in the receive- or transmit-PDOs is specified. In each PDO, up to 8 byte of data can be transmitted.

The location where which data is stored within these 8 bytes is defined via mapping, e.g.

Data bytes PDO			
1	2	3	4
Control word (16 Bit)		Setpoint1 (16 Bit)	

Fig. 15-40: Data bytes PDO

Control word, status word, setpoint values and actual values can be set via the following object numbers:

Index	Sub-index	Control objects
3000		**Control word (CTW)**
3002	**1**	**Setpoint 1 (SP1) 16 bit**
	2	**Setpoint 2 (SP2) 16 bit**
	3	**Setpoint 3 (SP3) 16 bit**
	4	**Setpoint 1 (SP1) 32 bit**

Fig. 15-41: Object numbers

Index	Sub-index	Status objects
3001		**Status word (STW)**
3003	**1**	**Actual value 1 (AV1) 16 bit**
	2	**Actual value 2 (AV2) 16 bit**
	3	**Actual value 3 (AV3) 16 bit**
	4	**Actual value 1 (AV4) 32 bit**

Fig. 15-42: Object numbers

Here, the specification is made by means of an entry in the object directory (objects 1600-1603 or 1A00-1A03). Here, it is defined which object of the device is transmitted to which location of the PDOs. For the FCS01, the following mappings are set:

PDO	Length	Identifier	1.word	2.word	3.word	4.word
PDO1 (Tx)	**4 bytes**	**180h + NODE-ID**	**STW**	**AV1**		
PDO1 (Rx)	**4 bytes**	**200h + NODE-ID**	**CTW**	**SW1**		
PDO2 (Tx)	**8 bytes**	**280h + NODE-ID**	**STW**	**IW1**	**IW3**	**IW2**
PDO2 (Rx)	**8 bytes**	**300h + NODE-ID**	**CTW**	**SW1**	**SW3**	**SW2**
PDO3 (Tx)	**8 bytes**	**380h + NODE-ID**	**STW**	**IW1 (32 Bit)**		**IW2**
PDO3 (Rx)	**8 bytes**	**400h + NODE-ID**	**CTW**	**SW1 (32 Bit)**		**SW2**
PDO4 (Tx)	**2 bytes**	**480h + NODE-ID**	**STW**			
PDO4 (Rx)	**2 bytes**	**500h + NODE-ID**	**CTW**			

Fig. 15-43: PDO mapping

The FCS01 devices of the IndraDrive Fc product family support dynamic mapping and dummy mapping!

The data content of the PDO telegrams is described in the following. When the drive profile is activated (P551=On), the objects 6040-6044 are relevant instead of the objects 3000-3003 (see drive profile DS-402).

CANopen Telegram Structure

Control word - CTW

see chapter "Profibus Telegram Structure, Control Word - CTW"

Status word - STW

see chapter "Profibus Telegram Structure, Status Word - STW"

Setpoint 1 - SP1

In parameter P546, the function of the 1. setpoint is set. The following possibilities are available:

Setpoint frequency (16 bit)

By default, the setpoint frequency is transmitted as a 16 bit value in setpoint 1. Setpoint 1 is transmitted to the converter in the job telegram in the process data section as the second word.

PCD 1	PCD 2	PCD 3	PCD 4
CTW	SP1	**SP3**	**SP2**

Fig. 15-44: Setpoint 1

The setpoint is transmitted as an integer figure with the value range -32768 to 32767 (8000 hex to 7FFF hex). The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%. A setpoint value of 100% corresponds to the parameter **maximum frequency** (parameter P105) set in the same parameter record.

Second and third setpoint - SP2 and SP3

If PPO type 2 or 4 is used, a 2. setpoint can be transmitted in word PCD4, and a 3. setpoint in PCD3, both in addition to setpoint 1.

PCD1	**PCD2**	**PCD3**	**PCD4**
CTW	**SP1**	**SP3**	**SP2**

Fig. 15-45: Second and third setpoint

A third setpoint can only be transmitted if no 32 bit setpoint is transmitted in the first setpoint.

PCD1	**PCD2**	**PCD3**	**PCD4**
CTW	**SP1**		**SP2**

Fig. 15-46: Setpoint

The second and third setpoint is always 16 bits wide. The function of the second and third setpoint can be set in the converter under the parameter P547 *'Function setpoint 2'* or P548 *'Function setpoint 3'*.

The first two setpoints are transmitted as integer figures in the range (-32768 to 32767). The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%; thus, no setpoints in the range -200% to +200% can be transmitted. Here, a setpoint of 100% corresponds to the respective rated quantity:

Setting in P547, P548	100% correspond
off	
Command frequency, actual frequency PID, actual frequency PID limited, actual frequency PID monitored, frequency addition, frequency subtraction, maximum frequency	**Maximum frequency**
Torque current limit	**torque current limit (P112)**
Current limit	**Rated converter current**
Rate-action torque	**rate-action torque (P214)**

Fig. 15-47: Setting in P547, P548

Actual value 1 - AV1

By default, the actual frequency - i.e. the actual output frequency of the converter- is transferred as a 16 bit value in actual value 1. In the converter response telegram, the actual value 1 is transmitted as the second word to the master in the section of the process data.

PCD1	PCD2	PCD3	PCD3
STW	**AV1**	**AV3**	**AV2**

Fig. 15-48: Actual value 1

Actual value 1 is transmitted as integer figures in the range (-32768 to 32767). In addition to the actual frequency, other current converter values can be transmitted. The setting is made in P543, *'Function actual value 1'*.

The settings 'Actual frequency', 'Actual speed', 'Current' and 'Torque current' are transmitted as a percentage of the respective rated quantity. The value 16384 (4000 hex) corresponds to 100%. The value C000 HEX corresponds to -100%. Actual values in the range -200% to +200% can be transmitted.

With setting 5 in parameter P543, the statuses of the control terminals and the relays (MFR) can be transmitted:

Bit	Status
Bit 0-4	**Digital input 1-5**
Bit 5-11	**reserved**
Bit 12, 13	**Relays 1 and 2**
Bit 14, 15	**reserved**

Fig. 15-49: Status digital I/O

Actual Value 2 and Actual Value 3 - AV2 and AV3

When PPO type 2 or 4 is used in a transmission, two more actual values can be transmitted to the control.

Actual value 2 (AV2) is sent in PCD4. The value to be transmitted can be selected in P544 (actual bus value 2). The actual value 3 (AV3) can be sent in PCD3 if actual value 1 is **not** a 32bit value. The value to be transmitted can be selected in P545 (actual bus value 3). The scalings correspond to those of actual value 1.

CANopen Data Transfer - Example

The following example is to illustrate control via PDOs. To this end, it is assumed that the following settings are true:

Node ID "4"

Parameter interface P509 (21FDh) = 6 (CANopen control)

Rx-PDO1 is used for the control. The device sends its actual values via Tx-PDO1.

Drive profile is switched off (P551).

Identifier

Rx-PDO1: 200h + NODE-ID → 204h

Tx-PDO1: 180h + NODE-ID → 184h

Mapping

Byte	1	2	3	4
Rx-PDO1	**Obj 3000 (control word)**		**0bj. 3002 Sub1 (setpoint1)**	

Byte	1	2	3	4
Tx-PDO1	**Obj 3001 (status word)**		**0bj. 3003 Sub1 (actual value1)**	

Note: The setpoint or actual value to be transmitted can be specified via the objects 3003 and 3003. The significance of the setpoints or actual values is set in the frequency converter via the parameters P543-P548.

Control data

To provide for controlling the frequency converter, it must first be switched to CANopen status "Operational".

After having been switched on, the frequency converter is in status "Activation disable". First, it must be switched to "Activation enable" status by means of a control command. To this end, the control word "0x047E" must be transmitted. Accordingly, the structure of the PDO telegram is as follows:

Byte	1	2	3	4
ID=204	**7Eh**	**04h**	**00h**	**00h**

Then, the drive is to traverse at 50% of its maximum frequency. To provide for this function, "0x047F" and "0x2000" must be sent as setpoint:

Byte	1	2	3	4
ID=204	**7Fh**	**04h**	**00h**	**20h**

CANopen Data Transfer - Status Machine

see chapter "Profibus Data Transfer - Status Machine"

CANopen Object Directory

All available objects are comprised in the "Electronic Data Sheet“ (eds file) of the FCS01 frequency converter.

Communication Objects (1000-1200)

Index	Sub	Object	Description	Unit	Acc	Type
1000	**-**	**Device Type**	**Device type and functionality**		**RO**	**U32**
1001	**-**	**Error Register**	**Register of errors**		**RO**	**U8**
1002	**-**	**Status Register**	**Status of the module**		**RO**	**U32**
1003	**ARR**	**Pre-defined Error**	**Errors which have been signaled by means of an emergency object**			**U8**
	0	**Number of errors**	**Number of errors; writing of 0 deletes the error list**		**RW**	**U8**
	1	**Error Code**	**Error number**		**RO**	**U32**
1005	**-**	**COB-ID SYNC**	**Identifier for SYNC messages (default 80h)**		**RW**	**U32**
1008	**-**	**Device Name**	**Device name**		**RO**	**STR**
1009	**-**	**Hardware Version**	**Version of hardware**		**RO**	**STR**
100A	**-**	**Software version**	**Software version FC+CO**		**RO**	**STR**
100C	**-**	**Guard Time**	**Guard time (0=off)**	**ms**	**RW**	**U16**
100D	**-**	**Life Time Faktor**	**Life time = life time factor * guard time**		**RW**	**U16**
1014	**-**	**COB-ID Emergency Object**	**Identifier emergency object (80h+Node-ID)**		**RW**	**U32**
1015	**-**	**Inhibit Time EMCY**	**Minimum repeat time**	**ms**	**RW**	**U16**
1017	**-**	**Producer Heartbeat Time**	**Cycle time of heartbeat**	**ms**	**RW**	**U16**
1018	**REC**	**Identity Object**	**General device information**			**U32**
	0	**Largest subindex**	**Number of elements**		**RO**	**U8**
	1	**Vendor ID**	**Vendor identification**		**RO**	**U32**
	2	**Product Code**	**Device version**		**RO**	**U32**
	3	**Revision Number**	**Revision Number**		**RO**	**U32**
	4	**Serial Number**	**Serial number**		**RO**	**U32**
1200	**REC**	**Default Server SDO**	**SDO server**			**0x22**
	0	**Largest subindex**	**Number of elements**		**RO**	**U8**
	1	**COB_ID Server>Client (rx)**	**Identifier receive-SDO (600h +ID)**		**RO**	**U32**
	2	**COB_ID Server>Client (tx)**	**Identifier transmit-SDO (580h +ID)**		**RO**	**U32**

Fig. 15-50: Communication Objects (1000-1200)

PDO Objects (1400-1A03)

Index	Sub	Object	Description	Unit	Acc	Type
1400-1403	**REC**	**Receive PDO Communication Parameter**	**Receive-PDO characteristics**		**RW**	**0x21**
	0	**Largest subindex**	**Number of elements**		**RO**	**U8**
	1	**COB-ID used by PDO**	**Identifier receive-PDO**		**RW**	**U32**
	2	**Transmission type**	**Receive-PDO type**		**RW**	**U8**
	3	**Not used**	**Not used**		**-**	**-**
	4	**Reserved**	**reserved**		**-**	**-**
	5	**Not used**	**Not used**		**-**	**-**
1600-1603	**REC**	**Receive PDO Mapping Parameter**	**Receive-PDO mapping**		**RW**	**0x21**
	0	**Largest subindex**	**number of elements**		**RW**	**U8**
	1-4	**PDO mapping**	**Mapped objects**		**RW**	**U32**
1800-1803	**REC**	**Transmit PDO Communication Parameter**	**Transmit-PDO characteristics**		**RW**	**0x21**
	0	**Largest subindex**	**number of elements**		**RO**	**U8**
	1	**COB-ID used by PDO**	**Identifier receive-PDO**		**RW**	**U32**
	2	**Transmission type**	**Transmit-PDO type**		**RW**	**U8**
	3	**Inhibit time**	**Minimum transmission time**	**100µs**	**RW**	**U16**
	4	**Reserved**	**reserved**		**-**	**-**
	5	**Event timer**	**Cyclic transmit-timer**	**ms**	**RW**	**U16**
1A00-1A03	**REC**	**Transmit PDO Mapping Parameter**	**Transmit PDO mapping**		**RW**	**0x21**
	0	**Largest subindex**	**number of elements**		**RW**	**U8**
	1-4	**PDO mapping**	**Mapped objects**		**RW**	**U32**

Fig. 15-51: PDO Objects (1400-1A03)

Frequency Converter Objects (2000-3003)

Index	Sub	Object	Description	Unit	Acc	Type
2000-23E7	**-**	**Manufactor Spec. Parameter**	**FC parameter**	**-**	**-**	**-**
3000		**Controlword**	**Control word (CTW)**			**U16**
3001		**Statusword**	**Status word (STW)**			**U16**
3002	**0**	**Largest subindex**	**Number of elements**			**U8**
	1	**Setpoint 1**	**Setpoint 1 (SP1) 16 bit**			**U16**
	2	**Setpoint 2**	**Setpoint 2 (SP2) 16 bit**			**U16**
	3	**Setpoint 3**	**Setpoint 3 (SP3) 16 bit**			**U16**
	4	**Setpoint 1 (long)**	**Setpoint 1 - (SP1) 32 bit**			**U32**
3003	**0**	**Largest subindex**	**number of elements**			**U8**
	1	**Actual Value 1**	**Actual value 1 (AV1) 16 bit**			**U16**
	2	**Actual Value 2**	**Actual value 2 (AV2) 16 bit**			**U16**
	3	**Actual Value 3**	**Actual value 3 (AV3) 16 bit**			**U16**
	4	**Actual Value 1 (long)**	**Actual value 1 - (AV1) 32 bit**			**U32**

Fig. 15-52: Frequency Converter Objects (2000-3003)

CANopen Drive Profiles

Drive Profile DS-402

If the drive profile parameter (P551) is activated in the frequency converter, the device supports the profile in accordance with DS-402 Velocity Mode (velocity profile).

The profile is valid in parameter record 1 only.

Objects in "Velocity" Drive profile

In accordance with "Velocity Mode CiA DSP 402 V1.1"

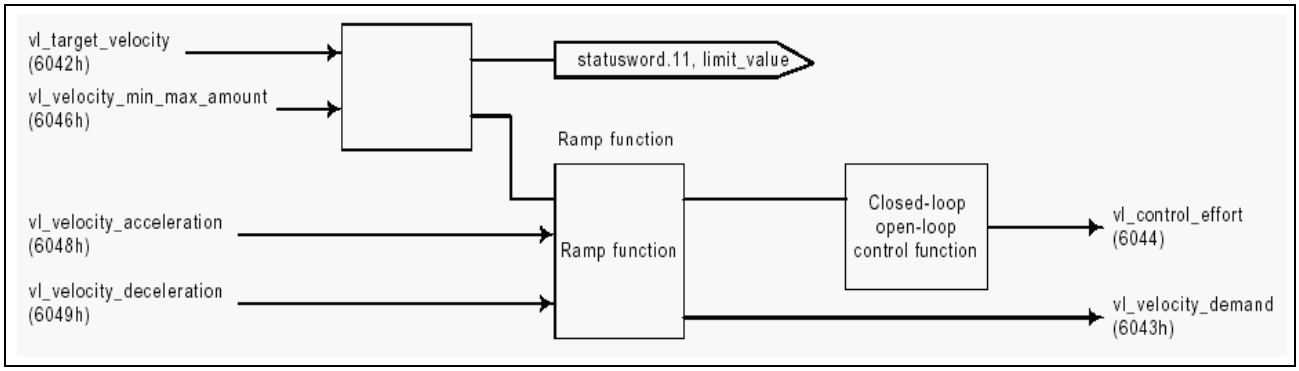


Fig. 15-53: "Velocity" drive profile

Drive Profile Objects DS-402

The following objects are only valid when the frequency converter parameter 'drive profile' (P551) is activated. Furthermore, the objects are only valid for the 1. parameter record.

Index	Sub	Object	Description	Unit	Acc	Type
603F	**-**	**Error Code**	**Error description**	**-**	**RO**	**U32**
6040	**-**	**Controlword**	**Control word**	**-**	**RW**	**U16**
6041	**-**	**Statusword**	**Status Word**	**-**	**R0**	**U16**
6042	**-**	**Vl_target_velocity**	**Velocity setpoint**	**1/min**	**RW**	**I16**
6043	**-**	**Vl_velocity_demand**	**Velocity setpoint behind ramp**	**1/min**	**RO**	**I16**
6044	**-**	**Vl_control_effort**	**actual velocity value**	**1/min**	**RO**	**I16**
6046	**ARR**	**Vl_velocity_min_max_amount**	**Min/max. amount velocity**	**-**	**RO**	**ARR**
	1	**Vl_velocity_min_amount**	**Min. amount velocity**	**1/min**	**RW**	**U32**
	2	**Vl_velocity_max_amount**	**Max. amount velocity**	**1/min**	**RW**	**U32**
6048	**REC**	**Vl_velocity_acceleration**	**Velocity acceleration**	**-**	**RO**	**REC**
	1	**Delta_speed**	**Delta speed**	**1/min**	**RW**	**U32**
	2	**Delta_time**	**Delta time**	**s**	**RW**	**U16**
6049	**REC**	**Vl_velocity_deceleration**	**Velocity deceleration**	**-**	**RO**	**REC**
	1	**Delta_speed**	**Delta speed**	**1/min**	**RW**	**U32**
	2	**Delta_time**	**Delta time**	**s**	**RW**	**U16**

Fig. 15-54: Drive Profile Objects DS-402

Object 603F error code

Code	Error description	Code	Error description
0	**No error**	**6000**	**Device software**
1000	**General error**	**6310**	**Parameter loss**
2200	**Current within the device**	**7112**	**Overcurrent brake chopper**
2310	**Permanent overcurrent output side**	**7120**	**Motor**
3110	**Mains overvoltage**	**7305**	**Incremental encoder 1**
3120	**Mains undervoltage**	**7300**	**Sensor**
3130	**Phase failure**	**7306**	**Incremental encoder 2**
3210	**Overvoltage within the device**	**7310**	**Speed sensor**
3230	**Charging error**	**7320**	**Sensor position**
4210	**Overtemperature device**	**8100**	**Monitoring communication**
4310	**Overtemperature drive**	**8300**	**Torque loop**
5110	**Low-voltage supply**	**8400**	**Speed loop**
5300	**Operating panel**	**8612**	**Reference limit**
5510	**Data storage RAM**	**9000**	**External error**
5520	**Data storage Eprom**		
5530	**Data storage EEPROM**		

Fig. 15-55: Error code

Object 6040 control word and 6041 status word

	6040 control word		6041 status word
Bit	**CanOpen significance**	**Bit**	**CanOpen significance**
0	**Activation**	**0**	**Ready for activation**
1	**Voltage disable**	**1**	**Activated**
2	**Quick stop**	**2**	**Operation enabled**
3	**Enable operation**	**3**	**Failure**
4	**Disable run-up encoder**	**4**	**Voltage disabled**
5	**Stop HLG**	**5**	**Quick stop**
6	**HLG zero**	**6**	**Activation disable**
7	**Error reset**	**7**	**Warning**
8	**Standstill**	**8**	**Actual value ok**
9	**Reserved**	**9**	**Remote**
10	**Reserved**	**10**	**Comparison value reached**
11	**Rotation direction (0=clockwise)**	**11**	**Internal limit reached***
12	**not used**	**12**	**0**
13	**not used**	**13**	**0**
14	**not used**	**14**	**Rotation direction (0=clockwise)**
15	**not used**	**15**	**0**

Fig. 15-56: Control word and status word

15.4 Universal Serial Interface Protocol - USIP

Use and Application

The **u**niversal **s**erial **i**nterface **p**rotocol USIP of the FCS01 series is used to control and parameterize the converter via an asynchronous serial interface.

To establish a point-to-point communication via the USI protocol, use interface RS-485 at the top of the device.

By means of the control and commissioning program **DriveTop Fc**, the devices can be commissioned through a PC.

USI Protocol

Supported by the USI protocol, the user can establish a serial bus coupling between a superimposed master and several slave systems. Master systems can for example be memory-programmable controls (PLCs) or PCs.

The USI protocol allows the user to realize automation tasks which demand a time-cyclic telegram traffic (⇒ fixed telegram length required), as well as visualization tasks.

The USI protocol is a simple serial transmission protocol defined by Siemens which is tailor-made for the requirements of drive engineering.

- master-slave access method
- Single master system
- Simple, safe telegram frame
- Data interface to the basic device after PROFILE variable-speed drives, i.e. information on the drive are transmitted via the USI protocol in the same way as with PROFIBUS DP.
- Suitable for commissioning, service and automation

USIP Bus Description

Bus structure

Elements		Description / data
Bus elements	**Topology**	**Linear topology without stubs; serial bus coupling between one master and several slaves;**
	Nodes	**max. 32, among them 1 master**
	Segments	
	Repeater	**Required for 33 nodes or more to connect segments.Recommendation: Do not connect more than 3 repeaters in series.**
	Interface	**EIA RS 485 for multipoint-capable couplings, or EIA RS 232 for point-to-point coupling**
	Bus terminator	**At both ends with 120Ω resistors between RS485 + and RS485 -**
Transmission physics	**Cable specification**	**Line type A acc. To EN 50 170 Bus physics identical to that of PROFIBUS (DIN 19245 part 1)**
	Cable design	**Twisted two-wire line, single-shielded as a minimum (also see specification for RS 485)**
	Recommended cable type	**Surge impedance: 135 ... 165 Ω Capacitance per unit length < 120 pF / m Loop resistance ≤ 40 Ω / km Insulation resistance ≥ 200 MΩ / km Strand diameter 0.64 mm Strand cross-section > 2 * 0.25 mm² Multi-wire single litz wires ≥ 16 × ≤ 0.2 mm Stranding ≥ 20 stranding twists / m Total diameter ≥ 5 mm Load capability ≥ 5 A**
	Shielding	**minimum requirement single-shield; Braided shield, tinned copper wire, Ø ≥ 1.1 mm^2, 85 % optical cover; placed on both sides;**
	Wiring arrangement, distances, shielding	**Inside and outside of control cabinets at least 20 cm distance to other lines with voltages > 60V;**
	Transmission technology	**semi-duplex, i.e. transmission and receipt alternate and must be controlled by the software.**

Fig. 15-57: Bus structure

Note: With point-to-point connection, a sub-quantity of EIA RS-232 (CCITT V.24), TTY (20mA current loop) or optical fiber can be used as physical interface.

Transmission speed

The maximum line lengths and thus the maximum distance between the master and the last slave is limited by the line characteristics, the environmental conditions and the transmission rate.

[EIA standard RS-422-A December 1978, Appendix, Page 14]

Transmission speed [kBit / s]	Max. line length[m]
< 100	**1200**

Fig. 15-58: Transmission speed

Note: Only when the specified line parameters are observed, the guaranteed transmission speeds or transmission distances can be maintained without any problems.

USI Parameterization

Pertinent Parameters

The following parameters are pertinent to communication via USIP:

Group	Parameter	parameter name
Bus parameter	**P503**	**Reference function output**
	P509	**Source control word**
	P510	**Source setpoint value**
	P511	**Baud rate**
	P512	**Address**
	P513	**Telegram downtime**
	P543	**Actual bus value 1**
	P544	**Actual bus value 2**
	P545	**Actual bus value 3**
	P546	**Bus setpoint value 1**
	P547	**Bus setpoint value 2**
	P548	**Bus setpoint value 3**
Information parameter	**P745**	**Modules version**
	P746	**Module status**

Fig. 15-59: USIP - pertinent parameters

Note: For detailed description of the pertinent parameters, please refer to Chapter 11, Parameterization.

Preset Values - Activation of USIP

To operate the converter with the USIP protocol, the bus must be connected to the master, and a number of settings must be made at the converter.

Control of the converter via the USI protocol can be activated by setting the parameter **P509** to the value 2. To address the converter via the control in this context, just set the used Baud rate in **P511** and the address of the converter in **P512**.

The telegram downtime **P513** can be selected in dependence on the USIP system.

Note: After activation, the functions **Block voltage, quick-stop, remote control**, and **error confirmation** are generally available at the control terminals (locally). To operate the drive in this case, a high signal must be applied at the used digital inputs before the drive can be released.

Data Coding

Telegram structure

Each telegram starts with the start character STX (= 02 Hex), followed by the indication of length (LG) and the address byte (ADR). The use characters follow after that. The telegram is completed by the data storage character BBC (Block Check Character).

STX	LGE	ADR	N_1	N_2	...		N_n	BCC

With word information (16 bit) in the useful data record (= use character record), the high byte (first character) is always transmitted first, followed by the low byte (second character). For double word information, the following applies analogously:

First, the high word is sent, followed by the low word.

Code	Significance
STX	**(Start of Text): ASCII character: 02 Hex** **The start character is the first character in the telegram; together with the start pause, it is used to reliably identify the start of telegram**
LG	**(Telegram length): 1 byte, contains the telegram length.** **The telegram length information is located in the 2. byte of the telegram; it indicates the telegram length in bytes, starting with the 3. byte. The length information is used to differentiate between the different telegram types. The data receiver can use the length byte to check the number of the characters to be received.**

ADR	**(Address byte): 1 byte, comprises the slave address among other information**
	`Bit7 Bit6 Bit5 Bit4 Bit3 Bit2 Bit1 Bit0`
	`0 M BC | Address (0..30) |`
	The USIP address is in the 3. byte (data bits 0 to 4) of the telegram. Via the USIP address, the slave device which is to transmit or receive data is addressed. Accordingly, each of the available 31 addresses (0 ... 30) can be represented by a maximum of one slave device. To this effect, the respective address must be set in the slave device. Bit 5 and bit 6 have a special significance.
	Bit 5 broadcast: By setting this bit, a so-called broadcast telegram can be activated. In a broadcast telegram, the address bits 0 t 4 are not taken into consideration by the connected slave, i.e. the transmitted master telegram is evaluated by all slaves. Contrary to a standard address, the slaves do not transmit a respond telegram, as this would cause bus conflicts.
	Bit 6 mirror: By setting bit 6, the converter returns the received telegram in identical fashion (for commissioning).

N_1... N_n	**Use character: One byte each, contents depending on job**
BCC	**1 byte, data storage character (Block Check Character)** **The checksum BBC is formed byte-wise over the whole telegram as an exclusive OR'd operation. After the last net character, the result is BBC.** **BCC = STX XOR LGE XOR ADR XOR N_1 XOR....N_N**

Fig. 15-60: Data Coding

Character Frame

Each transmitted character starts with a start bit (logic 0) and ends with a stop bit (logic 1). 8 bits are transmitted (1 byte). Saving is performed via a parity bit (even parity). Accordingly, 11 bits are transmitted per character.

Transmission Method

Only one slave device can be addressed with each telegram (exception: broadcast telegram without slave response).

For reliable identification of the telegram start by the slave, the master must observe a so-called **start break** between the receipt of the slave telegram and the transmission of the next telegram. The master starts with transmitting a telegram. After transmission of the data package, the master switches the bus data direction from send to transmit. Now, the slave addressed in the telegram must respond within a specified **response delay time**.

The telegram lengths of master and slave telegrams are always identical, i.e. the master telegram defines the telegram length of the slave response.

Telegram traffic can be cyclic or acyclic.

The following time definitions must be observed:

Time	Size	Significance
t_{SB}	**Minimum 2 character runtimes: Character runtime = 11 x (1/Baud rate)**	**Start - break time**
t_{CDT}	**Smallest start break time**	**Character - delay time**
t_{RDT}	**Maximum 20 ms**	**Response delay time**
t_{TRT}	**1.5 x flush telegram runtime** **= 1.5 x (n+4) x character runtime**	**Max. telegram remaining runtime**

Fig. 15-61: Time definitions

Start - break time

The start character STX (= 02 Hex) on its own is not sufficient for the slaves to reliably identify the start of a telegram because the bit combination 02/Hex may also appear in the use characters. For this reason, STX must be preceded by a character-less start-break character t_{SB} of at least 2 character runtimes for the master. The start-break time is part of the job telegram. Only an STX with preceding start break characterizes a valid telegram start.

Data exchange always proceeds in accordance with the schema described above (semi-duplex operation).

See the 'master telegram times' tables for the **minimum start-break times** which must be observed with the different Baud rates.

Response delay time

The time interval between the last character of the job telegram (BBC) and the start of the response telegram (STX) is called **response delay time t_{RDT}**. The maximum permissible response delay time is **20 ms but must never be smaller than the start break**. If the addressed node does not respond within the maximum permissible response delay time, an error message is stored in the master. Then, the master sends the telegram intended for the next slave node.

See the 'master telegram times' tables for the **smallest response delay times** which must be observed with the different Baud rates.

USIP Data Transfer - Structure of the Useful data

Structure of the Useful Data

see Chapter "Profibus - Structure of the Useful Data"

Types of Parameter Process Objects (PPO Types)

For cyclic data transfer, the parameter process data object (PPO) is defined which is used to transfer process data (PCD) and parameters (PIDV) from the master to the converter. The converter can handle PPO types 1, 2, 3 or 4.

Type	Task
PPO1	**extended parameter telegram with 32 bit parameter value and process data**
PPO2	**telegram with extended process data (main and two secondary command values) and 32 bit parameter value**
PPO3	**process data telegram with main command value without parameter data**
PPO4	**extended process data telegram with main and secondary command values without parameter data**

Fig. 15-62: PPO types

PPO 3 and PPO 4 are pure process data objects for applications which can do without cyclic parameter handling.

The following graphic shows an overview of the supported PPO types.

	PIDV				PCD			
	PID	**IND**	**PV**	**PV**	**PCD1**	**PCD2**	**PCD3**	**PCD4**
					CTW	**SP1**	**SP3**	**SP2**
					STW	**AV1**	**AV3**	**AV2**
	1. word	**2. word**	**3. word**	**4. word**	**5. word**	**6. word**	**7. word**	**8. word**
PPO 1								
PPO 2								
					1. word	**2. word**	**3. word**	**4. word**
PPO3								
PPO4								

Fig. 15-63: supported PPO types

Note: For the PPO types 2 and 4, 6 words each must be reserved for the address section of the process data (PCD) by reason of the protocol definition. The last two words are not used for the process data telegrams; they are only reserve sections. Description see Chapter "Profibus Telegram Structure".
The converter does not respond with the PPO types received last. A change of the PPO types is possible at any time.

USIP Telegram Structure

Useful Data Section PCD (Process Data)

Control word - CTW see Chapter "Profibus Telegram Structure".

Status word - STW see Chapter "Profibus Telegram Structure".

Second and third setpoint - SP2 and SP3 see Chapter "Profibus Telegram Structure".

Actual value 1 - AV1 see Chapter "Profibus Telegram Structure".

Actual Value 2 and Actual Value 3 - AV2 and AV3 see Chapter "Profibus Telegram Structure".

Useful Data Section PIDV (Parameter ID Value)

Parameter Section (PIDV) see chapter Useful Data Section PIDV (Parameter ID Value)

Parameter identification (PID) see chapter Useful Data Section PID (Parameter ID)

Parameter value (PV) see chapter Useful Data Section PID (Parameter ID)

Reference function output

To activate the "Reference function output", parameter P503 must be set to 1. Select the reference value for transmission via parameter P502.

The control source is still selected in P509. The transmission intervals depend upon the set USIP Baud rate:

Baud rate	interval
4800 baud	**100 ms**
9600 baud	**50 ms**
19200 baud	**25 ms**
38400 baud	**15 ms**

Fig. 15-64: Reference function output

USIP Data Transfer - Sample Telegrams

In the following, the control and parameterization of the converter via the USI protocol is illustrated by way of several sample telegrams.

Note: When transmitting the sample telegrams, please note that the slave will not directly respond to the job in the parameter channel of the master telegram but that the positive response may be delayed by one or several communication cycles. For this reason, the master must repeat the requested job until it has received the corresponding response from the slave.

As a programming tool, the macro generator of the parameterizing and commissioning software DriveTop Fc is used.

The Macrogenerator

Simple process sequences can be simulated by means of macros. This can for example be of help for testing during commissioning. Likewise, devices can be parameterized. The individual telegrams of a macro are represented in hexadecimal format. This information can be used for drawing up control programs based on the USI protocol.

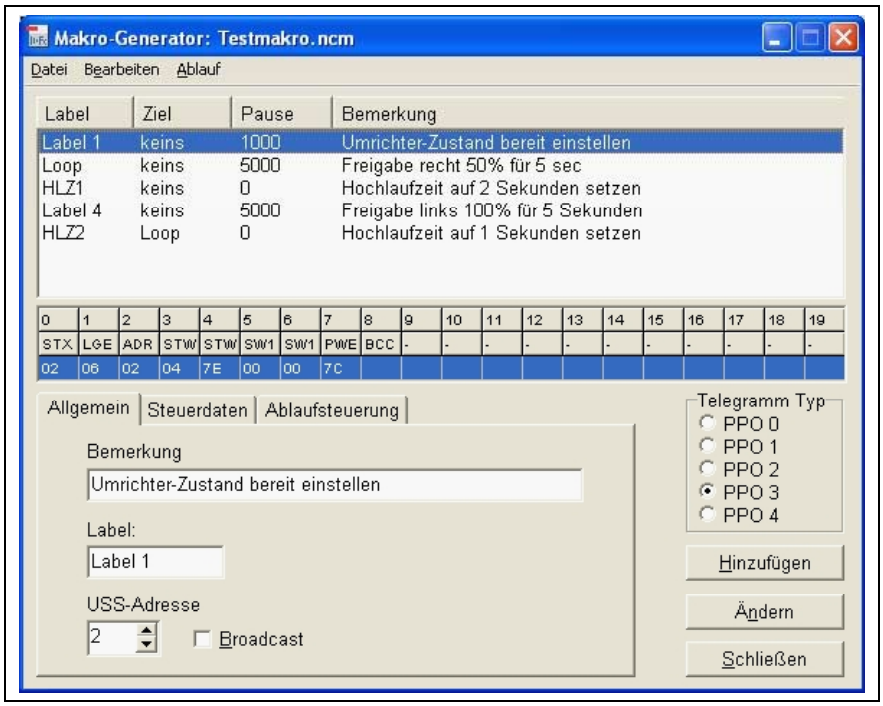


Fig. 15-65: Macro generator

A macro can consist of several steps. The telegram which is transmitted to the converter is represented as a hexadecimal value in the overview.

A sub-menu offers support with the generation of the individual steps.

- USIP address
- Control word
- Setpoint
- Parameter number
- Parameter index
- Parameter value
- Job

All points together make up one step in the macro. The telegram structure in hex representation of each single step is indicated in the 'macro' window.

Activation Disable → Ready for Activation

A frequency converter with the USIP address 0 is to be switched from the "activation disable" state (CTW bit 0 = 0), which is active after the device has been switched on, into the "ready for activation" state (CTW bit 0 = 1). Parameter record 1 is valid, and no parameter data is transmitted.

Procedure:

- Check status word (STW 0B 70)
- Set address (address 00)
- Generate control word (STW 04 7E)
- Transmit telegram
- Check response telegram (STW 0B 31)

Details:

Converter status word → converter is in *Activation disable* state

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	**ADR**	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	STW	STW	**AV1**	**AV1**	**BCC**
hexadecimal	**02**	**0C**	00	**00**	**00**	**00**	**00**	**00**	**00**	0B	70	**00**	**00**	**75**

Fig. 15-66: Status word of the converter

	Bit	Value	Value HEX	Significance
STW Byte No. 09	**15**	**0**	0	**Parameter record bit 1 off**
	14	**0**		**Parameter record bit 0 off**
	13	**0**		**reserved**
	12	**0**		**Counterclockwise rotation off**
	11	**1**	B	**Clockwise rotation on**
	10	**0**		**Value has fallen below comparison value**
	9	**1**		**Bus control**
	8	**1**		**Setpoint value = actual value**
STW Byte No. 10:	**7**	**0**	7	**No warning**
	6	**1**		**Activation disable**
	5	**1**		**No quick-stop**
	4	**1**		**Voltage disabled**
	3	**0**	0	**Free of failure**
	2	**0**		**Disable operation**
	1	**0**		**Not ready for operation**
	0	**0**		**Not ready for activation**

Fig. 15-67: Sample telegram status word

To switch the converter into *Ready for activation* status, the following telegram must be sent:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	**ADR**	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	CTW	CTW	**SP1**	**SP1**	**BCC**
hexadecimal	**02**	**0C**	00	**00**	**00**	**00**	**00**	**00**	**00**	04	7E	**00**	**00**	**74**

Fig. 15-68: Example: Control word transmission telegram

When the converter has switched to *Ready for activation* state, it will transmit the following response telegram:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	**ADR**	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	STW	STW	**AV1**	**AV1**	**BCC**
hexadecimal	**02**	**0C**	00	**00**	**00**	**00**	**00**	**00**	**00**	0B	31	**00**	**00**	**34**

Fig. 15-69: Example: Status word

	Bit	Value	Value HEX	Significance
STW Byte No. 09	15	0	0	**Parameter record bit 1 off**
	14	0		**Parameter record bit 0 off**
	13	0		**reserved**
	12	0		**Counterclockwise rotation off**
	11	1	B	**Clockwise rotation on**
	10	0		**Value has fallen below comparison value**
	9	1		**Bus control**
	8	1		**Setpoint value = actual value**
STW Byte No. 10:	7	0	3	**No warning**
	6	0		**No activation disable**
	5	1		**No quick-stop**
	4	1		**Voltage enable**
	3	0	1	**Free of failure**
	2	0		**Disable operation**
	1	0		**Not ready for operation**
	0	1		**Ready for activation**

Fig. 15-70: Example: Status word

Note: The control telegram must be transmitted cyclically as it cannot be guaranteed that the converter goes to the desired state within the response time of a telegram.

Enable with 50% setpoint value

A frequency converter with the USIP address 10 which is in "Ready for activation" state is to be enabled with 50% setpoint value in clockwise rotation. The control has received a last response telegram as follows.

Procedure:

- Check status word (STW 0B 31)
- Set address (address 0A)
- Generate control word (STW 04 7F)
- Generate setpoint (2000 hex)
- Transmit telegram
- Check response telegram (STW 0F 37)

Details:

Precondition (status word of the converter)

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	**ADR**	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	STW	STW	**AV1**	**AV1**	**BCC**
hexadecimal	**02**	**0C**	0A	**00**	**00**	**00**	**00**	**00**	**00**	0B	31	**00**	**00**	**37**

Fig. 15-71: Status word of the converter

The following telegram must be sent to the converter:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	**ADR**	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	CTW	CTW	SP1	SP1	**BCC**
hexadecimal	**02**	**0C**	0A	**00**	**00**	**00**	**00**	**00**	**00**	04	7F	20	00	**5F**

Fig. 15-72: Example: Status word transmission telegram

The converter accelerates the motor at the ramp. When the converter has reached 50% setpoint value, it will respond by transmitting the following telegram:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	ADR	**PID**	**PID**	**IND**	**IND**	**PV**	**PV**	STW	STW	**AV1**	**AV1**	**BCC**
hexadecimal	**02**	**0C**	0A	**00**	**00**	**00**	**00**	**00**	**00**	0F	37	**20**	**00**	**1C**

Fig. 15-73: Example: Status word response telegram

Note: In bit 10 of the response telegram, the status of MFR 1 is signaled. Depending on the programmed function and state, the status word may change.

Writing a Parameter

When transmitting parameter jobs, please note that the slave will not directly respond to the job in the parameter channel of the master telegram but that the positive response may be delayed by one or several communication cycles. For this reason, the master must repeat the requested job until it has received the corresponding response from the slave.

The run-up time parameter (USS no. = 102_{dez} / 66_{hex}) of a frequency converter with the USIP address 3 should be set to the value 10sec in parameter record 3. There aren't any process data transmitted.

As the run-up time has a converter-internal resolution of 0.01s, a parameter value of 10 / 0.01 = 1000 ($3E8_{hex}$) must be transmitted for a period of 10sec. PPO1 is selected as PPO type.

Procedure:

- Set address (address 03)
- Select parameter (P 102_{dez} / P 66_{hex})
- Select job identification (2 = change parameter value (word))
- Select parameter record 2 (IND = 01)
- Set parameter value (1000_{dez} / $3E8_{HEX}$)
- Transmit telegram
- Check response telegram

In hexadecimal notation, the telegram is made up as follows:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Significance	**STX**	**LG**	ADR	PID	PID	IND	IND	PV	PV	PV	PV	**CTW**	**CTW**	**SP1**	**SP1**	**BCC**
hexadecimal	**02**	**0E**	03	20	66	00	01	00	00	03	I8	**00**	**00**	**00**	**00**	**80**

Fig. 15-74: Example: Control word telegram structure

When the converter has completed the job, it responds with

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Significance	**STX**	**LG**	ADR	PID	PID	IND	IND	PV	PV	PV	PV	**CTW**	**CTW**	**SP1**	**SP1**	**BCC**
hexadecimal	**02**	**0E**	03	10	66	00	01	00	00	03	I8	**09**	**31**	**00**	**00**	**88**

Fig. 15-75: Example: Status word response telegram

Reading the Run-Up Time Parameter

The run-up time parameter (USS no. = 102_{dez} / 66_{hex}) in parameter record 2 of a frequency converter with the USIP address 3 is to be read out. There aren't any process data transmitted.

Procedure:

- Set address (address 03)
- Generate parameter identification (PKE 10 66)
- Select parameter record 2 (IND = 01)
- Transmit telegram
- Check response telegram (PV = 3E8)

Details:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	ADR	PID	PID	IND	IND	**PV**	**PV**	**CTW**	**CTW**	**SP1**	**SP1**	**BCC**
hexadecimal	**02**	**0C**	03	10	66	00	01	**00**	**00**	**00**	**00**	**00**	**00**	**7A**

Fig. 15-76: Transmission telegram

The slave's response telegram contains the requested parameter in internal scaling and could for example be as in the following example:

Byte no.	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Significance	**STX**	**LG**	ADR	PID	PID	IND	IND	PV	PV	**STW**	**STW**	**AV1**	**AV1**	**BCC**
hexadecimal	**02**	**0C**	03	10	66	00	01	03	I8	**0B**	**31**	**20**	**00**	**A8**

Fig. 15-77: Response telegram

The transmitted value in the PV is 03 $E8_{HEX}$ corresponding to 1000 $_{DEC}$; with a resolution of 0.01 seconds, this equals a run-up time of 1000 * 0.01 = 10 seconds

10 / 0.01 = 1000 (03 $E8_{hex}$)

USIP Data Transfer - Status Machine

see chapter "Profibus Data Transfer - Status Machine"

USIP Data Transfer - Master Telegram Times

The telegram times to be monitored depend upon the currently valid Baud rate and the telegram length.

For the data format: 8E1, the following runtimes are applicable:

Baud rate [kBit / s]	PPO type	Telegram bytes	Start - break time [ms]	Minimum total runtime [ms]	Maximum total runtime [ms]	Response delay time [ms]
4800	**PPO0**	**14**	**4,583**	**32,083**	**48,1**	**4,583**
4800	**PPO1**	**16**	**4,583**	**36,667**	**55**	**4,583**
4800	**PPO2**	**20**	**4,583**	**45,833**	**68,8**	**4,583**
4800	**PPO3**	**8**	**4,583**	**18,333**	**27,5**	**4,583**
4800	**PPO4**	**12**	**4,583**	**27,5**	**41,3**	**4,583**
9600	**PPO0**	**14**	**2,292**	**16,042**	**24,1**	**2,292**
9600	**PPO1**	**16**	**2,292**	**18,333**	**27,5**	**2,292**
9600	**PPO2**	**20**	**2,292**	**22,917**	**34,4**	**2,292**
9600	**PPO3**	**8**	**2,292**	**9,167**	**13,8**	**2,292**
9600	**PPO4**	**12**	**2,292**	**13,75**	**20,6**	**2,292**
19200	**PPO0**	**14**	**1,146**	**8,021**	**12**	**1,146**
19200	**PPO1**	**16**	**1,146**	**9,167**	**13,8**	**1,146**
19200	**PPO2**	**20**	**1,146**	**11,458**	**17,2**	**1,146**
19200	**PPO3**	**8**	**1,146**	**4,583**	**6,9**	**1,146**
19200	**PPO4**	**12**	**1,146**	**6,875**	**10,3**	**1,146**
38400	**PPO0**	**14**	**0,573**	**4,01**	**6**	**0,573**
38400	**PPO1**	**16**	**0,573**	**4,583**	**6,9**	**0,573**
38400	**PPO2**	**20**	**0,573**	**5,729**	**8,6**	**0,573**
38400	**PPO3**	**8**	**0,573**	**2,292**	**3,4**	**0,573**
38400	**PPO4**	**12**	**0,573**	**3,438**	**5,2**	**0,573**

Fig. 15-78: Runtimes

The start-break time and the typical response delay time are defined on the basis of the time it takes to transmit two data bytes. The maximum permissible response delay time intended by the telegram is 20 ms.

The total runtime in the table is the flush telegram runtime,i.e. the stop bit of the last character is immediately followed by the start character of the next telegram. In practice, however, character delay times occur between the bytes of a telegram. For this reason, factor 1.5 is applied for the maximum permissible telegram runtime.

Maximum total runtime = 1.5 * flush telegram runtime

The interface driver software must check or bring about the compliance with the following telegram parameters and trigger an error in case of the runtime is repeatedly exceeded:

- Telegram length data of the receipt telegram (LG)
- Telegram format (start character / STX, check sum / BBC)
- Character format (parity, start and stop bit)
- Total runtime of the slave response
- Response delay time (typical response period of two bytes, max. 20 ms)

15.5 DeviceNet

Use and Application

The FCS01 basic device is supplied with a blind cover for the function module slot. In basic version, it does not comprise components for parameterization or control.

In addition to the communication profile, DeviceNet defines the so-called device profiles for the main device types used in industrial automation engineering, e.g. digital and analog I/Os, drives etc.

DeviceNet is an open field bus system for networking various controls, e.g. PLC or PC, with sensors and actuators.

Devices by different manufacturers and different complexities can be interconnected per DeviceNet and controlled, diagnosed, configured and parameterized via the bus.

DeviceNet constitutes the link between the communication nodes by means of the well-proven "Common Industrial Protocol" (CIP). Physical basis is the CANbus.

DeviceNet Protocol

Overview

Element	Description
Nodes	**In a DeviceNet, up to 64 nodes can communicate with each other. Each node has its own node address.**
Communication, connection objects	**Communication between the individual devices takes place via connection objects. Before data exchange starts, these links (*connection objects*) must be established.**
Predefined Master/ Slave Connection Set	**The Predefined Master/ Slave Connection Set provides an interface which can be used to allocate a set of up to 4 connections:** **Explicit Messaging Connection** **Polled I/O Connection** **Bit.Strobe I/O Connection** **Change Of State / Cyclic I/O Connection** **The slave can only be accessed from a master.**
Object model	**DeviceNet describes all data and functions by way of an object model. Here, an *object* represents the individual components within a device.** **It is defined by its data or characteristics (*attributes*) and provides functions or *services* for external access. An object class defines all characteristics (attributes/services) of objects of the same type. The generation of an object instance creates a real copy of the object with data of its own.**
Explicit message	**Via *Explicit messages*, configuration/diagnosis data with low priority are exchanged (parameterization). This connection is always a point-to-point connection according to the client/server principle.**

I/O messages	***I/O messages*** **are used to transmit process data. An I/O message generally has a producer (sender). It can have several consumers (receivers), however. The process data can either comprise 8 bytes (non-fragmented) or be distributed among several telegrams (fragmented).**
Polling	**A *polled* connection corresponds to a master-slave-connection: A master transmits data cyclically to the slave. The slave responds by transmitting its status data.**
Bit strobe	**In a *bit strobe* connection, the master transmits an 8 byte telegram to all connected devices. Each node is assigned exactly one bit. As all nodes receive the telegram simultaneously, a synchronous reaction can be executed. The individual nodes' reaction to this bit is application-specific and must be known to the master. The bit strobe telegrams are unconfirmed.**

Fig. 15-79: DeviceNet Protocol

DeviceNet Bus Description

Bus structure

Elements		Description / data
Bus elements	**Topology**	**linear (serial bus system)**
	Nodes	**max. 64 nodes, depending on the driver modules used; standard drivers can drive approx. 100 nodes;**
	Segments	**max. 32 nodes per segment**
	Repeater	**Used for 33 nodes or more**
	Interface	**Via serial interface RS 485**
	Bus terminator	**With resistors at both ends**
Transmission physics	**Cable specification**	**Line type A acc. to EN 50 170**
	Cable design	**5-strand line according to DeviceNet specification**
	Recommended cable type	**Surge impedance: 135 ... 165 Ω Capacitance per unit length < 30 pF / m Loop resistance 110 Ω / km Strand diameter 0.64 mm Strand cross-section > 0.34sqmm**
	Shielding	**minimum requirement single-shield;placed on both sides;**
	Wiring arrangement, distances, shielding	**Inside and outside of control cabinets at least 20 cm distance to other lines with voltages > 60V;**

Fig. 15-80: Bus structure DeviceNet

Transmission Speed

The maximum line lengths and thus the maximum distance between the master and the last slave is limited by the line characteristics, the environmental conditions and the transmission rate.

The maximum length of the stubs depends on line material and the selected Baud rate. Please refer to the DeviceNet specification.

Transmission speed [kBit / s]	max. line (bus) lengths[m]
125	**up to 500**
250	**up to 250**
500	**up to 100**

Fig. 15-81: Transmission speed

Note: Only when the specified line parameters are observed, the guaranteed transmission speeds or transmission distances can be maintained without any problems.

DeviceNet Parameterization

Pertinent Parameters

The following parameters are pertinent to communication via DeviceNet:

Group	Parameter	Parameter name
Bus parameter	**P507**	**PPO type**
	P509	**Source control word**
	P510	**Source setpoint value**
	P513	**Telegram downtime**
	P514	**CAN bus Baud rate**
	P515	**CAN bus address**
	P543	**Actual bus value 1**
	P544	**Actual bus value 2**
	P545	**Actual bus value 3**
	P546	**Bus setpoint value 1**
	P547	**Bus setpoint value 2**
	P548	**Bus setpoint value 3**
	P551	**Drive profile**
Information parameter	**P745**	**Modules version**
	P746	**Module status**

Fig. 15-82: USIP - pertinent parameters

Note: For detailed description of the pertinent parameters, please refer to Chapter 11-1, Parameterization.

Preset Values - Activation of DeviceNet

To operate the converter with the DeviceNet protocol, the bus must be connected to the master, and a number of settings must be made at the converter.

With the DeviceNet protocol, the converter parameters are mapped to DeviceNet objects in the range 100 to 107.

	Computation
Class	**100 + parameter number / 100**
Attribute	**Parameter number % 100**
Instance	**SubIndex +1**
Parameter number	**(Class – 100) * 100 + attribute**
SubIndex	**Instance -1**

Fig. 15-83: Preset Values - Activation of DeviceNet

The converter can be parameterized at all times. Control of the converter via DeviceNet can be activated by setting the parameter **P509** to the value 7.

Note: After activation, the functions **Block voltage, quick-stop, remote control**, and **error confirmation** are generally available at the control terminals (locally). To operate the drive, a high signal must be applied at the used digital inputs before the drive can be released.

DeviceNet Error Monitoring and Indication

LED Indication at the Function Module FCC01.1F-DN

4 LEDs indicate the status at the function module:

- MS/NS for the status of the DeviceNet bus
- DS/DE for the status of the module

LED MS red/green	LED NS red/green	LED DS (green)	LED DE (red)	Significance
off				No supply voltage at the module
Green on				The module is ready
Flashing green				The module is in standby
Flashing red				Confirmable error
Red on				Non-confirmable error, modules possibly needs replacement
	OFF			Module is not online: • No supply voltage at the module • The module could not execute the Dup_MAC_ID test
	Flashing green			Module is online and has executed the Dup_MAC_ID test, but did not establish a connection to the other nodes
	Green on			Module is online and is connected to a master
	Flashing red			One or more I/O connections are in timeout status
	Red on			Module has detected an error that makes communication impossible, e.g. Bus-Off, Dup_MAC_IC test error
		OFF		No power supply
		Flashing		Initialisation (init phase)
		O (n)		Module OK
			OFF	no error
			Flashing ~ 5 Hz	Initialization phase
			Flashing ~ 2 Hz	Timeout error
			Flashing ~ 0.5 Hz	Converter error
			O (n)	System error, e.g. plug-in contact incorrect

Fig. 15-84: Diagnosis LED DeviceNet

DeviceNet Telegram Structure

Useful Data Section PCD (Process Data)

Control word - CTW see Chapter "Profibus Telegram Structure"

Status word - STW see Chapter "Profibus Telegram Structure"

Second and third setpoint - SP2 and SP3 see Chapter "Profibus Telegram Structure"

Actual value 1 - AV1 see Chapter "Profibus Telegram Structure"

Actual Value 2 and Actual Value 3 - AV2 and AV3 see Chapter "Profibus Telegram Structure"

DeviceNet Profile Selection - I/O Messages

Control data are transmitted form the master to the frequency converter, or status data from the frequency converter to the master via I/O messages.

Transmission can be effected in a cyclic (polling/cyclic) or event-controlled manner (change of state/bit strobe). With FCS01 converters, 4 or 8 bytes are transmitted.

Profil selection - assembly

P551 is used to specify whether the AC profile is active. Via P507, the active AC drive assembly- instance is selected and the data length is determined (see table).

For the I/O messages, the following assembly instances are available:

Assembly	Profile	Length		P551	P507
20	**AC-DRIVE**	**4 bytes**	**Control word + setpoint speed**	**1**	**1**
21	**AC-DRIVE**	**4 bytes**	**Control word + setpoint speed**	**1**	**2**
70	**AC-DRIVE**	**4 bytes**	**Status word + actual speed**	**1**	**1**
71	**AC-DRIVE**	**4 bytes**	**Status word + actual speed**	**1**	**2**
100	**IndraDrive Fc**	**4 bytes**	**Control word + setpoint 1**	**0**	**1**
101	**IndraDrive Fc**	**8 bytes**	**Control word + setpoint 1 + setpoint 2 + setpoint 3**	**0**	**2**
110	**IndraDrive Fc**	**4 bytes**	**Status word + actual word 1**	**0**	**1**
111	**IndraDrive Fc**	**8 bytes**	**Status word + actual value 1 + actual value 2 + actual value 3**	**0**	**2**

Fig. 15-85: Profile selection - assembly

AC profile

When the AC-DRIVE profile is activate (P551=1), the assembly instances 20, 21, 70 and 71 are valid. The process data have the following significance:

Instance	Byte	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
20	**0**						**Fault reset**		**Run forward**
	1	**Setpoint speed [min^{-1}](low byte)**							
	2	**Setpoint speed [min^{-1}](high byte)**							
	3								
21	**0**		**Netref**	**Netctrl**			**Fault reset**		**Run forward**
	1	**Setpoint speed [min^{-1}](low byte)**							
	2	**Setpoint speed [min^{-1}](high byte)**							
	3								
70	**0**						**Run 1**		**Fault**
	1	**Actual speed [min^{-1}](low byte)**							
	2	**Actual speed [min^{-1}](high byte)**							
	3								
71	**0**	**At reference**	**Ref from net**	**Ctrl from net**	**ready**	**Run 2**	**Run 1**	**Warning**	**Fault**
	1	**Drive state**							
	2	**Actual speed [min^{-1}](low byte)**							
	3	**Actual speed [min^{-1}](high byte)**							

Fig. 15-86: AC profile

Useful Data Section PIDV (Parameter ID Value)

Parameter Section (PIDV) see chapter Useful Data Section PIDV (Parameter ID Value)

Parameter identification (PID) see chapter Useful Data Section PID (Parameter ID)

Parameter value (PV) see chapter Useful Data Section PID (Parameter ID)

DeviceNet Data Transfer - Status Machine

see chapter "Profibus Data Transfer - Status Machine"

DeviceNet Object Classes

Class 01 - Identity Object

The identity object identifies devices within the DeviceNet network.

Inst	Attr.	Description	Type	Access
1	**1**	**Vendor ID**	**UINT**	**Get**
	2	**Device Type**	**UINT**	**Get**
	3	**Product Code**	**UINT**	**Get**
	4	**Revision (Major/Minor revision)**	**STRUCT**	**Get**
	5	**Status**	**UINT**	**Get**
	6	**Serial Number**	**UDINT**	**Get**
	7	**Product Name**	**SHORTSTR**	**Get**

Fig. 15-87: Class 01 - Identity Object

Class 03 - DeviceNet Object

Bus-specific settings are read out via the DeviceNet object.

Inst	Attr.	Description	Type	Access
1	**1**	**Node Address**	**USINT**	**Get**
	2	**Baud Rate**	**USINT**	**Get**
	3	**BOI**	**BOI**	**Get**
	4	**Bus-Off Counter**	**USINT**	**Get**
	5	**Allocation Information**	**STRUCT**	**Get**
	6	**MAC ID Switch Changed**	**BOOL**	**Get**
	7	**Baud Rate Switch Changed**	**BOOL**	**Get**
	8	**MAC ID Switch Value**	**USINT**	**Get**
	9	**Baud Rate Switch Value**	**USINT**	**Get**

Fig. 15-88: Class 03 - DeviceNet Object

Class 04 – Assembly Object

In the assembly objects, process data are mirrored.

Inst	Attr.	Description	Type	Access
20	**3**	**Assembly Data AC-Profil**	**UINT**	**Set**
21	**3**	**Assembly Data AC-Profil**	**UINT**	**Set**
70	**3**	**Assembly Data AC-Profil**	**UINT**	**Get**
71	**3**	**Assembly Data AC-Profil**	**UINT**	**Get**
100	**3**	**Assembly Data IndraDrive Fc-Profil**	**UINT**	**Set**
101	**3**	**Assembly Data IndraDrive Fc-Profil**	**UDINT**	**Set**
110	**3**	**Assembly Data IndraDrive Fc-Profil**	**UINT**	**Get**
111	**3**	**Assembly Data IndraDrive Fc-Profil**	**UDINT**	**Get**

Fig. 15-89: Class 04 – Assembly Object

Class 05 – DeviceNet Connection Object

In this object, the settings for each active connection can be read out:

- Instance 1: Expl. message
- Instance 2: Polling
- Instance 3: Bit strobe
- Instance 4: COS/cyclic

Inst	Attr.	Description	Type	Access
1-4	**1**	**State**	**USINT**	**Get**
	2	**Instance Type**	**USINT**	**Get**
	3	**transportClass_trigger**	**BYTE**	**Get**
	4	**produced_connection_id**	**UINT**	**Get**
	5	**consumed_connection_id**	**UINT**	**Get**
	6	**initial_comm_characteristic**	**BYTE**	**Get**
	7	**produced_connection_size**	**UINT**	**Get**
	8	**consumed_connection_size**	**UINT**	**Get**
	9	**expected_packet_rate**	**UINT**	**Get/Set**
	12	**watchdog_timeout_action**	**USINT**	**Get**
	13	**produced_con_path_length**	**UINT**	**Get**
	14	**produced_connection_path**	**EPATH**	**Get**
	15	**consumed_con_path_length**	**UINT**	**Get**
	16	**consumed_connection_path**	**EPATH**	**Get**
	17	**produced_inhibit_time**	**UINT**	**Get**

Fig. 15-90: Class 05 – DeviceNet Connection Object

Class 40 (28_{hex}) – Motor Data Object

Via the motor data object, motor-specific data can be entered or read. This object is valid only with the AC profile active.

Inst	Attr.	Description	Type	Access
1	**3**	**Motor type**	**USINT**	**Get**
	6	**Stator current [0.1A]**	**UINT**	**Get**
	7	**Rated voltage [V]**	**UINT**	**Get/Set**
	8	**Nominal power [W]**	**UDINT**	**Get/Set**
	9	**Rated frequency**	**UINT**	**Get/Set**
	12	**No. of poles**	**UINT**	**Get**

Fig. 15-91: Class 40 (28_{hex}) – Motor Data Object

Class 41 (29_{hex}) – Control Supervisor Object

This is used to set the control of the device and to read out the status. This object is valid only with the AC profile active.

Inst	Attr.	Description	Type	Access
1	**3**	**RunFwd (setpoint: clockwise rotation)**	**BOOL**	**Get/Set**
	4	**RunRev (setpoint: counterclockwise rotation)**	**BOOL**	**Get/Set**
	5	**NetCtrl (control via DeviceNet)**	**BOOL**	**Get/Set**
	6	**Drive State (FC status in AC profile)**	**USINT**	**Get**
	7	**Running Fwd (actual rotation: clockwise)**	**BOOL**	**Get**
	8	**Running Rev (actual rotation: counterclockwise)**	**BOOL**	**Get**
	9	**Ready**	**BOOL**	**Get**
	10	**Faulted**	**BOOL**	**Get**
	11	**Warning**	**BOOL**	**Get**
	12	**Fault reset (error confirmation)**	**BOOL**	**Get/Set**
	13	**Fault code (current error)**	**UINT**	**Get**

Fig. 15-92: Class 41 (29_{hex}) – Control Supervisor Object

Class 42 ($2A_{hex}$) – AC-Drive Object

This is used to set the setpoint value source of the device and to read out the actual value. This object is valid only with the AC profile active.

Inst	Attr.	Description	Type	Access
1	**4**	**NetRef (setpoint value source)**	**BOOL**	**Get/Set**
	6	**DriveMode**	**USINT**	**Get**
	7	**Current actual speed [rpm]**	**INT**	**Get**
	8	**Current setpoint speed [rpm]**	**INT**	**Get/Set**
	9	**Actual current [0.1 A]**	**INT**	**Get**
	15	**Current power [W]**	**INT**	**Get**
	16	**Input voltage [V]**	**INT**	**Get**
	17	**Output voltage [V]**	**INT**	**Get**
	18	**Runup time [ms]**	**UINT**	**Get/Set**
	19	**Brake time [ms]**	**UINT**	**Get/Set**
	20	**Minimum speed [rpm]**	**UINT**	**Get/Set**
	21	**Maximum speed [rpm]**	**UINT**	**Get/Set**
	29	**RefFromNet (setpoint via DeviceNet)**	**BOOL**	**Get**

Fig. 15-93: Class 42 ($2A_{hex}$) – AC-Drive Object

Class 42 ($2A_{hex}$) – Acknowledge Handler Object

The *acknowledge handler* is used to organize receipt of *message acknowledgements*

Inst	Attr.	Description	Type	Access
1	**1**	**Acknowledge Timer**	**UINT**	**Set**
	2	**Retry Limit**	**USINT**	**Get/Set**
	3	**COS Producing Connect Instance**	**UINT**	**Get**

Fig. 15-94: Class 42 ($2A_{hex}$) – Acknowledge Handler Object

Class 100-107 (64_{hex}-$6B_{hex}$) – IndraDrive Fc Objects

By means of the IndraDrive Fc objects, all parameters of the frequency converter can be accessed. See the frequency converter operating instructions for the parameter numbers (PNo.):

Range	Conversion PNo → class:	Conversion class → PNo:
(100-107)	**Class = 100 + PNo / 100**	**PNo = class – 100) * 100 + attribute**
(0-99)	**Attribute = PNo % 100**	**SubIndex = Instance -1**
(1-255)	**Instance = SubIndex +1**	

Fig. 15-95: Class 100-107 (64_{hex}-$6B_{hex}$) – IndraDrive Fc Objects

Example: P745, SubIndex 2 = class 107, attribute 45, instance 3

Class		Inst	Attr.	Description
100	**IndraDrive Fc Operation**	**1-255**	**0-99**	**Status indications**
101	**IndraDrive Fc Basic**	**1-255**	**0-99**	**Basic parameter**
102	**IndraDrive Fc Motor**	**1-255**	**0-99**	**Motor data**
103	**reserved**			
104	**IndraDrive Fc Terminal**	**1-255**	**0-99**	**Control terminals setting**
105	**IndraDrive Fc Additional**	**1-255**	**0-99**	**Additional functions**
106	**reserved**			
107	**IndraDrive Fc Information**	**1-255**	**0-99**	**Information parameter**

Fig. 15-96: Class 100-107 (64_{hex}-$6B_{hex}$) – IndraDrive Fc Objects

Class 120 (78_{hex}) – IndraDrive Fc Index Object

Enter the parameter number and the sub-index to access all parameters via this object. Then, the parameter can be read or written via attribute 3.

Inst	Attr.	Description	Type	Access
1	**1**	**Parameter number**	**UINT**	**Get/Set**
	2	**Parameter SubIndex**	**USINT**	**Get/Set**
	3	**Read / write parameter**	**DINT**	**Get/Set**

Fig. 15-97: Class 120 (78_{hex}) – IndraDrive Fc Index Object

16 Disposal and Environmental Protection

16.1 Disposal

Products

Our products can be returned to us free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

In addition, when returned the products mustn't contain any undue foreign matter or foreign component.

Please send the products free domicile to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Bürgermeister-Dr.-Nebel-Straße 2
D-97816 Lohr am Main

Packaging Materials

The packaging materials consist of cardboard, wood and polystyrene. They can be easily recycled. For ecological reasons you should not return the empty packages to us.

16.2 Environmental Protection

No Release of Hazardous Substances

Our products do not contain any hazardous substances that they can release in the case of appropriate use. Normally there aren't any negative effects on the environment to be expected.

Materials Contained in the Products

Electronic Devices

Electronic devices mainly contain:

- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Motors

Motors mainly contain:

- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

Recycling

Due to their high content of metal most of the product components can be recycled. In order to recycle the metal in the best possible way it is necessary to disassemble the products into individual modules.

The metals contained in the electric and electronic modules can also be recycled by means of specific separation processes.
The synthetic materials remaining after these processes can be thermally recycled.

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