SIEMENS

MICROMASTER 420

0.12 kW - 11 kW

Operating Instructions Issue 10/06



User Documentation
6SE6400-5AA00-0BP0

MICROMASTER 420 Documentation

Getting Started Guide

Is for quick commissioning with SDP and BOP.



Operating Instructions

Gives information about features of the MICROMASTER 420, Installation, Commissioning, Control modes, System Parameter structure, Troubleshooting, Specifications and available options of the MICROMASTER 420.



Parameter List

The Parameter List contains the description of all Parameters structured in functional order and a detailed description. The Parameter list also includes a series of function plans.



Catalogues

In the catalogue you will find all the necessary information to select an appropriate inverter, as well as filters, chokes, operator panels and communication options.



SIEMENS

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0.12 kW - 11 kW

Operating Instructions
User Documentation

Valid for Release Issue 10/06

Inverter Type
MICROMASTER 420
0.12 kW - 11 kW

Control Version
V1.2

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Commissioning 3

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Issue 10/06

Further information is available on the Internet under:

http://www.siemens.de/micromaster

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Siemens-Aktiengesellschaft

Foreword

User Documentation



WARNING

Before installing and commissioning, you must read the safety instructions and warnings carefully and all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

Information is also available from:

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Definitions and Warnings



DANGER

indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



WARNING

indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION

used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

used without safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in a property damage.

NOTICE

indicates a potential situation which, if not avoided, may result in an undesirable result or state.

NOTES

For the purpose of this documentation, "Note" indicates important information relating to the product or highlights part of the documentation for special attention.

Qualified personnel

For the purpose of this Instruction Manual and product labels, a "Qualified person" is someone who is familiar with the installation, mounting, start-up and operation of the equipment and the hazards involved. He or she must have the following qualifications:

1. Trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
2. Trained in the proper care and use of protective equipment in accordance with established safety procedures.
3. Trained in rendering first aid.

PE

= Ground

- PE – Protective Earth uses circuit protective conductors sized for short circuits where the voltage will not rise in excess of 50 Volts. This connection is normally used to ground the inverter.
-  - Is the ground connection where the reference voltage can be the same as the Earth voltage. This connection is normally used to ground the motor.

Use for intended purpose only

The equipment may be used only for the application stated in the manual and only in conjunction with devices and components recommended and authorized by Siemens.

Safety Instructions

The following Warnings, Cautions and Notes are provided for your safety and as a means of preventing damage to the product or components in the machines connected. This section lists Warnings, Cautions and Notes, which apply generally when handling MICROMASTER 420 Inverters, classified as **General**, **Transport & Storage**, **Commissioning**, **Operation**, **Repair** and **Dismantling & Disposal**.

Specific Warnings, Cautions and Notes that apply to particular activities are listed at the beginning of the relevant chapters and are repeated or supplemented at critical points throughout these chapters.

Please read the information carefully, since it is provided for your personal safety and will also help prolong the service life of your MICROMASTER 420 Inverter and the equipment you connect to it.

General



WARNING

- This equipment contains dangerous voltages and controls potentially dangerous rotating mechanical parts. Non-compliance with **Warnings** or failure to follow the instructions contained in this manual can result in loss of life, severe personal injury or serious damage to property.
- Only suitable qualified personnel should work on this equipment, and only after becoming familiar with all safety notices, installation, operation and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent upon its proper handling, installation, operation and maintenance.
- Risk of electric shock. The DC link capacitors remain charged for five minutes after power has been removed. **It is not permissible to open the equipment until 5 minutes after the power has been removed.**
- **HP ratings are based on the Siemens 1LA motors and are given for guidance only, they do not necessarily comply with UL or NEMA HP ratings.**



CAUTION

- Children and the general public must be prevented from accessing or approaching the equipment!
- This equipment may only be used for the purpose specified by the manufacturer. Unauthorized modifications and the use of spare parts and accessories that are not sold or recommended by the manufacturer of the equipment can cause fires, electric shocks and injuries.

NOTICE

- Keep these operating instructions within easy reach of the equipment and make them available to all users
- Whenever measuring or testing has to be performed on live equipment, the regulations of Safety Code VBG 4.0 must be observed, in particular § 8 "Permissible Deviations when Working on Live Parts". Suitable electronic tools should be used.
- Before installing and commissioning, please read these safety instructions and warnings carefully and all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

Transport & Storage



WARNING

- Correct transport, storage, erection and mounting, as well as careful operation and maintenance are essential for proper and safe operation of the equipment.

CAUTION

- Protect the inverter against physical shocks and vibration during transport and storage. Also be sure to protect it against water (rainfall) and excessive temperatures (see Table 5-1 on page 184).

Commissioning



WARNING

- Work on the device/system by **unqualified** personnel or failure to comply with warnings can result in severe personal injury or serious damage to material. Only suitably qualified personnel trained in the setup, installation, commissioning and operation of the product should carry out work on the device/system.
- Only permanently-wired input power connections are allowed. This equipment must be grounded (IEC 536 Class 1, NEC and other applicable standards).
- If a Residual Current-operated protective Device (RCD) is to be used, it must be an RCD type B. Machines with a three phase power supply, fitted with EMC filters, must not be connected to a supply via an ELCB (Earth Leakage Circuit-Breaker - see DIN VDE 0160, section 5.5.2 and EN50178 section 5.2.11.1).
- The following terminals can carry dangerous voltages even if the inverter is inoperative:
  - the power supply terminals L/L1, N/L2, L3.
  - the motor terminals U, V, W, DC+, DC-
- This equipment must not be used as an ‘emergency stop mechanism’ (see EN 60204, 9.2.5.4)

CAUTION

The connection of power, motor and control cables to the inverter must be carried out as shown in Fig. 2-8 on page 33, to prevent inductive and capacitive interference from affecting the correct functioning of the inverter.

Operation



WARNING

- Motor parameters must be accurately configured for the motor overload protection to operate correctly.
- MICROMASTERS operate at high voltages.
- When operating electrical devices, it is impossible to avoid applying hazardous voltages to certain parts of the equipment.
- Emergency Stop facilities according to EN 60204 IEC 204 (VDE 0113) must remain operative in all operating modes of the control equipment. Any disengagement of the Emergency Stop facility must not lead to uncontrolled or undefined restart.
- Wherever faults occurring in the control equipment can lead to substantial material damage or even grievous bodily injury (i.e. potentially dangerous faults), additional external precautions must be taken or facilities provided to ensure or enforce safe operation, even when a fault occurs (e.g. independent limit switches, mechanical interlocks, etc.).
- Certain parameter settings may cause the inverter to restart automatically after an input power failure.
- This equipment is capable of providing internal motor overload protection in accordance with UL508C section 42. Refer to P0610 and P0335, i^2t is ON by default. Motor overload protection can also be provided using an external PTC via a digital input.
- This equipment is suitable for use in a circuit capable of delivering not more than 10,000 symmetrical amperes (rms), for a maximum voltage of 230 V / 460 V when protected by an H, J or K type fuse, a circuit breaker or self-protected combination motor controller (for more details see Appendix F).
- This equipment must not be used as an ‘emergency stop mechanism’ (see EN 60204, 9.2.5.4).

Repair



WARNING

- Repairs on equipment may only be carried out by **Siemens Service**, by repair centers **authorized by Siemens** or by qualified personnel who are thoroughly acquainted with all the warnings and operating procedures contained in this manual.
- Any defective parts or components must be replaced using parts contained in the relevant spare parts list.
- Disconnect the power supply before opening the equipment for access

Dismantling & Disposal

NOTES

- The inverter's packaging is re-usable. Retain the packaging for future use or return it to the manufacturer.
- Easy-to-release screw and snap connectors allow you to break the unit down into its component parts. You can then re-cycle these component parts, dispose of them in **accordance with local requirements or return them to the manufacturer.**

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1 Overview

This Chapter contains:

A summary of the major features of the MICROMASTER 420 range.

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1.1 The MICROMASTER 420

The MICROMASTER 420s are a range of frequency inverters for controlling the speed of three phase AC motors. The various models available range from the 120 W single-phase input to the 11 kW three-phase input.

The inverters are microprocessor-controlled and use state-of-the-art Insulated Gate Bipolar Transistor (IGBT) technology. This makes them reliable and versatile. A special pulse-width modulation method with selectable Pulse frequency permits quiet motor operation. Comprehensive protective functions provide excellent inverter and motor protection.

The MICROMASTER 420 with its default factory settings, is ideal for a large range of simple motor control applications. The MICROMASTER 420 can also be used for more advanced motor control applications via its comprehensive parameter lists.

The MICROMASTER 420 can be used in both 'stand-alone' applications as well as being integrated into 'Automation Systems'.

1.2 Features

Main Characteristics

- Easy installation
- Easy commissioning
- Rugged EMC design
- Can be operated on IT line supplies
- Fast repeatable response time to control signals
- Comprehensive range of parameters enabling configuration for a wide range of applications
- Simple cable connection
- 1 Output relay
- 1 Analog output (0 – 20 mA)
- 3 Isolated and switchable NPN/PNP digital inputs
- 1 Analog input, ADC: 0 – 10 V
  The analog input can be used as the 4th digital input
- BICO technology
- Modular design for extremely flexible configuration
- High switching frequencies for low-noise motor operation
- Detailed status information and integrated message functions

Performance Characteristics

- V/f Control
  - Flux Current Control (FCC) for improved dynamic response and motor control
  - Multi-point V/f characteristic
- Automatic restart
- Flying restart
- Slip compensation
- Fast Current Limitation (FCL) for trip-free operation
- Motor holding brake
- Built-in DC injection brake
- Compound braking to improve braking performance
- Setpoint input via:
  - Analog input
  - Communication interface
  - JOG function
  - Motorized potentiometer
  - Fixed frequencies
- Ramp function generator
  - With smoothing
  - Without smoothing
- Closed-loop control with proportional-integral controller function (PI)

Protection characteristics

- Overvoltage/undervoltage protection
- Overtemperature protection for the inverter
- Ground fault protection
- Short-circuit protection
- i^2t thermal motor protection
- PTC for motor protection

Options

- Refer to Chapter 6

2 Installation

This Chapter contains:

- General data relating to installation
- Dimensions of Inverter
- Wiring guidelines to minimize the effects of EMI
- Details concerning electrical installation

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2.2 Ambient operating conditions 23
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WARNING

- Work on the device/system by **unqualified** personnel or failure to comply with warnings can result in severe personal injury or serious damage to material. Only suitably qualified personnel trained in the setup, installation, commissioning and operation of the product should carry out work on the device/system.
- Only permanently-wired input power connections are allowed. This equipment must be grounded (IEC 536 Class 1, NEC and other applicable standards).
- If a Residual Current-operated protective Device (RCD) is to be used, it must be an RCD type B. Machines with a three-phase power supply, fitted with EMC filters, must not be connected to a supply via an ELCB (Earth Leakage Circuit-Breaker EN50178 Section 5.2.11.1).
- The following terminals can carry dangerous voltages even if the inverter is inoperative:
  - the power supply terminals L/L1, N/L2, L3.
  - the motor terminals U, V, W, DC+, DC-
- Always wait **5 minutes** to allow the unit to discharge after switching off before carrying out any installation work.
- This equipment must not be used as an 'emergency stop mechanism' (see EN 60204, 9.2.5.4)
- The minimum size of the earth bonding conductor must be equal to or greater than the cross-section of the power supply cables.

CAUTION

The connection of power, motor and control cables to the inverter must be carried out as shown in Fig. 2-8 on page 33, to prevent inductive and capacitive interference from affecting the correct functioning of the inverter.

2.1 General

Installation after a Period of Storage

Following a prolonged period of storage, you must reform the capacitors in the inverter. The requirements are listed below.

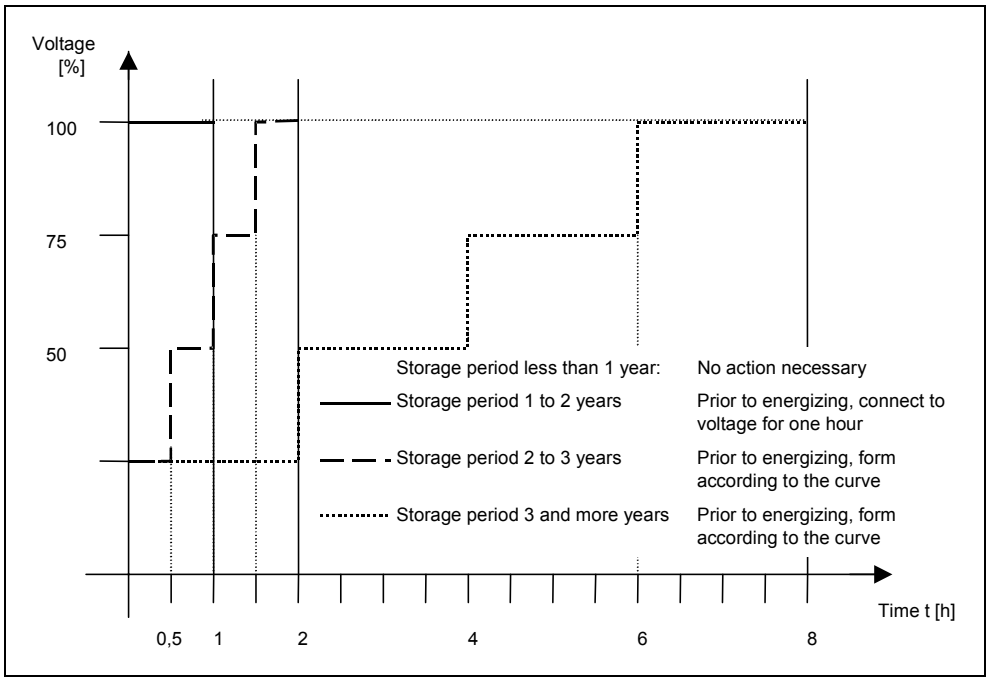


Fig. 2-1 Forming

2.2 Ambient operating conditions

Temperature

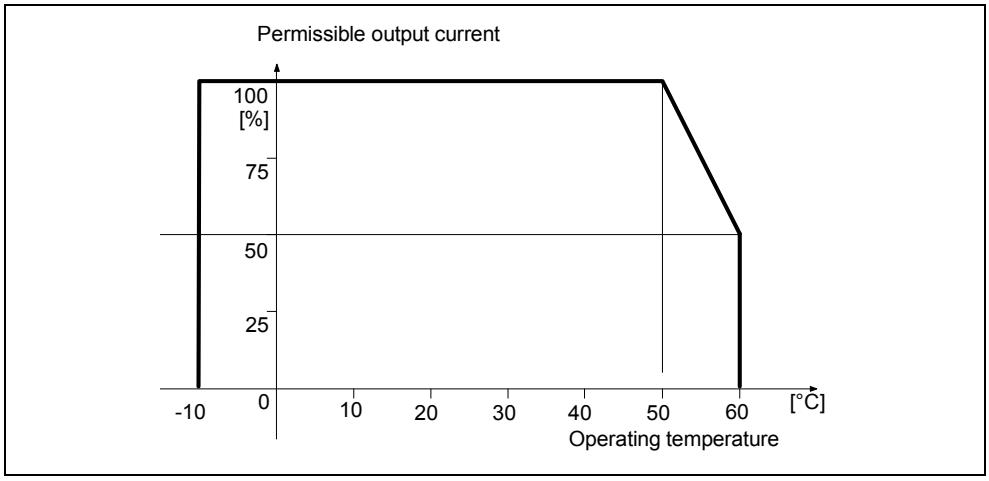


Fig. 2-2 Ambient operating temperature

Humidity

Relative air humidity ≤ 95% Non-condensing

Altitude

If the inverter is to be installed at an altitude > 1000 m or > 2000 m above sea level, derating will be required:

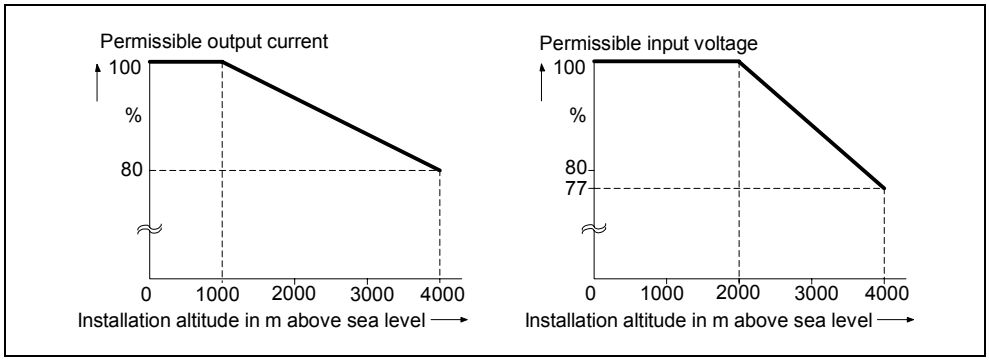


Fig. 2-3 Installation altitude

Shock and Vibration

Do not drop the inverter or expose to sudden shock. Do not install the inverter in an area where it is likely to be exposed to constant vibration.

Mechanical strength to EN 60721-3-3

- Deflection: 0.075 mm (10 ... 58 Hz)
- Acceleration: 9.8 m/s^2 (> 58 ... 200 Hz)

Electromagnetic Radiation

Do not install the inverter near sources of electromagnetic radiation.

Atmospheric Pollution

Do not install the inverter in an environment, which contains atmospheric pollutants such as dust, corrosive gases, etc.

Water

Take care to site the inverter away from potential water hazards, e.g. do not install the inverter beneath pipes that are subject to condensation. Avoid installing the inverter where excessive humidity and condensation may occur.

Installation and cooling

CAUTION

The inverters MUST NOT be mounted horizontally.

The inverters can be mounted without any clearance at either side.

Allow 100 mm clearance above and below the inverter. Make sure that the cooling vents in the inverter are positioned correctly to allow free movement of air.

2.3 Mechanical installation

WARNING

- To ensure the safe operation of the equipment, it must be installed and commissioned by qualified personnel in full compliance with the warnings laid down in these operating instructions.
- Take particular note of the general and regional installation and safety regulations regarding work on dangerous voltage installations (e.g. EN 50178), as well as the relevant regulations regarding the correct use of tools and personal protective gear.
- The mains input, DC and motor terminals, can carry dangerous voltages even if the inverter is inoperative; wait **5 minutes** to allow the unit to discharge after switching off before carrying out any installation work.
- The inverters can be mounted adjacent to each other. If they are mounted on top of each other, however, a clearance of 100 mm has to be observed.
- IP20 protection is only against direct contact, always use these products within a protective cabinet.

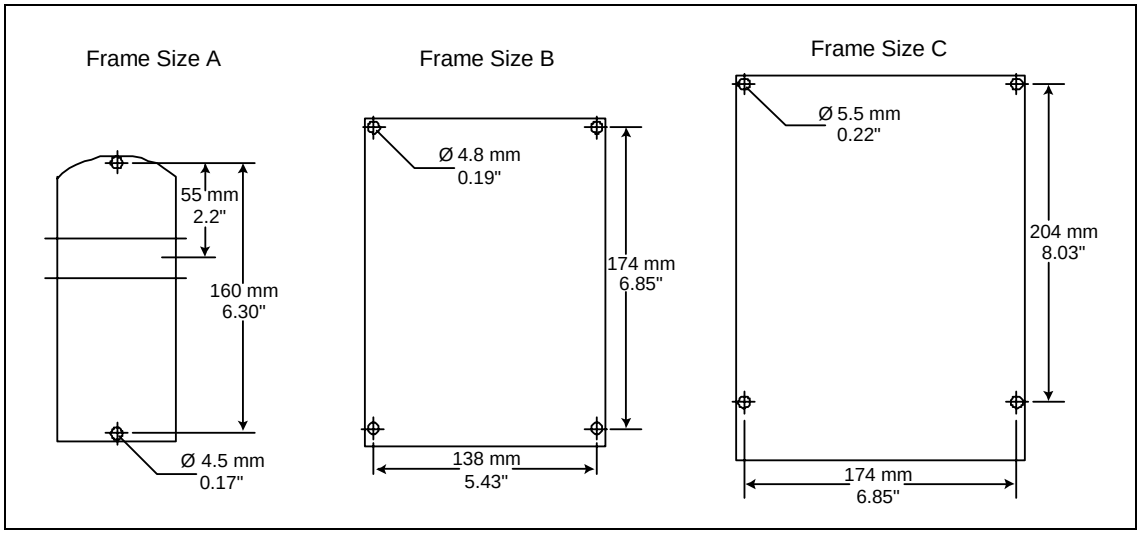


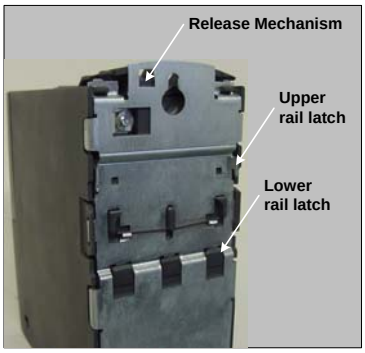
Fig. 2-4 Drill pattern for MICROMASTER 420

Table 2-1 Dimensions and Torques of MICROMASTER 420

Frame-Size		Overall Dimensions		Fixing Method	Tightening Torque
A	Width x Height x Depth	mm	73 x 173 x 149	2 x M4 Bolts 2 x M4 Nuts 2 x M4 Washers for mounting on standard rail	2.5 Nm with washers fitted
		inch	2.87 x 6.81 x 5.87		
B	Width x Height x Depth	mm	149 x 202 x 172	4 x M4 Bolts 4 x M4 Nuts 4 x M4 Washers	2.5 Nm with washers fitted
		inch	5.87 x 7.95 x 6.77		
C	Width x Height x Depth	mm	185 x 245 x 195	4 x M5 Bolts 4 x M5 Nuts 4 x M5 Washers	2.5 Nm with washers fitted
		inch	7.28 x 9.65 x 7.68		

2.3.1 Mounting on standard rail, Frame Size A

Fitting the Inverter to a 35 mm standard rail (EN 50022)



1. Fit the inverter to the rail using the upper rail latch.



2. Push the inverter against the rail and the lower rail latch should click into place.

Removing the Inverter from the rail

1. To disengaged the release mechanism of the inverter, insert a screwdriver into the release mechanism.
2. Apply a downward pressure and the lower rail latch will disengage.
3. Pull the inverter from the rail.

2.4 Electrical installation



WARNING

The inverter must always be grounded.

- To ensure the safe operation of the equipment, it must be installed and commissioned by qualified personnel in full compliance with the warnings laid down in these operating instructions.
- Take particular note of the general and regional installation and safety regulations regarding work on dangerous voltage installations (e.g. EN 50178), as well as the relevant regulations regarding the correct use of tools and personal protective gear.
- Never use high voltage insulation test equipment on cables connected to the inverter.
- The mains input, DC and motor terminals, can carry dangerous voltages even if the inverter is inoperative; wait **5 minutes** to allow the unit to discharge after switching off before carrying out any installation work.

CAUTION

The control, power supply and motor leads **must** be laid separately. Do not feed them through the same cable conduit/trunking.

2.4.1 General



WARNING

The inverter must always be grounded. If the inverter is not grounded correctly, extremely dangerous conditions may arise within the inverter, which could prove potentially fatal.

Operation with ungrounded (IT) supplies

Filtered

It is **not permissible** to connect MICROMASTER 4 drive converters equipped **with integrated filter** to non-grounded line supplies.

Unfiltered

If connected to non-grounded line supplies, the 'Y' capacitor must be disabled in the device. The procedure is described in Attachment B.2.

If the MICROMASTER is to remain in operation in non-grounded networks when a ground fault occurs during the input or output phase, an output reactor must be installed.

Operation with Residual Current Device

If an RCD (also referred to as ELCB or RCCB) is fitted, the MICROMASTER inverters will operate without nuisance tripping, provided that:

- A type B RCD is used.
- The trip limit of the RCD is 300mA.
- The neutral of the supply is grounded.
- Only one inverter is supplied from each RCD.
- The output cables are less than 50m (screened) or 100m (unscreened).

NOTE

The residual current operated circuit-breakers used must provide protection against direct-current components in the fault current and must be suitable for briefly suppressing power pulse current peaks. It is recommended to protect the frequency inverter by fuse separately.
The regulations of the individual country (e.g. VDE regulations in Germany) and the regional power suppliers must be observed!

2.4.2 Power and motor connections



WARNING

The inverter must always be grounded.

- Isolate the mains electrical supply before making or changing connections to the unit.
- Ensure that the motor is configured for the correct supply voltage: single / three-phase 230 V MICROMASTERS must not be connected to a 400 V three-phase supply.
- When synchronous motors are connected or when coupling several motors in parallel, the inverter must be operated with voltage/frequency control characteristic (P1300 = 0, 2 or 3).



CAUTION

After connecting the power and motor cables to the proper terminals, make sure that the covers have been replaced properly before supplying power to the unit!

NOTICE

- Ensure that the appropriate circuit-breakers/fuses with the specified current rating are connected between the power supply and inverter (see chapter 5, Tables starting on page 186).
- Use Class 1 60/75°C copper wire only (for UL compliance). For tightening torque see Table 5-2, page 185.

Operation with long cables

All inverters will operate at full specification with cable lengths up to 50 m screened or 100 m unscreened.

When using output reactors as shown in Catalog DA 51.2, the following cable lengths are possible:

Supply Voltage	**200 V … 240 V ± 10 %**	**380 V … 400 V ± 10 %**		**401 V … 480 V ± 10 %**
Frame Sizes	**A … C**	**A … B**	**C**	**A … C**
Shielded	200 m	150 m	200 m	100 m
Non-shielded	300 m	225 m	300 m	150 m

CAUTION

When using output reactors and LC filters, operation up to a pulse frequency of **4 kHz** only is permitted. Please ensure that the automatic pulse frequency reductions are also deactivated. **Mandatory** parameter settings when using an output reactor: **P1800 = 4 kHz , P0290 = 0 or 1**.

Access to the power and motor terminals

You can gain access to the mains and motor terminals by removing the covers (see also Appendices A and B).

The mains and motor connections must be made as shown in Fig. 2-6.

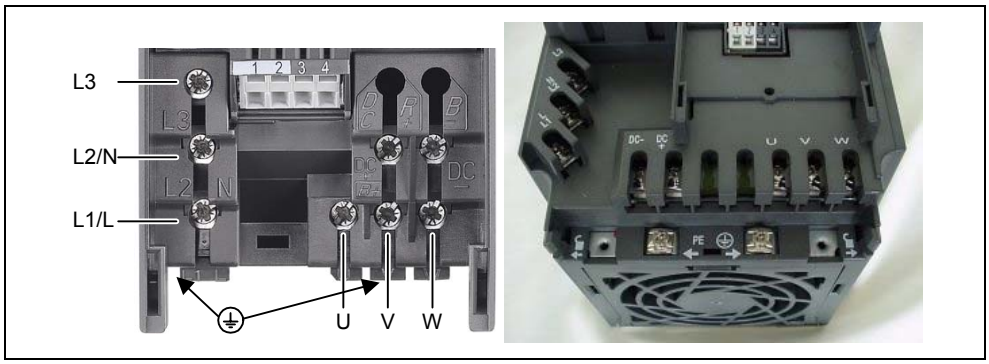


Fig. 2-5 MICROMASTER 420 connection terminals

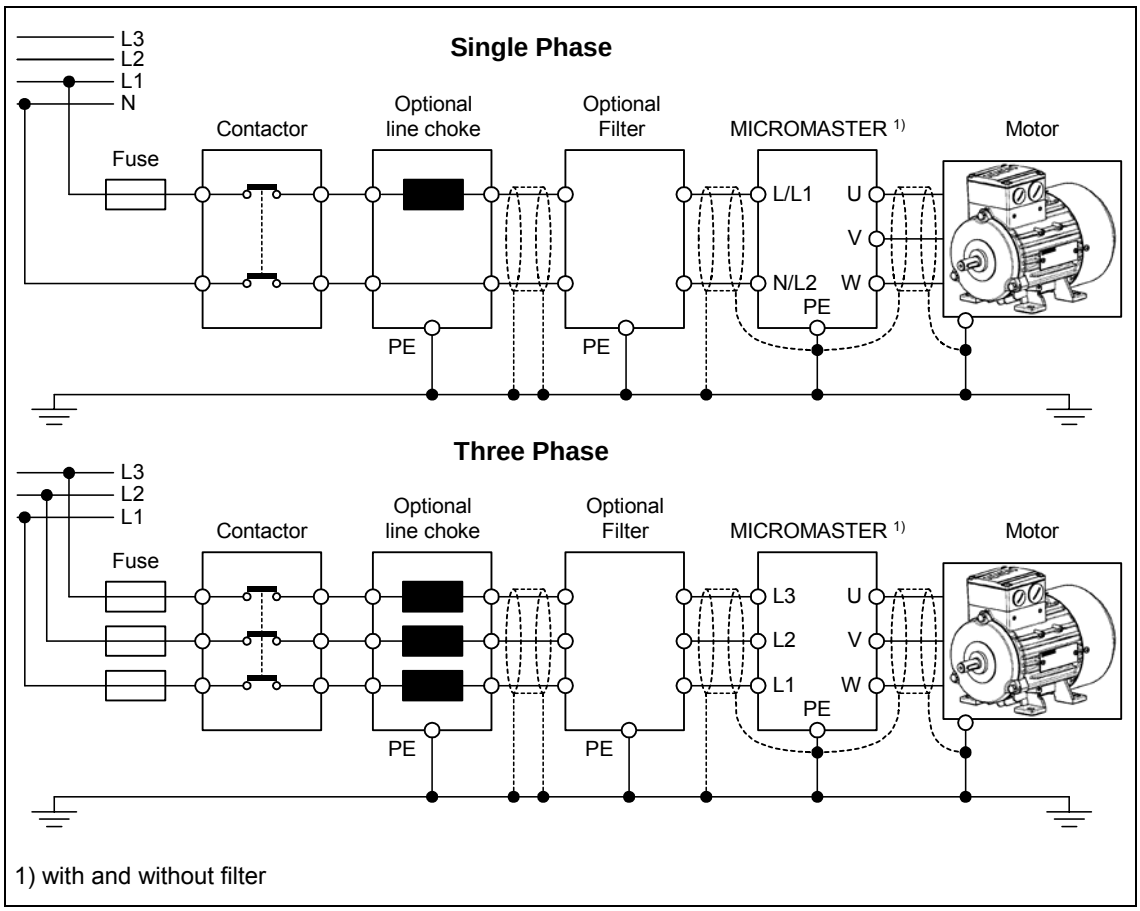


Fig. 2-6 Motor and Power Connections

2.4.3 Control terminals

Permitted cable diameters: 0.08 … 2.5 mm^2 (AWG: 28 … 12)

Terminal	Designation	Function
1	-	Output +10 V
2	-	Output 0 V
3	ADC+	Analog input 1 (+)
4	ADC-	Analog input 1 (-)
5	DIN1	Digital input 1
6	DIN2	Digital input 2
7	DIN3	Digital input 3
8	-	Isolated output +24 V / max. 100 mA
9	-	Isolated output 0 V / max. 100 mA
10	RL1-B	Digital output / NO contact
11	RL1-C	Digital output / Changeover contact
12	DAC+	Analog output (+)
13	DAC-	Analog output (-)
14	P+	RS485 port
15	P-	RS485 port

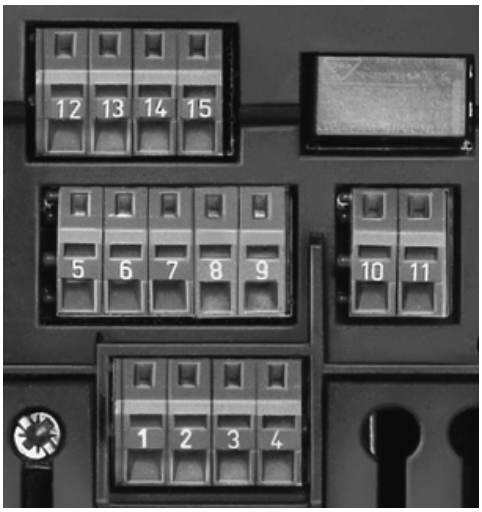


Fig. 2-7 Control terminals of MICROMASTER 420

A detailed description of the inputs and outputs is provided in Section 3.6.

2.4.4 Avoiding Electro-Magnetic Interference (EMI)

The inverters are designed to operate in an industrial environment where a high level of EMI can be expected. Usually, good installation practices will ensure safe and trouble-free operation. If you encounter problems, follow the guidelines stated below.

Action to Take

- Ensure that all equipment in the cubicle is well grounded using short, thick grounding cable connected to a common star point or busbar
- Make sure that any control equipment (such as a PLC) connected to the inverter is connected to the same ground or star point as the inverter via a short thick link.
- Connect the return ground from the motors controlled by the inverters directly to the ground connection (PE) on the associated inverter
- Flat conductors are preferred as they have lower impedance at higher frequencies
- Terminate the ends of the cable neatly, ensuring that unscreened wires are as short as possible
- **Separate the control cables from the power cables as much as possible, using separate trunking, if necessary at 90º to each other.**
- Whenever possible, use screened leads for the connections to the control circuitry
- Ensure that the contactors in the cubicle are suppressed, either with R-C suppressors for AC contactors or 'flywheel' diodes for DC contactors fitted to the coils. Varistor suppressors are also effective. This is important when the contactors are controlled from the inverter relay
- Use screened or armored cables for the motor connections and ground the screen at both ends using the cable clamps



WARNING

Safety regulations **must not** be compromised when installing inverters!

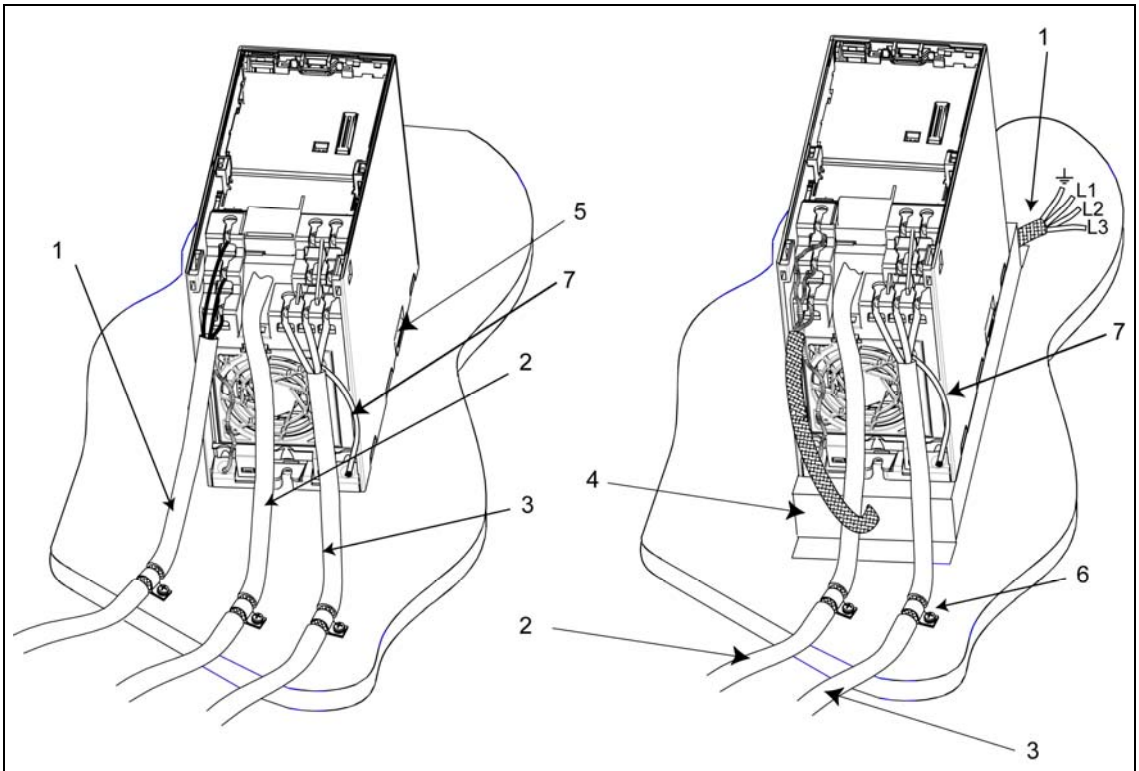
2.4.5 Screening Methods

Gland Plate

The Gland Plate Kit is supplied as an option. It allows easy and efficient connection of the necessary screening. See the Gland Plate Installation Instructions contained on the Docu-CD.

Screening without a Gland Plate

Should a Gland Plate not be available, then the inverter can be screened using the methodology shown in Fig. 2-8.



1 Mains power input
2 Control cable
3 Motor cable
4 Footprint filter
5 Metal back plate
6 Use suitable clips to fix motor and control cable screens securely to metal back plate
7 Screening cables

Fig. 2-8 Wiring Guidelines to Minimize the Effects of EMI

3 Functions

This Section includes the following:

- Explanation of the MICROMASTER 420 parameters
- An overview of the parameter structure of MICROMASTER 420
- A description of the display and operator control elements and communications
- A block diagram of MICROMASTER 420
- An overview of the various ways of commissioning the MICROMASTER 420
- A description of the inputs and outputs
- Possibilities of controlling the MICROMASTER 420
- A description of the various functions of the MICROMASTER 420 and their implementation
- Explanation and information on the protective functions

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WARNING

- MICROMASTER drive inverters operate with high voltages.
- When electrical equipment is operated, then specific parts of this equipment are at hazardous voltage levels.
- Emergency switching-off devices in compliance with EN 60204 IEC 204 (VDE 0113) must remain functional in all operating modes of the control device. When the Emergency switching-off device is reset, then it is not permissible that the equipment runs-up again in an uncontrolled or undefined way.
- In cases and situations where short-circuits in the control device can result in significant material damage or even severe bodily injury (i.e. potentially hazardous short-circuits), then additional external measures or devices/equipment must be provided in order to ensure or force operation without any potential hazards, even if a short-circuit occurs (e.g. independent limit switches, mechanical interlocks etc.).
- Certain parameter settings can mean that the drive inverter automatically restarts after the power supply voltage fails and then returns.
- The motor parameters must be precisely configured in order to ensure perfect motor overload protection.
- The drive inverter provides internal motor overload protection according to UL508C, Section 42. Also refer to P0610, P0611 and P0335 - I^2t is enabled in the default setting.
- This equipment is suitable for use in a circuit capable of delivering not more than 10,000 symmetrical amperes (rms), for a maximum voltage of 230 V / 460 V when protected by an H, J or K type fuse, a circuit breaker or self-protected combination motor controller (for more details see Appendix F).
- The drive unit may not be used as 'Emergency switching-off device' (refer to EN 60204, 9.2.5.4).



CAUTION

Only qualified personnel may commission (start-up) the equipment. Safety measures and warnings must be always extremely carefully observed and fulfilled.

3.1 Parameters

3.1.1 Setting / monitoring parameters and parameter attributes

The drive inverter is adapted to the particular application using the appropriate parameters. This means that each parameter is identified by a parameter number, parameter text and specific attributes (e.g. readable, can be written into, BICO attribute, group attribute etc.). Within any one particular drive system, the parameter number is unique. On the other hand, an attribute can be assigned a multiple number of times so that several parameters can have the same attribute.

For MICROMASTER, parameters can be accessed using the following operator units:

- BOP (option)
- AOP (option)
- PC-based commissioning (start-up) tool "Drive Monitor" or "STARTER". These PC-based tools are supplied on the CD-ROM.

The parameter types are the main differentiating feature of the parameters.

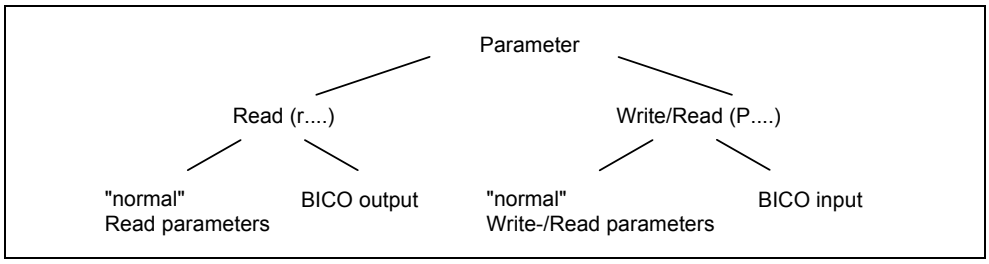


Fig. 3-1 Parameter types

Setting parameters

Parameters which can be written into and read – "P" parameters
These parameters are activated/de-activated in the individual functions and directly influence the behavior of a function. The value of this parameter is saved in a non-volatile memory (EEPROM) as long as the appropriate option was selected (non-volatile data save). Otherwise, these values are saved in the non-volatile memory (RAM) of the processor, which are lost after power failure or power-off/power-on operations.

Notation:

P0927 setting parameter 927

P0748.1 setting parameter 748, bit 01

P0719[1] setting parameter 719 index 1

P0013[0...19] setting parameter 13 with 20 indices (indices 0 to 19)

Abbreviated notation

P0013[20] setting parameter 13 with 20 indices (indices 0 to 19)

Monitoring parameters

These can only be read – "r" parameters
These parameters are used to display internal quantities, for example states and actual values. These parameters are indispensable, especially for diagnostics.

Notation:

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

Abbreviated notation

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

NOTE

- A parameter (e.g. P0013[20]) with x consecutive elements (in this case: 20) is defined using an index. x is defined by the numerical index value. When transferred to a parameter this means that an indexed parameter can assume several values. The values are addressed via the parameter number including the index value (e.g. P0013[0], P0013[1], P0013[2], P0013[3], P0013[4], ...). Index parameters, for example, are used for:
  - Table functions
  - Sub-functions



In addition to the parameter number and parameter text, every setting and monitoring parameter has different attributes which are used to individually define the properties/characteristics of the parameter. The attributes are listed in the following Table (refer to Table 3-1) which are used for MICROMASTER.

Table 3-1 Parameter attributes

Attribute group	Attribute	Description
Data types		The data type of a parameter defines the maximum possible value range. 3 data types are used for MICROMASTER. They either represent an unsigned integer value (U16, U32) or a floating-point value (float). The value range is frequently restricted by a minimum, maximum value (min, max) or using drive inverter/motor quantities.
	U16	Unsigned, integer value with a size of 16 bits, max. value range: 0 65535
	U32	Unsigned, integer value with a size of 32 bits max. value range: 0 4294967295
	Float	A simple precise floating point value according to the IEEE standard format max. value range: $-3.39e^{+38}$ – $+3.39e^{+38}$
Value range		The value range, which is specified as a result of the data type, is restricted/limited by the minimum, maximum value (min, max) and using drive inverter/motor quantities. Straightforward commissioning (start-up) is guaranteed in so much that the parameters have a default value. These values (min, def, max) are permanently saved in the drive inverter and cannot be changed by the user.
	-	No value entered (e.g.: "r parameter")
	Min	Minimum value
	Def	Default value
	Max	Maximum value
Unit		For MICROMASTER, the units of a particular parameter involve the physical quantity (e.g. m, s, A). Quantities are measurable properties/characteristics of physical objects, operations, states and are represented using characters of a formula (e.g. V = 9 V).
	-	No dimension
	%	Percentage
	A	Ampere
	V	Volt
	Ohm	Ohm
	us	Microseconds
	ms	Milliseconds
	s	Seconds
	Hz	Hertz
	kHz	Kilohertz
	1/min	Revolutions per minute [RPM]
	m/s	Meters per second
	Nm	Newton meter
	W	Watt
	kW	Kilowatt
	Hp	Horse power
	kWh	Kilowatt hours
	°C	Degrees Celsius
	m	Meter
	kg	Kilograms
	°	Degrees (angular degrees)

Attribute group	Attribute	Description
Access level		The access level is controlled using parameter P0003. In this case, only those parameters are visible at the BOP or AOP, where the access level is less than or equal to the value assigned in parameter P0003. On the other hand, for DriveMonitor and STARTER, only access levels 0 and 4 are relevant. For example, parameters with access level 4 cannot be changed if the appropriate access level has not been set. The following access levels are implemented in the family of MICROMASTER drive units:
	0	User-defined parameter list (refer to P0013)
	1	Standard access to the most frequently used parameters
	2	Extended access, e.g. to drive inverter I/O functions
	3	Expert access only for experienced users
		As far as the ability to visualize the parameters is concerned, the group assignment of the individual parameters must be taken into account. Parameter P0004 is used for the control (refer to the Grouping).
Grouping		The parameters are sub-divided into groups according to their functionality. This increases the transparency and allows a parameter to be quickly searched for. Furthermore, parameter P0004 can be used to control the ability to be visualized for the BOP / AOP.
		Main parameter area:
	ALWAYS	0 all parameters
	INVERTER	2 drive inverter parameters 0200 0299
	TECH_APL	5 technical applications / units 0500 0599
	COMMANDS	7 control commands, digital I/O 0700 .... 0749 and 0800 0899
	TERMINAL	8 Analog inputs/outputs 0750 0799
	SETPOINT	10 Setpoint channel and ramp-function gen. 1000 1199
	FUNC	12 Drive inverter functions 1200 1299
	CONTROL	13 Motor open-loop/closed-loop control 1300 1799
	COMM	20 Communications 2000 2099
	ALARMS	21 Faults, warnings, monitoring functions" 2100 2199
	TECH	22 Technological controller (PID controller) 2200 2399
BICO		Description for Binector Input (BI), Binector Output (BO), Connector Input (CI), Connector Output (CO) and Connector Output / Binector Output (CO/BO), refer to Section 3.1.2.3
	BI	Binector Input
	BO	Binector Output
	CI	Connector Input
	CO	Connector Output
	CO/BO	Connector Output / Binector Output
Change state		"P" parameters can only be changed depending on the drive state. The parameter value is not accepted if the instantaneous state is not listed in the parameter attribute "Change state". For instance, the commissioning (start-up) parameter P0010 with the attribute "CT" can only be changed in quick start-up "C" or ready "T" but not in run "U".
	C	Quick commissioning (start-up)
	U	Operation (run)
	T	Ready
QC.		This parameter attribute identifies as to whether the parameter is included in the quick commissioning (start-up) (P0010 = 1).
	No	The parameter is not included in the quick commissioning (start-up)
	Yes	The parameter is included in the quick commissioning (start-up)

Attribute group	Attribute	Description
Active		This attribute is only of importance in conjunction with a BOP. The "Immediate" attribute indicates that this value is already accepted when scrolling (when changing the value with ▲ or ▼). Especially parameters which are used for optimization functions have this property (e.g. constant voltage boost P1310 or filter time constants). On the other hand, for parameters with the attribute "After actuation", the value is only accepted after first actuating the key P. These include, for example, parameters where the parameter value can have different settings/meanings (e.g. selecting the frequency setpoint source P1000).
	Immediately	The value becomes valid by either scrolling with ▲ or ▼
	After actuation	The value is only accepted by pressing P

The attributes and groups are shown, in the parameter list, in the header line of the parameter. This is shown as an example in Fig. 3-2 using parameter P0305.

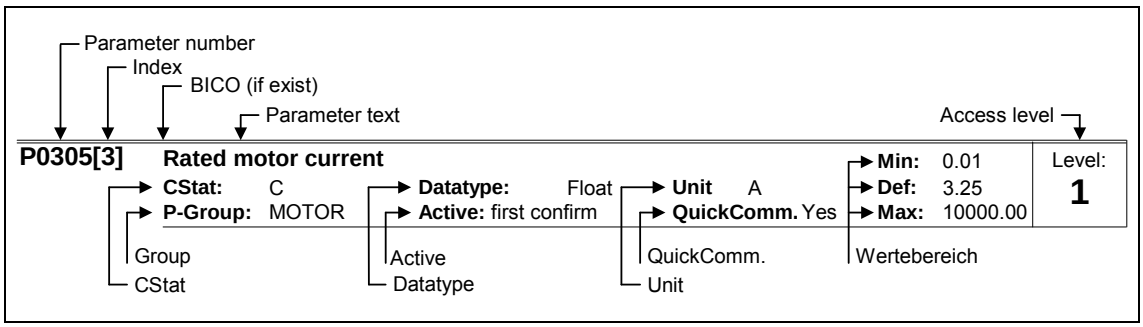


Fig. 3-2 Header line for parameter P0305

The interrelationship between access level P0003 and the grouping P0004 is schematically shown in Fig. 3-3.

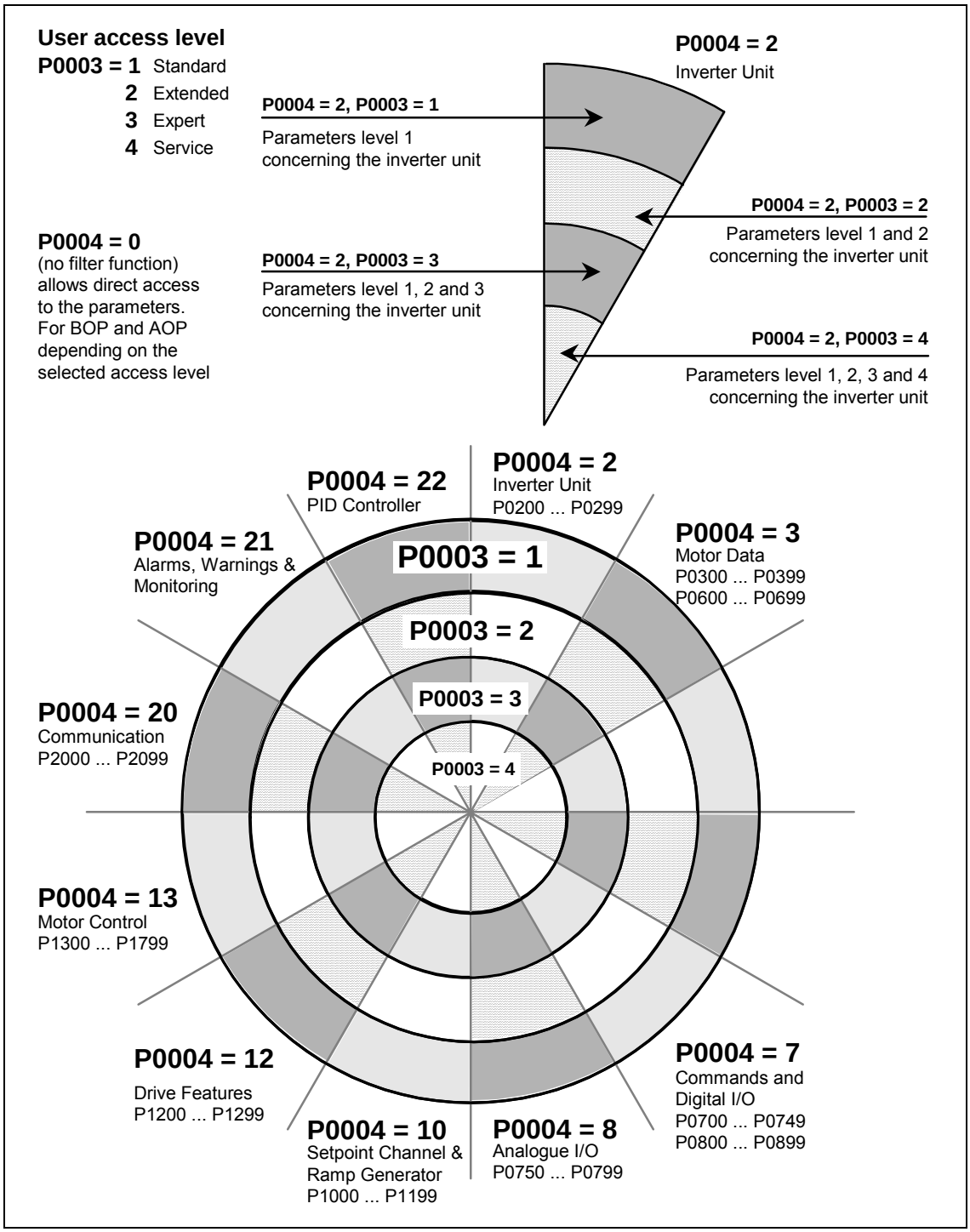


Fig. 3-3 Parameter grouping / access

3.1.2 Interconnecting signals (BICO technology)

A state-of-the-art drive unit must be able to interconnect internal and external signals (setpoint / actual values and control / status signal). This interconnection functionality must have a high degree of flexibility in order to be able to adapt the drive to new applications. Further, a high degree of usability is required, which also fulfills standard applications. This is the reason that within the MICROMASTER series of drive units, BICO technology (→ flexibility) and fast parameterization using parameters P0700 / P1000 (→ usability) or P0719 (→ combination P0700/P1000) have been introduced to be able to fulfill both of these requirements.

3.1.2.1 Selecting the command source P0700 / selecting the setpoint source P1000

The following parameters can be used to quickly interconnect setpoints and control signals:

- P0700 "Selection of command source"
- P1000 "Selection of setpoint source"

These parameters are used to define via which interface the drive inverter receives the setpoint or the power-on/power-off command. The interfaces, listed in Table 3-2 can be selected for the command source P0700.

Table 3-2 Parameter P0700

Parameter values	Significance / command source
0	Factory default
1	BOP (operator panel, refer to Section 3.2.1)
2	Terminal strip
4	USS on BOP link
5	USS on COM link
6	CB on COM link

The following internal or external sources / interfaces can be selected for the frequency setpoint source P1000. In addition to the main setpoint (1st position), a supplementary setpoint (2nd position) can be selected (refer to Table 3-3).

Table 3-3 Parameter P1000

Parameter values	Significance	
	Main setpoint source	Supplementary setpoint source
0	No main setpoint	-
1	MOP setpoint (motorized potentiometer)	-
2	Analog setpoint	-
3	Fixed frequency	-
4	USS on BOP link	-
5	USS on COM link	-
6	CB on COM link	-
10	No main setpoint	MOP setpoint
11	MOP setpoint	MOP setpoint
12	Analog setpoint	MOP setpoint
..	..	..
..	..	..
66	CB on COM link	CB on COM link

NOTE

- Communications between the AOP and MICROMASTER are established using the USS protocol. The AOP can be connected to both the BOP link (RS 232) as well as at the COM link interface (RS 485) of the drive inverter. If the AOP is to be used as command source or setpoint source then for parameter P0700 or P1000, either "USS on BOP link" or "USS on COM link" should be selected.
- The complete list of all of the setting possibilities can be taken from the parameter list (refer to parameter list P1000).
- Parameters P0700 and P1000 have the following default settings:

  a) P0700 = 2 (terminal strip)

  b) P1000 = 2 (analog setpoint)

In this case, the selection of the command source is made independently of the selection of the frequency setpoint source. This means that the source to enter the setpoint does not have to match the source to enter the power-on/power-off command (command source). This means, for example, that the setpoint (P1000 = 4) can be connected via an external device which is connected to the BOP link interface via USS and the control ON/OFF command, etc. is entered via digital inputs (terminals, P0700 = 2).



CAUTION

- When modifying P0700 or P1000, then the drive inverter also changes the subordinate BICO parameters (refer to the parameter list for P0700 or P1000 and the appropriate tables)
- No priority has assigned between the direct BICO parameterization and P0700/P1000. The last modification is valid.

3.1.2.2 Selection of command/frequency setpoint P0719

Parameter P0719 represents a combination of the functionalities of the two parameters P0700 and P1000. Here, it is possible to changeover the command source as well as also the frequency setpoint source via a parameter change. Contrary to P0700 and P1000, for parameter P0719, the subordinate (lower-level) BICO parameters are not changed. This characteristic/feature is especially used by PC tools in order to briefly retrieve the control authority for the drive without having to change the existing BICO parameterization. Parameter P0719 "Selection of command/frequency setpoint" comprises the command source (Cmd) and the frequency setpoint (setpoint).

Table 3-4 Parameter P0719

Parameter values	Significance	
	Command source	Setpoint source (frequency source)
0	Cmd = BICO parameter	Setpoint = BICO parameter
1	Cmd = BICO parameter	Setpoint = MOP setpoint
2	Cmd = BICO parameter	Setpoint = Analog setpoint
3	Cmd = BICO parameter	Setpoint = Fixed frequency
4	Cmd = BICO parameter	Setpoint = USS BOP link
5	Cmd = BICO parameter	Setpoint = USS COM link
6	Cmd = BICO parameter	Setpoint = CB COM link
10	Cmd = BOP	Setpoint = BICO parameter
11	Cmd = BOP	Setpoint = MOP setpoint
12	Cmd = BOP	Setpoint = Analog setpoint
..	..	..
..	..	..
64	Cmd = CB on COM link	Setpoint = USS on BOP link
66	Cmd = CB on COM link	Setpoint = USS on COM link

NOTE

- The complete list of all of the possible settings can be taken from the parameter list (refer to the parameter list, P0719).
- Contrary to parameter P0700 and P1000, subordinate BICO parameters are not changed for parameter P0719. This characteristic/feature can be used during service if the control authority must be briefly and quickly re-assigned (e.g. selecting and executing the motor data identification routine using a PC-based tool).

3.1.2.3 BICO technology

Using BICO technology (English: Binector Connector Technology), process data can be freely interconnected using the "standard" drive parameterization. In this case, all values which can be freely interconnected (e.g. frequency setpoint, frequency actual value, current actual value, etc.) can be defined as "Connectors" and all digital signals which can be freely interconnected (e.g. status of a digital input, ON/OFF, message function when a limit is violated etc.) can be defined as "Binectors".

There are many input and output quantities as well as quantities within the control which can be interconnected in a drive unit. It is possible to adapt the drive to the various requirements using BICO technology.

A binector is a digital (binary) signal without any units and which can either have the value 0 or 1. Binectors always refer to functions whereby they are sub-divided into binector inputs and binector outputs (refer to Fig. 3-4). In this case, the binector input is always designated using a "P" parameter plus attribute "BI" (e.g.: P1035 BI: Enable MOP (UP-command)), while the binector output is always represented using an "r" parameter plus attribute "BO" (e.g.: r2032 BO: CtrlWrd1 from BOP link (USS)).

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

- **BI Binector Input, signal receiver ("P" parameters)**

  → The BI parameter can be interconnected with a binector output as source, by entering the parameter number of the binector output (BO parameter) as value in the BI parameter.

- **BO Binector Output, signal source ("r" parameters)**

  → The BO parameter can be used as source for BI parameters. For the particular interconnection the BO parameter number must be entered into the BI parameter.

Example:

Wiring BO parameter r2032 to BI parameter P1035
→ P1035 = 2032.
If the BO parameter contains several bits, the bit number must be entered in the BI parameter in addition to the parameter number when wiring a single digital signal (here for example: P1035 = 2032.13).

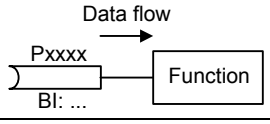
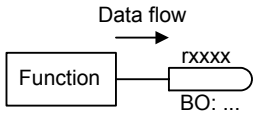
Abbreviation and symbol	Name	Function
BI	Binector input (signal receiver)	
BO	Binector output (signal source)	

Fig. 3-4 Binectors

A connector is a value (16 or 32 bit), which can include a normalized quantity (without dimension) as well as also a quantity with associated units. Connectors always refer to functions whereby they are sub-divided into connector inputs and connector outputs (refer to Fig. 3-5). Essentially the same as the binectors, the connector inputs are characterized by a "P" parameter plus attribute "CI" (e.g.: P0771 CI: DAC); while the connector outputs are always represented using an "r" parameter plus attribute "CO" (e.g.: r0021 CO: Smoothed output frequency).

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

- **CI Connector Input, signal sink ("P" parameters)**
  → The CI parameter can be interconnected with a connector output as source, by entering the parameter number of the connector output (CO parameter) as value in the CI parameter (e.g.: P0771 = 21).
- **CO Connector Output, signal source ("r" parameters)**
  → The CO parameter can be used as source for CI parameters. For the particular interconnection, the CO parameter number must be entered in the CI parameter (e.g.: P0771 = 21).

Further, MICROMASTER has "r" parameters where several binector outputs are combined in a word (e.g.: r0052 CO/BO: Status word 1). This feature reduces, on one hand, the number of parameters and simplifies parameterization via the serial interface (data transfer). This parameter is further characterized by the fact that it does not have any units and each bit represents a digital (binary) signal.

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

- **CO/BO Connector Output / Binector Output, signal source ("r" parameters)**
  → CO/BO parameters can be used as source for CI parameters and BI parameters:
  a) In order to interconnect all of the CO/BO parameters, the parameter number must be entered into the appropriate CI parameter (e.g.: P2016[0] = 52).
  b) When interconnecting a single digital signal, in addition to the CO/BO parameter number, the bit number must also be entered into the BI parameter (e.g.: P0731 = 52.3)

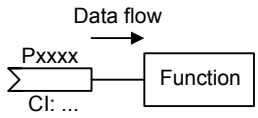
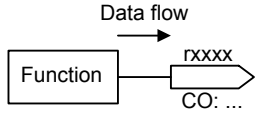
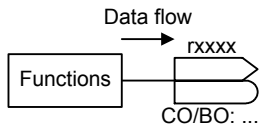
Abbreviation and symbol	Name	Function
CI	Connector input (signal receiver)	
CO	Connector output (signal source)	
CO BO	Binector/connector output (signal source)	

Fig. 3-5 Connectors

In order to interconnect two signals, a BICO setting parameter (signal receiver) must be assigned the required BICO monitoring parameter (signal source). A typical BICO interconnection is shown using the following examples (refer to Fig. 3-6).

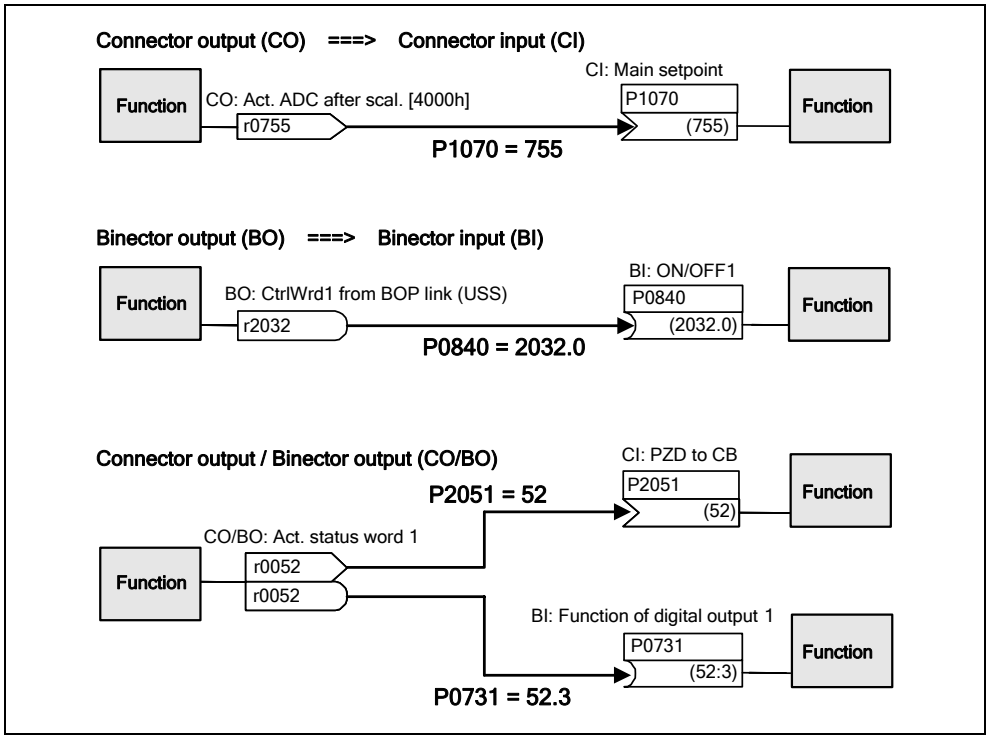


Fig. 3-6 BICO connections (examples)

NOTE

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

3.1.3 Reference quantities

Parameter range: P2000 - P2002

When being output or read-in by the drive inverter, physical quantities are normalized or de-normalized. This conversion is made directly by the particular interface using the reference quantities. The normalization / de-normalization is carried-out for the following interfaces:

Table 3-5 Normalized interfaces

Interface	100 %
Analog input (voltage input)	10 V
Analog output (current output)	20 mA
USS	4000 h
CB	4000 h

Further, a normalization is carried-out for a BICO connection if the connector output (CO) represents a physical quantity and the connector input (CI) a normalized (percentage) quantity (e.g. PID controller). A de-normalization is carried-out if the inverse applies.

Reference quantities (normalization quantities) are intended to allow setpoints and actual signals to be represented in a uniform, standard way (normalization / de-normalization of physical quantities such as setpoint and actual frequency). This also applies to permanently set parameters that are assigned the "percentage" units. A value of 100 % corresponds in this case to a process data value PZD of 4000 h (USS or CB) or a current value of 20 mA (analog output) or a voltage value of 10 V (analog input). The following reference parameters and permanently saved reference values are available:

Table 3-6 Normalization functions

Parameter	Designation	Value (100 % / 4000 h)	Units
P2000	Reference frequency	P2000	Hz
P2001	Reference voltage	P2001	V
P2002	Reference current	P2002	A
-	Reference speed	P2000 * 60 / r0313	RPM
-	Reference temperature	100 °C	°C
-	Reference energy	100 kWh	kWh

Example

The normalization / de-normalization via the "USS to BOP link" serial interface is shown using the reference frequency P2000.

If the connection between two BICO parameters is closed (directly using BICO parameters or indirectly using P0719 or P1000), that have a different representation/notation (normalized representation (hex) or physical representation (Hz)), then the following normalization is made in the drive inverter to the target value:

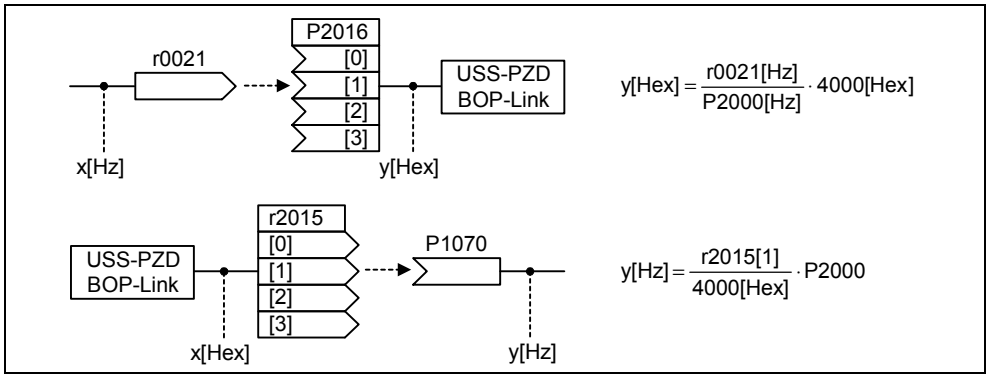


Fig. 3-7 Normalization / de-normalization

Note

- Analog values are limited to 10 V or 20 mA. A maximum of 100 % can be output / read-in referred to the appropriate reference values as long as no DAC/ADC scaling (factory setting) was made.
- Setpoints and actual value signals via the serial interface:
  - When transferring this data via the PZD part, it is limited to the value 7FFF h. This is the reason that the max. value 200 % is referred to the reference value.
  - When transferring this data via the PKW part, it is transferred as a function of the data type and units.
- Parameter P1082 (max. frequency) limits, in the drive inverter, the frequency independently of the reference frequency. This is the reason that when P1082 is changed (factory setting: 50 Hz), then the P2000 (factory setting: 50 Hz) should always be adapted. For instance, if for a NEMA motor the parameter is set to 60 Hz and P2000 is not changed, then the analog setpoint / actual value at 100 % or a setpoint/actual value signal at 4000 h is limited to 50 Hz!

3.2 Operator panels for MICROMASTER

MICROMASTER drive units can be optionally equipped with a BOP (Basic Operator Panel) or AOP (Advanced Operator Panel). The AOP distinguishes itself as a result of a plain text display which simplifies operator control, diagnostics as well as also commissioning (start-up).

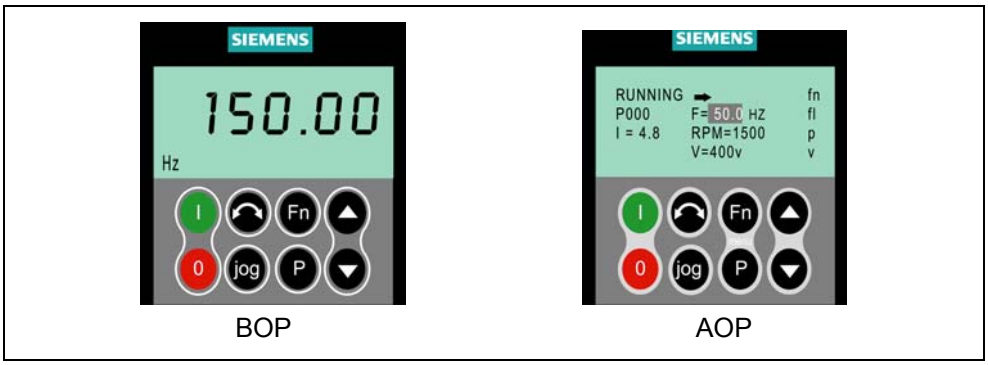


Fig. 3-8 Operator panels

3.2.1 Description of the BOP (Basic Operator Panel)

The BOP, available as option, allows drive inverter parameters to be accessed. In this case, the Status Display Panel (SDP) must be removed and the BOP either inserted or connected in the door of a cabinet using a special mounting kit (operator panel - door mounting kit) (refer to the Attachment A).

Parameter values can be changed using the BOP. This allows the MICROMASTER drive unit to be set-up for a particular application. In addition to the keys (refer to Section 3.2.3), it includes a 5-digit LCD display on which the parameter numbers rxxxx and Pxxxx, parameter values, parameter units (e.g. [A], [V], [Hz], [s]), alarm Axxxx or fault messages Fxxxx as well as setpoints and actual values.

NOTE

- Contrary to the AOP, for the BOP, parameters do not have to be set or taken into consideration when establishing the communications between the BOP and drive inverter.
- A BOP does not have a local memory. This means that it is not possible to save a parameter set on the BOP.

3.2.2 Description of the AOP (Advanced Operator Panel)

An AOP (this is available as option) has the following additional functions with respect to a BOP:

- Multi-language and multi-line plain text display
- Units are additionally displayed, such as [Nm], [°C], etc.
- Active parameters, fault messages, etc. are explained
- Diagnostics menu to support troubleshooting
- The main menu is directly called by simultaneously pressing keys Fn and P
- Timer with 3 switching operations per entry
- Up to 10 parameter sets can be downloaded / saved
- Communications between an AOP and MICROMASTER are realized using the USS protocol. An AOP can be connected to the BOP link (RS 232) as well as to the COM link interface (RS 485) of the drive inverter.
- Multi-point capable coupling to control (open-loop) and visualize up to 31 MICROMASTER drive inverters. The USS bus must, in this case, be configured and parameterized via the drive inverter terminals of the COM link interface.

Please refer to Sections 3.2.3, 3.2.4 and the AOP Manual for additional details.

NOTE

- Contrary to the BOP, for the AOP, the communications parameters of the particular interface must be taken into account.
- When inserting / connecting to the drive inverter, the AOP automatically changes the parameter P2012 (USS-PZD length) to 4 corresponding to the interface.
  COM link: P2012[0]
  BOP link: P2012[1]
- For DriveMonitor, the default value for the USS-PZD length is set to 2. This results in a conflict if the AOP and the DriveMonitor are operated, alternating, at the same interface.
  Remedy: Increase the USS-PZD length to 4.

3.2.3 Keys and their functions on the operator panel (BOP / AOP)

Operator panel/key	Function	Effects
	Indicates Status	The LCD displays the settings currently used by the converter.
	Start converter	Pressing the button starts the converter. This button is disabled by default. **Activate the button:** **BOP: P0700 = 1 or P0719 = 10 ... 16** **AOP: P0700 = 4 or P0719 = 40 ... 46** on BOP link **P0700 = 5 or P0719 = 50 ... 56** on COM link
	Stop converter	OFF1 Pressing the button causes the motor to come to a standstill at the selected ramp down rate. **Activate the button: see button "Start converter"** OFF2 Pressing the button twice (or once long) causes the motor to coast to a standstill. **BOP: This function is always enabled** (independent of P0700 or P0719).
	Change direction	Press this button to change the direction of rotation of the motor. Reverse is indicated by a minus (-) sign or a flashing decimal point. Disabled by default. **Activate the button: see button "Start converter".**
	Jog motor	In the "Ready to power-on" state, when this key is pressed, the motor starts and rotates with the pre-set jog frequency. The motor stops when the button is released. Pressing this button when the motor is running has no effect.
	Functions	This button can be used to view additional information. It works by pressing and holding the button. It shows the following, starting from any parameter during operation: 1. DC link voltage (indicated by d – units V). 2. output current. (A) 3. output frequency (Hz) 4. output voltage (indicated by o – units V). 5. The value selected in P0005 (If P0005 is set to show any of the above (1 - 4) then this will not be shown again). Additional presses will toggle around the above displays. **Jump Function** From any parameter (rxxxx or Pxxxx) a short press of the Fn button will immediately jump to r0000, you can then change another parameter, if required. Upon returning to r0000, pressing the Fn button will return you to your starting point. **Acknowledgement** If alarm and fault messages are present, then these can be acknowledged by pressing key Fn.
	Access parameters	Pressing this button allows access to the parameters.
	Increase value	Pressing this button increases the displayed value.
	Decrease value	Pressing this button decreases the displayed value.
	AOP menu	Calls the AOP menu prompting (this is only available for AOP).

Fig. 3-9 Operator panel keys

3.2.4 Changing parameters using the operator panel

The way that parameter P0719 can be changed will now be described; please use this description as a basis when setting all of the other parameters using the BOP.

Changing P0004 – parameter filter function

Step	Result on the display
1 Press P in order to access the parameter	r0000
2 Press ▲ until P0004 is displayed	P0004
3 Press P in order to reach the parameter value level	0
4 Press ▲ or ▼ in order to obtain the required value	7
5 Press P to acknowledge the value and to save the value	P0004
6 The user can only see the command parameters.	

Changing an indexed parameter P0719 – selecting the command/frequency setpoint

Step	Result on the display
1 Press P in order to access the parameter	r0000
2 Press ▲ until P0719 is displayed	P0719
3 Press P in order to reach the parameter value	in000
4 Press P in order to display the currently set value	0
5 Press ▲ or ▼ in order to obtain the required value	12
6 Press P to acknowledge the value and to save the value	P0719
7 Press ▼ until r0000 is displayed	r0000
8 Press P in order to return to the operating display (the display which the customer has defined)	

Fig. 3-10 Changing parameters using the BOP

NOTE

The BOP sometimes display buSY when changing parameter values. This means that the drive inverter is presently handling another higher-priority task.

3.3 Block diagram

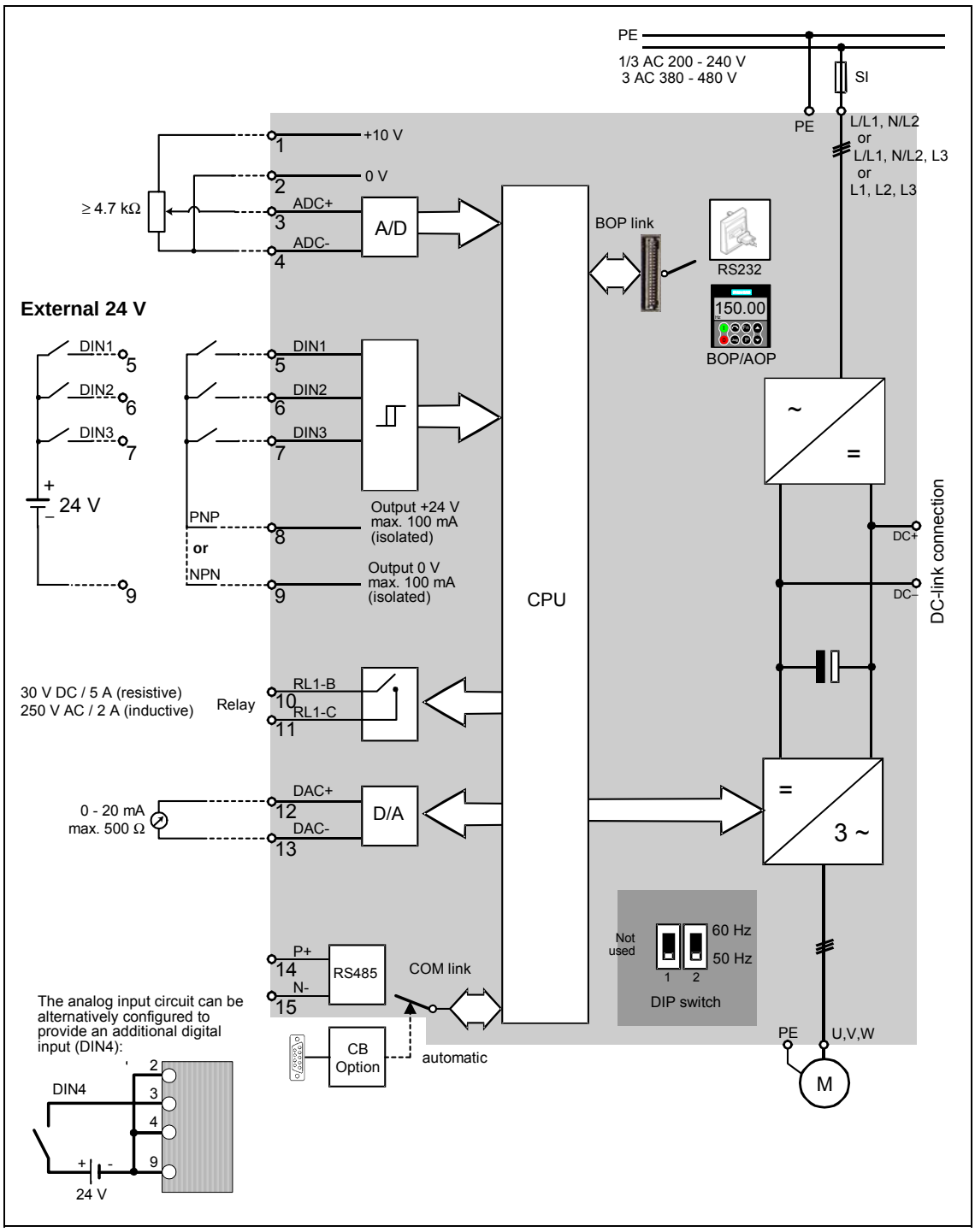


Fig. 3-11 MICROMASTER 420 – block diagram

3.4 Factory setting

The MICROMASTER drive unit is shipped from the plant with a Status Display Panel (SDP, refer to Fig. 3-12). The SDP has two LEDs on the front panel which display the operating state of the drive inverter (refer to Section 4.1).

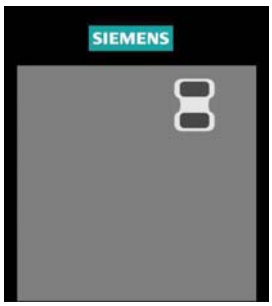


Fig. 3-12 Status Display Panel (SDP)

When MICROMASTER is shipped from the plant with the SDP functioning, it can be operated without any additional parameterization. In this case, the drive inverter default settings (which depend on the drive inverter type / size) match the following data of a 4-pole motor:

- Rated motor power P0307
- Rated motor voltage P0304
- Rated motor current P0305
- Rated motor frequency P0310

(We recommend a Siemens standard motor.)

Further, the following conditions must be fulfilled:

- Control (ON/OFF command) via digital inputs (refer to Table 3-7)
- Setpoint input via analog input 1 P1000 = 2
- Induction motor P0300 = 1
- Self-cooled motor P0335 = 0
- Motor overload factor P0640 = 150 %
- Min. frequency P1080 = 0 Hz
- Max. frequency P1082 = 50 Hz
- Ramp-up time P1120 = 10 s
- Ramp-down time P1121 = 10 s
- Linear V/f characteristic P1300 = 0

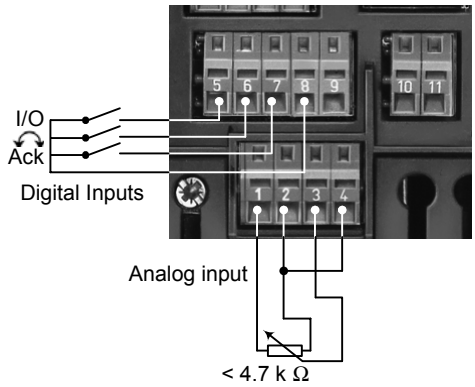
Table 3-7 Pre-assignment of the digital inputs

Digital inputs	Terminals	Parameter	Function	Active
Command source	-	P0700 = 2	Terminal strip	Yes
Digital input 1	5	P0701 = 1	ON / OFF1	Yes
Digital input 2	6	P0702 = 12	Reversing	Yes
Digital input 3	7	P0703 = 9	Fault acknowledge	Yes
Digital input 4	Via ADC	P0704 = 0	Digital input disabled	No

If the various prerequisites are fulfilled and the appropriate conditions present, then after the motor has been connected and the power connected, then the following is possible with the factory setting:

- The motor can be started and stopped (via DIN1 with external switch)
- The direction of rotation can be reversed (via DIN2 with external switch)
- Faults reset (via DIN3 with external switch)
- A frequency setpoint can be entered (via ADC with external potentiometer, default setting of the ADC: unipolar voltage input)
- The frequency actual value can be output (via DAC, DAC output: current output)

The potentiometer and the external switches can be connected through the drive inverter internal power supply, as shown in Fig. 3-13.



Pre-assignment of the digital inputs DIN1 to DIN3, refer to Table 3-7.

Fig. 3-13 Recommended wiring for the factory setting

If settings have to be made which go beyond the factory setting, then depending on the complexity of the application, when commissioning the drive system, the particular function description as well as the parameter list including function charts must be carefully taken into consideration.

3.5 Commissioning

A differentiation is made between the following scenarios when commissioning MICROMASTER:

- 50/60-Hz changeover
- Motor data identification
- Series commissioning
- Quick commissioning
- Calculating the motor / control data
- Commissioning the application

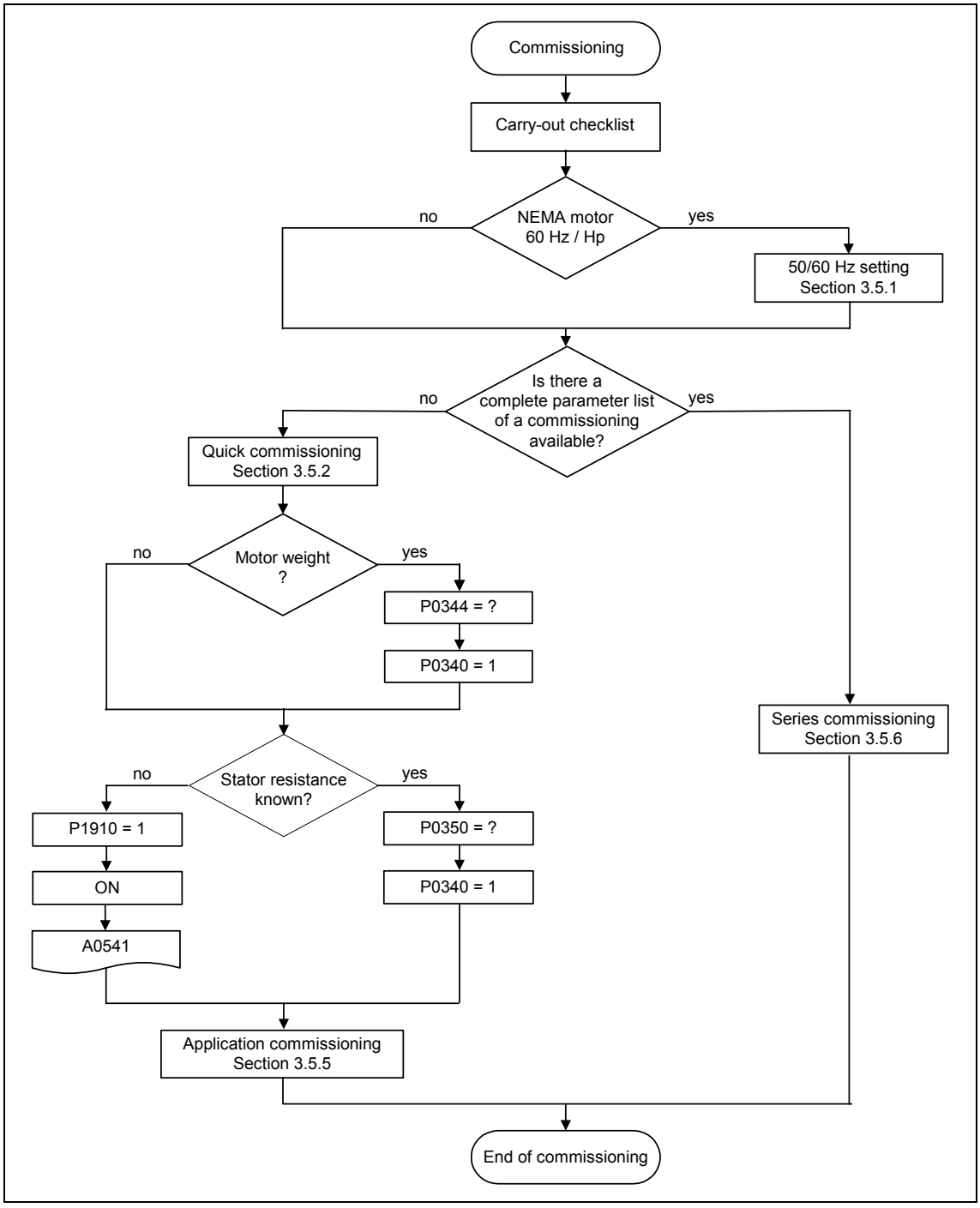


Fig. 3-14 Procedure when commissioning

When commissioning, initially, a quick commissioning should be carried-out. The actual application should only be commissioned if the drive inverter – motor combination provides a satisfactory result.

If the drive is to be commissioned from a defined state, then the drive inverter can be reset to the initial state when it left the plant. This is done as follows:

- Reset parameters to the factory setting (refer to Section 3.5.7)

Check list

The following check list is intended to help you to simply commission MICROMASTER and to guarantee a high degree of availability:

- For all activities relating to ESDS measures
- All of the screws must have been tightened to their specified torque.
- All connectors / option modules have been correctly inserted and interlocked / screwed into place.
- The DC link pre-charging must have been completed.
- All of the components are grounded at the locations provided and all of the shields have been connected.
- MICROMASTER has been designed for defined mechanical, climatic and electrical ambient conditions. The limit values may neither be exceeded in operation nor during transport. The following must always be carefully observed:
  - Line supply conditions
  - Level of pollutants and contaminants
  - Gases and vapors that can have a negative impact on the function of the drive inverter
  - Climatic ambient conditions
  - Storage / transport
  - Shock stressing
  - Vibration stressing
  - Ambient temperature
  - Installation altitude

In order to ensure that the drive inverter is successfully commissioned, in addition to completely carrying-out all of the installation work, it is important to note that the drive inverter may not be disconnected from the line supply while parameterizing the drive unit. If commissioning is interrupted due to a power failure, then parameters could be lost. In this case, commissioning must always be re-started (it may be necessary to restore the parameters to the factory setting (refer to Section 3.5.7).

NOTE

When using output reactors, the pulse frequency may not be set higher than 4 kHz.

The following parameter setting is mandatory when using an output reactor:

P1800 = 4 kHz , P0290 = 0 or 1

3.5.1 50/60 Hz setting

The frequency setting made in the factory can be adapted to the North American market, without requiring any parameterization using an operator panel or PC tool using the 50/60 Hz DIP switch (refer to Fig. 3-15).

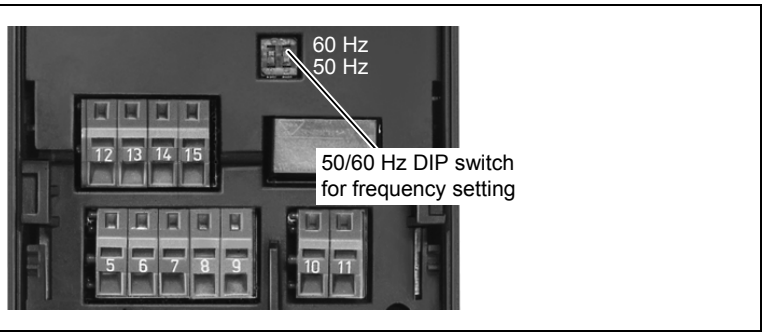


Fig. 3-15 DIP switch to change-over between 50/60 Hz

The switch determines the value of parameter P0100 corresponding to the following diagram (refer to Fig. 3-16). Besides P0100 = 2, after the power supply voltage has been switched-in, the 50/60 Hz DIP switch determines the 50/60 Hz setting (value of parameter P0100).

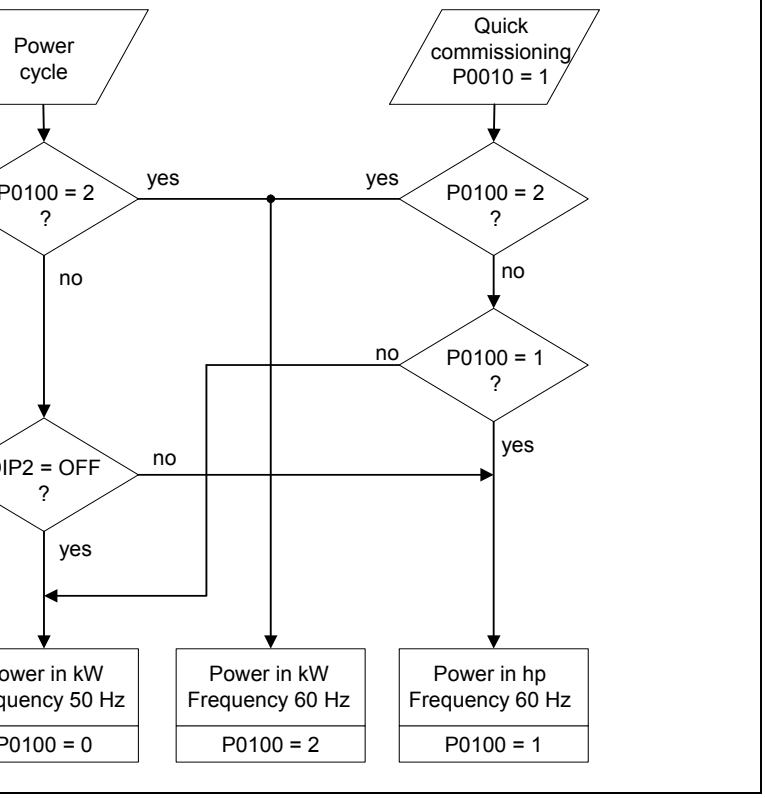


Fig. 3-16 Mode of operation of the 50/60 Hz DIP switch in conjunction with P0100

By changing the setting of 50/60 Hz DIP switch, after the drive inverter has been powered-down/powered-up, the parameters for the rated motor frequency P0310, max. frequency P1082 and reference frequency P2000 are automatically pre-set. In addition, the rated motor parameters as well as all of the other parameters which depend on the rated motor parameters, are reset. The units of the power parameters are, depending on P0100, are either interpreted as kW value or hp value.

3.5.2 Quick commissioning

If there is still no appropriate parameter set for the drive, then a quick commissioning must be carried-out including a motor data identification routine. The following operator units can be used to carry-out quick commissioning:

- BOP (option)
- AOP (option)
- PC Tools (with commissioning software STARTER, DriveMonitor)

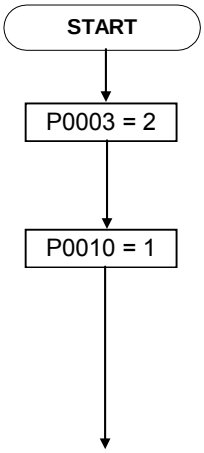
When the quick commissioning is carried-out, the motor – drive inverter is basically commissioned; the following data must be obtained, modified or entered before quick commissioning is started:

- Enter the line supply frequency
- Enter the rating plate data
- Command / setpoint sources
- Min. / max. frequency or ramp-up / ramp-down time
- Control mode
- Motor data identification

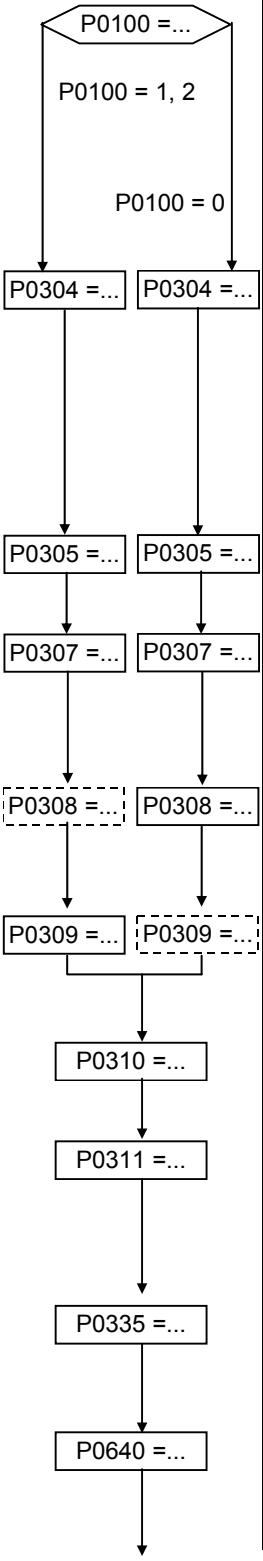
Parameterizing the drive with BOP or AOP

The frequency inverter is adapted to the motor using the quick commissioning function and important technological parameters are set. The quick commissioning shouldn't be carried-out if the rated motor data saved in the frequency inverter (4-pole 1LA Siemens motor, star circuit configuration ≙ frequency inverter (FU)-specific) match the rating plate data.

Parameters, designated with a * offer more setting possibilities than are actually listed here. Refer to the parameter list for additional setting possibilities.



	Factory setting
User access level *	1
1 Standard: Allows access into most frequently used parameters	
2 Extended: Allows extended access e.g. to inverter I/O functions	
3 Expert (For expert use only)	
Commissioning parameter *	0
0 Ready	
1 Quick commissioning	
30 Factory setting	
NOTE	
P0010 should be set to 1 in order to parameterize the data of the motor rating plate.	



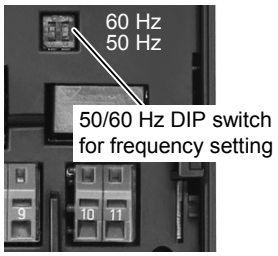
Europe/ North America 0

(enters the line supply frequency)

0 Europe [kW], **frequency default 50 Hz**
1 North America [hp], frequency default 60 Hz
2 North America [kW], frequency default 60 Hz

NOTE

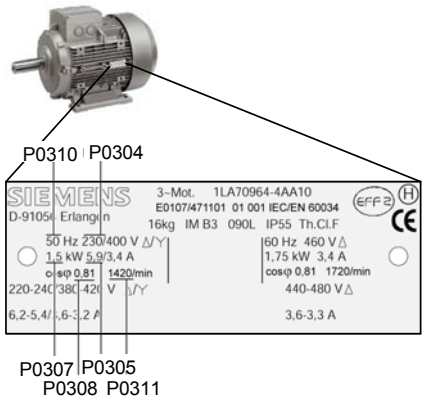
For P0100 = 0 or 1, the setting of switch DIP2(2) determines the value of P0100 (refer to the parameter list).



Rated motor voltage FU-spec.

(Nominal motor voltage [V] from rating plate)

The rated motor voltage on the rating plate must be checked, regarding the star/delta circuit configuration to ensure that it matches with the circuit connection configured at the motor terminal board



Rated motor current FU-spec.

(Nominal motor current [A] from rating plate)

Rated motor power FU-spec.

(Nominal motor power [kW/hp] from rating plate)

If P0100 = 0 or 2, value will be in kW. If P0100 = 1, value will be in in hp.

Rated motor cosPhi FU-spec.

(Nominal motor power factor (cos φ) from rating plate)

If the setting is 0, the value is automatically calculated

P0100 = 1,2: P0308 no significance, no entry required.

Rated motor efficiency FU-spec.

(Nominal motor efficiency in [%] from rating plate)

Setting 0 causes internal calculation of value.

P0100 = 0: P0309 no significance, no entry required.

Rated motor frequency 50.00 Hz

(Nominal motor frequency in [Hz] from rating plate)

Pole pair number recalculated automatically if parameter is changed.

Rated motor speed FU-spec.

(Nominal motor speed in [rpm] from rating plate)

Setting 0 causes internal calculation of value.

NOTE

For slip compensation, the input is absolutely necessary.

Motor cooling 0

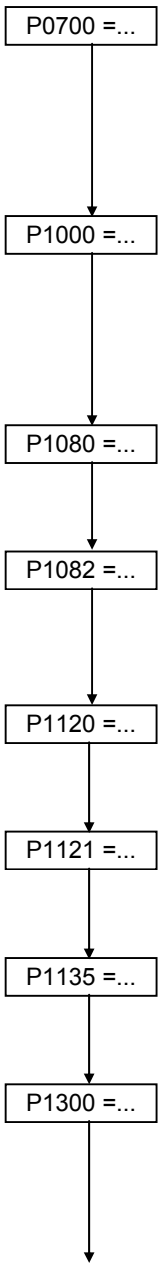
(Selects motor cooling system used)

0 Self-cooled: Using shaft mounted fan attached to motor
1 Force-cooled: Using separately powered cooling fan

Motor overload factor 150 %

(Motor overload factor in [%] relative to P0305)

This defines the limit of the maximum output current as a % of the rated motor current (P0305).



Selection of command source 0 Factory default setting 1 BOP (keypad) 2 Terminal 4 USS on BOP link 5 USS on COM link 6 CB on COM link	2
Selection of frequency setpoint 1 MOP setpoint 2 Analog setpoint 3 Fixed frequency 4 USS on BOP link 5 USS on COM link 6 CB on COM link	2
Min. frequency (enters the minimum motor frequency in Hz) Sets minimum motor frequency at which motor will run irrespective of frequency setpoint. The value set here is valid for both clockwise and anticlockwise rotation.	0.00 Hz
Max. frequency (enters the maximum motor frequency in Hz) Sets maximum motor frequency at which motor will run irrespective of the frequency setpoint. The value set here is valid for both clockwise and anticlockwise rotation.	50.00 Hz
Ramp-up time (enters the ramp-up time in s) Time taken for motor to accelerate from standstill up to maximum motor frequency (P1082) when no rounding is used.	10.00 s
Ramp-down time (enters the deceleration time in s) Time taken for motor to decelerate from maximum motor frequency (P1082) down to standstill when no rounding is used	10.00 s
OFF3 ramp-down time (enters the fast stop ramp-down time in s) Defines ramp-down time from maximum frequency to standstill for OFF3 command.	5.00 s
Control mode (enters the required control mode) 0 V/f with linear characteristic 1 V/f with FCC 2 V/f with parabolic characteristic 3 V/f with programmable characteristic	0

P3900 = 1

ENDE

	0
End of quick commissioning (start of the motor calculation) **0** **No quick commissioning** (no motor calculations) 1 Start quick commissioning with factory reset 2 Start quick commissioning 3 Start quick commissioning only for motor data **NOTE** For P3900 = 1,2,3 → P0340 is internally set to 1 and the appropriate data calculated (refer to the parameter list P0340).	
End of quick commissioning/ drive setting If additional functions must be implemented at the drive inverter, please use the instructions in Section 3.5.5 "Commissioning the application". We recommend this procedure for drives with a high dynamic response..	

WARNING

The motor data identification routine (refer to Section 3.5.4) may not be used for loads which are potentially hazardous (e.g. suspended loads for crane applications). Before the motor data identification run is started, the potentially hazardous load must be carefully secured (e.g. by lowering the load to the floor or by clamping the load using the motor holding brake).

NOTE

- The precise equivalent circuit diagram data are extremely important for the voltage boost of the V/f characteristic. The equivalent diagram data can only be estimated from the rating plate data. This is the reason that the equivalent circuit diagram data are, either
  - determined using the motor data identification routine (refer to Section 3.5.4), or
  - entered from the motor data sheet (refer to Section 3.5.3).
- Parameter P0308 or P0309 are only visible using the BOP or AOP if P0003 ≥ 2. Depending on the setting of parameter P0100, either P0308 or P0309 is displayed.
- The input value of P0307 and all other power data are either interpreted as kW or hp value depending on P0100.

The possible rating plate / power plate data is shown in Fig. 3-17. The precise definition and explanation of this data is defined in DIN EN 60 034-1.

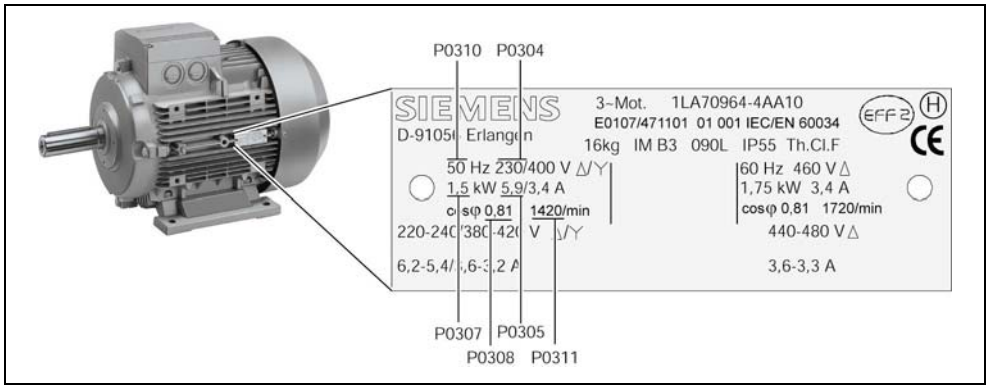
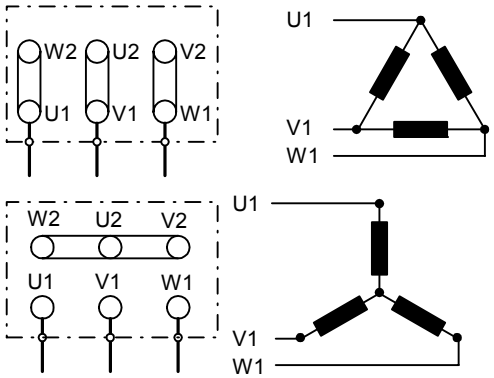


Fig. 3-17 Example of a typical motor rating plate

In order to ensure a straightforward, successful commissioning, it is important that the circuit connection in the motor terminal box (refer to Fig. 3-18) matches the rated motor voltage entered in P0304 or the rated motor current P0305.

IEC Motor

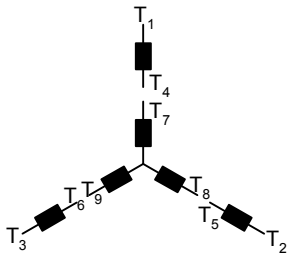


e.g.: Volts 230 V (Delta connection) / 400 V (Star connection)

NEMA Motor

Volts	U	V	W	Connected together	Connection
low	T_1-T_7	T_2-T_8	T_3-T_9	T_4-T_5-T_6	Y Y
high	T_1	T_2	T_3	T_1-T_7 | T_2-T_8 | T_3-T_9	Y

e.g.: Volts 230 V YY (low) / 460 V Y (high)



Volts	U	V	W	Connected together	Connection
low	T_1-T_6-T_7	T_2-T_4-T_8	T_3-T_5-T_9	-	Δ Δ
high	T_1	T_2	T_3	T_4-T_7 | T_5-T_8 | T_6-T_9	Δ

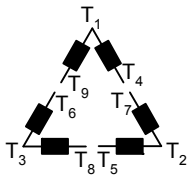


Fig. 3-18 Motor terminal box

The following must be noted when entering the rating plate data or the ESB data:

- The rated motor voltage P0304, the rated motor current P0305 and the stator resistance P0350 must always be entered in accordance with the motor circuit configuration (either delta or star).
- If the rated motor data that is available (P0304, P0305, P0350) does not match the motor circuit configuration, then the appropriate conversion (refer to Fig. 3-19) must be made and then entered.

NOTE

The outer conductor voltage/phase-to-phase voltage (voltage U_{12} between outer conductors L1, L2) and the outer conductor current (phase current) I_1 are always specified on the rating plate.

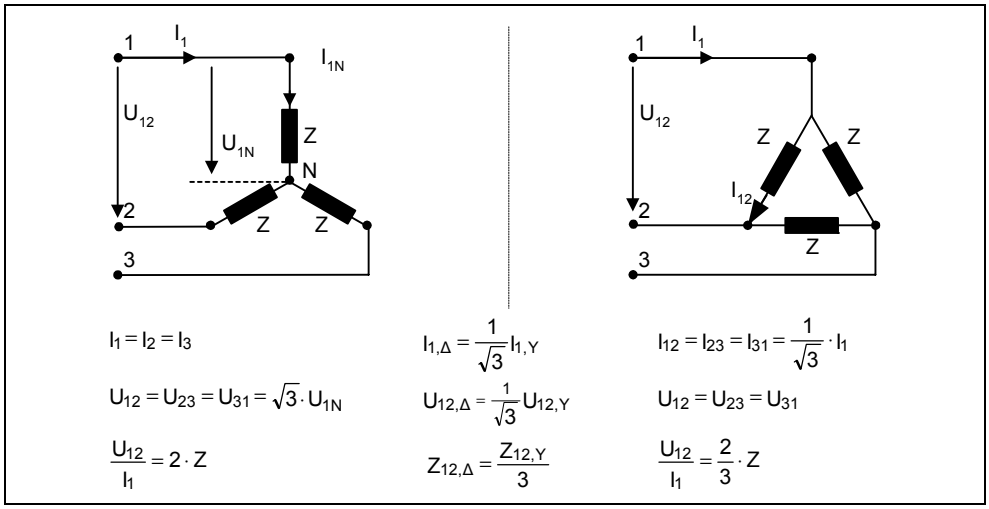


Fig. 3-19 Star / delta circuit configurations

87 Hz characteristic

When a motor with a delta circuit configuration (e. g. $V_{N\Delta,\ motor}$ = 230 V) is fed from a frequency inverter, where the rated voltage corresponds to the star circuit configuration (e.g. 400 V frequency inverter), then it is important to proceed as follows and observe the following:

- The motor must have the appropriate voltage strength.
- Above the rated motor frequency, the iron losses in the motor increase over-proportionally. This is the reason that above this frequency, the thermal motor torque should be reduced.
- For the quick commissioning, the rating plate data for the delta circuit configuration should be entered or the rating plate must be appropriately converted.
- The drive inverter must be designed for the higher current (delta circuit configuration).
- The 87 Hz characteristic is independent of the control type.
- When using the 87 Hz characteristic, the mechanical motor limits must be taken into account (refer to Catalog M11).

For the 87 Hz characteristic, the ratio between the voltage and frequency (V/f characteristic) remain constant. This is the reason that the following relationships apply:

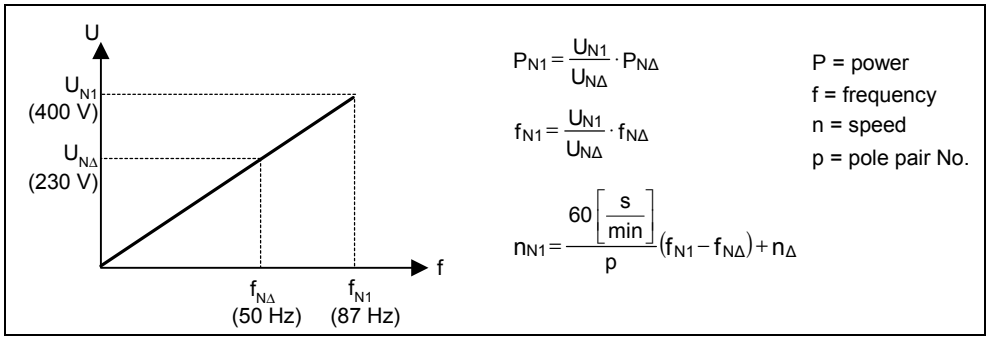


Fig. 3-20 V/f characteristic

Table 3-8 Example 1LA7060-4AB10

		Delta circuit configuration	87 Hz characteristic	Star circuit configuration
P0304	Rated motor voltage	230 V	400 V	400 V
P0305	Rated motor current	0.73 A	0.73 A	0.42 A
P0307	Rated motor power	120 W	207 W	120 W
P0308	Cos φ	0.75	0.75	0.75
P0310	Rated motor frequency	50 Hz	87 Hz	50 Hz
P0311	Rated motor speed	1350 RPM	2460 RPM	1350 RPM
P0314	Motor pole pairs	2	2	2

Contrary to the BOP, AOP operator panels or commissioning tool program DriveMonitor, the STARTER commissioning (start-up) program offers a mask-orientated quick commissioning, which is especially advantageous for users who are using MICROMASTER for the first time. On the other hand, BOP, AOP and DriveMonitor offer, in conjunction with the drive inverter, parameter-orientated quick commissioning where the user is navigated through the menu tree mentioned above.

NOTE

The MICROMASTER series of drive units is not available for 3-ph. 690 V AC.

3.5.3 Calculating the motor / control data

Internal motor / control data is calculated using parameter P0340 or, indirectly using parameter P3900 (refer to Section 3.5.2) or P1910 (refer to Section 3.5.4). The functionality of parameter P0340 can, for example, if the motor weight or the stator resistance is known. The following settings are possible for P0340:

0 No calculation

1 Complete parameterization

For the complete parameterization (P0340 = 1), in addition to the motor / control parameters, parameters are also pre-assigned which refer to the motor rated data (e.g. torque limits and reference quantities for interface signals).

Table 3-9 Parameter for motor/control data

	P0340 = 1
P0344 Motor weight	x
P0346 Magnetization time	x
P0347 Demagnetization time	x
P0350 Stator resistance (line-to-line)	x
P0611 Motor I2t time constant	x
P1253 Vdc-controller output limitation	x
P1316 Boost end frequency	x
P2000 Reference frequency	x
P2002 Reference current	x

NOTE

- When exiting the quick commissioning with P3900 > 0 (refer to Section 3.5.2), internally P0340 is set to 1 (complete parameterization).
- For the motor data identification (refer to Section 3.5.4), after the measurement has been completed, internally P0340 is set to 3.

3.5.4 Motor data identification (stator resistance)

MICROMASTER has a measuring technique which is used to determine the stator resistance:

We urgently recommend that the identification routine is carried-out for control-related reasons. For example, the stator resistance is extremely important for the voltage boost for the V/f characteristic. The motor data identification routine should be executed, especially if long feeder cables or if third-party motors are being used.

After selecting the motor data identification using parameter P1910, alarm A0541 is immediately generated. The motor identification routine is started by the ON command and different excitation signals are impressed in the motor (DC and AC voltages). This measurement is carried-out with the motor at a standstill and it takes, including the data calculation per selection (P1910 = 1) between 20 s ... 4 min. The identification time depends on the motor and increases with its size.

The motor data identification routine must be carried-out with the motor in the cold condition so that the motor resistance values saved can be assigned to the parameter of the ambient temperature. Only then is correct temperature adaptation of the resistances possible during operation.

The motor data identification routine operates with the results of the "Complete parameterization" P0340 = 1 or the motor equivalent diagram data which was last saved. The results become increasingly better the more times that the identification routine is executed (up to 3 times).



WARNING

- It is not permissible to carry-out the motor identification routine for loads which are potentially hazardous (e.g. suspended loads for crane applications). Before starting the motor data identification routine, the potentially hazardous load must be secured (e.g. by lowering the load to the floor or clamping the load using the motor holding brake).
- When starting the motor data identification routine, the rotor can move into a preferred position. This is more significant for larger motors.

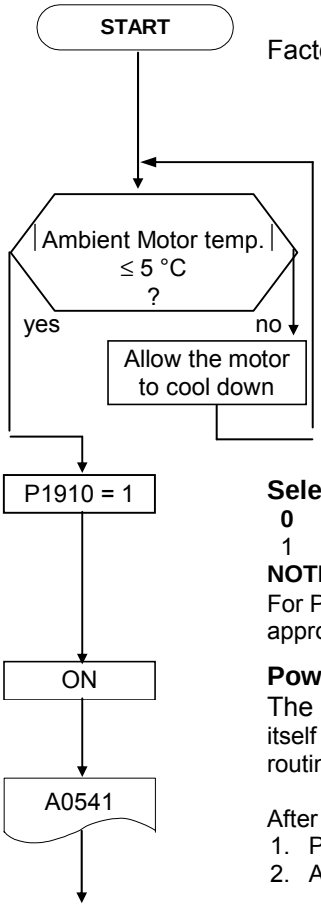
NOTE

- It is not necessary to lock the motor rotor for the motor data identification routine. However, if it is possible to lock the motor rotor during the identification routine (e.g. by closing the motor holding brake), then this should be used to determine the equivalent circuit diagram data.
- The following formula can be applied to check the correctness of the motor rating plate data:

$$P_N = \sqrt{3} * V_{N\,Y} * I_{NY} * \cos\varphi * \eta \approx \sqrt{3} * V_{N\,\Delta} * I_{N\Delta} * \cos\varphi * \eta$$

with	P_N	rated motor power
	$V_{N\,Y}$, $V_{N\,\Delta}$	rated motor voltage (star / delta)
	$I_{N\,Y}$, $I_{N\,\Delta}$	rated motor current (star / delta)
	$\cos\varphi$	power factor
	η	efficiency

Motor data identification routine



Factory setting: **Bold**

Ambient motor temperature (entered in °C)
The motor ambient temperature is entered at the instant that motor data is being determined (factory setting: **20 °C**).
The difference between the motor temperature and the motor ambient temperature must lie in the tolerance range of approx. ± 5 °C. If this is not the case, then the motor data identification routine can only be carried-out after the motor has cooled down.

Select motor data identification
0 Disabled
1 Identification of all parameters with parameter change

NOTE:
For P1910 = 1 → P0340 is internally set to P0340 = 1 and the appropriate data calculated (refer to parameter list P0340)

Power-up the motor
The ON command initiates the measuring operation. In so doing the motor aligns itself and conducts current. Alarm message A0541 (motor data identification routine active) is output.

After the motor data identification routine has been completed:
1. P1910 is reset (P1910 = 0)
2. A0541 is withdrawn

3.5.5 Commissioning the application

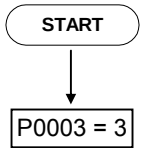
After the motor – drive inverter combination was commissioned using the quick or series commissioning, in the following step parameters should be adapted and set according to the technological requirements. As an example, the following points should be considered:

- Functional requirements of the drive inverter (e.g. process control with PID controller)
- Limit values
- Dynamic requirements
- Starting torques
- Load surge requirement
- Overload
- Diagnostics

If the application includes a function, which is not covered by the quick or series commissioning, then the following sections of the function description or the parameter list should be considered.

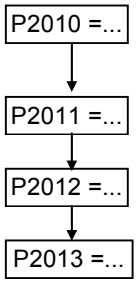
Adapting the drive inverter to the application

The parameters designated with * offer more setting possibilities than are listed here. Refer to the parameter list for additional setting possibilities.



	Factory setting
User access level *	1
1 Standard (Allows access into most frequently used parameters)	
2 Extended (Allows extended access e.g. to inverter I/O functions)	
3 Expert (for expert use only)	

3.5.5.1 Serial Interface (USS)



		Possible Settings:
USS baud rate Sets baud rate for USS communication.	6	3 1200 baud 4 2400 baud 5 4800 baud 6 9600 baud 7 19200 baud 8 38400 baud 9 57600 baud
USS address Sets unique address for inverter.	0	
USS PZD length Defines the number of 16-bit words in PZD part of USS telegram.	2	
USS PKW length Defines the number of 16-bit words in PKW part of USS telegram.	127	

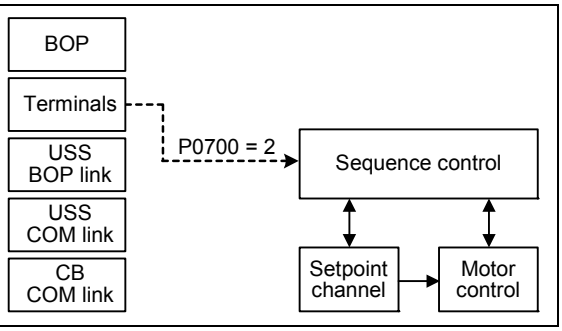
3.5.5.2 Selection of command source

P0700 =...

Selection of command source 2

Selects digital command source.

0 Factory fault setting
1 BOP (keypad)
2 Terminal
4 USS on BOP link
5 USS on COM link
6 CB on COM link



3.5.5.3 Digital input (DIN)

P0701=...
P0702 =...
P0703 =...
P0704 = 0
P0724 =...

Function of digital input 1 1
Terminal 5
1 ON / OFF1

Function digital input 2 12
Terminal 6
12 Reverse

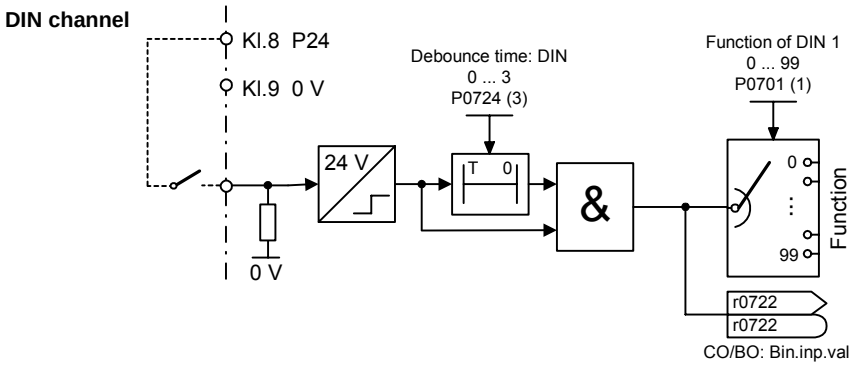
Function digital input 3 9
Terminal 7
9 Fault acknowledge

Function digital input 4 0
Via analog input
Terminals 3, 4
0 Digital input disabled

Debounce time for digital inputs 3
Defines debounce time (filtering time) used for digital inputs.
0 No debounce time
1 2.5 ms debounce time
2 8.2 ms debounce time
3 12.3 ms debounce time

Possible Settings:

0 Digital input disabled
1 ON / OFF1
2 ON + Reverse / OFF1
3 OFF2 – coast to standstill
4 OFF3 – quick ramp-down
9 Fault acknowledge
10 JOG right
11 JOG left
12 Reverse
13 MOP up (increase frequency)
14 MOP down (decrease frequency)
15 Fixed setpoint (Direct selection)
16 Fixed setpoint (Direct selection + ON)
17 Fixed setpoint (Binary coded selection + ON)
21 Local/remote
25 DC brake enable
29 External trip
33 Disable additional freq setpoint
99 Enable BICO parameterization



3.5.5.4 Digital output (DOUT)

P0731 =...

P0748 = 0

BI: Function of digital output 1* 52.3

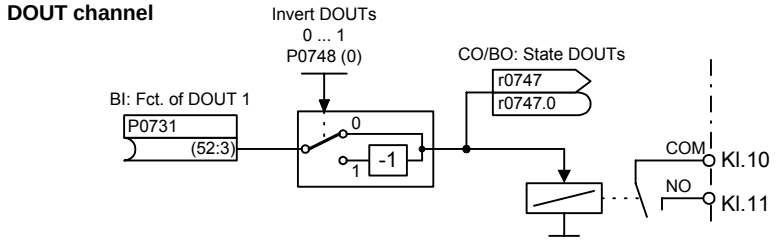
Defines source of digital output 1.

Invert digital output 0

Defines high and low states of relay for a given function.

Common Settings:

52.0	Drive ready	0	Closed
52.1	Drive ready to run	0	Closed
52.2	Drive running	0	Closed
52.3	Drive fault active	0	Closed
52.4	OFF2 active	1	Closed
52.5	OFF3 active	1	Closed
52.6	Switch on inhibit active	0	Closed
52.7	Drive warning active	0	Closed

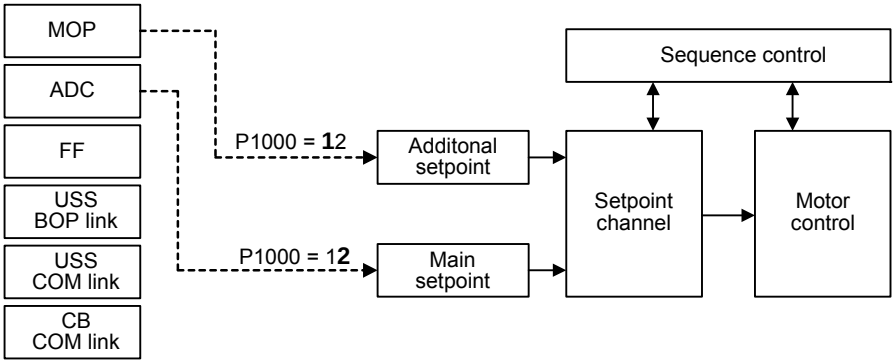


3.5.5.5 Selection of frequency setpoint

P1000 =...

Selection of frequency setpoint 2

0	No main setpoint
1	MOP setpoint
2	Analog setpoint
3	Fixed frequency
4	USS on BOP link
5	USS on COM link
6	CB on COM link



3.5.5.6 Analog input (ADC)

P0757 =...
P0758 =...
P0759 =...
P0760 =...
P0761 =...

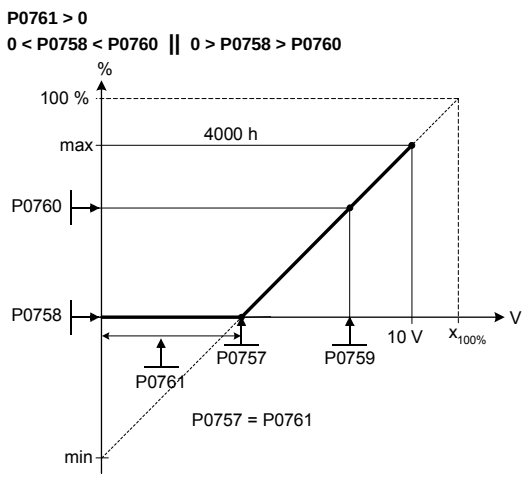
Value x1 of ADC scaling 0 V

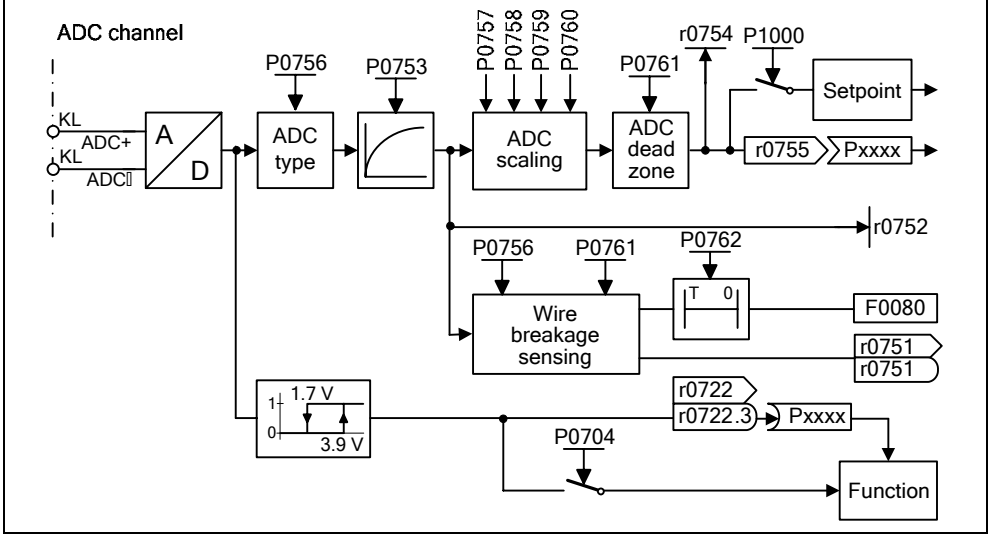
Value y1 of ADC scaling 0.0 %
This parameter represents the value of x1 as a % of P2000 (reference frequency).

Value x2 of ADC scaling 10 V

Value y2 of ADC scaling 100.0 %
This parameter represents the value of x2 as a % of P2000 (reference frequency).

Width of ADC deadband 0 V
Defines width of deadband on analog input.





3.5.5.7 Analog output (DAC)

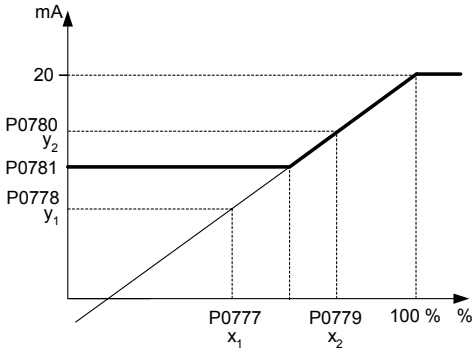
P0771 =...
P0773 =...
P0777 =...
P0778 =...
P0779 =...
P0780 =...
P0781 =...

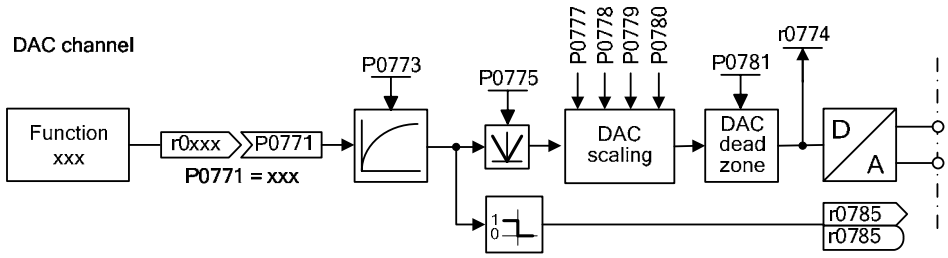
CI: DAC 21
Defines function of the 0 - 20 mA analog output.

Smooth time DAC 2 ms
Defines smoothing time [ms] for analog output signal. This parameter enables smoothing for DAC using a PT1 filter.

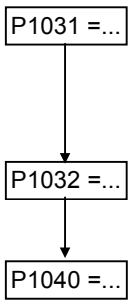
Value x1 of DAC scaling	0.0 %
Value y1 of DAC scaling	0
Value x2 of DAC scaling	100.0 %
Value y2 of DAC scaling	20
Width of DAC deadband	0

Sets width of deadband in [mA] for analog output.





3.5.5.8 Motor potentiometer (MOP)



Setpoint memory of the MOP 0

Saves last motor potentiometer setpoint (MOP) that was active before OFF command or power down.

0 MOP setpoint will not be stored
1 MOP setpoint will be stored (P1040 is updated)

Inhibit negative MOP setpoints 1

0 Neg. MOP setpoint is allowed
1 Neg. MOP setpoint inhibited

Setpoint of the MOP 5.00 Hz

Determines setpoint for motor potentiometer control.

MOP ramp-up and ramp-down times are defined by the parameters P1120 and P1121.

Possible parameter settings for the selection of MOP:

	Selection	MOP up	MOP down
DIN	P0719 = 0, P0700 = 2, P1000 = 1 or P0719 = 1, P0700 = 2	P0702 = 13 (DIN2)	P0703 = 14 (DIN3)
BOP	P0719 = 0, P0700 = 1, P1000 = 1 or P0719 = 11	UP button	DOWN button
USS on BOP link	P0719 = 0, P0700 = 4, P1000 = 1 or P0719 = 41	USS control word r2032 Bit13	USS control word r2032 Bit14
USS on COM link	P0719 = 0, P0700 = 5, P1000 = 1 or P0719 = 51	USS control word r2036 Bit13	USS control word r2036 Bit14
CB	P0719 = 0, P0700 = 6, P1000 = 1 or P0719 = 61	CB control word r2090 Bit13	CB control word r2090 Bit14

3.5.5.9 Fixed frequency (FF)

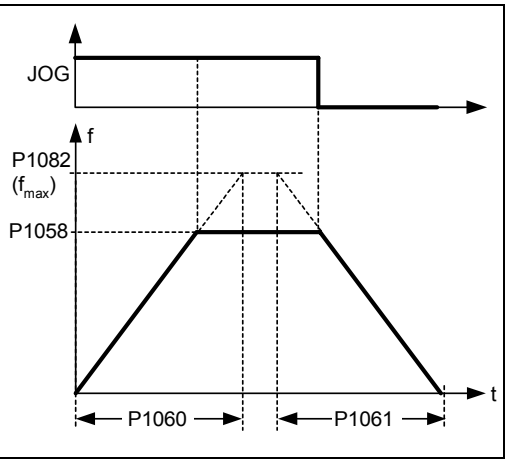
P1001 =...
P1002 =...
P1003 =...
P1004 =...
P1005 =...
P1006 =...
P1007 =...
P1016 =...
P1017 =...
P1018 =...

Fixed frequency 1 0.00 Hz Can be directly selected via DIN1 (P0701 = 15, 16)	When defining the function of the digital inputs (P0701 to P0703), three different types can be selected for fixed frequencies: **15 = Direct selection (binary-coded)** In this particular mode, the appropriate digital input always selects the associated fixed frequency, e.g.: Digital input 3 = selects fixed frequency 3. If several inputs are simultaneously active, then these are summed. An ON command is additionally required. **16 = Direct selection + ON command (binary-coded + On / Off1)** In this mode, the fixed frequencies are selected as for 15, however these are combined with an ON command. **17 = Binary coded selection + ON command (BCD-coded + On/ Off1)** The BCD-coded operating mode is effective for digital inputs 1 to 3.
Fixed frequency 2 5.00 Hz Can be directly selected via DIN2 (P0702 = 15, 16)	
Fixed frequency 3 10.00 Hz Can be directly selected via DIN3 (P0703 = 15, 16)	
Fixed frequency 4 15.00 Hz	
Fixed frequency 5 20.00 Hz	
Fixed frequency 6 25.00 Hz	
Fixed frequency 7 30.00 Hz	
Fixed frequency code – Bit 0 1 Defines the selection method for fixed frequencies.	1 Direct selection 2 Direct selection + ON command 3 Binary coded selection + ON command **NOTE** For settings 2 and 3, all parameters P1016 to P1019 must be set to the selected value so that the drive inverter accepts the ON command.
Fixed frequency code – Bit 1 1	
Fixed frequency code – Bit 2 1	

3.5.5.10 JOG

P1058 =...
P1059 =...
P1060 =...
P1061 =...

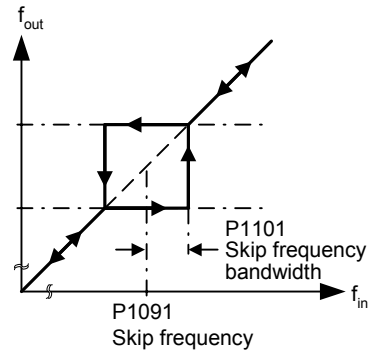
JOG frequency right 5.00 Hz Frequency in Hz when the motor is being jogged in the clockwise direction of rotation.
JOG frequency left 5.00 Hz Frequency in Hz when the motor is being jogged in the counter-clockwise direction of rotation.
JOG ramp-up time 10.00 s Ramp-up time in s from 0 to the maximum frequency (P1082). The JOG ramp-up is limited by P1058 or P1059.
JOG ramp-down time 10.00 s Ramp-down time in s from the maximum frequency (P1082) to 0.



3.5.5.11 Ramp-function generator (HLG)

P1091 =...

Skip frequency 1 (entered in Hz) 0.00 Hz
Defines skip frequency 1 which avoids effects of mechanical resonance and suppresses frequencies within +/- P1101 (skip frequency bandwidth).



P1091 =...

Skip frequency 2 0.00 Hz

P1091 =...

Skip frequency 3 0.00 Hz

P1091 =...

Skip frequency 4 0.00 Hz

P1101 =...

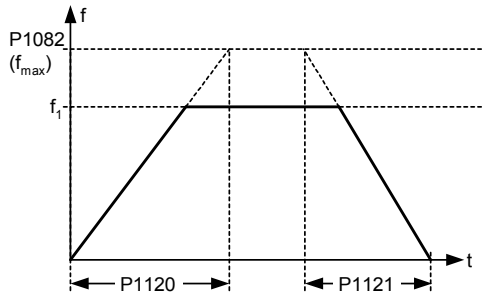
Skip frequency bandwidth 2.00 Hz
(entered in Hz)

P1120 =...

Ramp-up time 10.00 s
(enters the accelerating time in s)

P1121 =...

Ramp-down time 10.00 s
(enters the deceleration time in s)



P1130 =...

Rump-up initial rounding time 0.00 s
(entered in s)

P1131 =...

Ramp-up final rounding time 0.00 s
(entered in s)

P1132 =...

Rump-down initial rounding time 0.00 s
(entered in s)

P1133 =...

Ramp-down final rounding time 0.00 s
(entered in s)

P1134 =...

Rounding type 0
0 Continuous smoothing
1 Discontinuous smoothing

The rounding times are recommended as abrupt responses can be avoided therefore reducing stress and damage to the mechanical system.
The ramp-up and ramp-down times are extended by the component of the rounding ramps.

P1135 =...

OFF3 ramp-down time 5.00 s
Defines ramp-down time from maximum frequency to standstill for OFF3 command.

3.5.5.12 Reference/limit frequencies

P1080 =...

Min. frequency (entered in Hz) — 0.00 Hz

Sets minimum motor frequency [Hz] at which motor will run irrespective of frequency setpoint. If the setpoint falls below the value of P1080, then the output frequency is set to P1080 taking into account the sign.

P1082 =...

Max. frequency (entered in Hz) — 50.00 Hz

Sets maximum motor frequency [Hz] at which motor will run irrespective of the frequency setpoint. If the setpoint exceeds the value P1082, then the output frequency is limited. The value set here is valid for both clockwise and anticlockwise rotation.

P2000 =...

Reference frequency (entered in Hz) — 50.00 Hz

The reference frequency in Hertz corresponds to a value of 100 %. This setting should be changed if a maximum frequency of higher than 50 Hz is required. It is automatically changed to 60 Hz if the standard 60 Hz frequency was selected using the DIP50/60 switch or P0100.

NOTE

This reference frequency effects the setpoint frequency as both the analog setpoints (100 % ≙ P2000) as well as the frequency setpoints via USS (4000H ≙ P2000) refer to this value.

3.5.5.13 Motor control

P1300 =...

Control mode — 0

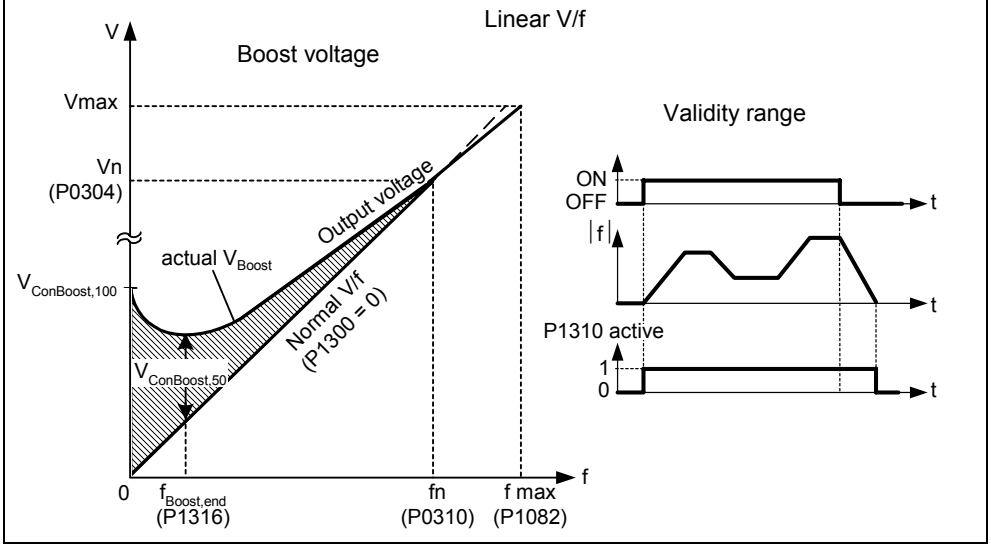
The control type is selected using this parameter. For the "V/f characteristic" control type, the ratio between the frequency inverter output voltage and the frequency inverter output frequency is defined.

0 V/f with linear
1 V/f with FCC
2 V/f with parabolic characteristic
3 V/f with programmable characteristic (→ P1320 – P1325)

P1310 =...

Continuous boost (entered in %) — 50.00 %

Voltage boost as a % relative to P0305 (rated motor current) and P0350 (stator resistance). P1310 is valid for all V/f versions (refer to P1300). At low output frequencies, the effective resistance values of the winding can no longer be neglected in order to maintain the motor flux.



P1311 =...

Acceleration boost (entered in %) 0.0 %
Voltage boost for accelerating/braking as a % relative to P0305 and P0350. P1311 only results in a voltage boost when ramping-up/ramp-down and generates an additional torque for accelerating/braking. Contrary to parameter P1312, that is only active for the 1st acceleration operation after the ON command, P1311 is effective each time that the drive accelerates or brakes.

P1312 =...

Starting boost (entered in %) 0.0 %
Voltage boost when starting (after an ON command) when using the linear or square-law V/f characteristic as a % relative to P0305 (rated motor current) or P0350 (stator resistance). The voltage boost remains active until
1) the setpoint is reached for the first time and
2) the setpoint is reduced to a value that is less than the instantaneous ramp-function generator output.

P1320 =...

Programmable V/f freq. coord. 1 0.0 Hz
Sets V/f coordinates (P1320/1321 to P1324/1325) to define V/f characteristic.

P1321 =...

Programmable. V/f volt. coord. 1 0.0 Hz

P1322 =...

Programmable V/f freq. coord. 2 0.0 Hz

P1323 =...

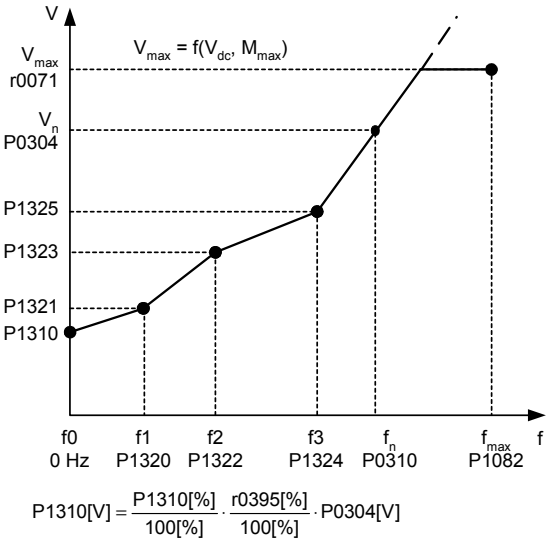
Programmable V/f volt. coord. 2 0.0 Hz

P1324 =...

Programmable U/f Freq. coord. 3 0.0 Hz

P1325 =...

Programmable V/f volt. coord. 3 0.0 Hz



$$P1310[V] = \frac{P1310[\%]}{100[\%]} \cdot \frac{r0395[\%]}{100[\%]} \cdot P0304[V]$$

P1335 =...

Slip compensation (entered in %) 0.0 %
Dynamically adjusts output frequency of inverter so that motor speed is kept constant independent of motor load.

P1338 =...

Resonance damping gain V/f 0.00
Defines resonance damping gain for V/f.

3.5.5.14 Inverter/motor protection

P0290 =...

Inverter overload reaction — 0

Selects reaction of inverter to an internal over-temperature.

0 Reduce output frequency
1 Trip (F0004)
2 Reduce pulse frequency and output frequency
3 Reduce pulse frequency then trip (F0004)

P0292 =...

Inverter temperature warning — 15 °C

Defines the temperature difference (in ºC) between the Overtemperature trip threshold and the warning threshold of the inverter. The trip threshold is stored internally by the inverter and cannot be changed by the user.

P0335 =...

Motor cooling (enters the motor cooling system) — 0

0 Self-cooled: Using shaft mounted fan attached to motor
1 Force-cooled: Using separately powered cooling fan

P0610 =...

Motor I^2t reaction — 2

Defines reaction when motor I^2t reaches warning threshold.

0 Warning, no reaction, no trip
1 Warning, I_{max} reduction, trip F0011
2 Warning, no reaction, trip (F0011)

P0611 =...

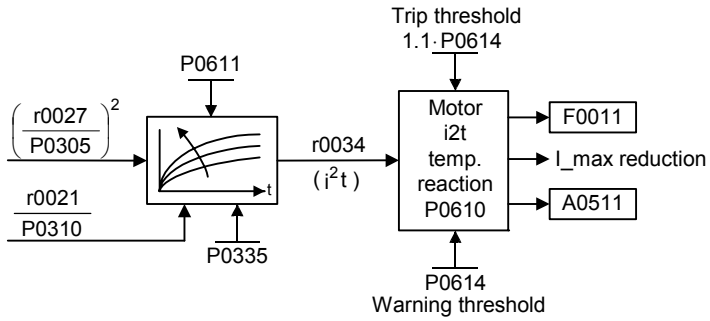
Motor I^2t time constant (entered in s) — 100 s

The time until the thermal limit of a motor is reached, is calculated via the thermal time constant. A higher value increases the time at which the motor thermal limit is reached. The value of P0611 is estimated according to the motor data during quick commissioning or is calculated using P0340 (Calculating of the motor parameters). When the calculation of motor parameters during quick commission is complete the stored value can be replaced by the value given by the motor manufacturer

P0614 =...

Motor I^2t warning level (entered in %) — 100.0 %

Defines the value at which alarm A0511 (motor overtemperature) is generated.



P0640 =...

Motor overload factor [%] — 150.0 %

Defines motor overload current limit in [%] relative to P0305 (rated motor current). Limited to maximum inverter current or to 400 % of rated motor current (P0305), whichever is the lower.

3.5.5.15 Inverter-specific Functions

Flying start

P1200 =...

Flying start 0
Starts inverter onto a spinning motor by rapidly changing the output frequency of the inverter until the actual motor speed has been found.
- 0 Flying start disabled
- 1 Flying start is always active, start in direction of setpoint
- 2 Flying start is active if power on, fault, OFF2, start in direction of setpoint
- 3 Flying start is active if fault, OFF2, start in direction of setpoint
- 4 Flying start is always active, only in direction of setpoint
- 5 Flying start is active if power on, fault, OFF2, only in direction of setpoint
- 6 Flying start is active if fault, OFF2, only in direction of setpoint

P1202 =...

Motor-current: Flying start (entered in %) 100 %
Defines search current used for flying start.

P1203 =...

Search rate: Flying start (entered in %) 100 %
Sets factor by which the output frequency changes during flying start to synchronize with turning motor.

Automatic restart

P1210 =...

Automatic restart 0
Configures automatic restart function.
- 0 Disabled
- 1 Trip reset after power on
- 2 Restart after mains blackout
- 3 Restart after mains brownout or fault
- 4 Restart after mains brownout
- 5 Restart after mains blackout and fault
- 6 Restart after mains brown/blackout or fault

Holding brake

P1215 =...

Holding brake enable 0
Enables/disables holding brake function (MHB).
- 0 Motor holding brake disabled
- 1 Motor holding brake enabled

NOTE

The following must apply when controlling the brake relay via a digital output: P0731 = 14 (refer to Section 3.5.5.4 "Digital ").

P1216 =...

Holding brake release delay (entered in s) 1.0 s
Defines the time interval during which the frequency inverter runs with the min. frequency P1080 after magnetizing, before the ramp-up starts.

P1217 =...

Holding time after ramp-down (entered in s) 1.0 s
Defines time for which inverter runs at minimum frequency (P1080) after ramping down.

DC braking

P1232 =...

P1233 =...

DC braking current (entered in %) — 100 %
Defines level of DC current in [%] relative to rated motor current (P0305).

Duration of DC braking (entered in s) — 0 s
Defines duration for which DC injection braking is to be active following an OFF1 or OFF3 command.

Compound braking

P1236 =...

Compound braking current (entered in %) — 0 %
Defines DC level superimposed on AC waveform after exceeding DC-link voltage threshold of compound braking. The value is entered in [%] relative to rated motor current (P0305). (see also "Vdc controller").

If P1254 = 0 :
Compound braking switch-on level $U_{DC_Comp} = 1.13 \cdot \sqrt{2} \cdot V_{mains} = 1.13 \cdot \sqrt{2} \cdot P0210$

otherwise :
Compound braking switch-on level $U_{DC_Comp} = 0.98 \cdot r1242$

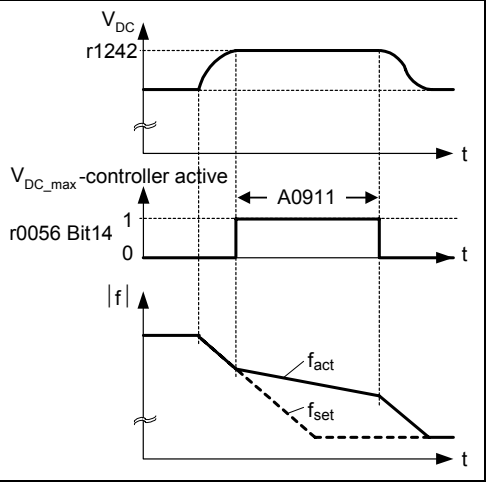
Vdc controller

P1240 =...

P1254 =...

Configuration of Vdc controller — 1
Enables / disables Vdc controller.
0 Vdc controller disabled
1 Vdc-max controller enabled

Auto detect Vdc switch-on levels — 1
Enables/disables auto-detection of switch-on levels for Vdc control functionalities.
0 Disabled
1 Enabled



PID controller

P2200 =...

P2253 =...

P2254 =...

P2257 =...

P2258 =...

P2264 =...

BI: Enable PID controller — 0.0
PID mode Allows user to enable/disable the PID controller. Setting to 1 enables the PID controller. Setting 1 automatically disables normal ramp times set in P1120 and P1121 and the normal frequency setpoints.

CI: PID setpoint — 0.0
Defines setpoint source for PID setpoint input.

CI: PID trim source — 0.0
Selects trim source for PID setpoint. This signal is multiplied by the trim gain and added to the PID setpoint.

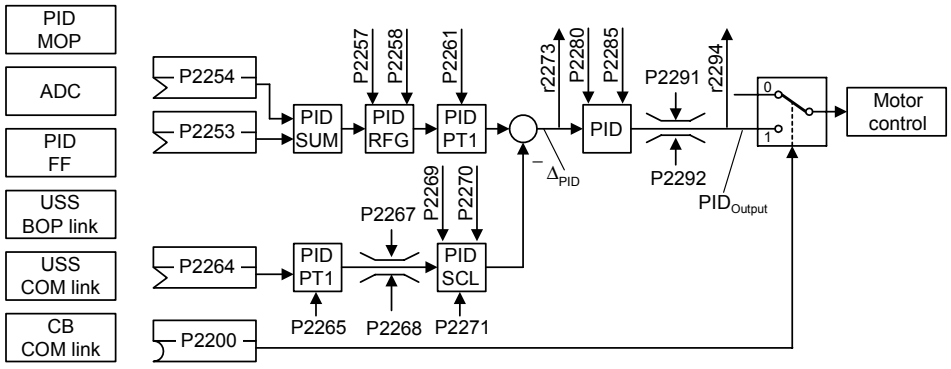
Ramp-up time for PID setpoint — 1.00 s
Sets the ramp-up time for the PID setpoint.

Ramp-down time for PID setpoint — 1.00 s
Sets ramp-down time for PID setpoint.

CI: PID feedback — 755.0
Selects the source of the PID feedback signal.

P2267 =...
P2268 =...
P2280 =...
P2285 =...
P2291 =...
P2292 =...

Max. value for PID feedback Sets the upper limit for the value of the feedback signal in [%]..	100.00 %
Min. value for PID feedback Sets lower limit for value of feedback signal in [%]..	0.00 %
PID proportional gain Allows user to set proportional gain for PID controller.	3.000
PID integral time Sets integral time constant for PID controller.	0.000 s
PID output upper limit Sets upper limit for PID controller output in [%].	100.00 %
PID output lower limit Sets lower limit for the PID controller output in [%].	0.00 %



Example:

Parameter	Parameter text	Example	
P2200	BI: Enable PID controller	P2200 = 1.0	PID controller active
P2253	CI: PID setpoint	P2253 = 2224	PID-FF1
P2264	CI: PID feedback	P2264 = 755	ADC
P2267	Max. PID feedback	P2267	Adapt to the application
P2268	Min. PID feedback	P2268	Adapt to the application
P2280	PID proportional gain	P2280	Determined by optimizing
P2285	PID integral time	P2285	Determined by optimizing
P2291	PID output upper limit	P2291	Adapt to the application
P2292	PID output lower limit	P2292	Adapt to the application

NOTE

If P0971 is used to start data save from the RAM to EEPROM, then after the data has been transferred, the communications memory is re-initialized. This means that communications via USS as well as also via the CB board are interrupted for the time it takes to reset:

- The connected PLC (e.g. SIMATIC S7) goes into stop
- The STARTER start-up program buffers the communications failure
- For the DriveMonitor start-up program, "NC" (not connected) or "drive busy" is displayed.
- The "busy" text is displayed at the BOP operator panel

After reset has been completed, for the start-up programs STARTER and DriveMonitor and the BOP operator panel, communications are automatically re-established.

3.5.6 Series commissioning

The parameter set can be read-out (upread) from the drive converter via the serial interface and saved on the hard disk / floppy disk or in a non-volatile memory (e.g. EEPROM) using the following

- PC Tools (e.g. STARTER, DriveMonitor) or the
- Operator panel AOP

(please refer to Fig. 3-21).

The interfaces of the drive inverter with USS protocol and the fieldbus interfaces (e.g. PROFIBUS) which can be used to transfer parameters, can be used as serial interface.

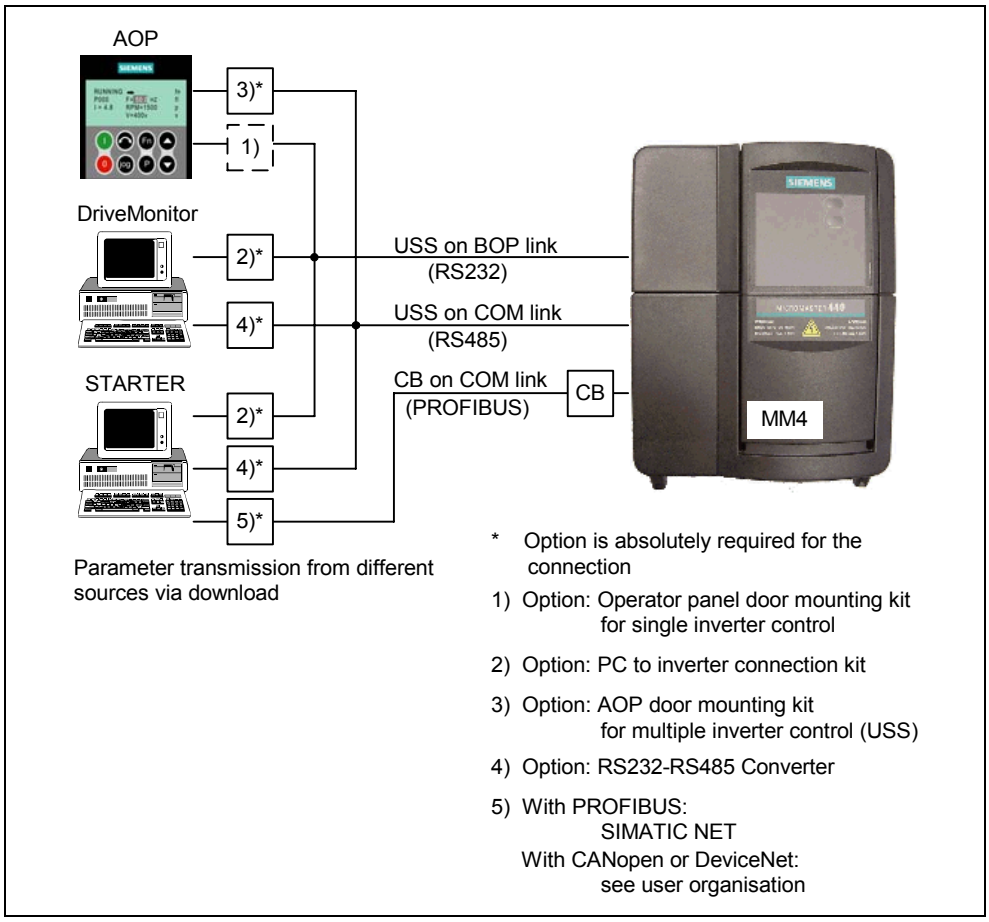


Fig. 3-21 Upread / download using AOP and PC Tools

If there is already an appropriate parameter set for the drive, which, for example, was created by either upreading or by programming offline, then this can be downloaded into the drive inverter. This means that it is possible to transfer the parameter set from drive inverter A to drive inverter B which, for identical applications (e.g. series machines, group drives) allows data to be copied and therefore in turn fast commissioning.



WARNING

- For series commissioning, all of the communication interfaces as well as also the digital and analog interfaces are re-initialized. This results in a brief communications failure or causes the digital output to switch.
- Potentially hazardous loads must be carefully secured before starting a series commissioning.
- Potentially hazardous loads can be secured as follows before starting series commissioning:
  - Lower the load to the floor, or
  - Clamp the load using the motor holding brake
    (Caution: During series commissioning, MICROMASTER must be prevented from controlling the motor holding brake).
- If the motor holding brake (refer to Section 3.13) is controlled by the MICROMASTER, then series commissioning may not be carried-out for potentially hazardous loads (e.g. suspended loads for crane applications).

3.5.7 Parameter reset to the factory setting

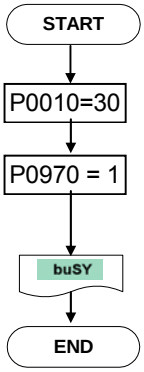
The factory setting is a defined initial state of all of the drive inverter parameters. The drive inverters are shipped from the factory in this state. The drive inverters have the following default settings:

- Control via the digital inputs
  a) ON/OFF via DIN1
  b) Direction of rotation reversal via DIN2
  c) Fault acknowledgement via DIN3
- Setpoint input via analog input
- Signal output via the digital output
  a) Fault active via DOUT 1
- Actual frequency via the analog output
- The basic V/f characteristic is the control mode (P1300 = 0)
- Induction motor (P0300 = 1)

When appropriately connected-up and with the appropriate motor – drive inverter combination, MICROMASTER drive inverters are ready to run when shipped from the factory without requiring any additional parameterization.

You can re-establish the initial state at any time by carrying-out a parameter reset to the factory setting. This undoes all of the parameter changes which were made since the drive inverter was supplied. This value is designated as "Def" in the parameter list.

Reset to the factory setting



Commissioning parameter 30 Factory setting	0
Factory reset 0 disabled 1 Parameter reset	0

The drive inverter carries-out a parameter reset (duration, approx. 10 s) and then automatically exits the reset menu and sets:

P0970 = 0 : disabled
P0010 = 0 : ready

NOTE

When resetting the parameters to the factory setting, the communications memory is re-initialized. This means that communications via USS as well as also via the CB board are interrupted for the time it takes to make the reset:

- The connected PLC (e.g. SIMATIC S7) goes into stop
- The STARTER start-up program buffers the communications failure
- For the DriveMonitor start-up program, "NC" (not connected) or "drive busy" is displayed.
- The "busy" text is displayed at the BOP operator panel

After reset has been completed, for the start-up programs STARTER and DriveMonitor or the BOP operator panel, communications are automatically re-established.

3.6 Inputs / outputs

3.6.1 Digital inputs (DIN)

Number: 3 + 1
Parameter range: r0722 – P0725
Function chart number: FP2000, FP2200
Features:
- cycle time: 2 ms
- switch-on threshold: 10.6 V
- switch-out threshold: 10.6 V
- electrical features: electrically isolated, short-circuit proof

External control signals are required for a drive converter to be able to operate autonomously. These signals can be entered via a serial interface as well as also via digital inputs (refer to Fig. 3-22). MICROMASTER has 3 digital inputs which can be expanded to a total of 4 by using the 2 analog inputs. The digital inputs, as far as their assignment, can be freely programmed to create a function. Whereby, regarding the program, it is possible to directly assign the function via parameters P0701 - P0704 or to freely program the function using BICO technology.

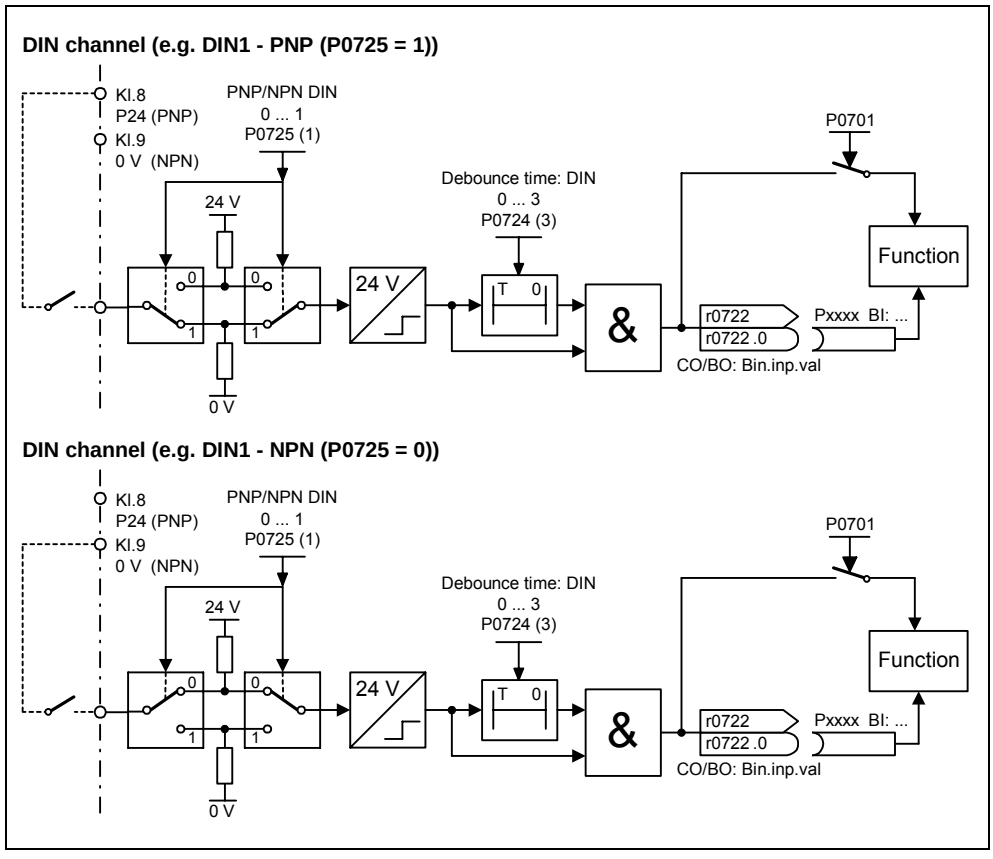


Fig. 3-22 Digital inputs

Parameter P0725 is used to define as to whether digital inputs DIN1 – DIN3 are logical "1" when appropriately connected to 0 V or 24 V. The logical states of the digital inputs can be de-bounced using P0724 and read-out using parameter r0722 (BICO monitoring parameter). Further, this parameter is used to parameterize BICO for the digital inputs (refer to BICO parameterization in the following Section).

P0701 – P0703 (digital inputs 1–3) or P0707 – P0703 (analog input)

The possible settings of the individual inputs are listed in Table 3-10.

Table 3-10 Parameters P0701 – P0706

Parameter value	Significance
0	Digital input disabled
1	ON / OFF1
2	ON+reverse / OFF1
3	OFF2 – coast to standstill
4	OFF3 – quick ramp-down
9	Fault acknowledge
10	JOG right
11	JOG left
12	Reverse
13	MOP up (increase frequency)
14	MOP down (decrease frequency)
15	Fixed setpoint (direct selection)
16	Fixed setpoint (direct selection + ON)
17	Fixed setpoint (binary-coded selection + ON)
25	Enable DC braking
29	External trip
33	Disable additional frequency setpoint
99	Enable BICO parameterization

Example:

An ON/OFF1 command should be realized using digital input DIN1.

P0700 = 2 Control enabled via terminal strip (digital inputs)

P0701 = 1 ON/OFF1 via digital input 1 (DIN1)

BICO parameterization

If the setting 99 (BICO) is entered into parameters P0701 – P0704, then the BICO wiring is enabled for the appropriate digital input. The output parameter number of the function (parameter, included in the parameter text BO) should be entered into the command source (parameter which contains the code BI in the parameter text).

Example:

An ON/OFF1 command should be realized using digital input DIN1.

P0700 = 2	Control enabled via digital inputs
P0701 = 99	BICO enabled for DIN1
P0840 = 722.0	ON/OFF1 via DIN1

NOTE

Only experienced users should use the BICO parameterization and for applications where the possibilities provided by P0701 – P0704 are no longer adequate.

3.6.2 Digital output (DOUT)

Number: 1
Parameter range: r0730 – P0748
Function chart number: FP2100
Features:
- cycle time: 1 ms

Binary states in the drive can be output via the digital output. As result of the fast cycle time, it is possible to control external devices and to display the state in real time. In order that higher powers can also be output, the internal signal (TTL level) is amplified using a relay (refer to Fig. 3-23).

Relay:
- max. opening / closing time: 5 / 10 ms
- voltage / current 30 V DC / 5 A
  250 V AC / 2 A

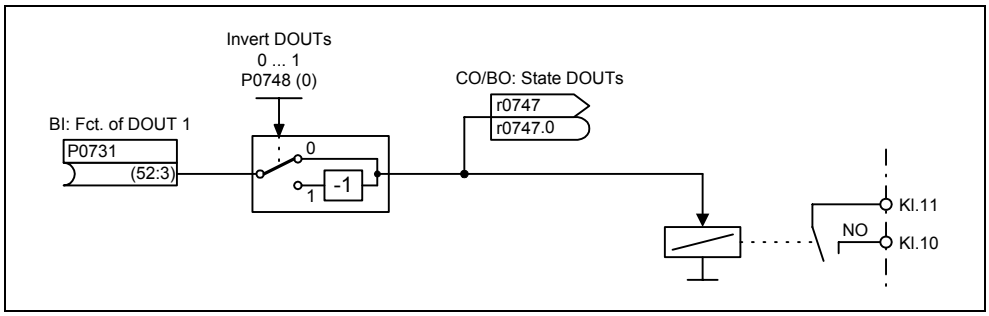


Fig. 3-23 Digital output

The states, which are to be output, are defined using the "BI" parameter P0731 (digital output). For the definition, the "BO" parameter number or "CO/BO" parameter number and the bit number of the particular state should be entered into P0731. Frequently used states including the parameter number and bit are shown in the following Table (refer to Table 3-11).

Table 3-11 Parameter P0731 (frequently used functions / states)

Parameter value	Significance
52.0	Drive ready
52.1	Drive ready to run
52.2	Drive running
52.3	Drive fault active
52.4	OFF2 active
52.5	OFF3 active
52.6	Switch-on inhibit active
52.7	Drive warning active
52.8	Deviation, setpoint / actual value
52.9	PZD control (Process Data Control)
52.A	Maximum frequency reached
52.B	Warning: Motor current limit
52.C	Motor holding brake (MHB) active
52.D	Motor overload
52.E	Motor running direction right
52.F	Inverter overload
53.0	DC brake active
53.1	Act. frequency f_act >= P2167 (f_off)
53.2	Act. frequency f_act > P1080 (f_min)
53.3	Act. current r0027 >= P2170
53.6	Act. frequency f_act >= setpoint

NOTE

A complete list of all of the binary status parameters (refer to "CO/BO" parameters) can be taken from the parameter list.

3.6.3 Analog input (ADC)

Number: 1
Parameter range: P0750 – P0762
Function chart number: FP2200
Features:
- cycle time: 4 ms
- resolution: 10 bits
- accuracy: 1 % referred to 10 V / 20 mA
- electrical features: incorrect polarity protection, short-circuit proof

Analog setpoints, actual values and control signals are read-into the drive inverter using the appropriate analog input and are converted into digital signals / values using the ADC converter.

The analog input represents a voltage input that can be additionally configured via parameter P0756.

Depending on the source, the appropriate connection must be made. Using, as an example, the internal 10 V voltage source, a connection is shown as an example in the following diagram (refer to Fig. 3-24).

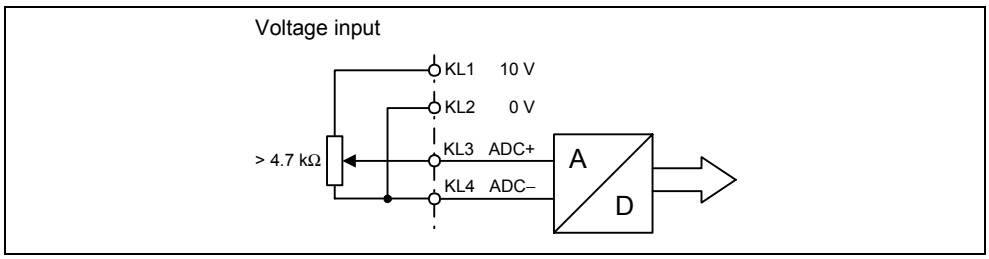


Fig. 3-24 Connection example for ADC voltage input

The ADC channel has several function units (filter, scaling, dead zone) (refer to Fig. 3-25).

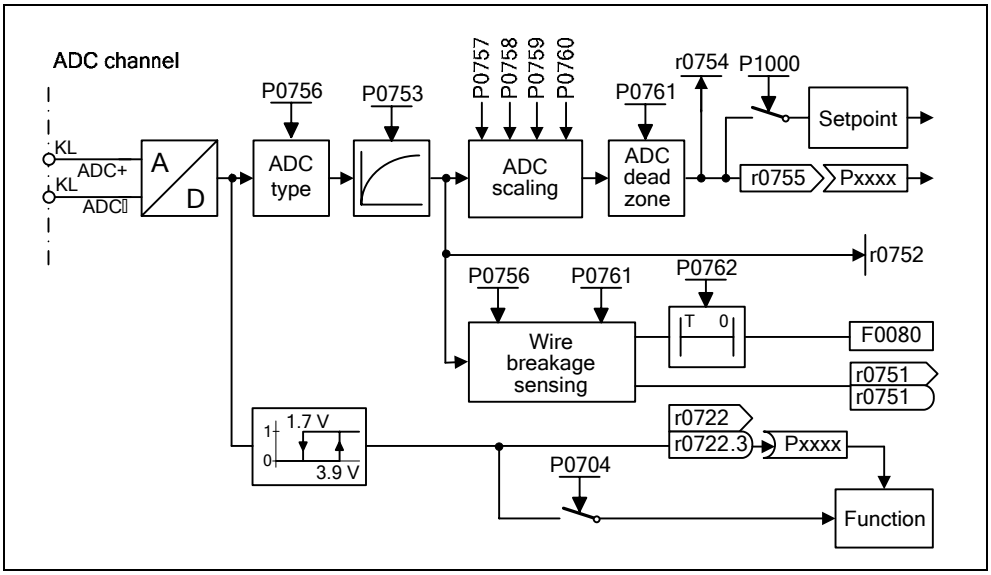


Fig. 3-25 ADC channel

NOTE

When the filter time constant P0753 (ADC-PT1) is increased, this smoothes the ADC input signal therefore reducing the ripple. When this function is used within a control loop, this smoothing has a negative impact on the control behavior and immunity to noise (the dynamic performance deteriorates).

Wire breakage monitoring

The wire breakage monitoring (refer to Fig. 3-25) is set using parameters P0756 and P0761. If the input signal of the analog input falls below the wire breakage threshold (0.5 * P0761), then after the time in P0762 expires, fault F0080 is output and the status bit is set in parameter r0751.

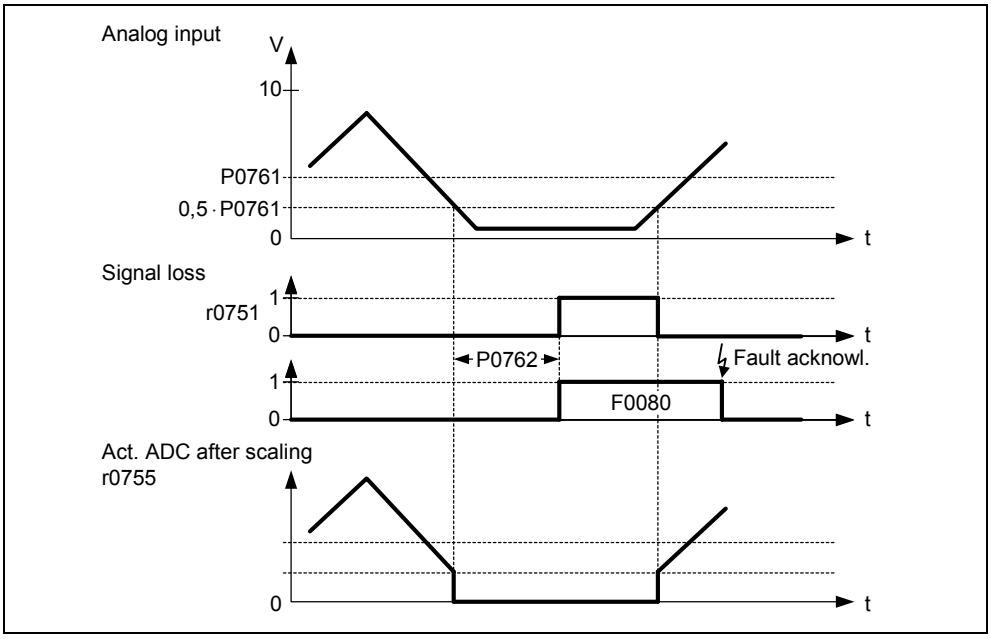


Fig. 3-26 Wire breakage monitoring

The following secondary conditions/limitations apply to the wire breakage monitoring:

- The monitoring function must be activated using parameter P0756
- Width of the ADC dead zone P0761 > 0
- Wire breakage monitoring if the ADC input quantity ≤ 0.5 * P0761

Note

- The wire-breakage monitoring function is only possible for unipolar analog inputs.
- Input range 0 to 0.5 * P0761 of the analog input must be excluded when activating the wire breakage monitoring for normal operation.

3.6.4 Analog output (DAC)

Number: 1
Parameter range: r0770 – P0785
Function chart number: FP2300
Features:
- cycle time: 4 ms
- resolution: 10 bit
- accuracy: 1 % referred to 20 mA

Setpoints, actual values and control signals inside the drive inverter are read-out via the D/A converter using these analog input. The digital signal is converted into an analog signal. All of the signals can be output via the D/A which contain the "CO" abbreviation in the parameter text (refer to list of all of the BICO parameters in the parameter list). Parameter P0771 defines, by assigning the parameter number, the quantity which is output as analog signal through the DAC channel (refer to Fig. 3-27). The smoothed output frequency is output, e.g. via the analog output, if P0771 = 21.

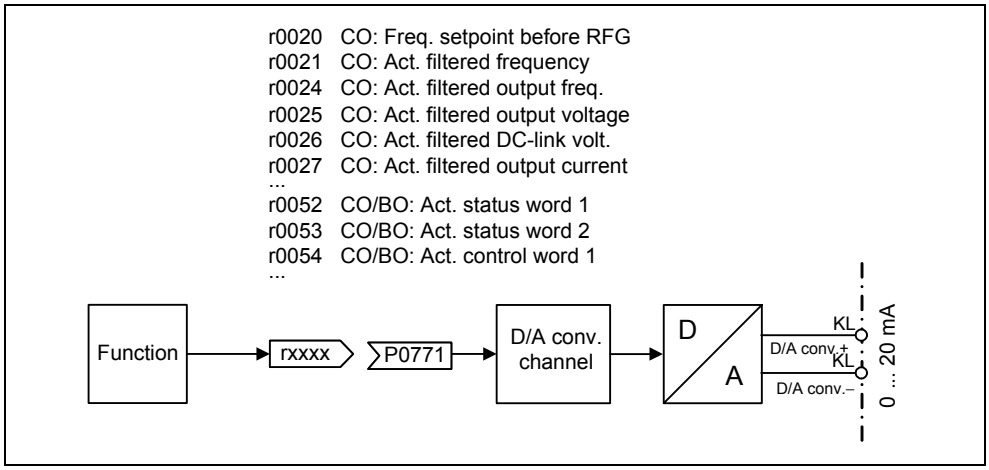


Fig. 3-27 Signal output through the DAC channel

In order to adapt the signal, the DAC channel has several function units (filter, scaling, dead zone) which can be used to modify the digital signal before conversion (refer to Fig. 3-28).

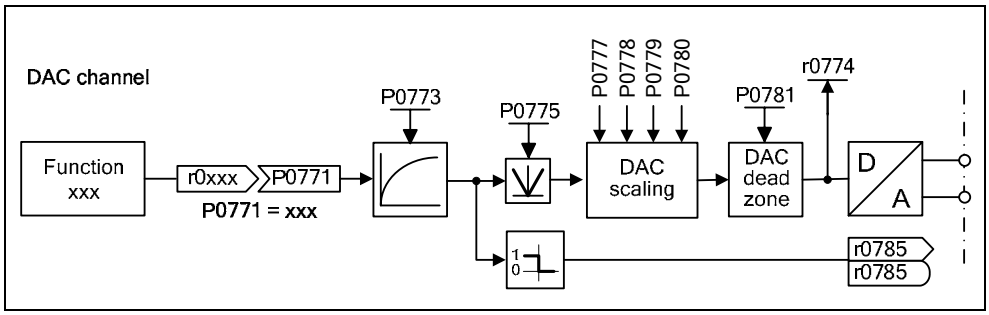


Fig. 3-28 DAC channel

NOTE

The analog output only provides the current output (0 ... 20 mA). A 0 ... 10 V voltage signal can be generated by connecting a 500 Ohm resistor across the output.

With parameter P0775 = 1, negative values can be avoided on the input side of the DAC channel. If this parameter is activated, the absolute value is always entered in the input of the DAC scaling (the DAC characteristic is mirrored on the Y axis).
If the value was originally a negative one, the corresponding bit in r0785 is set for detection.

3.7 Communications

Parameter range: P2009 – r2091

Function chart number:

CB at COM link	FP2700, FP2710
USS at COM link	FP2600, FP2610
USS at BOP link	FP2500, FP2510

MICROMASTER 420 has 2 serial communication interfaces which can be simultaneously used. These interfaces are designated as follows in the following text:

- BOP link
- COM link

Different units, such as the BOP and AOP operator panels, PCs with the start-up software DriveMonitor and STARTER, interface modules for PROFIBUS DP, DeviceNet and CAN as well as programmable controls with communication processors can be connected at this interface (refer to Fig. 3-21).

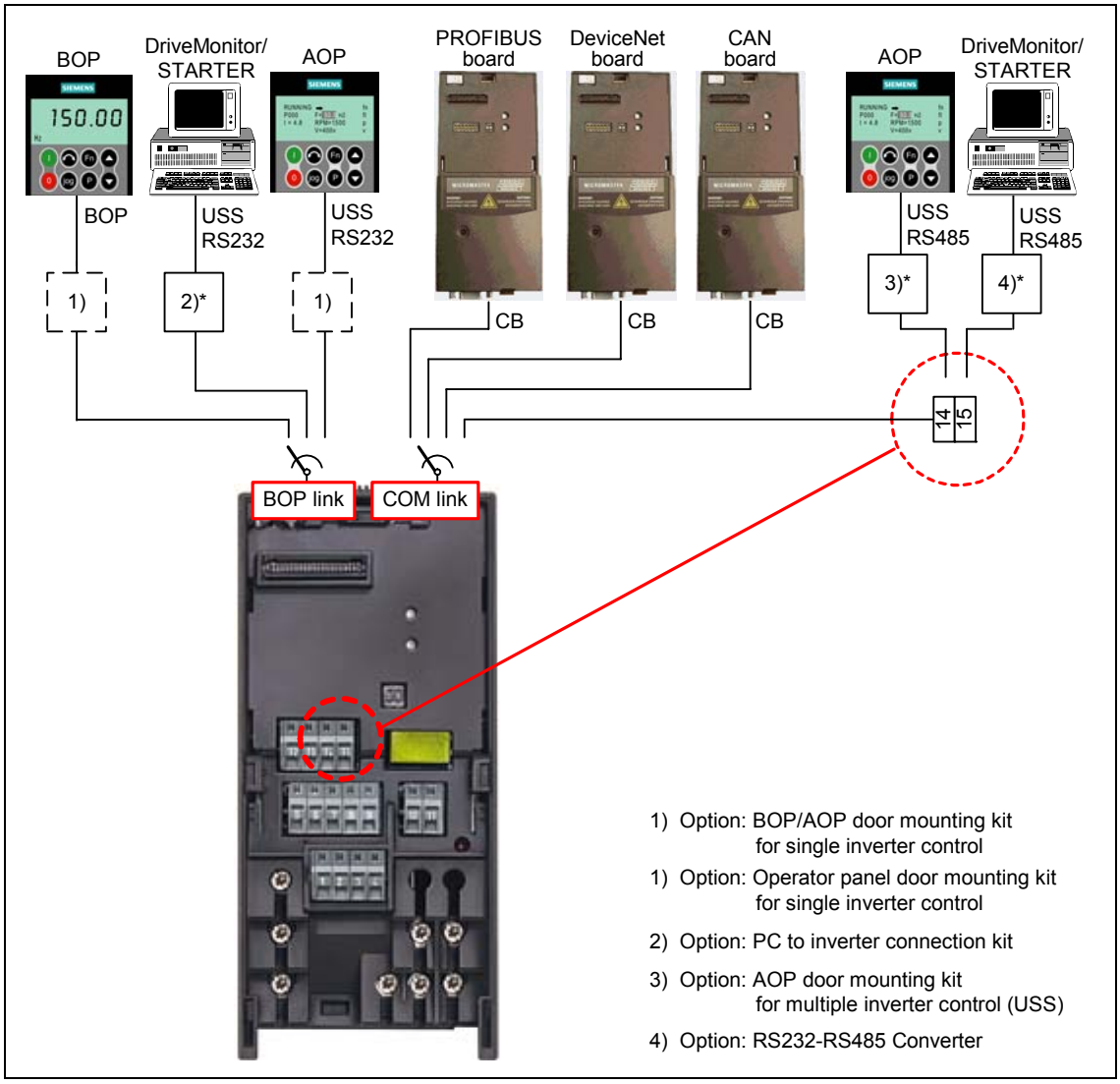


Fig. 3-29 Serial communication interfaces - BOP link and COM link

The BOP, a programming / operator unit (e.g. AOP, PC with DriveMonitor / STARTER) or a programmable control with communications processor can be connected via this BOP link. Data transfer between MICROMASTER and the programming / operator units is realized using the USS protocol via the RS232 interface (point-to-point data coupling). Communications between the BOP and MICROMASTER uses an optimized interface which takes into consideration the somewhat limited resources of the BOP. If the BOP is replaced by an USS unit (PC, AOP), then MICROMASTER automatically identifies the interface of the new unit. This is also true for the inverse replacement sequence. The BOP link interface can be adapted to the particular unit using the following parameters (refer to Table 3-12).

Table 3-12 BOP link

BOP link – interface		
BOP on BOP link	**USS on BOP link**	
No parameter	P2009[1] P2010[1] P2011[1] P2012[1] P2013[1] P2014[1] r2015 P2016	r2024[1] r2025[1] r2026[1] r2027[1] r2028[1] r2029[1] r2030[1] r2031[1] r2032 r2033

Communication modules (CB) such as PROFIBUS, DeviceNet, CANopen and also programming / operator units (e.g. PCs with the DriveMonitor / STARTER start-up software and AOP) as well as programmable controls with communication processor can be connected to the COM link. The plug connector allows the communication modules to be connected to MICROMASTER. On the other hand, the programming / operator units must be connected to the MICROMASTER through terminals 14/15. As for the BOP link, data is transferred between MICROMASTER and the programming / operator unit using the USS protocol. In so doing, for the COM link, the USS protocol is transferred via the bus-capable RS485 interface. Essentially the same as the BOP link, the COM link also automatically defines if a communications module is replaced with a USS unit (PC, AOP). The COM link can be adapted to the particular unit using the following parameters (refer to Table 3-13).

Table 3-13 COM link

COM link – interface			
CB on COM link		**USS on COM link**	
P2040 P2041 r2050 P2051	r2053 r2054 r2090 r2091	P2009[0] P2010[0] P2011[0] P2012[0] P2013[0] P2014[0] r2018 P2019	r2024[0] r2025[0] r2026[0] r2027[0] r2028[0] r2029[0] r2030[0] r2031[0] r2036 r2037

NOTE

- A communications (CB) module as well as a programming / operator unit can be simultaneously connected to the COM link interface via terminals 14/15 (USS). This is the reason that the communications module has priority over USS. In this case, the USS node (USS station) via the COM link is de-activated.
- Contrary to PROFIBUS, the RS485 port (terminals 14/15) is not optically isolated (not floating). When installing the system, it must be ensured that EMC faults do not result in communication failures or damage to the RS485 drivers.

3.7.1 Universal serial interface (USS)

Parameter range: P2009 – r2037

Significance	COM link	BOP link
USS basic setting		
USS baud rate	P2010[0]	P2010[1]
USS address	P2011[0]	P2011[1]
USS-PZD length	P2012[0]	P2012[1]
USS-PKW length	P2013[0]	P2013[1]
PZD data		
Received data	r2018[8]	r2015[8]
Received control word 1	r2036	r2032
Received control word 2	r2037	r2033
Sent data	P2019[8]	P2016[8]
Sent status word 1	r0052	r0052
Sent status word 2	r0053	r0053

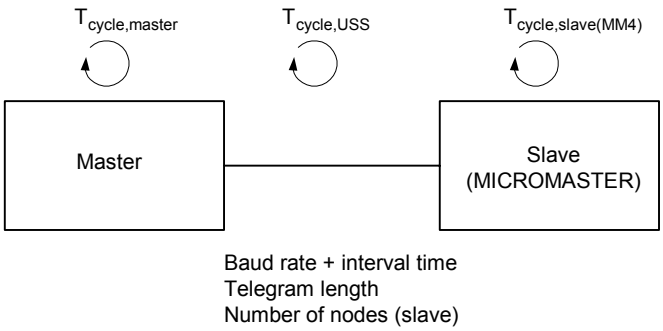
Alarms: ---

Faults: F0071, F0072

Function chart number: FP2500, FP2510, FP2600, FP2610

Features:

- electrical features: Not electrically isolated — USS at the BOP link with PC-converter connecting set
  Not electrically isolated — USS at COM link (terminals 14 / 15)
- cycle time (MM420): 8 ms (process data PZD)
  Background (parameter ID value PKW)



NOTE

From the user's perspective, the total cycle time between the master and slave is of significance. As shown in the diagram above, this time depends on several factors.

Fig. 3-30 Cycle times

Using the USS protocol, a user can establish a serial point-to-point data link and a serial bus data link between a higher-level master system and several slave systems. Master systems can be, for example, PLCs (e.g. SIMATIC S7-200) or PCs. MICROMASTER drive converters are always the slaves on the bus system.

The USS protocol allows the user to implement both automation tasks with cyclical telegram traffic (→ a fixed telegram length is necessary) as well as visualization tasks. In this case, the protocol with variable telegram length is advantageous, as texts and parameter descriptions can be transferred in one telegram without chopping up the information.

3.7.1.1 Protocol specification and bus structure

The USS protocol has the following significant features:

- Supports
  - a multi-point-capable link, e.g. EIA RS 485 hardware or
  - a point-to-point link, e.g. EIA RS 232
- Master-slave access technique
- Single-master system
- Maximum 32 nodes (max. 31 slaves)
- Operation with variable or fixed telegram length
- Simple, reliable telegram frames
- The same bus mode of operation as with the PROFIBUS (DIN 19245 Part 1)
- Data interface to the basic unit according to PROFILE variable-speed drives. This means that, when the USS is being used, information is transferred to the drive in the same way as with the PROFIBUS-DP.
- Can be used for start-up, service and automation
- PC-based service tools (e.g. STARTER and DriveMonitor)
- Can be easily implemented in customized systems

Protocol specification

The USS protocol defines an access technique according to the master-slave principle for communications via a serial bus. The point-to-point link is included as a sub-quantity.

One master and a maximum of 31 slaves can be connected to the bus. The individual slaves are selected by the master using an address character in the telegram. A slave can never transmit without first being initiated by the master so that direct information transfer between individual slaves is not possible. The master function cannot be transferred (single-master system). The following illustration shows a bus configuration using drive technology as an example.

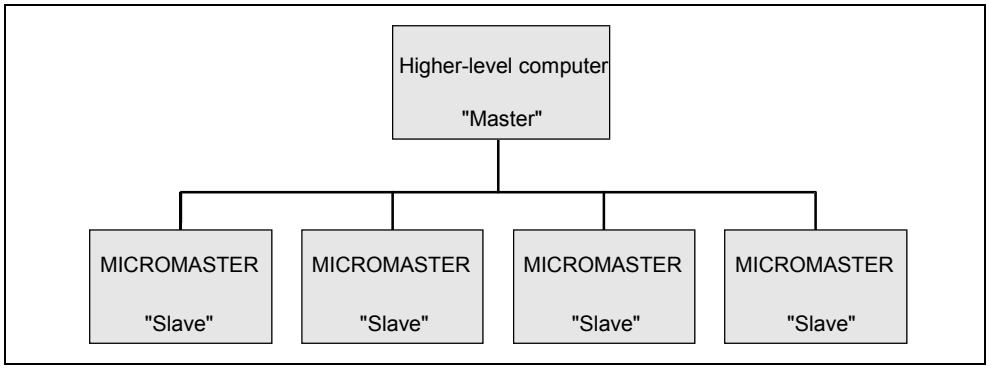


Fig. 3-31 Serial linking of MICROMASTER (slaves) with a higher-level computer (master)

The telegram has the following structure:

- Each telegram begins with the start character STX (= 02 hex), followed by the length information (LGE) and the address byte (ADR). The net characters then follow. The telegram is terminated by the BCC (Block Check Character).
- For single-word data (16 bit) in the net data block (= net character block), the high byte (first character) is always sent and then the low byte (second character).
- The same applies to double-word data: the high word is sent first followed by the low word.
- The necessary settings / parameter assignments must be made both at the master as well as at the slave and can no longer be changed in bus operation.
- The protocol does not identify tasks in the net characters. The contents of the net characters/data for the MICROMASTER drives is discussed in Section 3.7.1.2 "Structure of the net data".

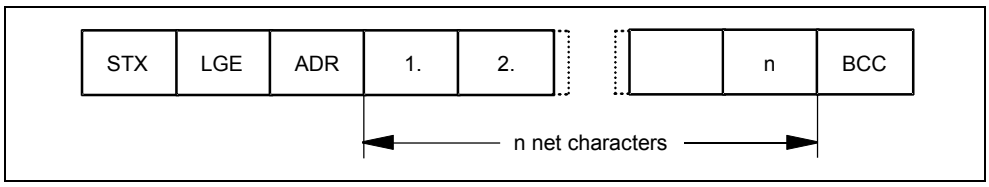


Fig. 3-32 Telegram structure

Information is coded as follows:

Abbreviation	Significance	Size	Explanation
STX	Start of text	ASCII characters	02 hex
LGE	Telegram length	1 byte	Contains the telegram length
ADR	Address	1 byte	Contains the slave address and the telegram type (binary coded)
---	Net characters	Each one byte	Net data, contents are dependent on the request
BCC	Block check character	1 byte	Data security characters

In the address byte, information other than the node number is coded:
The individual bits in the address byte are assigned as follows:

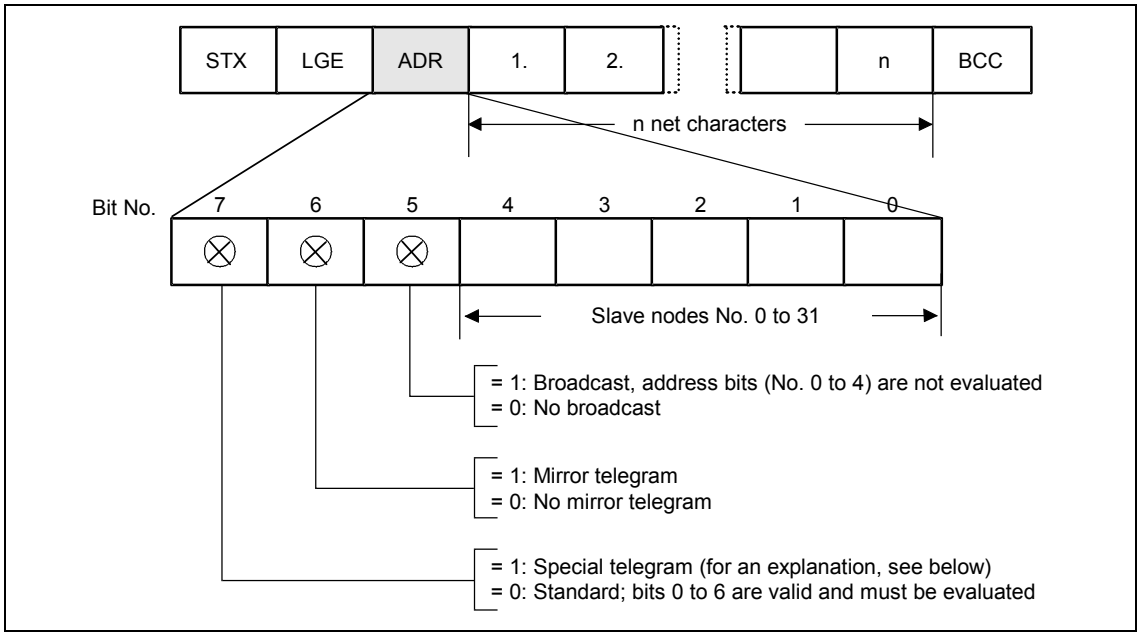


Fig. 3-33 Assignment of the address byte (ADR)

The master ensures cyclical telegram data transfer. The master addresses all of the slave nodes one after the other with a task telegram. The addressed nodes respond with a reply telegram. In accordance with the master-slave procedure, the slave, after receiving the task telegram, must send the reply telegram to the master before the master can address the next slave node.

The sequence of the addressed slave nodes can be specified, for example, by entering the node numbers (ADR) in a circulating list (polling list) in the master. If it is necessary to address several slaves in a faster cycle than the other slaves, their node number can occur several times in the circulating list. A point-to-point link can be implemented by means of the circulating list, in which case only one node is entered into the circulating list.

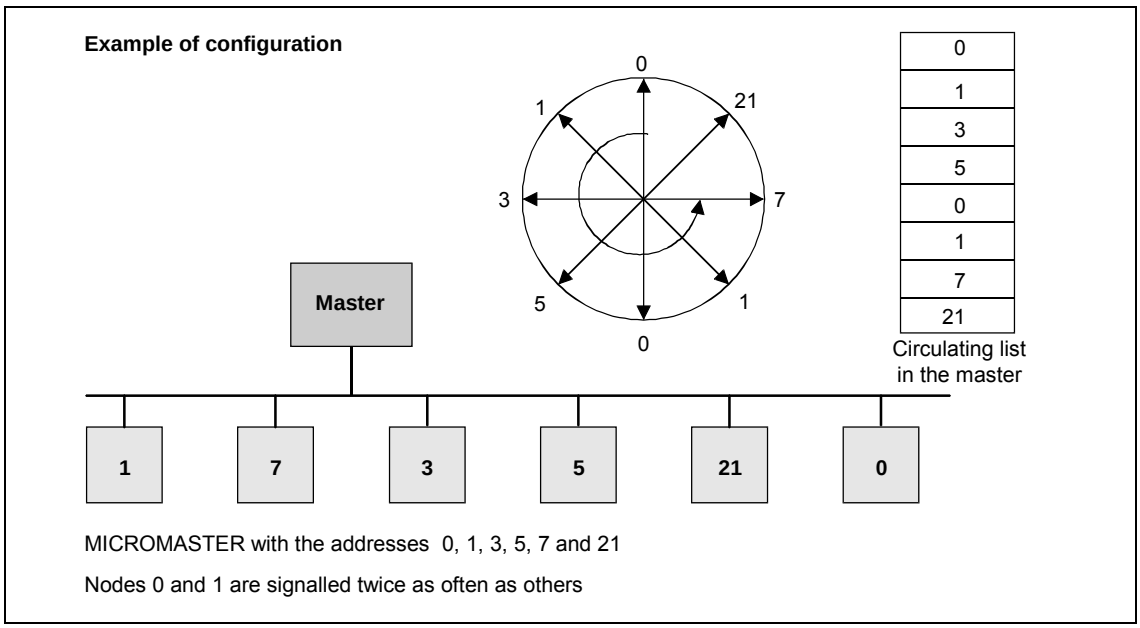


Fig. 3-34 Circulating list (Example of configuration)

The length of a cycle time is determined by the time needed for the sequential occurrence of data exchange with the individual nodes.

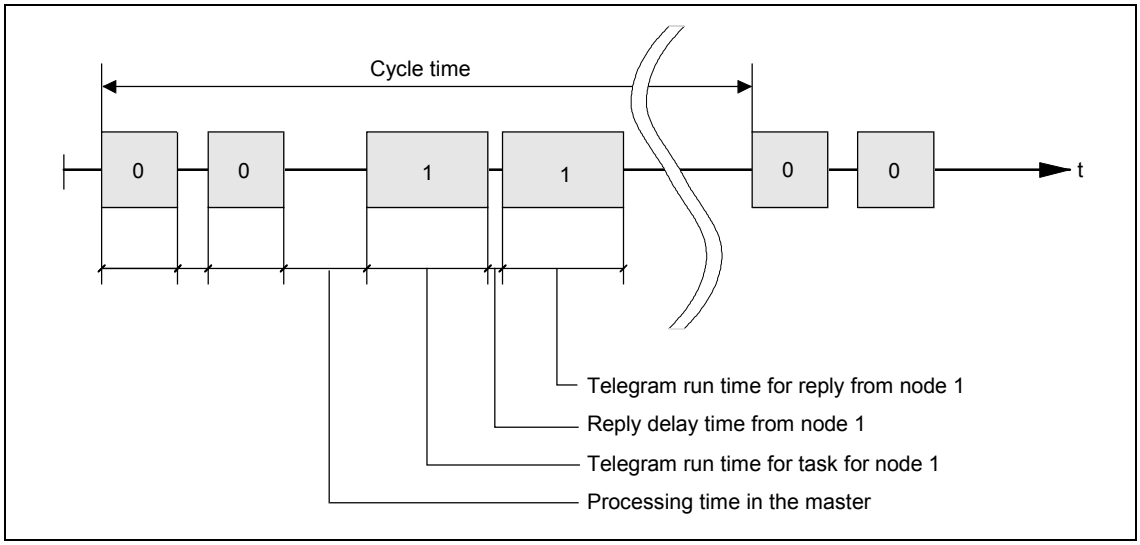


Fig. 3-35 Cycle time

Due to inconstant reply delay and processing times, the cycle time is not fixed.

The STX start character (= 02 hexadecimal) by itself is not sufficient for the slaves to clearly identify the start of a telegram because the bit combination 02/hexadecimal can also occur in the net characters. For this reason, a no-character start interval of at least 2 character run-times before the STX is specified for the master. The start interval is part of the task telegram.

Table 3-14 Minimum start intervals for various baud rates

Baud rate in bit/s	Start interval in ms
2400	9,20 ms
4800	4,60 ms
9600	2,30 ms
19200	1,15 ms
38400	0,57 ms
57600	0,38 ms
76800	0,29 ms
93750	0,24 ms
115200	0,19 ms

Only an STX with a preceding start interval identifies the valid start of a telegram. Data is always transferred in accordance with the diagram illustrated below (half-duplex mode):

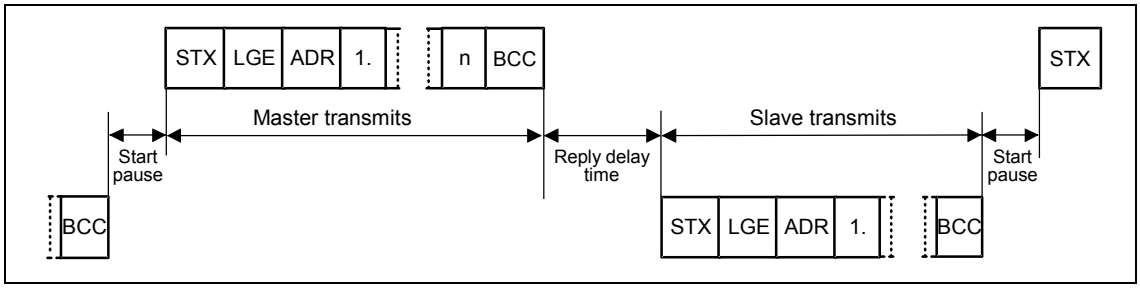


Fig. 3-36 Transmit sequence

The time interval between the last character of the task telegram (BCC) and the start of the reply telegram (STX) is known as the **reply delay time**. The maximum permissible reply delay time is **20 ms, but it must not be less than the start interval**. If node x does not respond within the maximum permissible reply delay time, an error message is deposited in the master.

The master than sends the telegram for the next slave node.

Bus structure

The data transfer medium and the physical bus interface are essentially determined by what the bus system is used for. The physical interface of the USS protocol is based on the "Recommended Standard RS-485". For point-to-point links, a sub-quantity of EIA RS-232 (CCITT V.24) or TTY (20 mA current loop) can be used as the physical interface.

The USS bus is based on a linear topology without branches. Both ends of the line terminate at a node. The maximum cable length (50 m) and therefore the maximum distance between the master and the last slave is limited by the characteristics of the cable, the ambient conditions and the data transfer rate [EIA Standard RS-422-A Dezember 1978, Appendix, Page 14]

The number of nodes is limited to a maximum of 33 (1 master, 32 slaves).

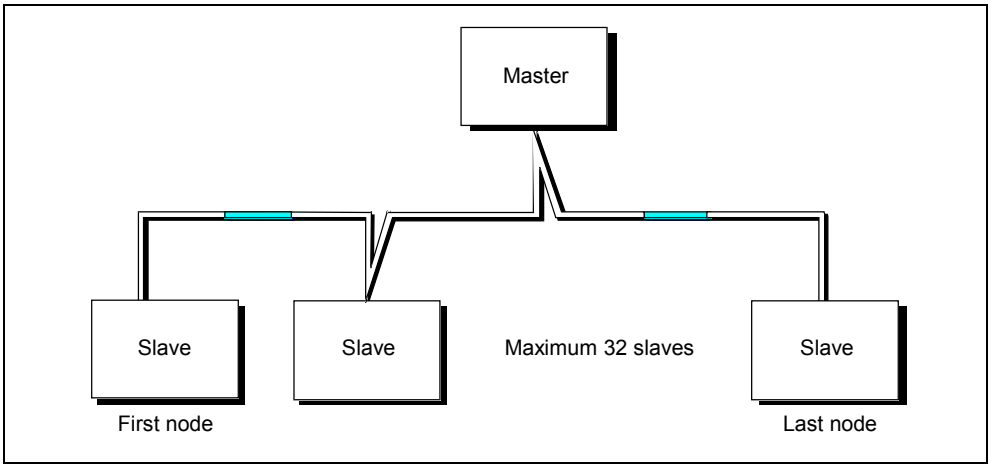


Fig. 3-37 USS bus topology

The two ends of a bus line (first node and last node) must be terminated with bus terminating networks. (refer to Section 3.7.1.3). Point-to-point connections are handled just like bus connections. One node has the master function and the other has the slave function.

Data is transferred in accordance with Standard EIA 485. RS 232 can be used for point-to-point links. Data transfer is always half-duplex – i.e. alternating between transmitting and receiving – and it must be controlled by the software. The half-duplex technique allows the same cables to be used for both data-transfer directions. This permits simple and inexpensive bus cabling, operation in environments subject to interference and a high data transfer rate.

A shielded, twisted two-wire cable is used as the bus cable.

Table 3-15 Structural data

Conductor diameter	2 x ≈ 0,5 mm^2
Conductor	≥ 16 x ≤ 0,2 mm
Lay ratio	≥ 20 twists / m
Overall shield	Braided, tin-plated copper wire, diameter ∅ ≥ 1,1 mm^2 85 % optical coverage
Overall diameter -∅	5 mm
External sheath	Depending on the requirements regarding flame retardation, deposits after burning etc.

NOTE

- All information should only be considered as a recommendation.
- Deviations or different measures may be required depending on the particular requirements, the specific application and the conditions on site.

Table 3-16 Thermal and electrical characteristics

Cable resistance (20°C)	≤ 40 Ω/km
Insulation resistance (20°C)	≥ 200 MΩ/km
Operating voltage (20°C)	≥ 300 V
Test voltage (20°C)	≥ 1500 V
Temperature range	-40 °C ≤ T ≥ 80 °C
Load capability	≥ 5 A
Capacitance	≤ 120 pF/m

Mechanical characteristics

- Single bending: ≤ 5 x outer diameter
- Repeated bending: ≤ 20 x outer diameter

Recommendations

- Standard cable, without any special requirements:
  Two-core, flexible, shielded conductor in accordance with VDE 0812, with colored PVC sheath. PVC insulation resistant to oil, resistant to cold and petroleum products.
  Type: LiYCY 2 x 0,5 mm^2
  e.g. Fa. Metrofunk Kabel-Union GmbH, www.metrofunk.de
  Postfach 41 01 09, 12111 Berlin
- Halogen-free cable (no hydrochloric acid is generated when the cable burns):
  Halogen-free, highly flexible, resistant to extreme heat and cold. Sheath manufactured from a special ASS silicon-based composite.
  Type: ASS 1 x 2 x 0,5 mm^2
  e.g. Fa. Metrofunk Kabel-Union GmbH, www.metrofunk.de
  Postfach 41 01 09, 12111 Berlin
- Recommended if halogen-free and silicon-free cables are required:
  Type: BETAflam 145 C-flex. 2x0,5 mm^2
  e.g. Fa. Studer-Kabel-AG, http://www.studer-kabel.ch/
  Herrenmattstrasse 20, CH 4658 Däniken

The total cable length of the USS connection may not exceed 50 m (max. cable length).

The max. data transfer rate depends on the number of connected nodes (devices) as well as on the closed-loop control technique / function selection (processor utilization). Nominal values can be taken from the following table:

Table 3-17 Max. number of nodes (devices) depending on the max. data transfer rate

Max. data transfer rate	Max. number of nodes (devices)	
	V/f control	Closed-loop vector control
9.6 kbit/s	32	32
19.2 kbit/s	32	32
38.4 kbit/s	32	7
93.7 kbit/s	32	-
115.2 kbit/s	32	-

NOTE

If a higher baud rate or higher number of nodes is required, then the CB option boards (e.g. PROFIBUS, CAN) should be used to ensure disturbance-free operation.

3.7.1.2 The structure of net data

Information which, for example, a SIMATIC S7 control unit (= master) sends to a drive (= slave) or the drive sends to the control unit is placed in the net-data area of each telegram.

General structure of the net-data block

The net-data block is divided into two areas:

the PKW (parameter ID value) range

the PZD (process data) range

The structure of the net data in the USS-protocol telegram is shown below.

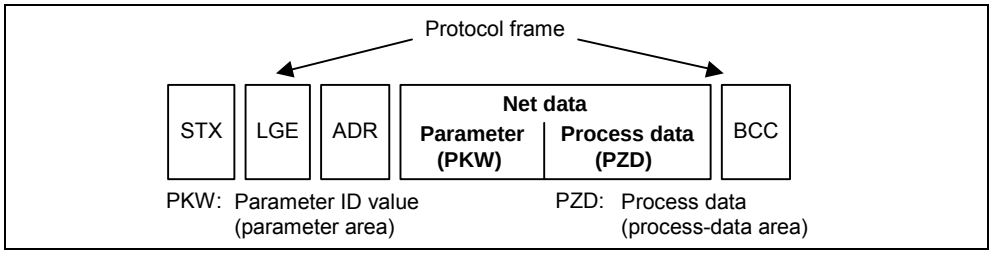


Fig. 3-38 Telegram structure

- The **PKW area** relates to the handling of the parameter ID value (PKW) interface. The PKW interface is not a physical interface but a mechanism which handles parameter transfer between two communication partners (e.g. control unit and drive). This involves, for example, reading and writing parameter values and reading parameter descriptions and associated texts.
  All tasks which are performed via the PKW interface essentially involve operator control and visualization, service and diagnosis.
- The **PZD area** contains the signals required for the **automation** system:
  - Control word(s) and setpoint(s) from the master to the slave
  - Status word(s) and actual value(s) from the slave to the master.

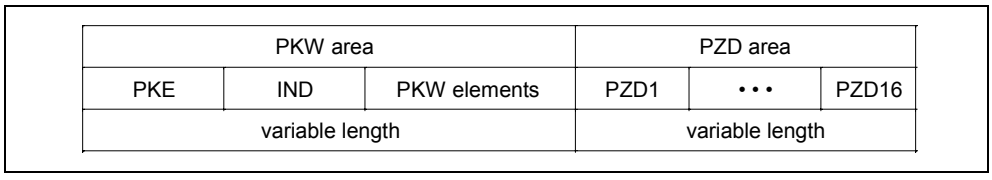


Fig. 3-39 Structure of the PKW and PZD areas

The two areas together make up the net data block. This structure applies to telegrams from the master to the slave and vice versa.

PKW area

With the help of the PKW mechanism, the following tasks can be performed via any serial interface with the USS protocol:

- Reading and writing parameters
- Reading the description of a parameter

The PKW area can be varied. Depending on the requirements, the following lengths can be parameterized using parameter P2013:

- 3 words ➔ P2013 = 3
- 4 words ➔ P2013 = 4
- variable word length ➔ P2013 = 127

The following is an example of a structure when access (write/read) is made to **single-word** (16 bit) parameter values. The PKW area must be permanently set to 3 words at the master and the slave. This setting is made during start-up and should not be altered any more during bus operation.

1st word	2nd word	3rd word
PKE	IND	PWE1
Parameter ID	Index	Parameter value 1

The following is an example of a structure when access (write/read) is made to **double-word** (32 bit) parameter values. Parameterization to a fixed length of 4 words applies to telegrams from the master to the slave and from the slave to the master.

1st word	2nd word	3rd word	4th word
PKE	IND	PWE1	PWE2
Parameter ID	Index	Parameter value (double word)	

Telegram data transfer with variable telegram length (refer to the following example) means that the slave responds to a telegram from the master with a telegram whose length does not have to be the same length as the telegram from the master to the slave.

1st word	2nd word	3rd word	4th word	.....	(m+2). word
PKE	IND	PWE1	PWE2	.....	

With:

- 1 word ≤ m ≤ 118 words (maximum) when 8 PZD words (maximum) are contained in the net data block.
- 1 word ≤ m ≤ 126 words (maximum) when there is no PZD.

The length of elements PEW1 to PWEm in the reply telegram and what is contained in them depends on the task issued by the master. Variable length means that only the number of words necessary to pass on the appropriate information is transferred. The minimum length, however. is always 3 words. If a slave, for example, transfers a parameter value which is a 16-bit quantity (e.g. the status word in parameter r0052; data format: U16), then only 3 words of the PKW area are sent in the telegram from the slave to the master. If, for example, for MICROMASTER the actual frequency is to be read (parameter r0021), then the PKW area in the telegram from the slave to the master is 4 words large; the reason for this is that the speed is represented as 32-bit quantity (data format: Float). It is

mandatory to parameterize for a variable word length, if e.g. all values are to be read at once from an “indexed” parameter (refer to "Index", special setting, index = 255). This setting to variable word-length is made during start-up. (refer to parameter P2013).

Parameter ID (PKE)																1st word
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Bit No.:
AK				SPM	PNU1											

Parameter index (IND)																2nd word
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Bit No.:
PNU2				RES		TXT		Index								

Parameter value (PWE)																
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Bit No.:
Parameter value, **high** (PWE1)																3rd word
Parameter value, **low** (PWE2)																4th word

The following applies:

- AK Task or reply ID
- SPM Toggle bit for processing of parameter-change reports (MICROMASTER does not support this, SPM = 0)
- PNU Parameter number
- RES Reserved
- TXT Read / write from parameter text (MICROMASTER does not support this, TXT = 0)

CAUTION

- Do not use a variable word length if SIMATIC S5 or SIMATIC S7 is the master.
- This setting must be made both at the master as well as at the slave – and cannot be changed while the bus is operational.

NOTE

- The PKW area is transferred in increasing order, always starting with the 1st word.
- Reserved fields or functions that are not supported should be specifically pre-assigned zero in the master implementation.
- The bit 11 (SPM) is the toggle bit for parameter change reports. Parameter change reports when reading/writing parameter texts are not supported by MICROMASTER.

Task or reply ID (AK):

Bits 12 to 15 (AK) contain the task or reply ID. The **task IDs** are sent in the telegram from the master to the slave. The meaning of the IDs is listed in the following table.

Table 3-18 Task IDs (master -> drive converter)

Task ID	Meaning	Reply ID	
		positive	negative
0	No task	0	-
1	Request parameter value	1 or 2	7
2	Change parameter value (word) and save only in RAM	1	7 or 8
3	Change parameter value (double word) and save only in RAM	2	7 or 8
4	Request descriptive element [1]	3	7
5	Changing the descriptive element [1] MICROMASTER does not support this	3	7 or 8
6	Request parameter value (array)[1]	4 or 5	7
7	Change parameter value (array, word)[2] and save only in RAM	4	7 or 8
8	Change parameter value (array, double word)[2] and save only in RAM	5	7 or 8
9	Request the number of array elements	6	7
10	Reserved	-	-
11	Change parameter value (array, double word) and save in RAM and EEPROM[2]	5	7 or 8
12	Change parameter value (array, word) and save in RAM and EEPROM[2]	4	7 or 8
13	Change parameter value (double word) and save in RAM and EEPROM	2	7 or 8
14	Change parameter value (word) and save in RAM and EEPROM	1	7 or 8
15	Read or change text MICROMASTER does not support this	15	7 or 8

[1] The required element of the parameter description is specified in IND (2nd word)

[2] The required element of the indexed parameter is specified in IND (2nd word)

Correspondingly, the **Response IDs** are transferred in the telegram from the slave to the master at this position. Depending on the request ID, only specific response IDs are possible.

Table 3-19 Response ID (converter -> master)

Response ID	Significance	Request ID
0	No response	0
1	Transfer parameter value (word)	1, 2 or 14
2	Transfer parameter value (double word)	1, 3 or 13
3	Transfer descriptive element [1]	4 or 5
4	Transfer parameter value (array, word) [2]	6, 7 or 12
5	Transfer parameter value (array, double word) [2]	6, 8 or 11
6	Transfer the number of array elements	9
7	Request cannot be executed (with fault number)	1 or 15
8	The PKW interface does not have master authority	2, 3, 5, 7, 8, 11-14 or 15
9	Parameter change report (word) MICROMASTER does not support this	-
10	Parameter change report (double word) MICROMASTER does not support this	-
11	Parameter change report (array, word) [2] MICROMASTER does not support this	-
12	Parameter change report (array, double word) [2] MICROMASTER does not support this	-
13	Reserved	-
14	Reserved	-
15	Transfer text MICROMASTER does not support this	15

[1] The required element of the parameter description is specified in IND (2nd word)

[2] The required element of the indexed parameter is specified in IND (2nd word)

If the response ID has the value 7 (request cannot be executed), then a **fault number** is saved in parameter value 2 (PWE2). The fault numbers are documented in the following table.

Table 3-20 Fault numbers for the response ID "Request cannot be executed"

Fault No.	Significance
0	Inadmissible legal parameter number (PNU); if PNU is not available
1	Parameter value cannot be changed; if the parameter is a visualization parameter
2	Lower or upper limit exceeded
3	Erroneous sub-index
4	No array
5	Incorrect type of data
6	Setting not permitted (can only be reset)
7	Descriptive element cannot be changed; not possible
11	No operator control rights
12	Key word missing, device parameter: ‘access keyl’ and/or ‘special parameter access’ not appropriately set
15	No text array available
17	Request cannot be executed due to operating states; The frequency inverter state presently does not allow the request that was issued
101	Parameter number presently de-activated; In the present frequency inverter state, the parameter has no function (e.g. closed-loop control type)
102	Channel width too small: Only for short channels; the parameterized length of the PKW area has been selected too large due to the restrictions in the device. This fault message can only occur for the USS protocol on the technology module T 100 if basic device parameters are accessed from this interface
103	Incorrect PKW number; only for G-SST 1/2 and SCB interface (USS). The fault number is transferred in the following two cases: If the request involves all indices of an indexed parameter (request index equal to 255) or the complete parameter description is requested and a variable telegram length was not parameterized. If, for the request issue, the parameterized number of PKW data in the telegram is too low (e.g.: Changing from a double word and PKW number equal to 3 (words).
104	Parameter value not permissible; This fault number is transferred if the parameter value – that is to be transferred – is not assigned any function in the device or at the time of the change it is not able to be transferred for internal reasons (although it lies within the limits).
105	The parameter is indexed e.g. request: ‘PWE, change word’ for indexed parameters
106	Request not implemented
200	New minimum value
201	New maximum value
203	No BOP/AOP display, Parameter cannot be displayed on the BOP or AOP.
204	The ‘BOP/AOP key word’ does not match the parameter access stage.

Parameter number (PNU)

The complete parameter number (refer to the parameter list) is formed from the "basis parameter number" PNU1 and the "page parameter number" PNU2. The following applies:

PNU = PNU1 + 2000 • PNU2

With PNU2 definition:

PNU2				2^{nd} word
15	14	13	12	Bit No.:
2^0	2^3	2^2	2^1	Weighting

The parameter areas are mapped using PNU1 and PNU2 as follows:

Basis parameter number PNU1 bits 0 – 10 (PKE)	**Page parameter number PNU2 bits 12 – 15 (IND)**	**Parameter number (area)**
0 ... 1999	0	0 ... 1999
0 ... 1999	1	2000 ... 3999
0 ... 1999	2	4000 ... 5999
0 ... 1999	3	6000 ... 7999
0 ... 1999	4	8000 ... 9999
...	...	...
0 ... 1999	15	30000 ... 31999

Index

The index (bit 0 to 7), depending on the task, describes a definite element:

- desired array element in the case of indexed parameters,
- desired element of the parameter description,

Special significance of index value 255

For the following requests, the index value 255 has a special significance:

- "request parameter descriptive element", or.
- for the requests to read/write indexed parameters (= arrays)

Here, the following applies:

Task ID	**Meaning**
4	The complete parameter description is requested
6	All values of the indexed parameters are requested This request can generate fault message 102.
7, 8, 11 or 12	All values of the indexed parameters should be changed. These requests can generate fault message 102.

Parameter value (PWE)

The parameter value (PWE) is transferred, depending on the parameterization of the word length (refer to parameter "USS-PKW length" P2013) of the PKW area as word or double word (32 bit). Only one parameter value can be transferred in a telegram.

If the word length of the PKW area is parameterized with 3 words (P2013 = 3), then only 16-bit parameters can be transferred. Parameter descriptive elements, that are greater than 16 bit cannot be transferred.

If the word length of the PKW area is parameterized to be 4 words (P2013 = 4), then 16 and 32-bit parameters can be transferred. Parameter descriptive elements that exceed 32 bits cannot be transferred.

If the word length of the PKW area is parameterized with "variable length" (P2013 = 127), then 16, 32-bit parameter and parameter descriptive elements can be transferred. Further, all elements of an indexed parameter can be read or changed with a single request, as well as the complete parameter description requested if the index corresponds to the value 255 (index = 255).

Transferring **one** 16-bit parameter value:

1. Fixed PKW area, 3 words:
   The value is in PWE1
2. Fixed PKW area, 4 words:
   The value is in PWE2 (least significant word, 4th word); PWE1 is set to 0.
3. Variable PKW area:
   The value is in PWE1. PWE2 and higher not available!

Transferring **one** 32-bit parameter value:

1. Fixed PKW area, 3 words:
   Request is rejected with fault message 103.
2. Fixed PKW area, 4 words:
   PWE1 (most significant word; 3rd word) contains the high word of the double word,
   PWE2 (least significant word; 4th word) contains the low word of the double word.
3. Variable PKW area:
   As for 2.; PWE3 and higher not available!

Process data area (PZD)

Process data is continually exchanged between the master and slaves in this area. At the start of communications it is configured as to which process data is to be exchanged with a slave. For instance, for slave x, the current setpoint is to be transferred in the second PZD (= PZD2). This setting remains for the complete data transfer.

1 word	1 word	1 word	1 word		1 word
PZD1	PZD2	PZD3	PZD4	.....	PZD8

PZD1 – PZD8 = process data
= control / status word(s) and setpoint / actual value(s));

The control / status word(s), setpoints and actual values required for the automation are transferred in this area.

The length of the PZD area is defined by the number of PZD elements (P2012). Contrary to the PKW area, that can be variable, the length of this area between the

communication partners (master and slave) must always be permanently declared. The maximum number of PZD words per telegram is, for MICROMASTER, limited to 8 words (USS-PZD length in MICROMASTER is set using parameter P2012). If only PKW data are to be transferred in the net data block, then the number of the PZD can also be 0!

Depending on the data transfer direction, always control word 1 or status word 1 are to be transferred in the PZD1. Depending on the data transfer direction, the main setpoint or the main actual value is always transferred in PZD 2. Additional setpoints or actual values are set in the following process data PZD3 to PZDn. For MICROMASTER, if required, control word 2 or status word 2 should be transferred in PZD4.

Request telegram, master ⇒ slave

PZD1	PZD2	PZD3	PZD4	.....	PZD8
Control word 1	Setpoint 1	Control word 2	Setpoint 2	.....	Setpoint 6

Response telegram, slave ⇒ master

PZD1	PZD2	PZD3	PZD4	.....	PZD8
Status word 1	Main actual value 1	Actual value 2 status word 2	Actual value 3	.....	Actual value 7

NOTE

- A maximum of 8 PZD words
- A minimum of 0 PZD words - i.e. no PZD area in the net data area
- On the USS bus, PZD n is always transferred before PZD n+1.
- For MICROMASTER, double words cannot be transferred in the PZD section.
- Data received from MICROMASTER is always interpreted as 16-bit words. The appropriate de-normalization is implemented by assigning the appropriate parameters.
- If MICROMASTER sends data to the master via the PZD area, then for physical quantities, a normalization is made to a 16-bit value (4000 hex notation).
- The setpoint can be freely assigned to the actual value; This means for example that the frequency setpoint is transferred in the request telegram in PZD2 so the actual frequency value can be signaled back in PZD2 in the response telegram (this also makes sense from a technological/process perspective); or however, also another actual value – such as the actual torque value, actual voltage actual value or actual current value. The setpoint can be freely assigned to the actual value; for example the frequency setpoint is transferred in the request telegram in PZD2, which means that the actual frequency value can be signaled back in the response telegram in PZD2 (this also makes sense from a technological/process perspective) – or also another actual value – such as actual torque value, actual voltage value or actual current value.

3.7.1.3 USS bus configuration via COM link (RS485)

In order to ensure disturbance-free USS operation, the bus cable must be terminated at both ends using bus terminating resistors. In this case, the bus cable from the first node up to the last node should be considered as **one** bus cable – so that the USS bus should be terminated twice. For the **first** bus node [device] (e.g. master) and **last** bus node [device] (e.g. drive converter), th bus terminating resistor must be switched-in.

NOTE

- When supplied, the bus terminating resistors are not switched-in!
- Please note that you only switch-in the bus terminating at the first bus node [device] and last bus note! The **bus terminating** resistors should be always set when the system is powered-down!
- **Data transfer errors on the bus are possible!**
  In active bus operation, nodes where the terminating **resistor** is switched-in, must always be powered-up. The terminating resistor draws the voltage from the connected device. This is the reason that the terminating resistor is no longer effective when the node is powered down .

The following diagram shows the structure of a bus connection through terminals 14, 15:

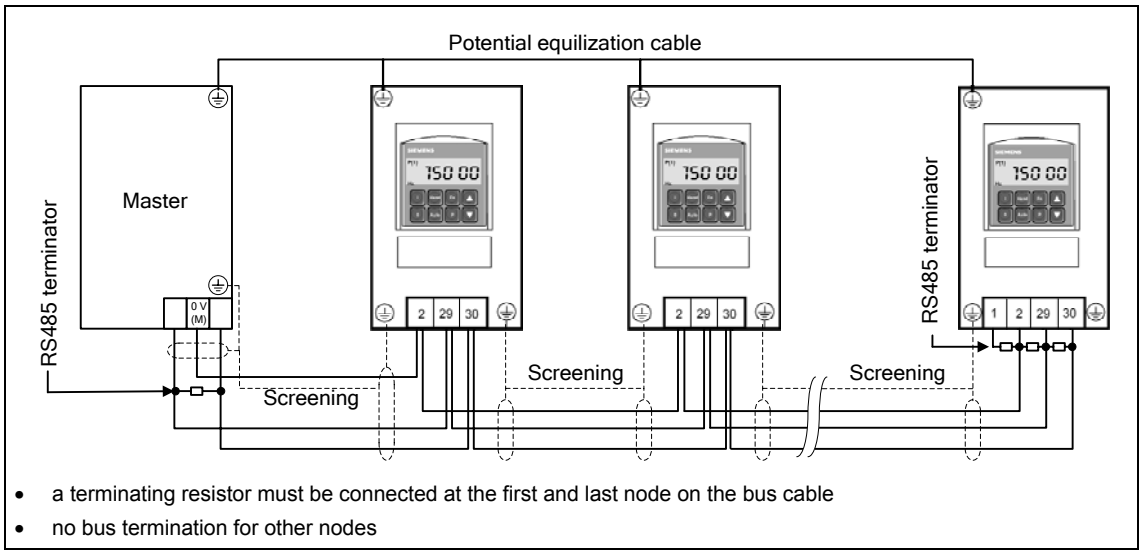


Fig. 3-40 Connecting the USS bus cable

When the MICROMASTER is used in an RS485 bus communications network the following is required:

1. A power supply
2. A terminating resistor between P+ and N- at both bus ends (refer to Fig. 3-41)

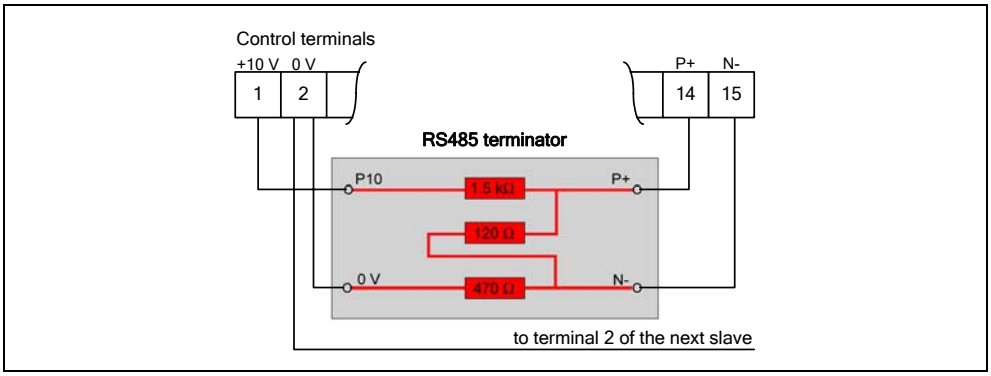


Fig. 3-41 Connecting the RS485 terminator

If the frequency inverter is the last slave on the bus (refer to Fig. 3-40), then the P+ and N- of the RS485 terminator provided must be connected there to the RS485 terminals (refer to Fig. 3-41). P10 and 0 V can be connected to terminals 1 and 2 for the power supply.

If the first or last node is not a MICROMASTER 4 the bus should be terminated between P+ and N- with a resistor (with a value between 120 Ω and 220 Ω).

The bus must be biassed (pull-up resistor from P+ to P5 or P10, pull-down from N- to 0 V) at one or both ends. If the first and/or the last node is not a MICROMASTER 4 (e.g. a S7-200 series PLC), the bus can be biassed by connecting a 390 Ω resistor from P+ to P5 and a 390 Ω pull-down resistor from N- to 0 V.

SIMATIC PROFIBUS connectors, e.g. 6ES7972-0BA41-0XA0, can be used for biassing and termination when the first or last node is an S7-200 series PLC.

NOTE

- When making the installation it must be ensured that EMC disturbances/noise cannot result in communication failures/errors or damage to the RS485 drivers.

  As a minimum, the following measures must be taken:

  1) Shield the motor cable and correctly ground the shield at both ends. If at all possible, avoid interruptions in the cables. If this cannot be avoided, then it must be ensured that the shield continues in an EMC-correct fashion at the connecting locations.
  2) All node points must be well grounded (EMC ground).
  3) All relay coils must be provided with noise suppression elements.
  4) The cables should be routed - as far as possible - separately from other cables. For RS485 cables it is especially important that they are kept well away from motor cables.
  5) The shields of RS485 cables must be correctly grounded.

- If the AOP communicates via the USS protocol, then contrary to the BOP, the appropriate USS parameters (Table 3-12 and Table 3-13) should be set.
- For error-free communications, the appropriate communication parameters must be harmonized with one another and correctly set - in the frequency inverter, the connected device and/or in the connected option board. Please refer to the corresponding Operating Instructions for the AOP and for the communications modules.
- While RS485 communications is operational the power supply must always be available using pull-up/pull-down resistors.

3.8 Fixed frequencies (FF)

Number:	8
Parameter range:	P1001 – r1024
Warnings	-
Faults	-
Function chart number:	FP3200, FP3310

A setpoint can be entered via the analog input, the serial communication interfaces, the JOG function, the motorized potentiometer as well as also using fixed frequencies. The fixed frequencies are defined using parameters P1001 – P1007 and selected via binector inputs P1020 – P1022. The effective fixed frequency setpoint is available via connector output r1024 which means that it can be connected further. If this is to be used as setpoint source, then either parameter P1000 or P0719 should be modified or BICO parameter r1024 should be connected to the main setpoint P1070 or supplementary setpoint P1075. Contrary to parameter P0719, when parameter P1000 is modified, this implicitly changes BICO parameters P1070, P1075.

Example: Fixed frequencies as setpoint source
a) Standard method → P1000 = 3
b) BICO method → P1070 = 1024, P1075 = 0

3 methods are available when selecting the fixed frequencies.

Direct selection

In this particular mode, the control signal directly selects the fixed frequency. This control signal is entered via the binector inputs. If several fixed frequencies are simultaneously active, then the selected frequencies are added.

Table 3-21 Example for direct coding via digital inputs

		DIN3	DIN2	DIN1
FF0	0 Hz	0	0	0
FF1	P1001	0	0	1
FF2	P1002	0	1	0
FF3	P1003	1	0	0
FF1+FF2		0	1	1
⋮		⋮		
FF1+FF2+FF3		1	1	1

The fixed frequencies can be selected via the digital inputs as well as also via serial communication interfaces. The fixed frequency is selected, when using digital inputs, using 2 techniques. This will be shown in the following example using the fixed frequency P1001 and digital input 1 (refer to Fig. 3-42).

a) Standard methods → P0701 = 15

b) BICO methods → P0701 = 99, P1020 = 722.0, P1016 = 1

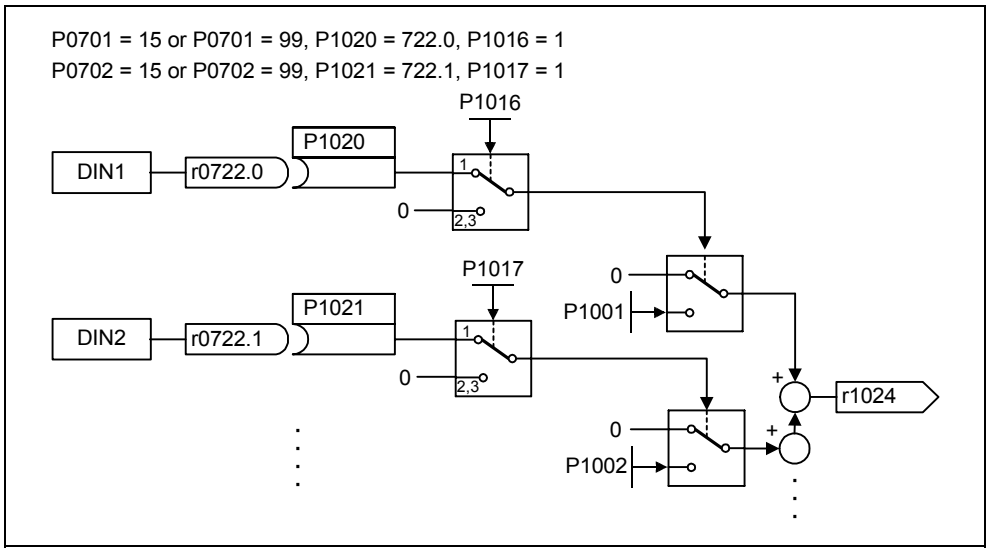


Fig. 3-42 Example for directly selecting FF1 via DIN1 and FF2 via DIN2

Direct selection + ON command

When this fixed frequency is selected, the fixed frequencies are also directly selected whereby the selection is combined with the ON command. When this technique is used, a separate ON command is not required. The following is obtained essentially analog to the example shown above:

a) Standard method → P0701 = 16

b) BICO method → P0701 = 99, P1020 = 722.0, P1016 = 2

Binary-coded selection + ON command

Using this technique up to 8 fixed frequencies can be selected using 3 control signals. These control signals are either entered via digital inputs or a serial communications interface. The fixed frequencies are indirectly selected using the binary coding (refer to Table 3-22, → e.g. selected using the digital DIN inputs), whereby the selection is combined with the ON command.

Table 3-22 Example for binary coding via digital inputs

		DIN3	DIN2	DIN1
0 Hz	FF0	0	0	0
P1001	FF1	0	0	1
P1002	FF2	0	1	0
…	…	…	…	…
…	…	…	…	…
P1006	FF6	1	1	0
P1007	FF7	1	1	1

Contrary to "Direct selection + ON command", the ON command is only active if the setting for the first 3 binary inputs is set to "Binary-coded selection + ON command" or P0701 = P0702 = P0703 = 17. The following is obtained analog to the above example:

a) Standard method → P0701 = 17

b) BICO method → P0701 = 99, P1020 = 722.0, P1016 = 3

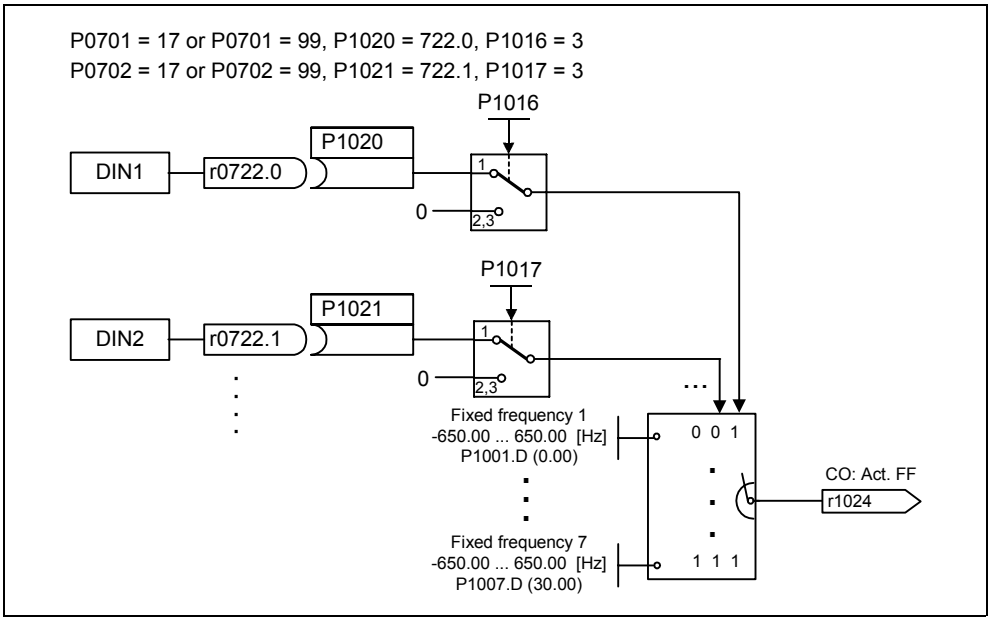


Fig. 3-43 Example for selecting FF1 via DIN1 and FF2 via DIN2 using the binary-coded method

3.9 Motorized potentiometer (MOP)

Parameter range: P1031 – r1050
Warnings -
Faults -
Function chart number: FP3100

This function emulates an electromechanical potentiometer to enter setpoints. The motorized potentiometer value is adjusted using the "Raise" and "Lower control signal" which is selected using BICO parameters P1035 and P1036 (refer to Fig. 3-44). The value which has been set is available through connector output r1050 so that it can be further connected and used.

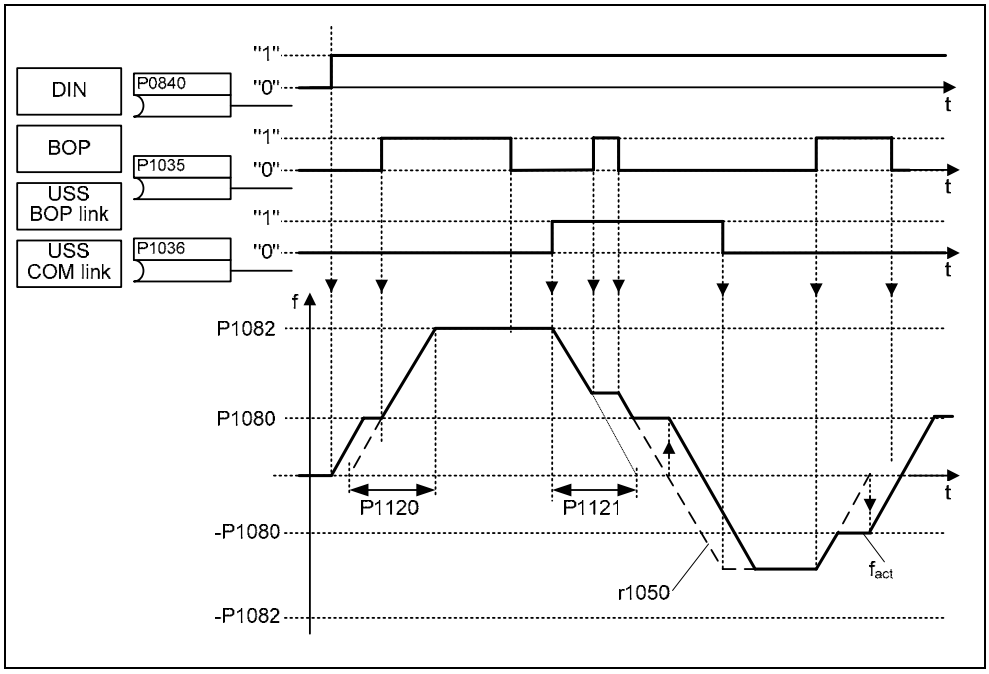


Fig. 3-44 Motorized potentiometer

Selecting via serial interfaces

The MOP functionality can be selected via the operator panels (refer to Section 3.1.3), digital inputs as well as via serial interfaces (refer to the example). Parameterization is also possible directly using BICO parameters P1035 and P1036 as well as also parameters P0700 and P0719. In this case, for a value assigned to P0700, the BICO parameter is appropriately modified.

Example: Command source via "USS on BOP link" interface

a) Standard method → P0700 = 4

b) BICO method → P1035 = 2032.13
P1036 = 2032.14
::::
(refer to P0700 for a complete list)

If the motorized potentiometer is to be used as setpoint source, then either parameter P1000 or P0719 should be modified or the BICO parameter r1050 should be connected to the main setpoint P1070 or supplementary setpoint P1075. Contrary to parameter P0719, when parameter P1000 is modified, this implicitly changes BICO parameters P1070, P1075.

Example: Setpoint via the motorized potentiometer (MOP)

a) Standard method → P1000 = 1

b) BICO method → P1070 = 1050
P1075 = 0

The MOP is configured using the following parameters and has the mode of operation as shown in Table 3-23:

- Limits using the minimum frequency P1080 or maximum frequency P1082
- Ramp-up/ramp-down time P1120 or P1121
- Inhibits MOP reversing function P1032
- Saves the MOP setpoint P1031
- MOP setpoint P1040

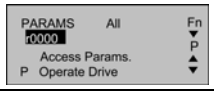
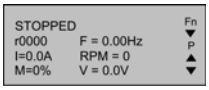
Table 3-23 Mode of operation of the MOP

Motorized potentiometer		Function
Lower	Raise	
0	0	Setpoint is frozen
0	1	Raise setpoint
1	0	Lower setpoint
1	1	Setpoint is frozen

Selecting via BOP or AOP

The following settings / operator actions should be made when selecting the motorized potentiometer using the BOP or AOP:

Table 3-24 Selecting the motorized potentiometer

Parameters / keys		BOP	AOP (at the BOP link)
Command source	P0700	1	4
Setpoint source	P1000	1	
	P1035	-	2032.13 (2032.D)
	P1036	-	2032.14 (2032.E)
	Fn		
	P		
	▲	Raise MOP output frequency	
	▼	Lower MOP output frequency	

3.10 JOG

Parameter range:	P1055 – P1061
Warnings	A0923
Faults	-
Function chart number:	FP5000

The JOG function is used as follows:

- To check the functionality of the motor and drive inverter after commissioning has been completed (the first traversing motion, checking the direction of rotation, etc.)
- Positioning a drive / a driven load into a specific position
- Traversing a drive, e.g. after a program has been interrupted

The drive is traversed using this function by entering fixed frequencies P1058, P1059. The JOG mode can be selected either using the operator panel (refer to Section 3.1.3), digital inputs or also via the serial interfaces (refer to the example). An ON/OFF command is not used to move the drive, but when the "JOG keys" are pressed. These "JOG keys" are selected using the BICO parameters P1055 and P1056.

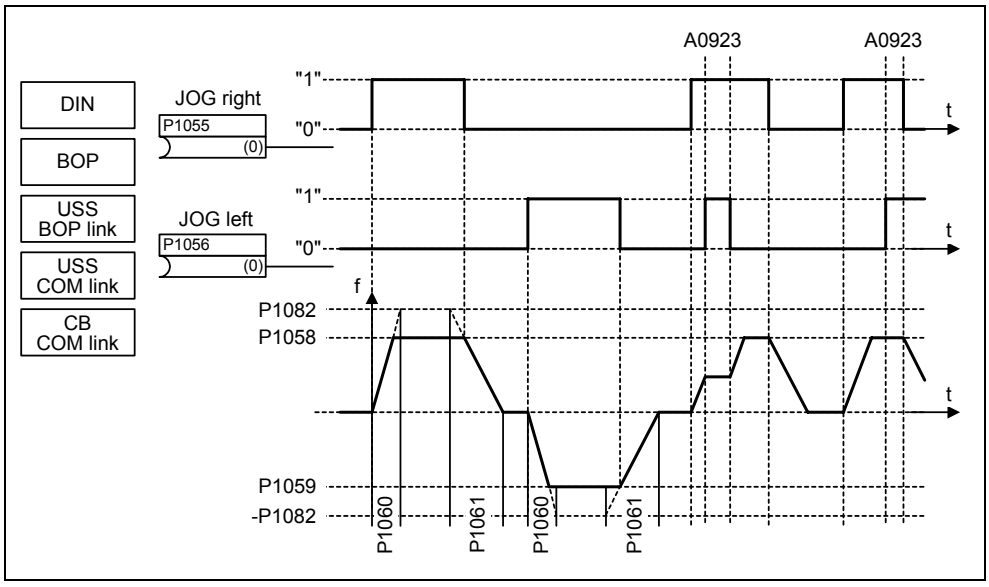


Fig. 3-45 JOG counter-clockwise and JOG clockwise

If both JOG keys are simultaneously pressed, then the instantaneous frequency is kept (constant velocity phase) and alarm A0923 is output. When a key is pressed, the drive inverter accelerates the motor to the fixed frequency in the time entered in P1060. This frequency is only exited after the key has been cancelled and the drive then brakes down to 0 Hz in the time entered in P1061.

In addition to the explicit parameterization (P1055 and P1056), the JOG functionality is also enabled via parameter P0700 or P0719 (implicit parameterization). In this case, if a value is assigned to P0700, the BICO parameter is appropriately modified.

Example: Command source via "USS on BOP link" interface

a) Standard method	→	P0700 = 4
b) BICO method	→	P1055 = 2032.8 P1056 = 2032.9 :::: (refer to P0700 for a complete list)

3.11 PID controller (technological controller)

Parameter range:	P2200 P2201 – r2294
Warnings	-
Faults	-
Function chart number:	FP3300, FP3310, FP3400, FP5100
Features:	
- cycle time:	8 ms

MICROMASTER has an integrated technological controller (PID controller, enabled via P2200). This can be used to process basic higher-level control functions. These typically include:

- Pressure control for extruders
- Water level control for pump drives
- Temperature control for fan drives
- And similar control tasks

The technological setpoints and actual values can be entered via the PID motorized potentiometer (PID-MOP), PID fixed setpoint (PID-FF), analog input (ADC) or via serial interfaces (USS on BOP link, USS on COM link, CB on COM link) (refer to the example). The appropriate parameterization of the BICO parameter defines which setpoints or actual values are to be used (refer to Fig. 3-46).

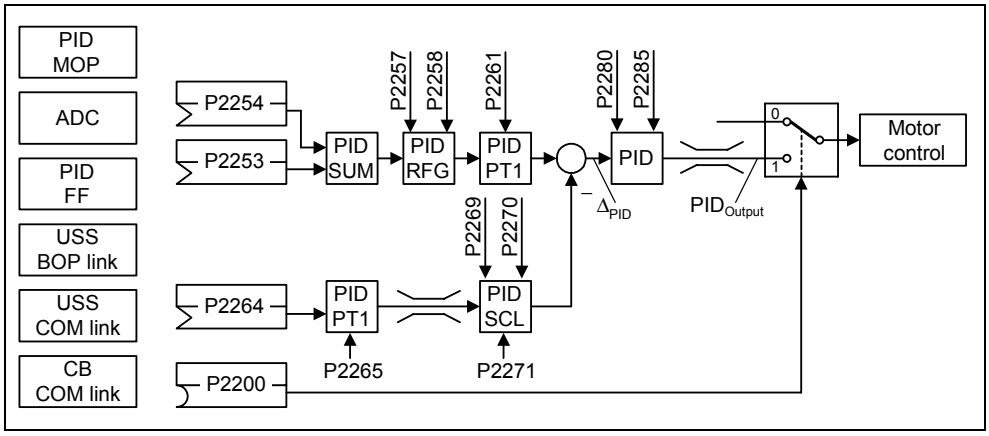


Fig. 3-46 Structure of the technological controller (PID controller)

NOTICE

Changes in parameter P2200 take effect only after a fresh ON command.

Example: **The permanent PID controller should fulfill the following secondary conditions/limitations:**
PID controller enable and PID setpoint input via PID fixed frequencies and PID actual value via the analog input.

Parameterizations:

a. Permanent PID controller enable:	P2200 = 1.0
b. Setpoint input via PID-FF:	P2253 = 2224
c. Actual value input via analog input ADC:	P2264 = 755

The supplementary (additional) setpoint is added to the main setpoint (PID-SUM) and the sum is fed to the setpoint filter (PID-PT1) at the setpoint-actual value summation point via the PID ramp-function generator (PID-RFG). The source of the supplementary setpoint (BICO parameter P2254), the ramp-up / ramp-down times of the PID ramp-function generator (P2257, P2258) as well as also the filter time (P2261) can be adapted to the particular application by appropriately parameterizing the corresponding parameters.

Similar to the PID setpoint branch, the actual value branch of the technological controller has a filter (PID-PT1) which can be set using parameter P2265. In addition to the smoothing, the actual value can be modified using a scaling unit (PID-SCL).

The technological controller can be parameterized as either P, I or PI controller using parameters P2280 and P2285.

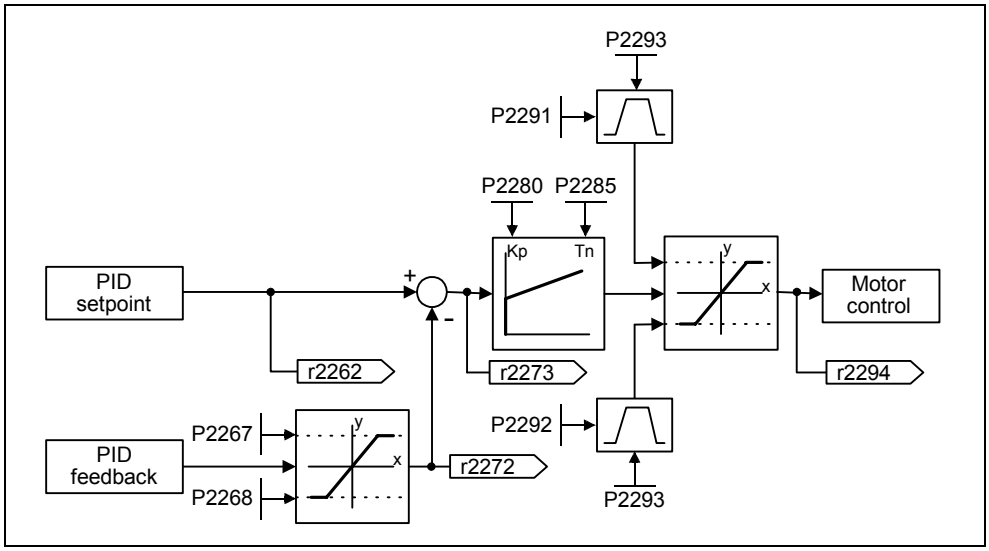


Fig. 3-47 PID controller

For specific applications, the PID output quantity can be limited to defined values. This can be achieved using the fixed limits - P2291 and P2292. In order to prevent the PID controller output exercising large steps at power-on, these PID output limits are ramped-up with ramp time P2293 from 0 to the corresponding value P2291 (upper limit for the PID output) and P2292 (lower limit for the PID output). As soon as these limits have been reached, the dynamic response of the PID controller is no longer limited by this ramp-up/ramp-down time (P2293).

3.11.1 PID motorized potentiometer (PID-MOP)

Parameter range: P2231 – r2250
Warnings -
Faults -
Function chart number: FP3400

The PID controller has a PID motorized potentiometer which can be separately adjusted. The functionality is identical with the motorized potentiometer (refer to Section 3.9), whereby the PID parameters are emulated in the range from P2231 – r2250 (refer to the comparison → Table 3-25).

Table 3-25 Correspondence between the parameters

PID motorized potentiometer		Motorized potentiometer	
P2231[3]	Setpoint memory of PID-MOP	P1031[3]	Setpoint memory of the MOP
P2232	Inhibit rev. direct. of PID-MOP	P1032	Inhibit reverse direction of MOP
P2235[3]	BI: Enable PID-MOP (UP-cmd)	P1035[3]	BI: Enable MOP (UP-command)
P2236[3]	BI: Enable PID-MOP (DOWN-cmd)	P1036[3]	BI: Enable MOP (DOWN-command)
P2240[3]	Setpoint of PID-MOP	P1040[3]	Setpoint of the MOP
r2250	CO: Output setpoint of PID-MOP	r1050	CO: Act. output freq. of the MOP

3.11.2 PID fixed setpoint (PID-FF)

Number:	7
Parameter range:	P2201 – r2224
Warnings	-
Faults	-
Function chart number:	FP3300, FP3310

Analog to the fixed frequencies (refer to Section 3.8), the PID controller has separate programmable PID fixed setpoints. The values are defined using parameters P2201 – P2207 and are selected using binector inputs P2220 – P2222. The selected PID fixed setpoint is available via connector output r2224 where it can be further processed (e.g. as PID main setpoint → P2253 = 2224).

3 methods are available to select the PID fixed setpoints, analog to the fixed frequencies (Section 3.8):

- Direct selection
- Direct selection + ON command
- Binary-coded selection + ON command

The methods are selected using parameters P2216 – P2218.

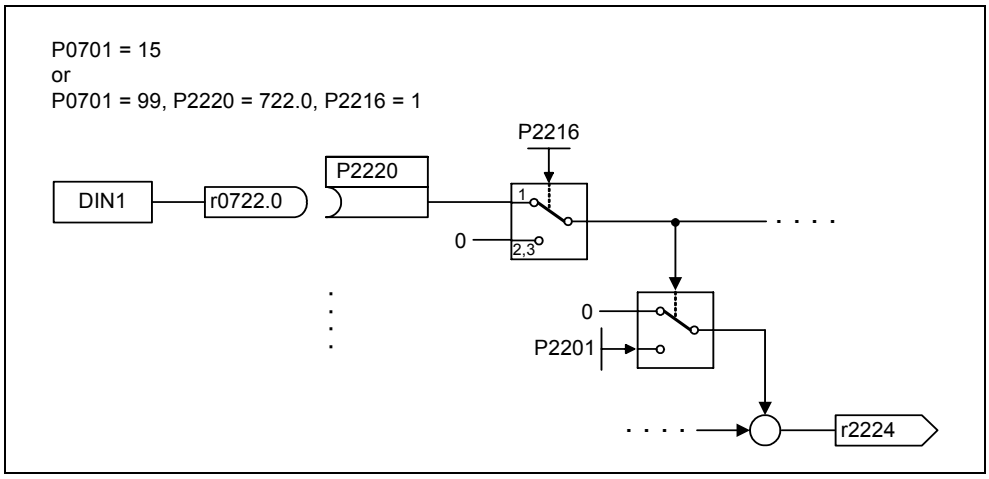


Fig. 3-48 Example to directly select the PID fixed frequency of fixed frequency 1 via DIN1

3.12 Setpoint channel

The setpoint channel (refer to Fig. 3-49) forms the coupling element between the setpoint source and the motor control. MICROMASTER has a special characteristic which allows the setpoint to be entered simultaneously from two setpoint sources. The generation and subsequent modification (influencing the direction, suppression frequency, up/down ramp) of the complete setpoint is carried-out in the setpoint channel.

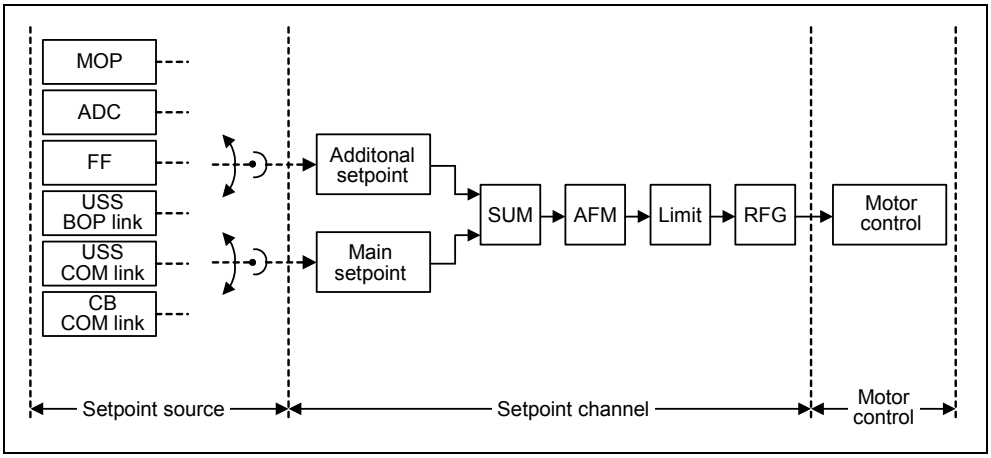


Fig. 3-49 Setpoint channel

3.12.1 Summation and modification of the frequency setpoint (AFM)

Parameter range:	P1070 – r1114
Warnings	-
Fault	-
Function chart number:	FP5000, FP5200

For applications where the control quantities are generated from central control systems, fine tuning is often required locally on-site (correction quantity). For MICROMASTER, this can be very elegantly realized using the summation point where the main and supplementary (additional) setpoint are added in the setpoint channel. In this case, both quantities are simultaneously read-in via two separate or one setpoint source and summed in the setpoint channel. Depending on external circumstances, the supplementary setpoint can be dynamically disconnected or switched-in to the summation point (refer to Fig. 3-50). This functionality can be used to advantage, especially for discontinuous processes.

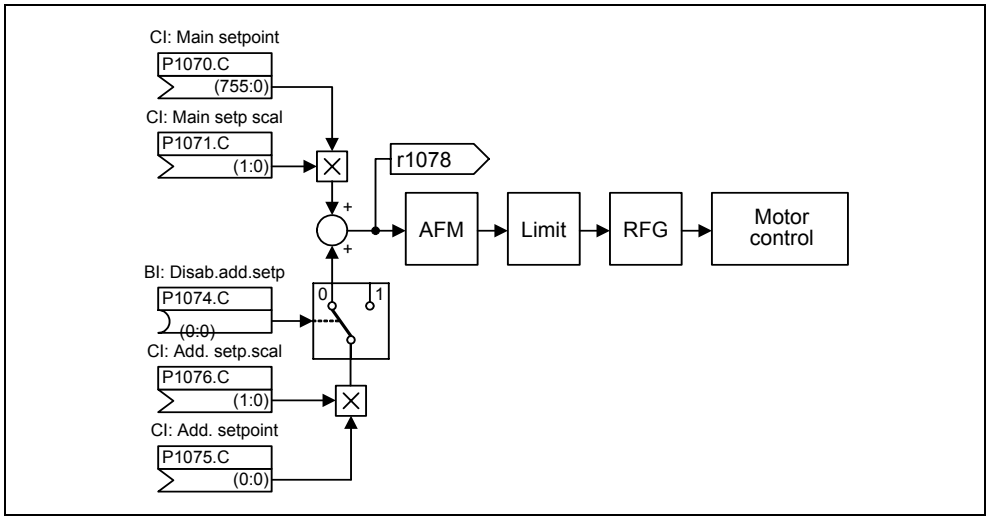


Fig. 3-50 Summation

MICROMASTER has the following possibilities to select the setpoint source:

1. P1000 – selecting the frequency setpoint source
2. P0719 – selecting the command / setpoint source
3. BICO parameterization
   - P1070 CI: Main setpoint
   - P1075 CI: Additional setpoint

Further, the main setpoint as well as the supplementary (additional) setpoint can be scaled independently of one another. In this case, for example, a user can simply implement an override function using the appropriate parameterization.

A scan sequence is generally associated with a forwards and a backwards motion. When selecting the reversing functionality, after reaching the end position, a direction of rotation reversal can be initiated in the setpoint channel (refer to Fig. 3-51).

On the other hand, if it is to be prevented that a direction of rotation reversal or a negative frequency setpoint is to be entered via the setpoint channel, then this can be inhibited using BICO parameter P1110.

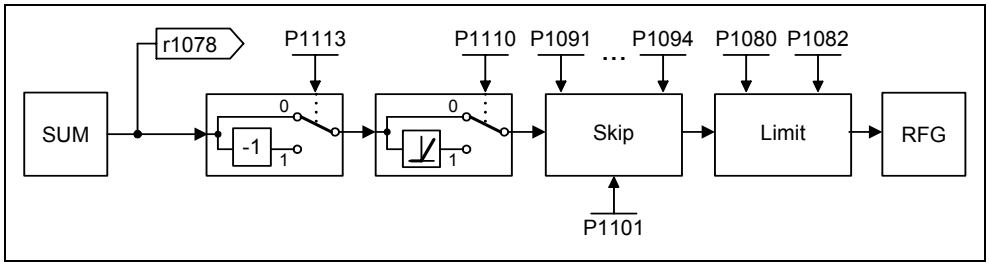


Fig. 3-51 Modifying the frequency setpoint

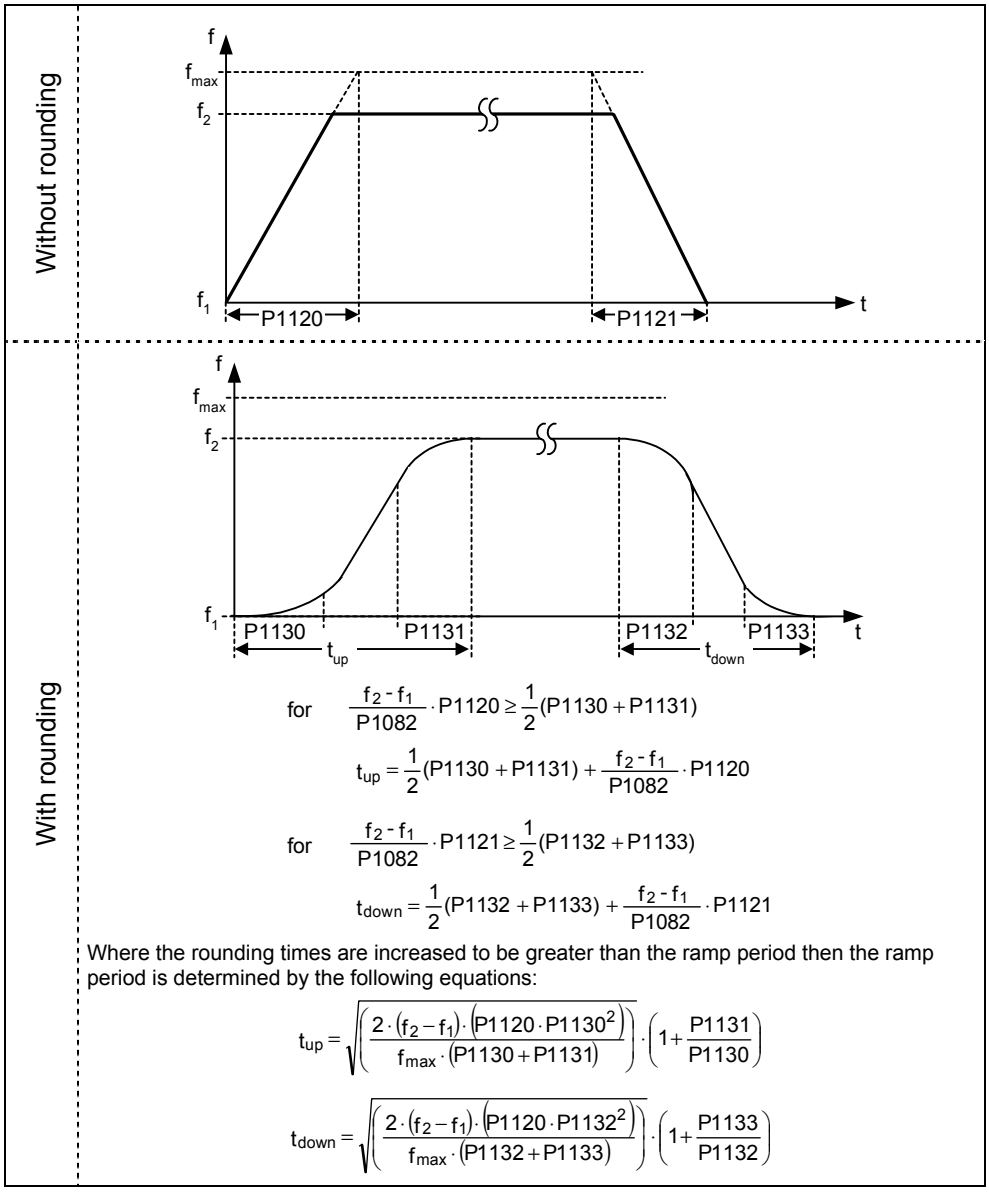
Driven machines can have one or several resonance points in the range from 0 Hz up to the reference frequency. These resonance points result in oscillations which, under worst case conditions, can damage the driven load. Using suppression frequencies, MICROMASTER allows these resonant frequencies to be passed through as quickly as possible. This means that the suppression frequencies increase the availability of the driven load over the long term.

3.12.2 Ramp-function generator (RFG)

Parameter range: P1120, P1121
r1119, r1170
P1130 – P1142

Function chart number: FP5000, FP5300

The ramp-function generator is used to limit the acceleration when the setpoint changes according to a step function. This therefore helps to reduce the stressing on the mechanical system of the machine. An acceleration ramp and a braking ramp can be set independently of one another using the ramp-up time P1120 and the ramp-down time P1121. This allows a controlled transition when the setpoint is changed (refer to Fig. 3-52).



for $\frac{f_2 - f_1}{P1082} \cdot P1120 \geq \frac{1}{2}(P1130 + P1131)$

$$t_{up} = \frac{1}{2}(P1130 + P1131) + \frac{f_2 - f_1}{P1082} \cdot P1120$$

for $\frac{f_2 - f_1}{P1082} \cdot P1121 \geq \frac{1}{2}(P1132 + P1133)$

$$t_{down} = \frac{1}{2}(P1132 + P1133) + \frac{f_2 - f_1}{P1082} \cdot P1121$$

Where the rounding times are increased to be greater than the ramp period then the ramp period is determined by the following equations:

$$t_{up} = \sqrt{\left(\frac{2 \cdot (f_2 - f_1) \cdot (P1120 \cdot P1130^2)}{f_{max} \cdot (P1130 + P1131)}\right)} \cdot \left(1 + \frac{P1131}{P1130}\right)$$

$$t_{down} = \sqrt{\left(\frac{2 \cdot (f_2 - f_1) \cdot (P1120 \cdot P1132^2)}{f_{max} \cdot (P1132 + P1133)}\right)} \cdot \left(1 + \frac{P1133}{P1132}\right)$$

Fig. 3-52 Ramp-function generator

In order to avoid torque surges at the transitions (constant velocity phase ←→ accelerating / braking phase), additional rounding-off times P1130 – P1133 can be programmed. This is especially important for applications (e.g. transporting/pumping liquids or for cranes) which require an especially "soft", jerk-free acceleration and braking.

If the OFF1 command is initiated while the drive is accelerating, then rounding-off can be activated or de-activated using parameter P1134 (refer to Fig. 3-53). These rounding-off times are defined using parameters P1132 and P1133.

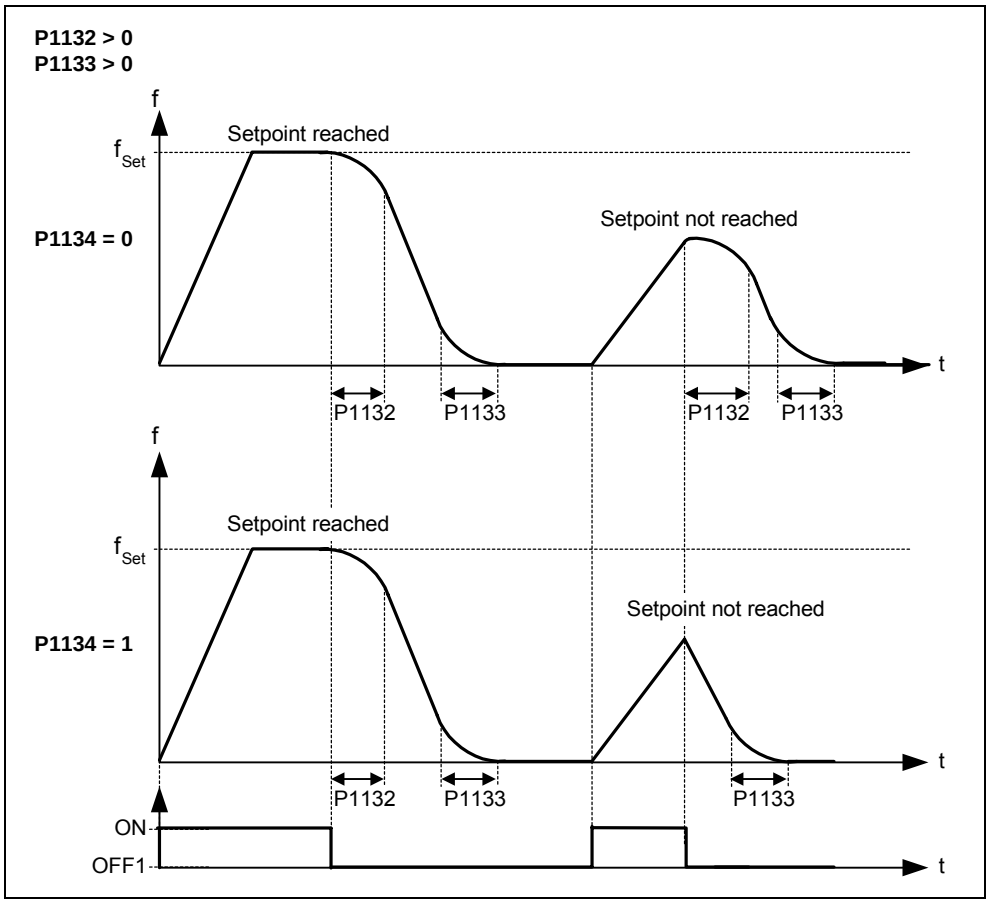


Fig. 3-53 Rounding off after an OFF1 command

In addition to the rounding-off times, the ramp-function generator can be influenced using external signals. The ramp-function generator provides the following functionality using BICO parameters P1140, P1141 and P1142.

Table 3-26 BICO parameters for ramp-function generator

Parameter	Description
P1140 BI: RFG enable	The ramp-function generator output is set to 0 if the binary signal = 0.
P1141 BI: RFG start	The ramp-function generator output keeps its actual value if the binary signal = 0.
P1142 BI: RFG enable setpoint	If the binary signal = 0, then the ramp-function generator input is set to 0 and the output is reduced to 0 via the ramp-function generator ramp.

The ramp-function generator itself is enabled after the pulses have been enabled (inverter enable) and after the excitation time has expired (P0346). After limiting to the maximum speeds for the positive and negative directions of rotation (P1082, -P1082 or 0 Hz for the direction of rotation inhibit) the setpoint speed for the control is obtained (r1170).

NOTE

The maximum drive inverter frequency is defined in the setpoint channel using parameter P1080. The maximum possible frequency is 650 Hz.

3.12.3 OFF/braking functions

Parameter range:	P1121, P1135, P2167, P2168 P0840 – P0849 r0052 bit 02
Warnings	-
Faults	-
Function chart number:	-

The drive inverter and the user must respond to an extremely wide range of situations and stop the drive. In this case, both requirements relating to operations as well as drive inverter protective functions (e.g. electrical and thermal overload) and man-machine protective functions have to be taken into account. As a result of the different OFF/braking functions (OFF1, OFF2, OFF3) MICROMASTER can flexibly respond to the requirements mentioned above.

OFF1

The OFF1 command is closely coupled to the ON command. When the ON command is withdrawn, then OFF1 is directly activated. The drive is braked by OFF1 with the ramp-down time P1121. If the output frequency falls below the parameter value P2167 and if the time in P2168 has expired, then the inverter pulses are cancelled.

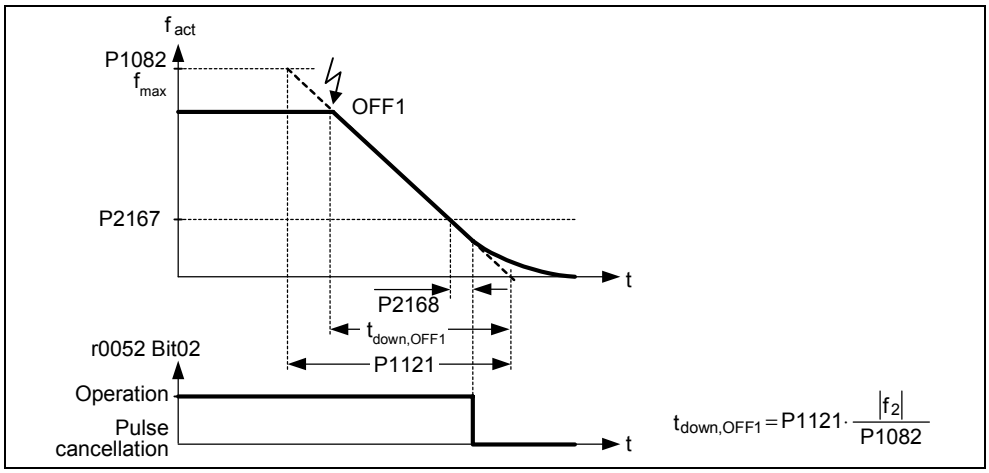


Fig. 3-54 OFF1

NOTE

- OFF1 can be entered using a wide range of command sources via BICO parameter P0840 (BI: ON/OFF1) and P0842 (BI: ON/OFF1 with reversing).
- BICO parameter P0840 is pre-assigned by defining the command source using P0700.
- The ON and the following OFF1 command must have the same source.
- If the ON/OFF1 command is set for more than one digital input, then only the digital input that was last set, is valid, e.g. DIN3 is active.
- OFF1 can be combined with DC current braking or compound braking.
- When the motor holding brake MHB (P1215) is activated, for an OFF1, P2167 and P2168 are not taken into account.

OFF2

The inverter pulses are immediately cancelled by the OFF2 command. This means that the motor coasts-down and it is not possible to brake in a controlled fashion.

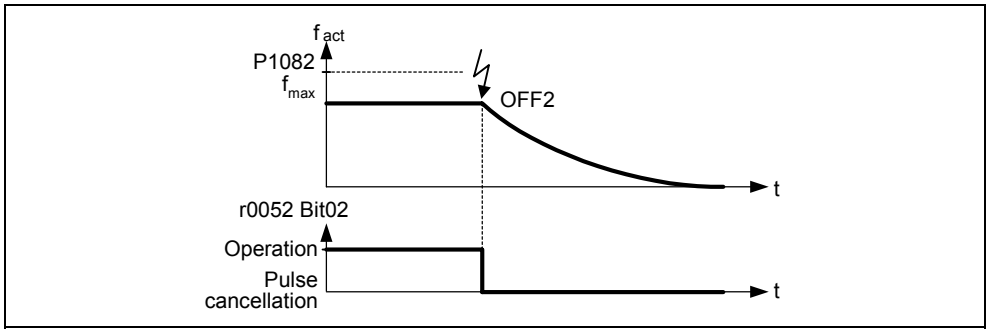


Fig. 3-55 OFF2

NOTE

- The OFF2 command can have one or several sources. The command sources are defined using BICO parameters P0844 (BI: 1. OFF2) and P0845 (BI: 2. OFF2).
- As a result of the pre-assignment (default setting), the OFF2 command is set to the BOP. This source is still available even if another command source is defined (e.g. terminal as command source → P0700 = 2 and OFF2 is selected using DIN2 → P0702 = 3).

OFF3

The braking characteristics of OFF3 are identical with those of OFF1 with the exception of the autonomous OFF3 ramp-down time P1135. If the output frequency falls below parameter value P2167 and if the time in P2168 has expired, then the inverter pulses are cancelled as for the OFF1 command.

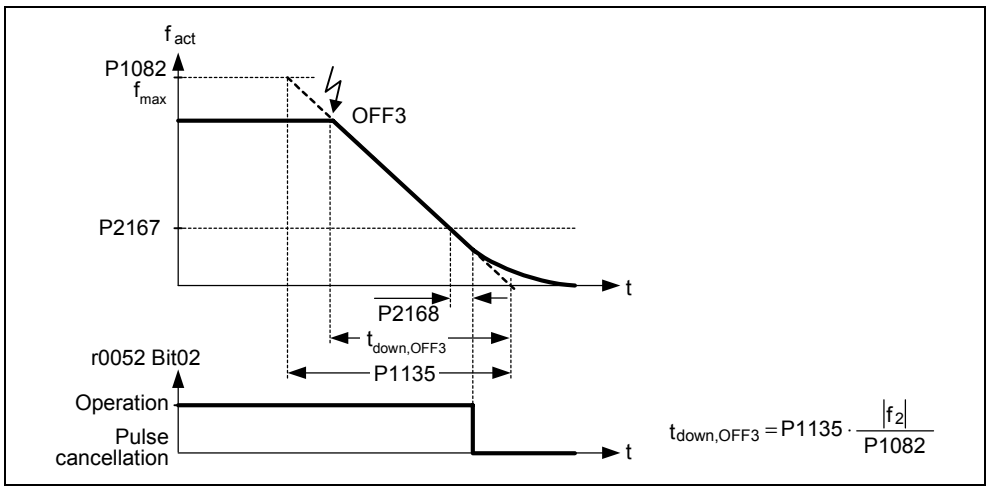


Fig. 3-56 OFF3

NOTE

OFF3 can be entered using a wide range of command sources via BICO parameters P0848 (BI: 1. OFF3) and P0849 (BI: 2. OFF3).

3.12.4 Manual / automatic operation

Parameter range:	P0719, P0810
Warnings	-
Faults	-
Function chart number:	-

It is necessary to change-over from the automatic mode into the manual mode to load and unload production machines and to feed new materials (e.g. batch processing). The machine operator carries-out the preparatory activities for subsequent automatic operation in the manual mode. In the manual mode, the machine operator locally controls the machine (enters the ON/OFF command as well as also the setpoint). A changeover is only made into the automatic mode after the set-up has been completed. In the automatic mode, the control (open-loop) of the machines and production processes are handled by a higher-level control system (e.g. PLC). This operation is maintained until it is necessary to again load and unload the machine or feed new material into the machine or production process.

For MICROMASTER 420, indexed parameter P0719 and BICO parameter P0810 are used to change over between the manual and automatic mode. The command and setpoint sources are defined using P0719 (refer to Table 3-28), whereby P0719 index 0 (P0719[0]) defines the automatic mode and P0719 index 1 (P0719[1]) the manual mode. BICO parameter P0810 is used to change-over between the automatic and manual modes. P0810 can be controlled from any control sources (refer to Table 3-27).

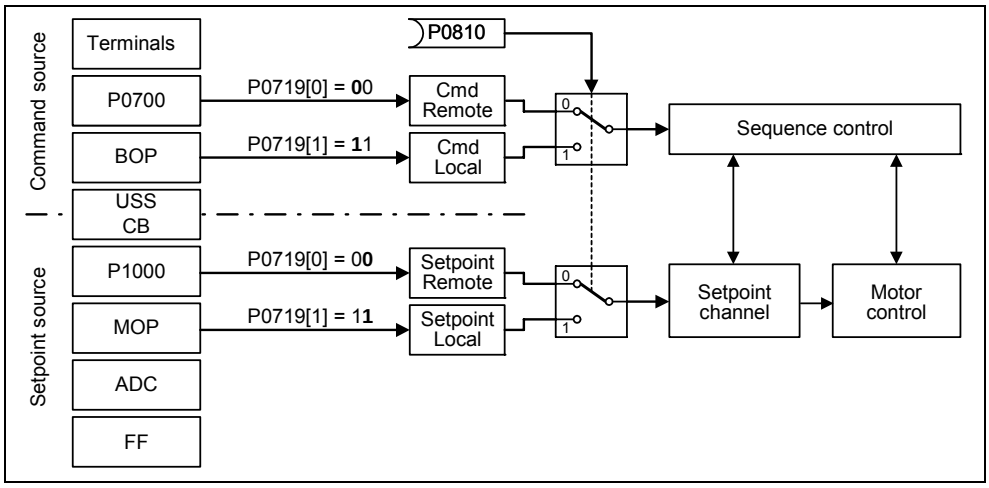


Fig. 3-57 Changing-over using the BICO parameter P0810

Table 3-27 Examples for the parameter settings of P0810

Parameter setting	Command source
P0810 = 722.2 requires P0703 = 99	Digital input 3
P0810 = 2032.15	USS at the BOP link
P0810 = 2036.15	USS at the COM link
P0810 = 2090.15	CB at the COM link

Table 3-28 Possible parameter settings for P0719

Value	Command source	Setpoint source
0	Cmd = BICO parameter	Setpoint = BICO parameter
1	Cmd = BICO parameter	Setpoint = MOP setpoint
2	Cmd = BICO parameter	Setpoint = Analog setpoint
3	Cmd = BICO parameter	Setpoint = Fixed frequency
4	Cmd = BICO parameter	Setpoint = USS on BOP link
5	Cmd = BICO parameter	Setpoint = USS on COM link
6	Cmd = BICO parameter	Setpoint = CB on COM link
10	Cmd = BOP	Setpoint = BICO parameter
11	Cmd = BOP	Setpoint = MOP setpoint
12	Cmd = BOP	Setpoint = Analog setpoint
13	Cmd = BOP	Setpoint = Fixed frequency
15	Cmd = BOP	Setpoint = USS on BOP link
16	Cmd = BOP	Setpoint = USS on COM link
40	Cmd = USS on BOP link	Setpoint = BICO parameter
41	Cmd = USS on BOP link	Setpoint = MOP setpoint
42	Cmd = USS on BOP link	Setpoint = Analog setpoint
43	Cmd = USS on BOP link	Setpoint = Fixed frequency.
44	Cmd = USS on BOP link	Setpoint = USS on BOP link
45	Cmd = USS on BOP link	Setpoint = USS on COM link
46	Cmd = USS on BOP link	Setpoint = CB on COM link
50	Cmd = USS on COM link	Setpoint = BICO parameter
51	Cmd = USS on COM link	Setpoint = MOP setpoint
52	Cmd = USS on COM link	Setpoint = Analog setpoint
53	Cmd = USS on COM link	Setpoint = Fixed frequency
54	Cmd = USS on COM link	Setpoint = USS on BOP link
55	Cmd = USS on COM link	Setpoint = USS on COM link
60	Cmd = CB on COM link	Setpoint = BICO parameter
61	Cmd = CB on COM link	Setpoint = MOP setpoint
62	Cmd = CB on COM link	Setpoint = Analog setpoint
63	Cmd = CB on COM link	Setpoint = Fixed frequency
64	Cmd = CB on COM link	Setpoint = USS on BOP link
66	Cmd = CB on COM link	Setpoint = USS on COM link

3.13 Motor holding brake (MHB)

Parameter range:	P1215 P0346, P1216, P1217, P1080 r0052 bit 12
Warnings	-
Faults	-
Function chart number:	-

For drives which must be secured when powered-down to prevent them undesirably moving, the MICROMASTER brake sequence control (enabled via P1215) can be used to control the motor holding brake.

Before opening the brake, the pulse inhibit must be removed and a current impressed which keeps the drive in that particular position. In this case, the impressed current is defined by the min. frequency P1080. A typical value in this case is the rated motor slip r0330. In order to protect the motor holding brake from continuous damage, the motor may only continue to move after the brake has been released (brake release times lie between 35 ms and 500 ms). This delay must be taken into account in parameter P1216 "Holding brake release delay" (refer to Fig. 3-58).

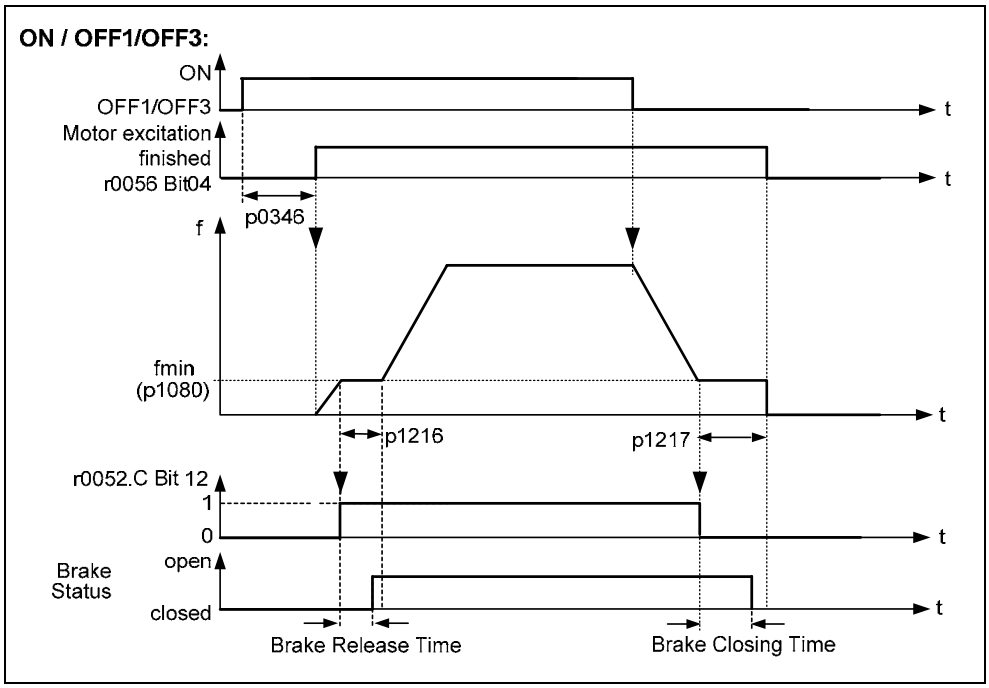


Fig. 3-58 Motor holding brake after ON / OFF1

The motor holding brake is either closed using OFF1 / OFF3 or OFF2. For OFF1 / OFF3, when the minimum frequency P1080 is reached, the motor is operated at this frequency until the brake has been applied (closing times of brakes lie between 15 ms and 300 ms). The actual time is specified using parameter P1217 "Holding time after ramp down" (refer to Fig. 3-58). If, on the other hand, an OFF2 command has been output, then independent of the drive state, the status signal r0052 bit 12 "Motor holding brake active" is reset. This means that the brake immediately closes after OFF2 (refer to Fig. 3-59).

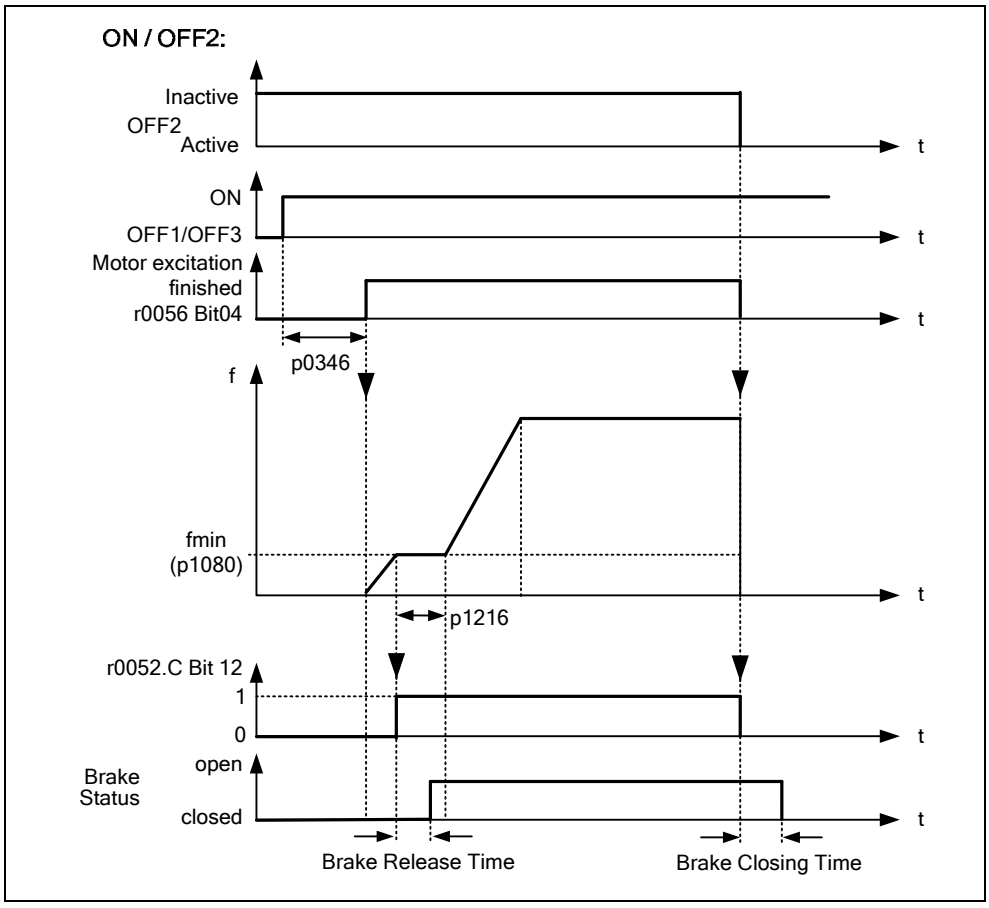


Fig. 3-59 Motor holding brake after OFF2

The mechanical brake is controlled using the status signal r0052 bit 12 "Motor holding brake active" of the brake control. This signal can be output as follows:

- Via digital outputs
  The status signal is output via the digital output. In this case, the internal MICROMASTER relay (if the specification is sufficient) or also an external contactor or relay can be used to control the brake.
- Via status signal using the serial interface (USS or PROFIBUS)
  The master must process the status signal. The signal must be connected to the digital output of the master to which the contactor / relay for the motor holding brake is connected.

NOTE

- Motors have optional holding brakes which are not designed to be used as brakes for normal operation. The holding brakes are only designed for a limited number of emergency braking operations / motor revolutions with the brake closed (refer to the Catalog data).
- When commissioning a drive with integrated holding brake it is therefore absolutely imperative that it is ensured that the holding brake functions perfectly. A "clicking noise" in the motor indicates that the brake has been correctly released.
- **Parameter settings:**
  - To open/close, the digital output controls the motor holding brake at point 1/2 (refer to Fig. 3-58). In this case the prerequisite is that the motor holding brake P1215 has been activated as well as the selection of the motor holding brake at the digital output.
  - Brake opening time P1216 is greater than/equal to the time to open the holding brake.
  - Brake delay time P1217 is greater than/equal to the time to close the holding brake.
  - Select the min. frequency P1080 so that it acts just like a weight equalization function.
  - A typical value for the min. frequency P1080 for the motor holding brake is the slip frequency of the motor r0330. The rated slip frequency can be calculated using the following formula:

$$f_{Slip}[Hz] = \frac{r0330}{100} \cdot P0310 = \frac{n_{syn} - n_n}{n_{syn}} \cdot f_n$$

  - The following control parameters should be noted in conjunction with the motor holding brake:
    - P1310, P1311, P1333, P1335



WARNING

- It is not sufficient to select the status signal r0052 bit 12 "Motor holding brake active" in P0731 – P0733. In order to activate the motor holding brake, in addition, parameter P1215 must also be set to 1.

- If the frequency inverter controls the motor holding brake, then a commissioning may not be carried-out for potentially hazardous loads (e.g. suspended loads for crane applications) unless the load has been secured. Potentially hazardous loads can be secured as follows before commissioning is started:
  - Lower the load to the floor
  - During the commissioning phase or after the frequency inverter has been replaced, the frequency inverter must be inhibited from controlling the motor holding brake (it is not permissible that the frequency inverter controls the holding brake). Quick commissioning or a parameter download using STARTER etc. may only be carried-out after this has been absolutely ensured. The motor holding brake terminals can then be re-assigned (in this case, it is not permissible that digital output P0748 is inverted for the motor holding brake).
  - In order to hold the motor against the mechanical brake at a specific frequency, it is important that the min. frequency P1080 approximately corresponds to the slip frequency. If the value is selected to be too high, then the current drawn can be too high so that the frequency inverter shuts-down (trips) due to an overcurrent. If the value selected is too low, then it is possible that not enough torque is produced to hold the load.
- It is not permissible to use the motor holding brake as operating brake. The reason for this is that generally it is only dimensioned/designed for a limited number of emergency braking operations.

Motor with motor holding brake (example)

A motor with motor holding brake for a hanging (suspended) axis is connected to the frequency inverter. This holding brake is to be controlled using the 1st digital output.

Which settings have to be made?

- Select the "motor holding brake active" function (52.12) at digital output P0731.
- Activate the brake sequence control in the frequency inverter (P1215 = 1).
- Set parameter P1216 to open the holding brake after an ON command.
  The brake opening time P1216 must be set so that it is equal to or longer than the time required to open the holding brake. The opening time of the brake (refer to the Motor Catalog, e.g. M11) plus the relay opening time can be used as nominal value for P1216.
- Set parameter P1217 to close the holding brake after an OFF1/3 command.
  The brake delay time P1217 must be set so that it is equal to or longer than the time required to close the holding brake. The closing time of the brake (refer to Motor Catalog, e.g. M11) plus the relay closing time can be used as nominal value for P1217.

➢ **Set the load holding**
The opening / closing times of mechanical brakes are subject to certain fluctuations; this is the reason that a weight equalization function must be parameterized in the frequency inverter for the time P1216 and P1217. The following parameters must be defined so that the axis cannot sag (i.e. the axis cannot drop/fall).

- In order that the motor can immediately establish a torque after an ON command, the magnetizing time P0346, determined with the quick commissioning, may not be reset. This is the reason that parameter P0346 should be checked for the weight equalization.

  Typical magnetizing times for 4-pole 1LA7 motors are:

0.12 kW	50 ms	5.50 kW	250 ms
1.50 kW	100 ms	7.50 kW	300 ms

- The min. frequency P1080 should approximately correspond to the rated motor slip (P1080 ≈ r0330[Hz])
- In addition, the voltage boost should be adapted:
  - constant voltage boost P1310 ≈ 90 % (empirical value)
  - voltage boost when accelerating P1311 ≈ 50 % (empirical value)

➢ **Connecting-up the motor holding brake control**

- Directly connected to the relay output

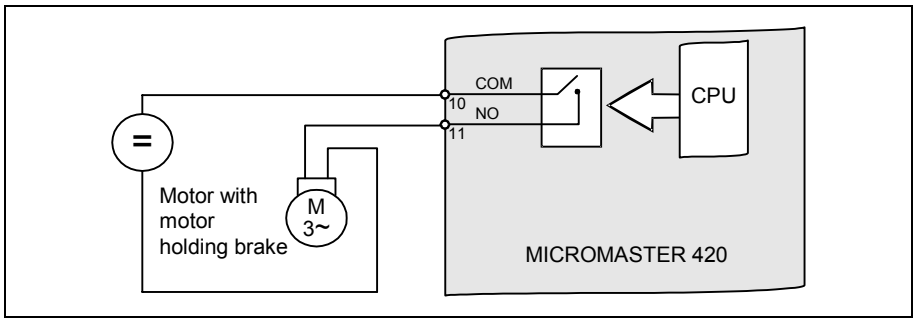


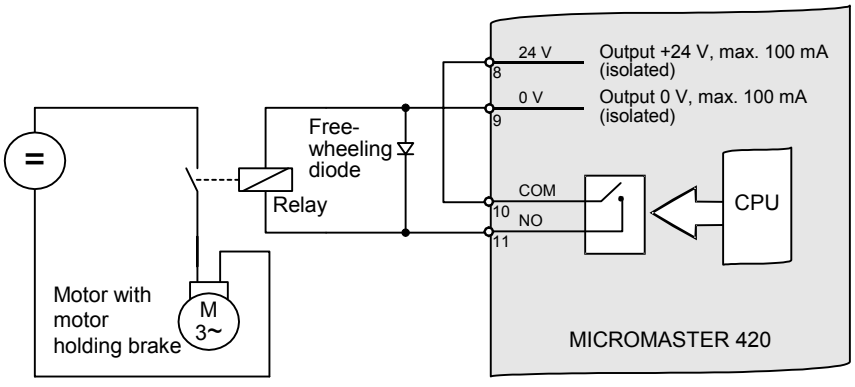
Fig. 3-60 Direct motor holding brake connection

If the frequency inverter directly controls the motor holding brake using the relay integrated in the frequency inverter, then the max. load capability of this relay should be carefully taken into consideration in conjunction with the voltage/current data of the holding brake. The following applies for the relay integrated in the frequency inverter:

- 30 V DC / 5 A
- 250 V AC / 2 A

If this value is exceeded, an additional relay should, for example, be used.

♦ Indirectly connecting relay output via an additional relay



Caution

The relay may not overload the internal 24 V power supply!

Fig. 3-61 Indirect motor holding brake connection

3.14 Electronic brakes

MICROMASTER 420 has 2 electronic brakes:

DC braking (refer to Section 3.14.1)

Compound braking (refer to Section 3.14.2)

These brakes can actively brake the drive and avoid a possible DC link overvoltage condition. An inter-dependency as shown in Fig. 3-62 is present.

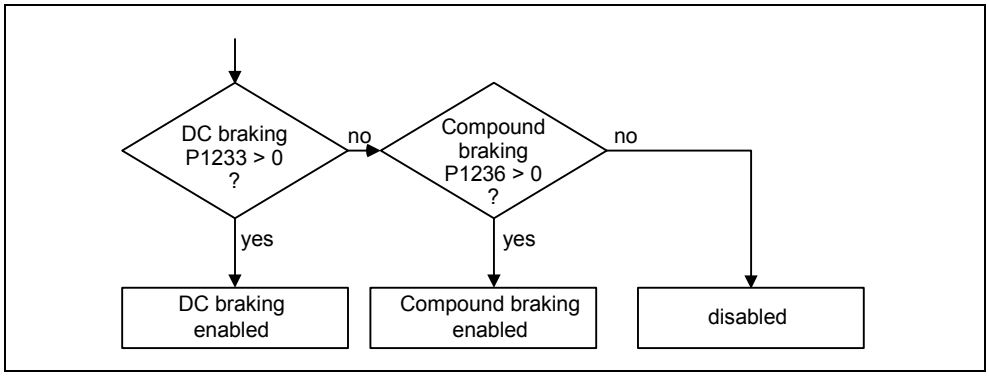


Fig. 3-62 Inter-dependency of the electronic brakes

3.14.1 DC braking

Parameter range:	P1230, P1232, P1233 r0053 Bit00
Warnings	-
Faults	-
Function chart number:	-

The drive decelerates along a parameterized braking ramp if an OFF1 / OFF3 command is output. A "flat" ramp must be selected so that the drive inverter is not tripped (shutdown) due to the high regenerative energy which would cause a DC link overvoltage condition. The DC brake should be activated while the OFF1 / OFF3 command is present if the drive is to be braked faster. For DC braking, instead of continually reducing the output frequency / voltage during the OFF1 / OFF3 phase, a DC voltage / current is input (refer to sequence a).

The drive can be brought to a standstill in the shortest time using DC current braking (DC brake). DC braking is selected as follows:

- After OFF1 or OFF3 (the DC brake is released via P1233) Sequence ①
- Directly selected using BICO parameter P1230 Sequence ②

For DC braking, a DC current is impressed in the stator winding which results in a significant braking torque for an induction motor. The magnitude, duration and frequency at which braking starts can be set for the braking current and therefore braking torque by setting the appropriate parameters.

The DC brake can therefore support a braking operation from approx. < 10 Hz or prevents / minimizes the increase in the DC link voltage for regenerative braking. This is realized because energy is directly absorbed in the motor. The essential advantage and the main application of the DC brake is the fact that a holding torque can be generated at standstill (0 Hz). For instance, this is important for applications where after positioning, any motion in the mechanical system / product itself can result in waste.

DC braking is especially used for:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

Sequence ①

1. Enabled using P1233
2. DC braking is activated with the OFF1 or OFF3 command (refer to Fig. 3-63)
3. The inverter pulses are inhibited for the duration of the de-magnetizing time P0347.
4. The required braking current P1233 is then impressed for the selected braking time P1232. The status is displayed using signal r0053 bit 00.

The inverter pulses are inhibited after the braking time has expired.

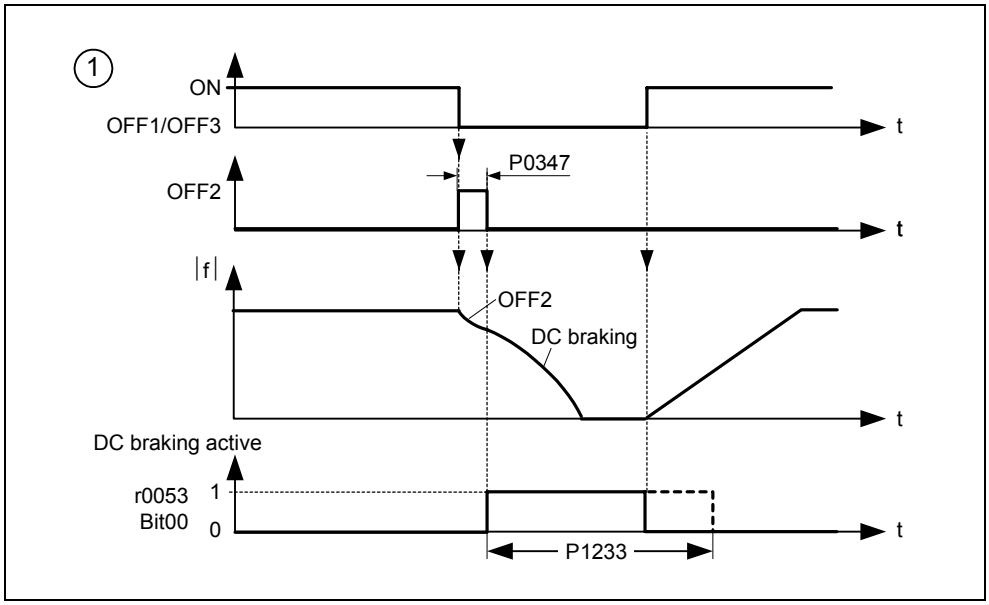


Fig. 3-63 DC braking after OFF1 / OFF3

Sequence ②

1. Enabled and selected using BICO parameter P1230 (refer to Fig. 3-64)
2. The inverter pulses are inhibited for the duration of the de-magnetizing time P0347.
3. The requested braking current P1232 is impressed for the time selected and the motor is braked. This state is displayed using signal r0053 bit 00.
4. After DC braking has been cancelled, the drive accelerates back to the setpoint frequency until the motor speed matches the drive inverter output frequency. If there is no match, then there is danger that a fault will be output as a result of overcurrent - F0001. This can be avoided by activating the flying restart function.

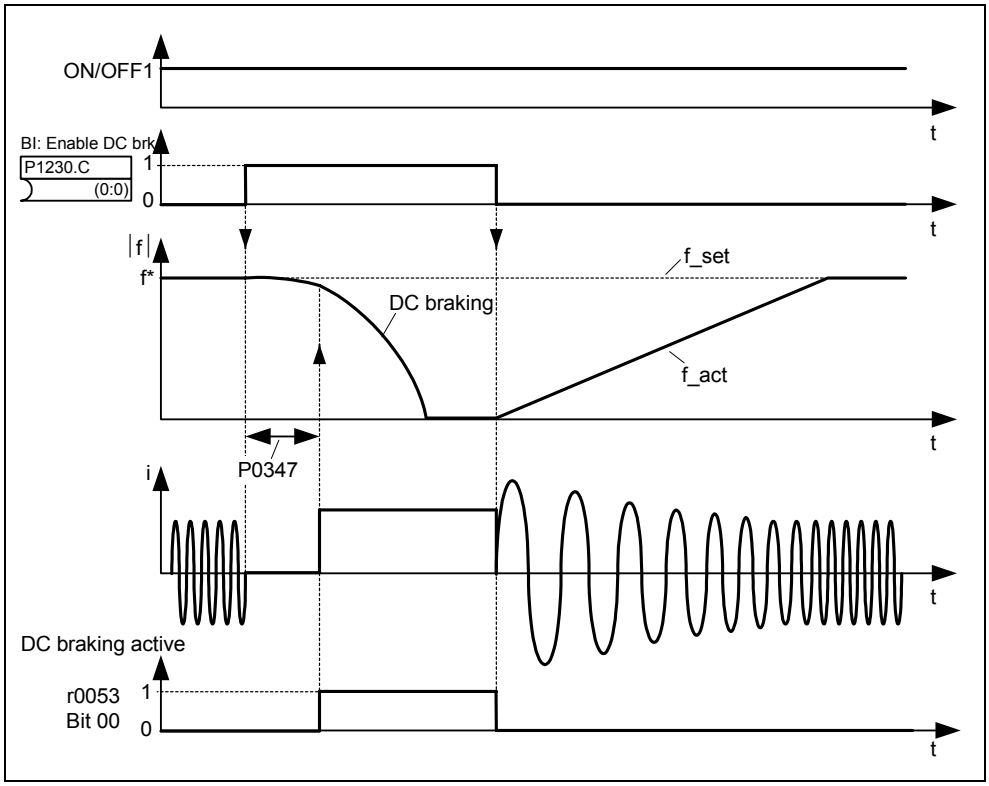


Fig. 3-64 DC braking after external selection

NOTE

1. The "DC braking" function is only practical for induction motors !
2. DC braking is <u>not</u> suitable to hold suspended loads !
3. For DC current braking, the motor kinetic energy is converted into thermal energy in the motor. If braking lasts too long, then the drive can overheat !
4. While DC braking, there is no other way of influencing the drive speed using an external control. When parameterizing and setting the drive system, then as far as possible, it should be tested using real loads !
5. DC braking is independent of the ON command. This means that it can even be selected in the "Ready" state.

3.14.2 Compound braking

Parameter range:	P1236
Warnings	-
Faults	-
Function chart number:	-

For compound braking (this is enabled using P1236) DC braking is superimposed with regenerative braking (where the drive regenerates into the line supply as it brakes along a ramp). If the DC link voltage exceeds the compound switch-in threshold $V_{DC\text{-}Comp}$ (refer to Fig. 3-65), then a DC current is impressed as a function of P1236. In this case, braking is possible with a controlled motor frequency and minimum regenerative feedback. Effective braking is obtained without having to use additional components by optimizing the ramp-down time (P1121 for OFF1 or when braking from f_1 to f_2, P1135 for OFF3) and using compound braking P1236.

Compound braking is suitable for:

- Horizontal motion (e.g. traversing drives, conveyor belts)
- Vertical motion (e.g. hoisting gear)

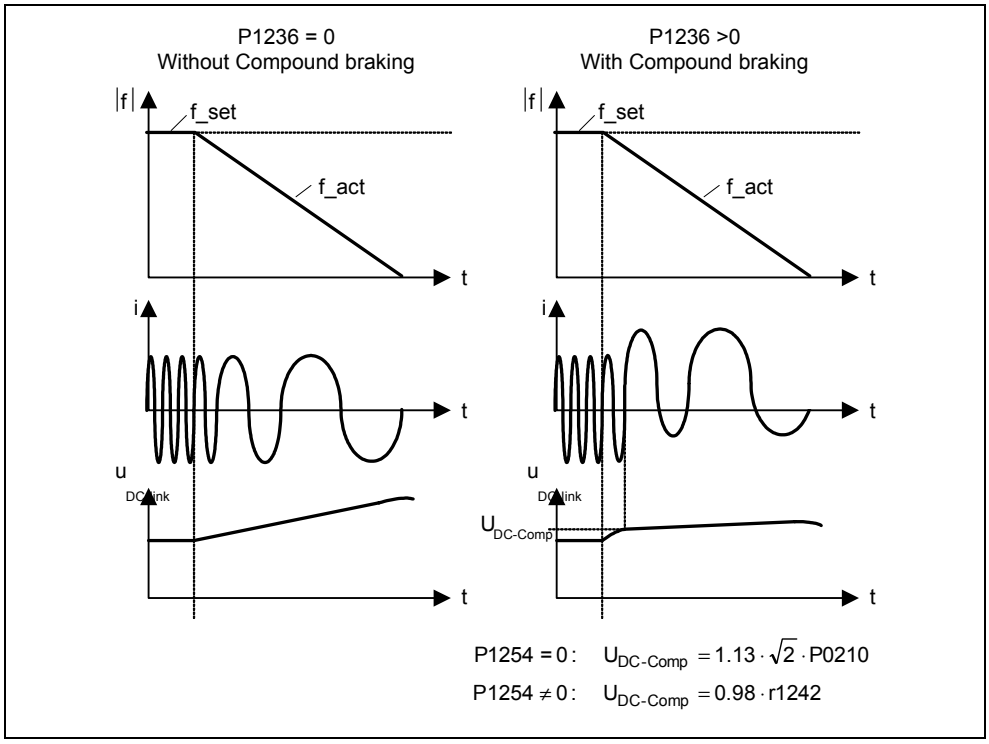


Fig. 3-65 Compound braking

The compound braking switch-in threshold $V_{DC\text{-}Comp}$ is calculated as a function of parameter P1254 (Auto detect V_{DC} switch-on levels) either directly using the line supply voltage P0210 or indirectly using the DC link voltage and r1242 (refer to the formula in Fig. 3-65).



WARNING

- For compound braking, regenerative braking is superimposed on the DC braking (braking along a ramp). This means that components of the kinetic energy of the motor and driven load are converted into thermal energy in the motor. If this power loss is too high or if the braking operation takes too long, then this can cause the drive to overheat !
- When using compound braking it must be expected that there is a higher level of noise above the compound braking switch-in threshold.

NOTE

- Compound braking is de-activated, if
  - flying restart is active, and
  - DC braking is active is selected.
- The compound switch-in threshold $V_{DC\text{-}Comp}$ is dependent on P1254

  $V_{DC\text{-}Comp}(P1254 = 0) \neq V_{DC\text{-}Comp}(P1254 \neq 0)$

  a) Auto-detect circuit enabled (P1254 = 1):
     - $V_{DC\text{-}Comp}$ (P1254 = 1) is automatically calculated when the drive inverter runs-up - i.e. after the line supply voltage has been connected
     - Using the auto-detect function, the $V_{DC\text{-}Comp}$ threshold automatically adapts itself to the line supply voltage at the particular installation location.

  b) Auto-detect function disabled (P1254 = 0):
     - $V_{DC,\,Comp} = 1.13 \cdot \sqrt{2} \cdot P0210$
     - The $V_{DC\text{-}Comp}$ threshold is immediately re-calculated after entering P0210
     - P0210 must be adapted to the particular installation location

3.15 Automatic restart

Parameter range:	P1210 P1211
Warnings	A0571
Faults	F0035
Function chart number:	-

After a power failure (F0003 "Undervoltage"), the "Automatic restart" function (enabled using P1210) automatically powers-up the drive inverter again. Any faults are automatically acknowledged by the drive inverter.

When it comes to power failures (line supply failure), then a differentiation is made between the following conditions:

Line undervoltage (brownout)

"Line undervoltage" is a situation where the line supply is interrupted and returns before (if installed) the BOP display has gone dark (this is an extremely short line supply interruption where the DC link hasn't completely collapsed).

Line failure (blackout)

"Line failure" is a situation where the display has gone dark (this represents a longer line supply interruption where the DC link has completely collapsed) before the line supply returns.

The automatic restart function P1210 is shown in the following diagram (refer to Table 3-29) as a function of external states / events.

Table 3-29 Automatic restarts

P1210	ON always active (permanent)				ON in no-voltage condition	
	Fault F0003 on		All other faults on			
	Blackout	Brownout	Blackout	Brownout	All faults on Blackout	No faults on Blackout
0	–	–	–	–	–	–
1	Fault acknowl.	–	Fault acknowl.	–	Fault acknowl.	–
2	Fault acknowl. + restart	–	–	–	–	Restart
3	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	–
4	Fault acknowl. + restart	Fault acknowl. + restart	–	–	–	–
5	Fault acknowl. + restart	–	Fault acknowl. + restart	–	Fault acknowl. + restart	Restart
6	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Fault acknowl. + restart	Restart

The number of start attempts is specified using parameter P1211. The number is internally decremented after each unsuccessful attempt. After all attempts have been made (as specified in parameter P1211), automatic restart is cancelled with message F0035. After a successful start attempt, the counter is again reset to the initial value.

NOTE

- The "Flying restart" function (refer to Section 3.16) must be additionally activated if, for an automatic restart, the drive inverter is to be connected to a motor which may already be spinning.



DANGER

- For longer line supply failures (blackouts)and when the automatic restart function is activated, over a longer period of time it may be assumed that MICROMASTER is powered-down. However, when the line supply returns, motors can automatically start to run again without any operator intervention.
- If the operating range of the motors is entered in this status, this can result in death, severe injury or material damage.

3.16 Flying restart

Parameter range:	P1200 P1202, P1203 r1204, r1205
Warnings	-
Faults	-
Function chart number:	-

The "Flying restart" function (this is enabled using P1200, refer to Table 3-30) allows the drive inverter to be switched to a motor which is still spinning. If the drive inverter was to be powered-up without using the flying restart function, there would be a high possibility that a fault with overcurrent F0001 would occur. The reason for this is that the flux must first be established in the motor and the V/f control must be set corresponding to the actual motor speed. The drive inverter frequency is synchronized with the motor frequency using the flying restart function.

When the drive inverter is normally powered-up it is assumed that the motor is stationary and the drive inverter accelerates the motor from standstill and the speed is ramped-up to the setpoint which has been entered. However, in many cases this condition is not fulfilled. A fan drive is a typical example. When the drive inverter is powered-down the air flowing through the fan can cause it to rotate in any direction.

Table 3-30 Settings for parameter P1200

Parameter P1200	Flying restart active	Search direction
0	Disabled	-
1	Always	Start in the direction of the setpoint
2	For line supply on and fault	Start in the direction of the setpoint
3	For fault and OFF2	Start in the direction of the setpoint
4	Always	Only in the direction of the setpoint
5	For line supply on, fault and OFF2	Only in the direction of the setpoint
6	For fault and OFF2	Only in the direction of the setpoint

Depending on parameter P1200, after the de-magnetizing time has expired P0347, flying restart is started with the maximum search frequency $f_{search,max}$ (refer to Fig. 3-66).

$$f_{search,max} = f_{max} + 2 \cdot f_{slip,standard} = P1802 + 2 \cdot \frac{r0330}{100} \cdot P0310$$

This is realized either after the line supply returns when the automatic restart function has been activated or after the last shutdown with the OFF2 command (pulse inhibit).

V/f characteristic (P1300 < 20):
The search frequency is reduced, as a function of the DC link current with the search rate which is calculated from parameter P1203. In so doing, the parameterizable search current P1202 is impressed. If the search frequency is close to the rotor frequency, the DC link current suddenly changes because the flux in the motor establishes itself. Once this state has been reached, the search frequency is kept constant and the output voltage is changed to the voltage value of the V/f characteristic with the magnetizing time P0346 (refer to Fig. 3-66).

After the magnetizing time P0346 has expired, the ramp-function generator is set to the speed actual value and the motor is operated with the actual reference frequency.

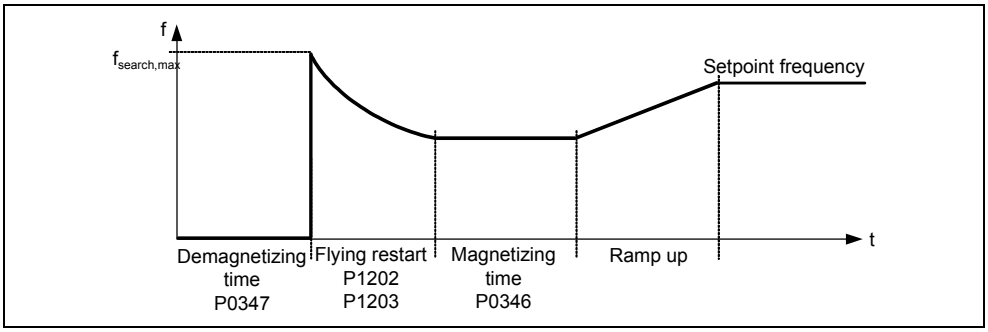


Fig. 3-66 Flying restart

NOTE

- If a higher value is entered for the search velocity P1203 this results in a flatter search curve and therefore to an extended search time. A lower value has the opposite effect.
- For "Flying restart", a braking torque is generated which can cause drives, with low moments of inertia, to brake.
- For group drives, "Flying restart" should not be activated due to the different characteristics of the individual motors when coasting down.



WARNING

- When "Flying restart" is activated (P1200 > 0), although the drive is at a stand-still and the setpoint is 0, it is possible that the drive is accelerated as a result of the search current !
- If the operating range of the motors is entered when the drive is in this state, this can result in death, severe injury or material damage.

3.17 Closed-loop Vdc control

3.17.1 Vdc_max controller

Parameter range:	P1240, r0056 bit 14 r1242, P1243 P1250 – P1254
Warnings	A0502, A0910
Faults	F0002
Function chart number:	FP4600

DC link undervoltage

- **Cause:**
  Line supply voltage failure or dip (blackout or brownout)
- **Remedy:**
  A regenerative torque is entered for the operational drive which compensates the existing losses and therefore stabilizes the voltage in the DC link. This technique is carried-out using the Vdc_min controller (refer to Section 3.18) and is known as kinetic buffering.

A brief regenerative load can be handled using this function (enabled using P1240) without the drive inverter being shut down (tripped) with fault message F0002 ("DC link overvoltage"). In this case, the frequency is controlled so that the motor doesn't go too far into regenerative operation.

If the drive inverter regenerates too much when braking the machine due to a fast ramp-down time P1121, then the braking ramp / ramp time are automatically extended and the drive inverter is operated at the DC link voltage limit r1242 (refer to Fig. 3-67). If the DC link threshold r1242 is again fallen below, then the Vdc_max controller withdraws the extension of the braking ramp.

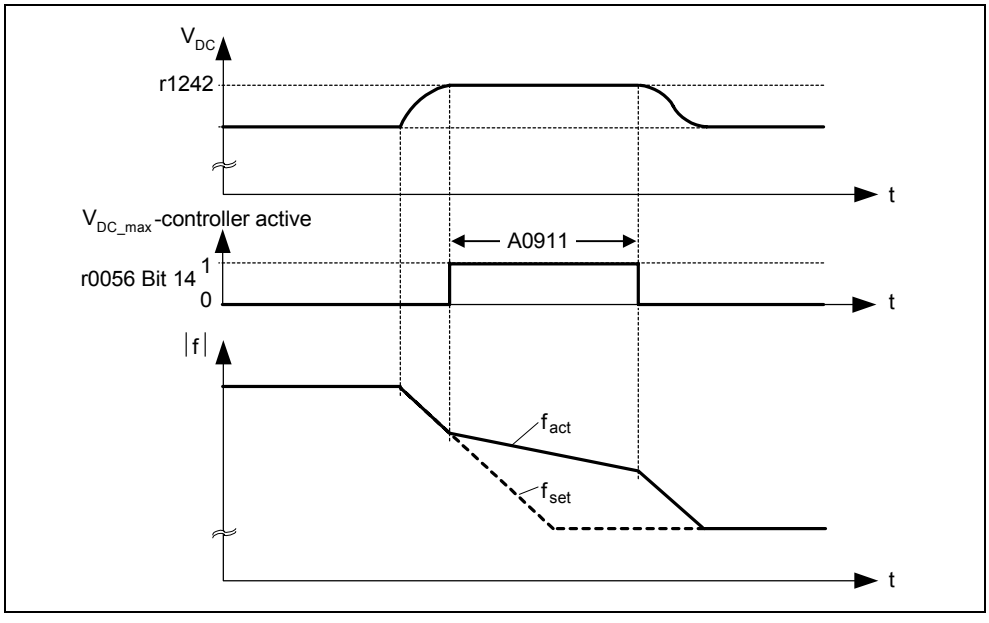


Fig. 3-67 Vdc_max controller

On the other hand, if the Vdc_max controller increases the output frequency (e.g. for a steady-state regenerative load), then the Vdc_max controller is disabled by an internal drive inverter monitoring function and warning A0910 is output. If the regenerative load continues, the drive inverter is protected using fault F0002.

In addition to controlling the DC link, the Vdc_max controller supports the stabilizing processes of the speed at the end of an acceleration phase. This is especially the case if there is an overshoot and the motor therefore briefly goes into regenerative operation (damping effect).

NOTE

- If the DC link voltage exceeds the power-on threshold r1242 (switch-on level of Vdc_max.) of the Vdc_max controller in the "Ready" state, then the Vdc_max controller is de-activated and warning A0910 is output.
  Cause: The line supply voltage does not match the application situation.
  Remedy: Refer to parameters P1254 and P0210.
- If, in the "Run" state, the DC link voltage exceeds the power-on threshold r1242 and if the Vdc_max controller output is limited by parameter P1253 for approx. 200 ms, then the Vdc_max controller is de-activated and warning A0910 and, where relevant, fault F0002 are output.
  Cause: Line supply voltage P0210 or ramp-down time P1121 too low
  The moment of inertia of the driven load is too high
  Remedy: Refer to parameters P1254, P0210, P1121
- The Vdc_max switch-in threshold V_{DC_max} depends on P1254

  V_{DC_max}(P1254 = 0) ≠ V_{DC_max}(P1254 ≠ 0)

  a) Auto-detect function enabled (P1254 = 1):
  - V_{DC_max} (P1254 = 1) is automatically calculated when the drive inverter runs-up, i.e. after the line supply voltage has been connected
  - Using the auto-detect function, the $V_{DC\text{-}Comp}$ threshold automatically adapts itself to the line supply voltage at the particular installation location.

  b) Auto-detect function disabled (P1254 = 0):
  - $U_{DC_max} = 1.15 \cdot \sqrt{2} \cdot$ P0210
  - The $V_{DC\text{-}Comp}$ threshold is immediately re-calculated after entering P0210
  - P0210 must be adapted to the particular installation location.

3.18 Monitoring functions / messages

3.18.1 General monitoring functions / messages

Parameter range:	P2150 – r2197 r0052, r0053, r2197
Warnings	-
Faults	-
Function chart number:	FP4100, FP4110

MICROMASTER has an extensive range of monitoring functions / messages which can be used for open-loop process control. The control can either be implemented in the drive inverter or also using an external control (e.g. PLC). The interlocking functions in the drive inverter (refer to Section 3.1.2.3) as well as the output of signals (refer to Section 3.6.2 or 0) for external control are implemented using BICO technology.

The status of the individual monitoring functions / messages are emulated in the following CO/BO parameters:

- r0019 CO/BO: BOP control word
- r0052 CO/BO: Status word 1
- r0053 CO/BO: Status word 2
- r0054 CO/BO: Control word 1
- r0055 CO/BO: Supplementary (additional) control word
- r0056 CO/BO: Status word – motor control
- r0722 CO/BO: Status, digital inputs
- r0747 CO/BO: Status, digital outputs
- r2197 CO/BO: Messages 1

Frequently used monitoring functions / messages including parameter number and bit are shown in the following Table.

Table 3-31 Partial excerpt of monitoring functions / messages

Functions / states	Parameter / bit number	Function chart
Drive ready	52.0	-
Drive ready to run	52.1	-
Drive running	52.2	-
Drive fault active	52.3	-
OFF2 active	52.4	-
OFF3 active	52.5	-
On inhibit active	52.6	-
Drive warning active	52.7	-
Deviation setpoint – actual value	52.8	-
PZD control	52.9	-
Maximum frequency reached	52.A	-
Warning: Motor current limit	52.B	-
Motor holding brake active	52.C	-
Motor overload	52.D	-
Motor runs right	52.E	-
Drive inverter overload	52.F	-
DC brake active	53.0	-
Ramping finished	53.9	-
PID output R2294 == P2292 (PID_min)	53.A	FP5100
PID output R2294 == P2291 (PID_max)	53.B	FP5100
Download data set 0 from AOP	53.E	-
Download data set 0 from AOP	53.F	-
|f_act| > P1080 (f_min)	53.2 2197.0	FP4100
|f_act| <= P2155 (f_1)	53.5 2197.1	FP4110
|f_act| > P2155 (f_1)	53.4 2197.2	FP4110
f_act > zero	2197.3	FP4110
f_act >= setpoint (f_set)	53.6 2197.4	-
|f_act| >= P2167 (f_off)	53.1 2197.5	FP4100
|f_act| > P1082 (f_max)	2197.6	-
f_act == setpoint (f_set)	2197.7	FP4110
i_act r0068 >= P2170	53.3 2197.8	FP4100
Approx. Vdc_act < P2172	53.7 2197.9	FP4110
Approx. Vdc_act > P2172	53.8 2197.A	FP4110
No-load operation	2197.B	-

3.19 Thermal motor protection and overload responses

Parameter range:	P0610 – P0614 P0345 r 0034
Warnings	A0511
Faults	F0011
Function chart number:	-

MICROMASTER 420 has a completely new integrated concept for thermal motor protection. There are numerous possibilities of effectively protecting the motor but at the same time ensuring high motor utilization. The basic philosophy of this innovative concept is to detect critical thermal states, output warnings and initiate the appropriate responses. By responding to critical states it is possible to operate the drive at the thermal power limit and to avoid, under all circumstances, an immediate shutdown (where the drive inverter is tripped).

Features

The protective concept distinguishes itself as a result of the following individual features:

- Protection is effective without using any temperature sensor. The temperatures of various locations in the motor are indirectly determined using a temperature model.
- Selectable responses P0610 which are to be initiated when the warning threshold is exceeded in order to prevent an overload condition.
- The motor protection has been designed to be completely independent of the drive inverter protection. Warning thresholds and responses for drive inverter protection must be separately parameterized.

3.19.1 Thermal motor model

The motor temperature rise increases because of the losses occurring during the energy-conversion process in the motor. These losses can be essentially sub-divided into two groups:

- No-load losses
  The no-load losses include the bearing and air friction losses as well as the re-magnetizing losses (eddy current and hysteresis losses). All of these loss components dependent on the speed and electrical frequency.
- Load losses
  The load losses are mainly determined by the thermal losses in the windings due to the current flowing through them.

An electrical motor represents a multi-material system (iron, copper, insulating material, air) where the heat source is especially concentrated in the windings, the laminated core and the shaft bearings. The following simplifications were made to replicate the thermal processes in the motor:

- The motor is a homogenous body
- Heat sources are uniformly distributed in the motor
- Heat is only dissipated using convection

Using these simplifications, the thermal motor behavior can be defined using a 1st Order filter (PT1 filter). In this case, the square of the normalized motor current (measured motor current r0027 divided by the rated motor current P0305) weighted by the thermal motor time constant P0611 results in the I²t value of the motor r0034. The I²t value represents a parameter for the temperature rise / temperature of the motor.

In addition, the output frequency (motor speed) is included in the calculation in order to take into account the cooling effect of the motor fan.

If parameter P0335 is changed to a force-ventilated motor, then the calculation is also appropriately modified.

If the I²t value of the motor (r0034) reaches the value defined in P0614 (default: 100%), alarm message A0511 is output and depending on P0610, a response is initiated, or, when the shutdown threshold is reached, a fault. The following settings are possible for P0610:

0 No response, only a warning

1 Warning and Imax is reduced
(this results in a lower output frequency)

2 Warning and fault (F0011)

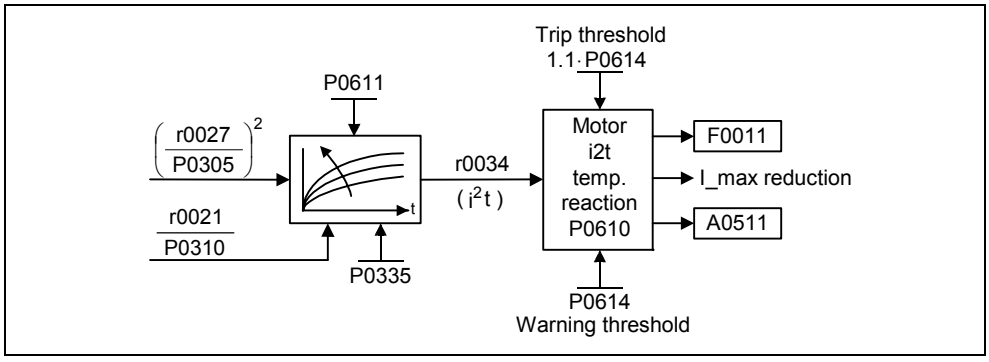


Fig. 3-68 Drive inverter response

The thermal motor time constant P0611 is a measure for the rate at which the motor temperature changes and must be entered depending on the motor.

NOTE

- For motors with a higher weight P0344, the temperature increase characteristic is significantly slower than for small motors.
- If thermal data of a third-party motor is not entered, then values are used that are based on a Siemens motor.
- Thermal motor data should be taken from the appropriate motor Catalogs.

Temperature Classes

The permissible temperature rise of electrical machinery (motors) is limited due to the thermal strength of the insulating materials.

Different maximum values are permissible depending on the material used. In compliance with regulations for rotating electrical machinery, a differentiation is made between several temperature Classes (refer to the motor rating plate) and these are assigned to the highest permissible continuous temperature. An excerpt from IEC 85 is shown in the "Thermal Classes" table.

Table 3-32 Thermal classes

Excerpt from IEC 85	
Thermal Class	Max.perm.temperature
Y	90 °C
A	105 °C
E	120 °C
B	130 °C
F	155 °C
H	180 °C

3.19.2 PTC temperature sensor

When the motor is operated below the rated speed the cooling effect of the shaft-mounted fan is reduced. As a result, for most motors when continually operated at lower frequencies, the power has to be reduced. Under these particular conditions, the motors are only protected against overheating if either the parameters of the motor temperature model (refer to Section 3.19.1) were precisely determined or a PTC temperature sensor is mounted to the motor and connected to one of the digital inputs of the MICROMASTER 420 (refer to Fig. 3-69).

Parameters P0701, P0702 or P0703 = 29 (external fault) should be set to activate the shutdown (tripping) function for a motor overtemperature condition. If the resistance of the PTC temperature sensor exceeds the shutdown (trip) threshold (motor overtemperature condition), then Fault F0085 is output (external fault).

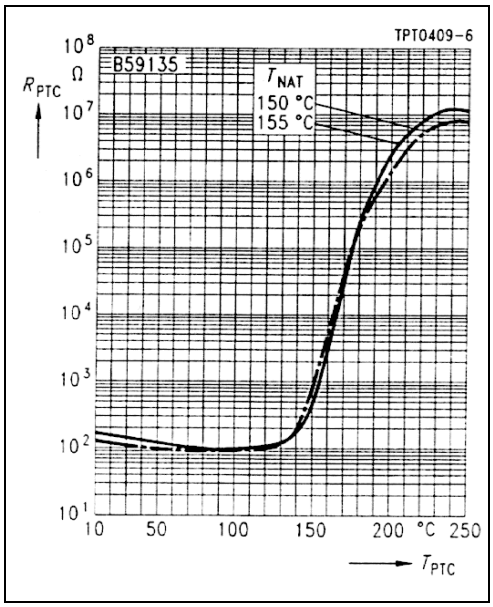


Fig. 3-69 PTC characteristic for 1LG / 1LA motors

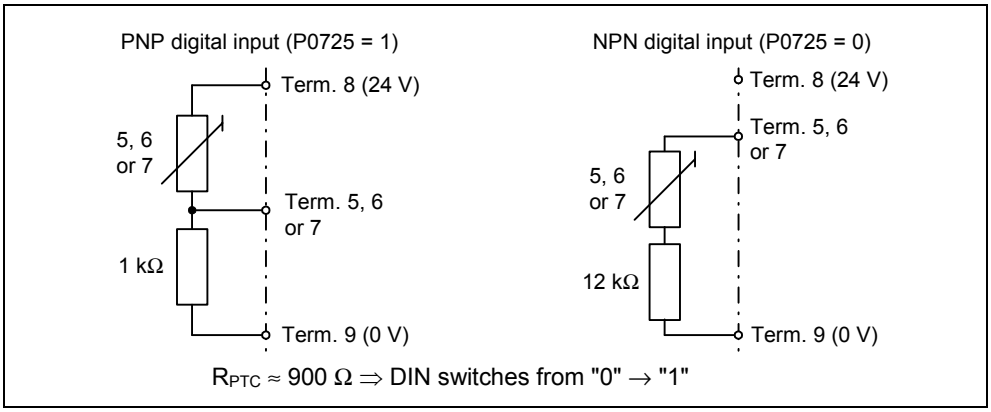


Fig. 3-70 Connecting a temperature sensor to MICROMASTER 420

NOTE

The specified circuit examples apply for the PTC temperature sensor from the M11 Motor Catalog (motor protection using PTC thermistors, Code Z = A10 – A16) - that is used for the 1LA and 1LG Siemens motors.

NOTE

In order to avoid noise from being coupled into the drive inverter electronics - with the associated disturbances - none of the free conductors in the motor cable may be used to connect the temperature sensor to the drive inverter. The temperature sensor must be connected to the drive inverter using a separate cable (if possible, using a shielded cable).

3.20 Power module protection

3.20.1 General overload monitoring

Parameter range: P0640, r0067, r1242, P0210
Warnings A0501, A0502, A0503
Faults F0001, F0002, F0003
Function chart number: -

Just the same as for motor protection, MICROMASTER provides extensive protection for the power components. This protection concept is also sub-divided into 2 levels:

- Warning and response
- Fault and shutdown

Using this concept, a high utilization of the power module components can be achieved without the drive inverter being immediately shut down. The power module components are monitored as follows:

Table 3-33 General protection of the power components

	Warning and response	Fault and shutdown
Overcurrent / short circuit	Imax controller for V/f A0501 r0056 bit 09 r0056 bit 13 (refer to Section 3.21.1.2)	F0001
DC link overvoltage	Vdc_max controller A0502 (refer to Section 3.17.1)	F0002

The monitoring thresholds for the right-hand column in the table above are permanently saved in the drive inverter and cannot be changed by the user. On the other hand, the threshold levels for the "Warning and response" column can be modified by the user to optimize the system. These values have default settings so that the "Fault and shutdown" thresholds do not respond.

3.20.2 Thermal monitoring functions and overload responses

Parameter range:	P0290 – P0294 r0036 – r0037
Warnings	A0504, A0505
Faults	F0004, F0005, F0012, F0020, F0022
Function chart number:	-

Similar to motor protection, the main function of the thermal power module monitoring is to detect critical states. Parameterizable responses are provided to the user which allows the drive system to be still operated at the power limit thus avoiding immediate shutdown. However, the possibilities of assigning parameters only involves interventions below the shutdown threshold which cannot be changed by users.

MICROMASTER 420 has the following thermal monitoring functions:

- **Heatsink temperature**

  The monitoring of the heatsink temperature r0037[0] of the power semiconductor (IGBT).

- **i^2t monitoring**

  The i^2t monitoring is used to protect components which have a long thermal time constant in comparison to the semiconductors. An overload with reference to i^2t is present if the drive inverter utilization r0036 indicates a value greater than 100 % (utilization as a % referred to rated operation).

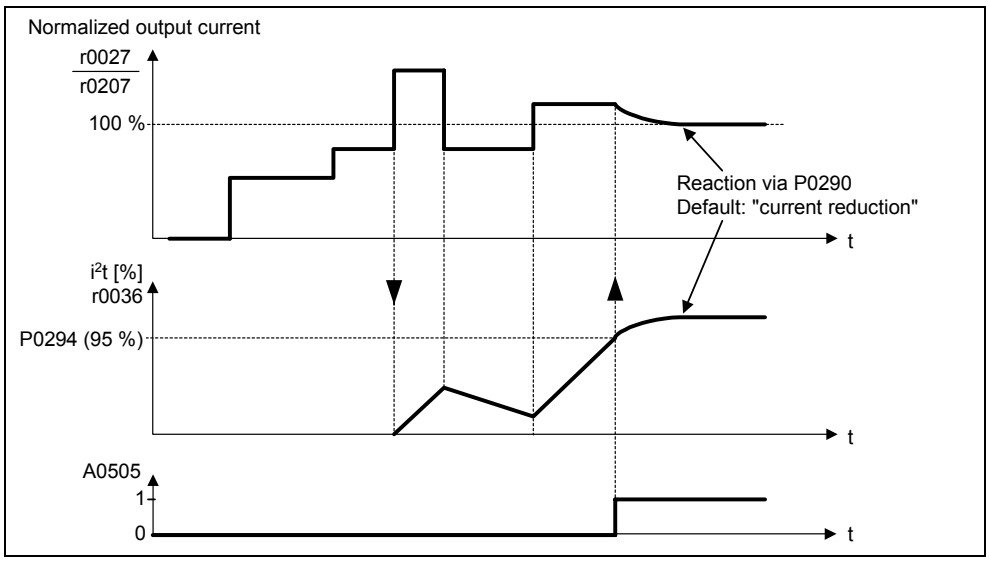


Fig. 3-71 Drive inverter response to an overload condition

Parameter P0290 defines how the drive inverter responds to an overload condition.

The following settings are possible:

0 "Reduce the output frequency"
1 "Shutdown (F0004)"
2 "Reduce the pulse frequency and output frequency"
3 "Reduce the pulse frequency then shutdown (F0004)"

When an overload occurs regarding one of these monitoring functions, initially, a warning is output. The warning threshold P0294 (i^2t monitoring) and P0292 (heatsink temperature monitoring) can be parameterized relative to the shutdown values.

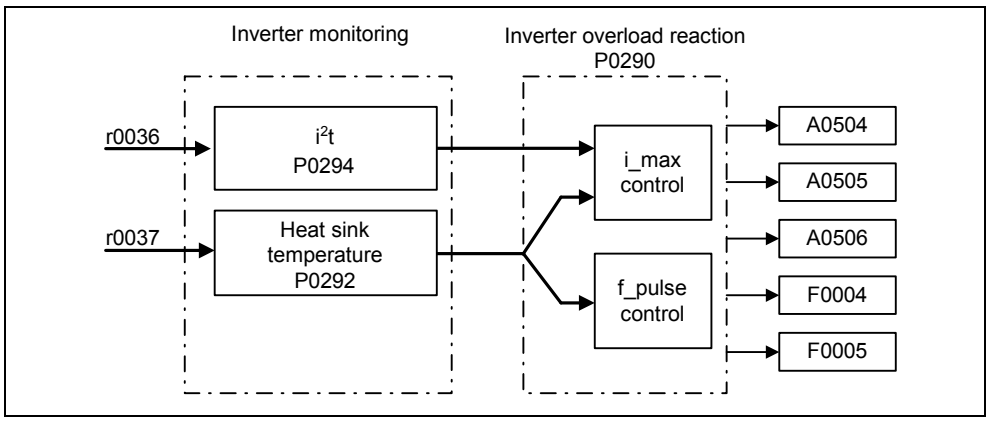


Fig. 3-72 Overload response of the drive inverter (P0290)

Example

The warning threshold P0292 for the temperature monitoring (heatsink temperature) is set to 15 °C in the factory. This means that warning A0504 is output 15 °C below the shutdown threshold.

At the same time that the warning is output, the parameterized responses are initiated via P0290. Possible responses include:

- **Reducing the pulse frequency (P0290 = 2, 3)**

  This is an extremely effective method to reduce losses in the power module, as the switching losses represent a very high proportion of the overall losses. In many applications, a temporary reduction of the pulse frequency can be tolerated in favor of maintaining the process.

  Disadvantage

  The current ripple is increased when the pulse frequency is reduced. This can result in an increase of the torque ripple at the motor shaft (for low moments of inertia) and an increase in the noise level.

- **Reducing the output frequency (P0290 = 0,2)**

  This is advantageous if it is not desirable to reduce the pulse frequency or if the pulse frequency is already set to the lowest level. Further, the load should have a characteristic similar to that of a fan, i.e. a square-law torque characteristic for decreasing speed. When the output frequency is reduced, this significantly reduces the drive inverter output current and in turn reduces the losses in the power module.

- **No reduction (P0290 = 1)**

  This option should be selected if neither a reduction in the pulse frequency nor a reduction in the output current is being considered. In this case, the drive inverter does not change its operating point after the warning threshold has been exceeded so that the drive can be further operated until the shutdown values are reached. After the shutdown threshold has been reached, the drive inverter shuts down (trips) with fault F0004. The time which expires up to shutdown is however not defined and depends on the magnitude of the overload. Only the warning threshold can be changed in order to obtain an earlier warning and, if required, externally intervene in the drive process (e.g. by reducing the load, lowering the ambient temperature).

NOTE

- If the drive inverter fan fails, this would be indirectly detected by the measurement of the heatsink temperature.
- A wire breakage or short circuit of the temperature sensor(s) is also monitored.

3.21 Open-loop/closed-loop control technique

There are several open-loop/closed-loop techniques for speed and torque control for drive inverters with induction and synchronous motors. These techniques can be roughly classified as follows:

- V/f characteristic control (briefly: V/f control)
- Field-orientated closed-loop control technique (briefly: Vector control)

These techniques differ from one another both regarding the control quantity as also in the complexity of the technique, which in turn are obtained as a result of the requirements associated with the particular application. For basic applications (e.g. pumps and fans), to a large extent, V/f control is used. Vector control is mainly used for sophisticated applications (e.g. winders), where a good control and behavior in noisy conditions are required regarding the speed and torque. If these requirements are also present in the range from 0 to approx. 1 Hz, then the speed/torque accuracy without encoder is not sufficient. In this case, Vector control with speed feedback must be used.

NOTE

Vector control is only available for MICROMASTER 440.

3.21.1 V/f control

Parameter range:	P1300 P1310 – P1350
Warnings	-
Faults	-
Function chart number:	FP6100

The V/f characteristic represents the simplest control technique. In this case the stator voltage of the induction motor or synchronous motor is controlled proportionally to the stator frequency. This technique has proven itself for a wide range of "basic" applications, such as

- Pumps, fans
- Belt drives

and similar processes.

The goal of V/f control is to keep the flux Φ constant in the motor. In this case, this is proportional to the magnetizing current I_μ and the ratio between voltage V and frequency f.

$$\Phi \sim I_\mu \sim V/f$$

The torque M, developed by induction motors, is proportional to the product (precisely the vectorial product $\underline{\Phi} \times \underline{I}$) of flux and current.

$$M \sim \Phi * I$$

In order to generate the highest possible torque from a given current, the motor must operate with a constant flux which is as high as possible. In order to keep the flux Φ constant, when frequency f changes, the voltage V must be changed in proportion so that a constant magnetizing current I_μ flows. The V/f characteristic control is derived from these basic principles.

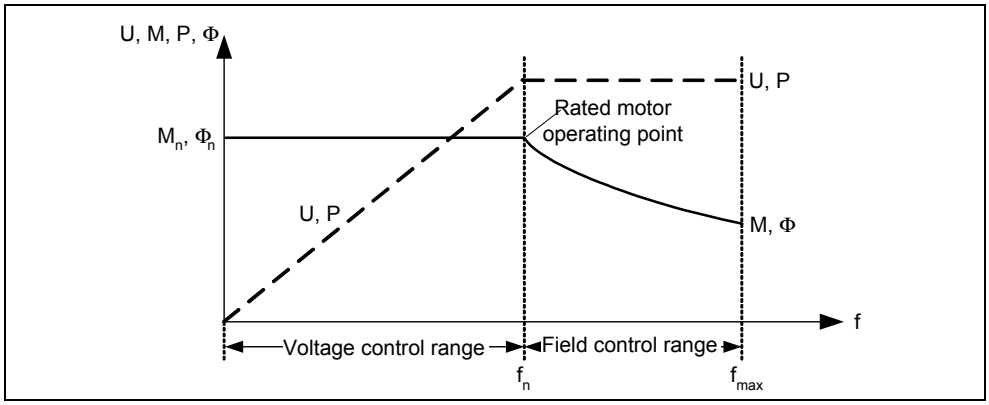
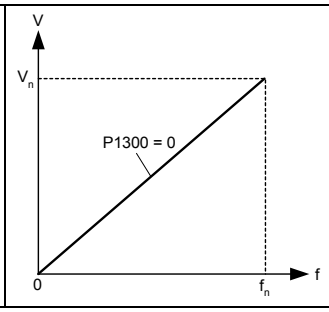
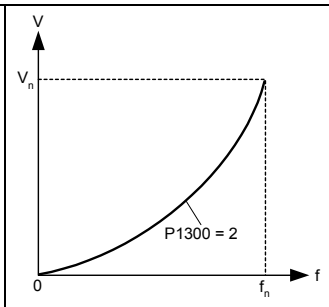
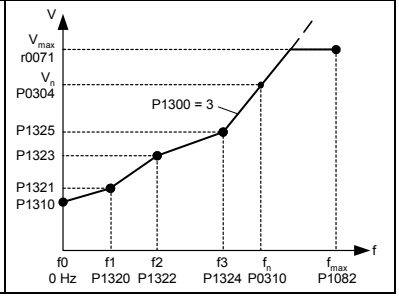


Fig. 3-73 Operating ranges and characteristics of an induction motor when fed from a drive inverter

There are several versions of the V/f characteristic as shown in Table 3-34.

Table 3-34 V/f characteristic (parameter P1300)

Parameter value	Significance	Use / property	
0	Linear characteristic	Standard case	
1	FCC	Characteristic which compensates the voltage losses of the stator resistance for static (steady-state) or dynamic loads (flux current control FCC). This is especially used for small motors which have a relatively high stator resistance. Refer to Section 3.21.1.2.	
2	Square-law characteristic	This is a characteristic which takes into consideration the torque characteristic of the driven load (e.g. fan / pump) a) Square-law characteristic (f^2 characteristic) b) Energy saving as the lower voltage also results in lower currents and losses.	
3	Programmable characteristic	Characteristic which takes into consideration the torque characteristic of the motor / driven load (e.g. synchronous motor).	

3.21.1.1 Voltage boost

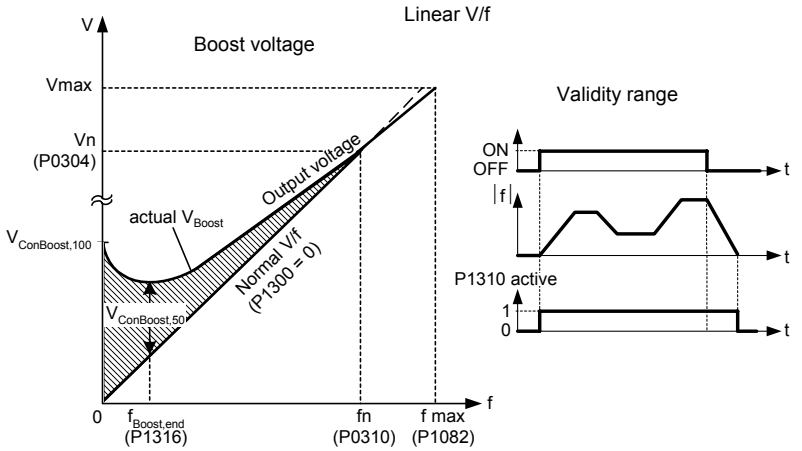
Parameter range:	P1310, P1311, P1312 r0056 bit 05
Warnings	-
Faults	-
Function chart number:	FP6100

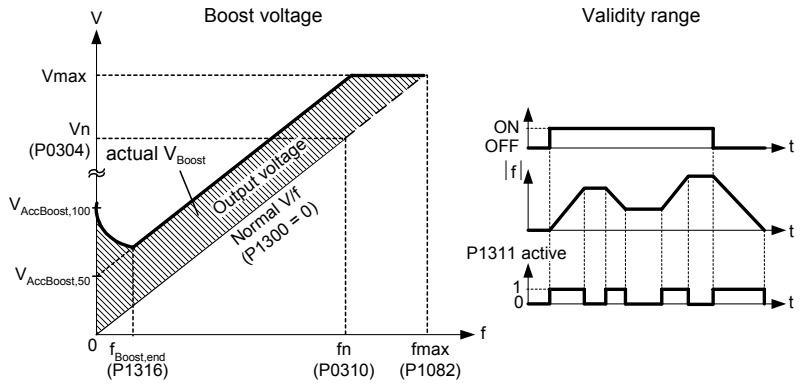
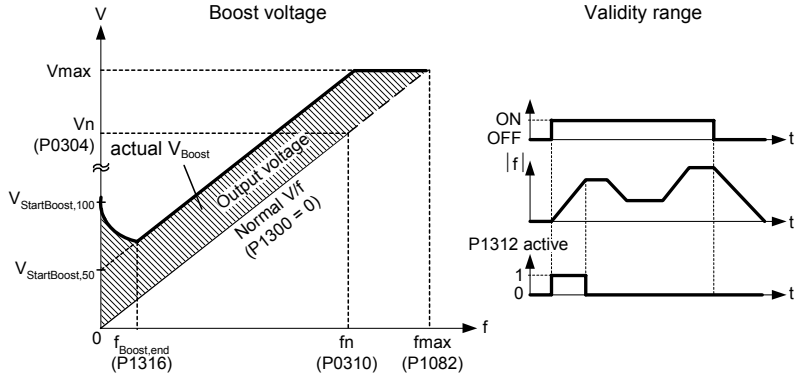
For low output frequencies, the V/f characteristics only output a low output voltage. Even at low frequencies, the ohmic resistances of the stator winding play a role, which are neglected when determining the motor flux in Section 3.21.1. This means that the output voltage can be too low in order to

- implement the magnetization of an induction motor,
- to hold the load
- to voltage drops (ohmic losses in the winding resistances) in the system or
- to provide a breakaway / accelerating / braking torque.

The output voltage can be increased (boosted) in MICROMASTER using the following parameters (refer to Table 3-35):

Table 3-35 Voltage boost

Parameter	Voltage boost	Explanation
P1310	Constant voltage boost	The voltage boost is effective over the complete frequency range whereby the value continually decreases at high frequencies.
	 \\erlf305a\Graphics_PLI\Images\p1310_linear_MM420.vsd	
P1311	Voltage boost when accelerating- / braking	The voltage boost is only effective when accelerating or braking.

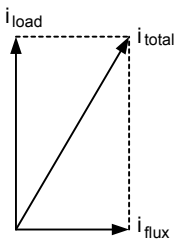
Parameter	Voltage boost	Explanation
	 \\erlf305a\Graphics_PLI\Images\p1311_MM420.vsd	
P1312	Voltage boost when starting	The voltage boost is only effective when accelerating for the first time (standstill)
	 \\erlf305a\Graphics_PLI\Images\p1312_MM420.vsd	

NOTE

- Especially at low frequencies, the motor temperature is additionally increased as a result of the voltage boost (the motor overheats) !
- The voltage value at 0 Hz is determined from the product of rated motor current P0305, stator resistance P0350 and the appropriate parameters P1310 – P1312.

3.21.1.2 V/f open-loop control with flux current control (FCC)

Parameter range:	P1300, P1333
Warnings	-
Faults	-
Function chart number:	-



An improved current measurement function has been developed for our MICROMASTER drive inverters. This permits the output current to be precisely determined referred to the motor voltage. This measurement guarantees that the output current is sub-divided into a load component and a flux component. Using this sub-division, the motor flux can be controlled and can be appropriately adapted and optimized in-line with the prevailing conditions.

FCC operation is only activated after the FCC starting frequency P1333 has been exceeded. The FCC starting frequency P1333 is entered as a percentage to the rated motor frequency P0310. For a rated motor frequency of 50 Hz and a factory setting of P1333 = 10 %, this results in an FCC starting frequency of 5 Hz. The FCC starting frequency may not be selected too low as this has a negative impact on the control characteristics and can result in oscillation and system instability.

The "V/f with FCC" control type (P1300 = 1) has proven itself in many applications. It has the following advantages with respect to the standard V/f control:

- Higher motor efficiency
- Improved stabilizing characteristics
  - → higher dynamic response
  - → improved behavior to disturbances / control

3.21.1.3 Slip compensation

Parameter range:	P1335 – r1337
Warnings	-
Faults	-
Function chart number:	FP6100

In the V/f characteristic operating mode the motor frequency is always lower than the drive inverter output frequency by the slip frequency f_s. If the load (the load is increased from M_1 to M_2) is increased with a constant output frequency, then the slip s when motoring increases and the motor frequency decreases (from f_1 to f_2). This behavior, typical for an induction motor, can be compensated using slip compensation P1335. This therefore eliminates the speed reduction, caused by the load, by boosting (increasing) the drive inverter output frequency (refer to Fig. 3-74).

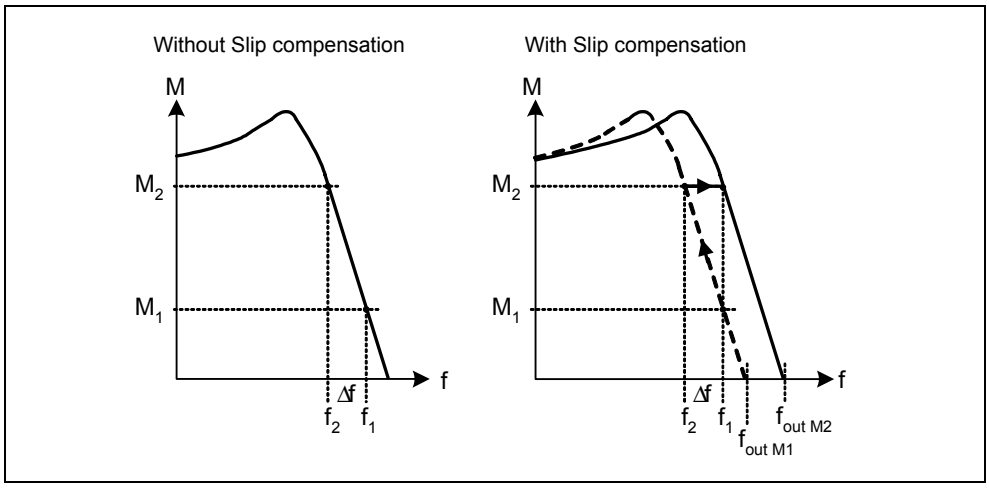


Fig. 3-74 Slip compensation

3.21.1.4 V/f resonance damping

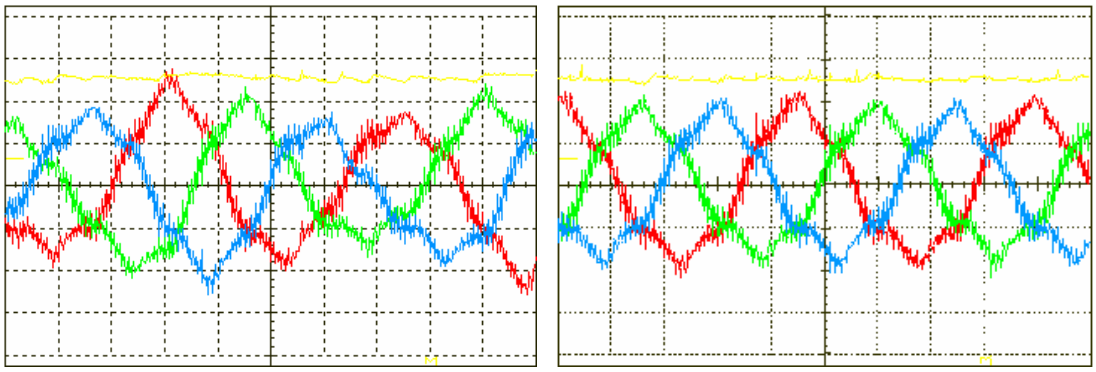
Parameter range:	P1338, P1349
Warnings	-
Faults	-
Function chart number:	-

For variable-speed drives, resonance effects can occur in the upper frequency range (> 20 Hz). These resonance effects result in an increased noise level and also can damage / destroy the mechanical system. These resonance effects can occur for:

- Geared motors
- Reluctance motors
- Large motors
  (low stator resistance → poor electrical damping)

Contrary to the "skip frequency" function (refer to Section 3.12.1 and parameters P1091 to P1094), where the resonance frequency is passed through as quickly as possible, for the V/f resonance damping (parameter P1338), the resonance effects are dampened from a control-related perspective. The advantage of this function is that by using this active damping, operation is possible in the resonance range.

The V/f resonance damping is activated and adjusted using parameter P1338. This parameter represents a gain factor that is a measure for the damping of the resonance frequency. With parameter P1349 the upper limit is defined for the effectiveness of this parameter. In a range of 5 % below the upper limit, damping is reduced linearly from 100 % to 0 %. The following oscillogram (refer to Fig. 3-75) indicates the effect of the resonance damping function using as an example a reluctance motor with gearbox. The phase output currents are displayed for an output frequency of 45 Hz.



Without V/f resonance damping (P1338 = 0) V/f resonance damping active (P1338 = 1)

Fig. 3-75 Effect of V/f resonance damping

3.21.1.5 Current limiting (Imax controller)

Parameter range:	P1340 – P1344
	r0056 bit 13
Warnings	A0501
Faults	F0001
Function chart number:	FP6100

Our drive inverters have, in the V/f characteristic mode, a current limiting controller (Imax controller, refer to Fig. 3-76). This controller avoids overload conditions. This controller protects the drive inverter and the motor against continuous overload conditions by automatically reducing the drive inverter output frequency by f_{Imax} (r1343) or the drive inverter output voltage by V_{Imax} (r1344). By either reducing the output frequency or the output voltage, this reduces the load on the drive inverter and protects against continuous damage.

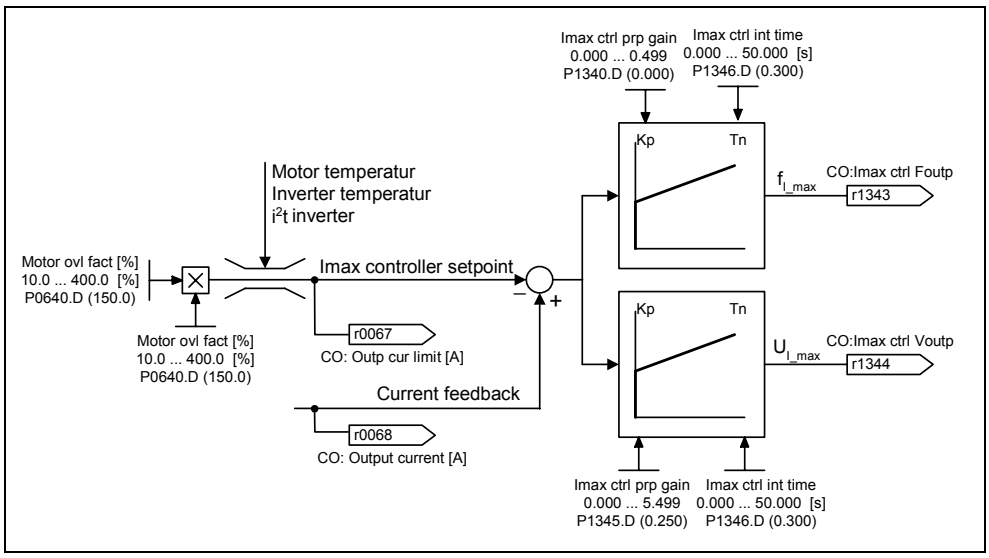


Fig. 3-76 Imax controller

NOTE

A reduction in the frequency only reduces the load if the load decreases at lower speeds (e.g. square-law torque-speed characteristic of the driven load).

4 Troubleshooting

This Chapter contains:

- Operating statuses and messages of the inverter with the SDP
- Notes on troubleshooting with the BOP
- A list of the alarms and fault messages

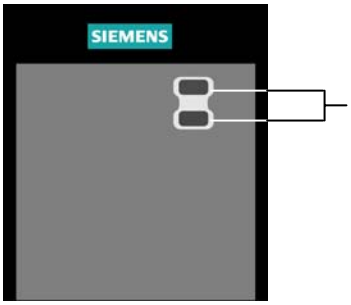
4.1 Troubleshooting with the SDP 178
4.2 Troubleshooting with the BOP 179
4.3 Fault messages 180

WARNING

- Repairs on equipment may only be carried out by **Siemens Service**, by repair centers **authorized by Siemens** or by qualified personnel who are thoroughly acquainted with all the warnings and operating procedures contained in this manual.
- Any defective parts or components must be replaced using parts contained in the relevant spare parts list.
- Disconnect the power supply before opening the equipment for access

4.1 Troubleshooting with the SDP

Table 4-1 explains the meaning of the various states of the LEDs on the SDP.



LEDs for indicating the drive state
- Off
- On
- approx. 0,3 s, flashing
- approx. 1 s, twinkling

Table 4-1 Inverter conditions indicated by the LEDs on the SDP

● ●	Mains not present
☼ ☼	Ready to run
● ☼	Inverter fault - other than the ones listed below
☼ ●	Inverter running
● ◎	Fault overcurrent
◎ ●	Fault overvoltage
◎ ☼	Fault motor overtemperature
☼ ◎	Fault inverter temperature
◎ ◎	Warning current limit - both LEDs twinkling **same time**
◎ ◎	Other warnings - both LEDs twinkling **alternatively**
◎ ◎	Undervoltage trip / undervoltage warning
◎ ◎	Drive is not in ready state
◎ ◎	ROM failure - Both LEDs flashing **same time**
◎ ◎	RAM failure - Both LEDs flashing **alternatively**

4.2 Troubleshooting with the BOP

Warnings and faults are displayed on the BOP with Axxx and Fxxx respectively. The individual messages are shown in the Parameter list.

If the motor fails to start when the ON command has been given:

- Check that P0010 = 0.
- Check that a valid ON signal is present.
- Check that P0700 = 2 (for digital input control) or
  P0700 = 1 (for BOP control).
- Check that the setpoint is present (0 to 10V on Terminal 3) or the setpoint has been entered into the correct parameter, depending upon the setpoint source (P1000). See the Parameter List for further details.

If the motor fails to run after changing the parameters, set P0010 = 30 then P0970 = 1 and press **P** to reset the inverter to the factory default parameter values.

Now use a switch between terminals **5** and **8** on the control board. The drive should now run to the defined setpoint by analogue input.

NOTICE

Motor data must relate to the inverter data power range and voltage.

4.3 Fault messages and alarm messages

4.3.1 Fault messages

In the event of a failure, the inverter switches off and a fault code appears on the display.

NOTE
To reset the fault code, one of three methods listed below can be used:

1. Cycle the power to the drive.
2. Press the Fn button on the BOP or AOP.
3. Via Digital Input 3 (default setting)

Fault messages are stored in parameter r0947 under their code number (e.g. F0003 = 3). The associated error value is found in parameter r0949. The value 0 is entered if a fault has no error value. It is furthermore possible to read out the point in time that a fault occurred (r0948) and the number of fault messages (P0952) stored in Parameter r0947.

A detailed description of the fault messages is provided in the parameter list.

4.3.2 Alarm messages

Alarm messages are stored in parameter r2110 under their code number (e.g. A0503 = 503) and can be read out from there.

A detailed description of the alarm messages is provided in the parameter list.

4.3.3 Suppressing fault / alarm messages

From the perspective of the application and user, fault-free operation is the decisive criterion when it comes to the acceptance of drive systems. For special applications, not only this, but fault-free operation is required even if an overload condition exists or external events cause faults. For applications such as these (e.g. mixer systems), fault-free operation has a higher priority than the protection of the drive system.

With MICROMASTER, it is possible to suppress up to 3 fault / alarm messages using the indexed parameters P2100 and P2101. The fault / alarm messages to be suppressed (refer to Section "Fault / alarm messages") are selected using parameter P2100 while the response is entered using parameter P2101. Indices 0 - 2 of the two parameters are used to correlate between suppressing the fault / alarm messages and the response. The following settings are possible for the responses:

0 No response, no display

1 OFF1 stop response

2 OFF2 stop response

3 OFF3 stop response

4 No response, only a warning

Example:

Alarm A0911 indicates that the drive has extended the ramp run-down time in order to avoid an overvoltage condition. If you wish to suppress this message, then set the following parameters:

P2100[0] = 911 (selects Alarm A0911)

P2101[0] = 0 (no response, no display)

NOTE

- All of the fault messages are assigned the standard response to OFF2 (refer to the fault/alarm list).
- The standard responses of several fault messages, caused by the hardware - e.g. overcurrent F0001 - can neither be suppressed nor modified.

5 MICROMASTER 420 specifications

This Chapter contains:

- Table 5-1 contains the general technical specifications for the MICROMASTER 420 inverter
- Table 5-2 contains terminal tightening torques
- Table 5-3 contains information on reducing the current as a function of the pulse frequency
- Table 5-4 includes various tables of specific technical data for individual MICROMASTER 420 inverters

Table 5-1 MICROMASTER Performance Ratings

Feature	Specification
Mains operating voltage and Power ranges	1 AC 200 V to 240 V ± 10 % 0,12 kW – 3,0 kW (0,16 hp – 4,0 hp) 3 AC 200 V to 240 V ± 10 % 0,12 kW – 5,5 kW (0,16 hp – 7,5 hp) 3 AC 380 V to 480 V ± 10 % 0,37 kW – 11,0 kW (0,50 hp – 15,0 hp)
Input frequency	47 Hz to 63 Hz
Output frequency	0 Hz to 650 Hz
Power factor	≥ 0,7
Inverter efficiency	96 % to 97 %
Overload capability	50 % overload capability for 60 s within 5 min period referred to the rated output current
Inrush current	Less than nominal input current
Power-ON-OFF cycle time	Every 30 s
Control method	Linear V/f Control; Linear V/f with Flux Current Control (FCC), Quadratic V/f Control; Multi-point V/f control
Pulse frequency	2 kHz to 16 kHz (2 kHz steps)
Fixed frequencies	7, programmable
Skip frequencies	4, programmable
Setpoint resolution	0.01 Hz Digital, 0.01 Hz Serial, 10 bit Analogue (motor potentiometer 0.1 Hz [0.1% (in PID mode)])
Digital inputs	3, programmable (isolated), switchable active high / active low (PNP/NPN)
Analogue input	1, (0 to 10 V) used for frequency setpoint or PI feedback signal, scalable or usable as 4th digital input
Relay output	1, programmable 30 V DC / 5 A (resistive), 250 V AC / 2 A (inductive)
Analogue output	1, programmable (0 mA to 20 mA)
Serial interface	RS-485, Option RS-232
Electromagnetic compatibility	Optional EMC filters to EN55011 Class A or B, also Internal Class A filters available
Braking	DC braking, compound braking
Protection level	IP20
Temperature range	-10 °C to +50 °C (14 °F to 122 °F)
Storage temperature	-40 °C to +70 °C (-40 °F to 158 °F)
Humidity	< 95 % RH – non-condensing
Operational altitudes	up to 1000 m above sea level without derating
Protection features	Undervoltage , Overvoltage, Overload, Ground Faults, Short circuit, Stall Prevention, Motor Blocking Protection, Motor Overtemperature, Inverter Overtemperature, Parameter Interlock
Standards	UL, cUL, CE, C-tick
CE Marked	Conformity with EC Low Voltage Directive 73/23/EEC and Electromagnetic Compatibility Directive 89/336/EEC

Table 5-2 Dimensions, required cooling air flow and tightening torques for power terminals

Frame Size	Dimensions			Required cooling air flow		Tightening torque for power connections	
A	W x H x D	mm	73 × 173 × 149	l/s	4.8	Nm	1.1
		inch	2.87 × 6.81 × 5.87	CFM	10.2	lbf.in	10
B	W x H x D	mm	149 × 202 × 172	l/s	24	Nm	1.5
		inch	5.87 × 7.95 × 6.77	CFM	51	lbf.in	13.3
C	W x H x D	mm	185 × 245 × 195	l/s	54.9	Nm	2.25
		inch	7.28 × 9.65 × 7.68	CFM	116.3	lbf.in	20

Table 5-3 Current reduction depending on pulse frequency

Mains voltage	Power (CT) [kW]	Output current in A with a switching frequency of:						
		4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
1/3 AC 200 V	0.12 to 5.5	Factory setting 16 kHz – no derating necessary						
3 AC 400 V	0.37	1.2	1.2	1.2	1.2	1.2	1.2	1.1
	0.55	1.6	1.6	1.6	1.6	1.6	1.6	1.1
	0.75	2.1	2.1	2.1	2.1	1.6	1.6	1.1
	1.1	3.0	3.0	2.7	2.7	1.6	1.6	1.1
	1.5	4.0	4.0	2.7	2.7	1.6	1.6	1.1
	2.2	5.9	5.9	5.1	5.1	3.6	3.6	2.6
	3.0	7.7	7.7	5.1	5.1	3.6	3.6	2.6
	4.0	10.2	10.2	6.7	6.7	4.8	4.8	3.6
	5.5	13.2	13.2	13.2	13.2	9.6	9.6	7.5
	7.5	19.0	18.4	13.2	13.2	9.6	9.6	7.5
	11.0	26.0	26.0	17.9	17.9	13.5	13.5	10.4

Table 5-4 MICROMASTER 420 Specifications

In order to have a UL compliant installation fuses from the SITOR range with the appropriate current rating must be used.

Input voltage range 1 AC 200 V – 240 V, ± 10 %
(with built in Class A Filter)

Order No. 6SE6420-		**2AB11 -2AA1**	**2AB12 -5AA1**	**2AB13 -7AA1**	**2AB15 -5AA1**	**2AB17 -5AA1**	**2AB21 -1BA1**	**2AB21 -5BA1**	**2AB22 -2BA1**	**2AB23 -0CA1**
Output Rating	[kW] [hp]	0.12 0.16	0.25 0.33	0.37 0.5	0.55 0.75	0.75 1.0	1.1 1.5	1.5 2.0	2.2 3.0	3.0 4.0
Output Power	[kVA]	0.4	0.7	1.0	1.3	1.7	2.4	3.2	4.6	6.0
Input Current 1)	[A]	1.8	3.2	4.6	6.2	8.2	11.0	14.4	20.2	35.5
Output Current	[A]	0.9	1.7	2.3	3.0	3.9	5.5	7.4	10.4	13.6
Fuse	[A]	10	10	10	10	16	20	20	32	40
Recommended	3NA	3803	3803	3803	3803	3805	3807	3807	3812	3817
For UL specified		*	*	*	*	*	*	*	*	*
Input Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	2.5 16	2.5 16	4.0 12	6.0 10
Input Cable, max.	[mm^2] [awg]	2.5 14	2.5 14	2.5 14	2.5 14	2.5 14	6.0 10	6.0 10	6.0 10	10.0 8
Output Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.5 16
Output Cable, max.	[mm^2] [awg]	2.5 14	2.5 14	2.5 14	2.5 14	2.5 14	6.0 10	6.0 10	6.0 10	10.0 8
Weight	[kg] [lbs]	1.2 2.6	1.2 2.6	1.2 2.6	1.3 2.9	1.3 2.9	3.3 7.3	3.6 7.9	3.6 7.9	5.2 11.4

1) Secondary conditions: Input current at the rated operating point - applies for the short-circuit voltage of the line supply V_k = 2 % referred to the rated drive converter power and a rated line supply voltage of 240 V without line commutating reactor.

* UL listed fuses such as Class NON from Bussmann are required for use in America

Input voltage range (Unfiltered) **1 AC 200 V – 240 V, ± 10 %**

Order No.	6SE6420-	**2UC11 -2AA1**	**2UC12 -5AA1**	**2UC13 -7AA1**	**2UC15 -5AA1**	**2UC17 -5AA1**	**2UC21 -1BA1**	**2UC21 -5BA1**	**2UC22 -2BA1**	**2UC23 -0CA1**
Output Rating	[kW]	0.12	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3.0
	[hp]	0.16	0.33	0.5	0.75	1.0	1.5	2.0	3.0	4.0
Output Power	[kVA]	0.4	0.7	1.0	1.3	1.7	2.4	3.2	4.6	6.0
Input Current 1)	[A]	1.8	3.2	4.6	6.2	8.2	11.0	14.4	20.2	35.5
Output Current	[A]	0.9	1.7	2.3	3.0	3.9	5.5	7.4	10.4	13.6
Fuse	[A]	10	10	10	10	16	20	20	32	40
Recommended	3NA	3803	3803	3803	3803	3805	3807	3807	3812	3817
For UL specified		*	*	*	*	*	*	*	*	*
Input Cable, min.	[mm^2]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5
	[awg]	18	18	18	18	18	18	18	18	14
Input Cable, max.	[mm^2]	2.5	2.5	2.5	2.5	2.5	6.0	6.0	6.0	10.0
	[awg]	14	14	14	14	14	10	10	10	8
Output Cable, min.	[mm^2]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5
	[awg]	18	18	18	18	18	18	18	18	16
Output Cable, max.	[mm^2]	2.5	2.5	2.5	2.5	2.5	6.0	6.0	6.0	10.0
	[awg]	14	14	14	14	14	10	10	10	8
Weight	[kg]	1.2	1.2	1.2	1.2	1.2	2.9	2.9	3.1	5.2
	[lbs]	2.6	2.6	2.6	2.6	2.6	6.4	6.4	6.8	11.4

Input voltage range (with built in Class A Filter) **3 AC 200 V – 240 V, ± 10 %**

Order No.	6SE6420-	**2AC23 -0CA1**	**2AC24 -0CA1**	**2AC25 -5CA1**
Output Rating	[kW]	3.0	4.0	5.5
	[hp]	4.0	5.0	7.5
Output Power	[kVA]	6.0	7.7	9.6
Input Current 1)	[A]	15.6	19.7	26.5
Output Current	[A]	13.6	17.5	22.0
Fuse	[A]	25	32	35
Recommended	3NA	3810	3812	3814
For UL specified		*	*	*
Input Cable, min.	[mm^2]	2.5	2.5	4.0
	[awg]	14	14	12
Input Cable, max.	[mm^2]	10.0	10.0	10.0
	[awg]	8	8	8
Output Cable, min.	[mm^2]	1.5	2.5	4.0
	[awg]	16	14	12
Output Cable, max.	[mm^2]	10.0	10.0	10.0
	[awg]	8	8	8
Weight	[kg]	5.2	5.5	5.5
	[lbs]	11.4	12.1	12.1

1) Secondary conditions: Input current at the rated operating point - applies for the short-circuit voltage of the line supply V_k = 2 % referred to the rated drive converter power and a rated line supply voltage of 240 V without line commutating reactor.

* UL listed fuses such as Class NON from Bussmann are required for use in America

Input voltage range (Unfiltered) **3 AC 200 V – 240 V, ± 10 %**

Order No.	6SE6420-	2UC11-2AA1	2UC12-5AA1	2UC13-7AA1	2UC15-5AA1	2UC17-5AA1	2UC21-1BA1	2UC21-5BA1	2UC22-2BA1
Output Rating	[kW]	0.12	0.25	0.37	0.55	0.75	1.1	1.5	2.2
	[hp]	0.16	0.33	0.5	0.75	1.0	1.5	2.0	3.0
Output Power	[kVA]	0.4	0.7	1.0	1.3	1.7	2.4	3.2	4.6
Input Current 1)	[A]	1.1	1.9	2.7	3.6	4.7	6.4	8.3	11.7
Output Current	[A]	0.9	1.7	2.3	3.0	3.9	5.5	7.4	10.4
Fuse	[A]	10	10	10	10	10	16	16	20
Recommended	3NA	3803	3803	3803	3803	3803	3805	3805	3807
For UL specified		*	*	*	*	*	*	*	*
Input Cable, min.	[mm^2]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	[awg]	18	18	18	18	18	18	18	18
Input Cable, max.	[mm^2]	2.5	2.5	2.5	2.5	2.5	6.0	6.0	6.0
	[awg]	14	14	14	14	14	10	10	10
Output Cable, min.	[mm^2]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	[awg]	18	18	18	18	18	18	18	18
Output Cable, max.	[mm^2]	2.5	2.5	2.5	2.5	2.5	6.0	6.0	6.0
	[awg]	14	14	14	14	14	10	10	10
Weight	[kg]	1.2	1.2	1.2	1.2	1.2	2.9	2.9	3.1
	[lbs]	2.6	2.6	2.6	2.6	2.6	6.4	6.4	6.8

Order No.	6SE6420-	2UC23-0CA1	2UC24-0CA1	2UC25-5CA1
Output Rating	[kW]	3.0	4.0	5.5
	[hp]	4.0	5.0	7.5
Output Power	[kVA]	6.0	7.7	9.6
Input Current 1)	[A]	15.6	19.7	26.5
Output Current	[A]	13.6	17.5	22.0
Fuse	[A]	25	32	35
Recommended	3NA	3810	3812	3814
For UL specified		*	*	*
Input Cable, min.	[mm^2]	2.5	2.5	4.0
	[awg]	14	14	12
Input Cable, max.	[mm^2]	10.0	10.0	10.0
	[awg]	8	8	8
Output Cable, min.	[mm^2]	1.5	2.5	4.0
	[awg]	16	14	12
Output Cable, max.	[mm^2]	10.0	10.0	10.0
	[awg]	8	8	8
Weight	[kg]	5.2	5.5	5.5
	[lbs]	11.4	12.1	12.1

1) Secondary conditions: Input current at the rated operating point - applies for the short-circuit voltage of the line supply V_k = 2 % referred to the rated drive converter power and a rated line supply voltage of 240 V without line commutating reactor.

* UL listed fuses such as Class NON from Bussmann are required for use in America

Input voltage range 3 AC 380 V – 480 V, ± 10 %
(with built in Class A Filter)

Order No.	6SE6420-	**2AD22-2BA1**	**2AD23-0BA1**	**2AD24-0BA1**	**2AD25-5CA1**	**2AD27-5CA1**	**2AD31-1CA1**
Output Rating	[kW] [hp]	2.2 3.0	3.0 4.0	4.0 5.0	5.5 7.5	7.5 10.0	11.0 15.0
Output Power	[kVA]	4.5	5.9	7.8	10.1	14.0	19.8
Input Current 1)	[A]	7.5	10.0	12.8	15.6	22.0	32.3
Output Current	[A]	5.9	7.7	10.2	13.2	19.0	26.0
Fuse	[A]	16	16	20	20	25	35
Recommended	3NA	3805	3805	3807	3807	3810	3814
For UL specified		*	*	*	*	*	*
Input Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.5 16	2.5 14	4.0 12	6.0 10
Input Cable, max.	[mm^2] [awg]	6.0 10	6.0 10	6.0 10	10.0 8	10.0 8	10.0 8
Output Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.0 18	1.5 16	2.5 14	4.0 12
Output Cable, max.	[mm^2] [awg]	6.0 10	6.0 10	6.0 10	10.0 8	10.0 8	10.0 8
Weight	[kg] [lbs]	3.1 6.8	3.3 7.3	3.3 7.3	5.4 11.9	5.7 12.5	5.7 12.5

1) Secondary conditions: Input current at the rated operating point - applies for the short-circuit voltage of the line supply V_k = 2 % referred to the rated drive converter power and a rated line supply voltage of 400 V without line commutating reactor.

* UL listed fuses such as Class NON from Bussmann are required for use in America

Input voltage range (Unfiltered) **3 AC 380 V – 480 V, ± 10 %**

Order No.	6SE6420-	**2UD13-7AA1**	**2UD15-5AA1**	**2UD17-5AA1**	**2UD21-1AA1**	**2UD21-5AA1**	**2UD22-2BA1**	**2UD23-0BA1**	**2UD24-0BA1**
Output Rating	[kW] [hp]	0.37 0.5	0.55 0.75	0.75 1.0	1.1 1.5	1.5 2.0	2.2 3.0	3.0 4.0	4.0 5.0
Output Power	[kVA]	0.9	1.2	1.6	2.3	3.0	4.5	5.9	7.8
Input Current 1)	[A]	2.2	2.8	3.7	4.9	5.9	7.5	10.0	12.8
Output Current	[A]	1.2	1.6	2.1	3.0	4.0	5.9	7.7	10.2
Fuse	[A]	10	10	10	10	10	16	16	20
Recommended	3NA	3803	3803	3803	3803	3803	3805	3805	3807
For UL specified		*	*	*	*	*	*	*	*
Input Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.5 16
Input Cable, max.	[mm^2] [awg]	2.5 14	2.5 14	2.5 14	2.5 14	2.5 14	6.0 10	6.0 10	6.0 10
Output Cable, min.	[mm^2] [awg]	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18	1.0 18
Output Cable, max.	[mm^2] [awg]	2.5 14	2.5 14	2.5 14	2.5 14	2.5 14	6.0 10	6.0 10	6.0 10
Weight	[kg] [lbs]	1.3 2.9	1.3 2.9	1.3 2.9	1.3 2.9	1.3 2.9	3.3 7.3	3.3 7.3	3.3 7.3

Order No.	6SE6420-	**2UD25-5CA1**	**2UD27-5CA1**	**2UD31-1CA1**
Output Rating	[kW] [hp]	5.5 7.5	7.5 10.0	11.0 15.0
Output Power	[kVA]	10.1	14.0	19.8
Input Current 1)	[A]	15.6	22.0	32.3
Output Current	[A]	13.2	19.0	26.0
Fuse	[A]	20	25	35
Recommended	3NA	3807	3810	3814
For UL specified		*	*	*
Input Cable, min.	[mm^2] [awg]	2.5 14	4.0 12	6.0 10
Input Cable, max.	[mm^2] [awg]	10.0 8	10.0 8	10.0 8
Output Cable, min.	[mm^2] [awg]	1.5 16	2.5 14	4.0 12
Output Cable, max.	[mm^2] [awg]	10.0 8	10.0 8	10.0 8
Weight	[kg] [lbs]	5.5 12.1	5.5 12.1	5.5 12.1

1) Secondary conditions: Input current at the rated operating point - applies for the short-circuit voltage of the line supply V_k = 2 % referred to the rated drive converter power and a rated line supply voltage of 400 V without line commutating reactor.

* UL listed fuses such as Class NON from Bussmann are required for use in America

6 Options

An overview of the options available for the MICROMASTER 420 is given in this section. For further information about options, please refer to the catalog or the documentation CD.

6.1 Device-independent options

- Basic Operator Panel (BOP)
- Advanced Operator Panel (AOP)
- PROFIBUS module
- PC to inverter connection kit
- PC to AOP connection kit
- BOP/AOP door mounting kit for single inverter control
- AOP door mounting kit for multiple inverter control
- "DriveMonitor" and "Starter" commissioning tool

6.2 Device-dependent options

- EMC filter, Class A
- EMC filter, Class B
- Additional EMC filter, Class B
- Low leakage Class B filter
- Line commutating choke
- Output choke
- LC filter
- Gland plate

CAUTION

If using output chokes or LC filters operation is only permissible with a pulse frequency of **4 kHz.** Make shure that the automatic pulse frequency reductions are disabled.
Coercing required parameter adjusting: **P1800 = 4 kHz , P0290 = 0 or 1**.

7 Electro-magnetic compatibility (EMC)

This Chapter contains:

EMC information.

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7.1 Electro-magnetic compatibility (EMC)

All manufacturers / assemblers of electrical apparatus which "performs a complete intrinsic function and is placed on the market as a single unit intended for the end user" must comply with the EMC directive 89/336/EEC.

There are three routes for the manufacturer/assembler to demonstrate compliance:

7.1.1 Self-certification

This is a manufacturer's declaration that the European standards applicable to the electrical environment for which the apparatus is intended have been met. Only standards that have been officially published in the Official Journal of the European Community can be cited in the manufacturer's declaration.

7.1.2 Technical construction file

A technical construction file can be prepared for the apparatus describing its EMC characteristics. This file must be approved by a 'Competent Body' appointed by the appropriate European government organization. This approach allows the use of standards that are still in preparation.

7.1.3 EC type examination certificate

This approach is only applicable to radio communication transmitting apparatus. All MICROMASTER units are certified for compliance with the EMC directive, when installed in accordance with the recommendations in Section 2.

7.1.4 EMC Directive Compliance with Imminent Harmonics Regulations

From 1st January 2001 all electrical apparatus covered by the EMC Directive will have to comply with EN 61000-3-2 "Limits for harmonic current emissions (equipment input ≤ 16 A per phase)".

All Siemens variable speed drives of the MICROMASTER, MIDIMASTER, MICROMASTER Eco and COMBIMASTER ranges, which are classified as "Professional Equipment" within the terms of the standard, fulfill the requirements of the standard.

Special considerations for 250 W to 550 W drives with 230 V 1ac mains supplies when used in non-industrial applications

Units in this voltage and power range will be supplied with the following warning:

"This equipment requires supply authority acceptance for connection to the public supply network". Please refer to EN 61000-3-12 sections 5.3 and 6.4 for further information. Units connected to Industrial Networks[1] do not require connection approval (see EN 61800-3, section 6.1.2.2).

The harmonic current emissions from these products are described in the table below:

Table 7-1 Permissible harmonic current emissions

Rating	**Typical Harmonic Current (A)**					**Typical Harmonic Current (%)**					**Typical Voltage Distortion**		
											Distribution Transformer Rating		
											10 kVA	100 kVA	1 MVA
	3rd	5th	7th	9th	11th	3rd	5th	7th	9th	11th	THD (%)	THD (%)	THD (%)
250 W 1AC 230 V	2.15	1.44	0.72	0.26	0.19	83	56	28	10	7	0.77	0.077	0.008
370 W 1AC 230 V	2.96	2.02	1.05	0.38	0.24	83	56	28	10	7	1.1	0.11	0.011
550 W 1AC 230 V	4.04	2.70	1.36	0.48	0.36	83	56	28	10	7	1.5	0.15	0.015

The allowed harmonic currents for "professional equipment" with an input power > 1 kW are not yet defined. Therefore, any electrical apparatus containing the above drives which has an input power > 1 kW will not require connection approval.

Alternatively, the necessity to apply for connection approval can be avoided by fitting the input chokes recommended in the technical catalogues (except 550 W 230 V 1ac units).

1 Industrial Networks are defined as those which do not supply buildings used for domestic purposes.

7.1.5 Classification of EMC performance

Three General classes of EMC performance are available as detailed below:

Class 1: General Industrial

Compliance with the EMC Product Standard for Power Drive Systems EN 61800-3 for use in **Second Environment (Industrial)**.

Table 7-2 Class 1 - General Industrial

EMC Phenomenon		**Standard**	**Level**
Emissions:	Radiated Emissions	EN 55011	Level A1
	Conducted Emissions	EN 61800-3	Limits complying with EN 55011, Class A, Group 2
Immunity:	Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
	Burst Interference	EN 61000-4-4	2 kV power cables, 1 kV control
	Radio Frequency Electromagnetic Field	EN 61000-4-3	26-1000 MHz, 10 V/m

Class 2: Filtered Industrial

This level of performance will allow the manufacturer/assembler to self-certify their apparatus for compliance with the EMC directive for the industrial environment as regards the EMC performance characteristics of the power drive system. Performance limits are as specified in the Generic Industrial Emissions and Immunity standards EN 61000-6-4 and EN 61000-6-2.

Table 7-3 Class 2 - Filtered Industrial

EMC Phenomenon		**Standard**	**Level**
Emissions:	Radiated Emissions	EN 55011	Limit A1
	Conducted Emissions	EN 61800-3	Limits complying with EN 55011, Class A, Group 2
Immunity:	Supply Voltage Distortion	EN 61000-2-4	
	Voltage Fluctuations, Dips, Unbalance, Frequency Variations	EN 61000-2-1	
	Magnetic Fields	EN 61000-4-8	50 Hz, 30 A/m
	Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
	Burst Interference	EN 61000-4-4	2 kV power cables, 2 kV control
	Radio Frequency Electromagnetic Field, amplitude modulated	EN 61000-4-3	80-1000 MHz, 10 V/m, 80% AM, power and signal lines
	Radio-frequency Electromagnetic Field, pulse modulated	EN 61000-4-3	900 MHz, 10 V/m 50% duty cycle, 200 Hz repetition rate

Class 3: Filtered - for residential, commercial and trade applications

This level of performance will allow the manufacturer / assembler to self-certify compliance of their apparatus with the EMC directive for the residential, commercial and trade applications environment as regards the EMC performance characteristics of the power drive system. Performance limits are as specified in the generic emission and immunity standards EN 61000-6-3 and EN 61000-6-1 in residential.

Table 7-4 Class 3 - Filtered for Residential, Commercial and trade applications

EMC Phenomenon		Standard	Level
Emissions:	Radiated Emissions*	EN 55011	Limit B
	Conducted Emissions	EN 61800-3	Category C1: Limit complying with EN 55011, Class B Category C2: Limit complying with EN 55011, Class A
Immunity:	Supply Voltage Distortion	EN 61000-2-4	
	Voltage Fluctuations, Dips, Unbalance, Frequency Variations	EN 61000-2-1	
	Magnetic Fields	EN 61000-4-8	50 Hz, 30 A/m
	Electrostatic Discharge	EN 61000-4-2	8 kV air discharge
	Burst Interference	EN 61000-4-4	2 kV power cables, 2 kV control
	Radio Frequency Electromagnetic Field, amplitude modulated	EN 61000-4-3	80-1000 MHz, 10 V/m, 80% AM, power and signal lines
	Radio-frequency Electromagnetic Field, pulse modulated	EN 61000-4-3	900 MHz, 10 V/m 50% duty cycle, 200 Hz repetition rate

* These limits are dependent on the inverter being correctly installed inside a metallic switchgear enclosure. The limits will not be met if the inverter is not enclosed.

NOTICE

- To achieve these performance levels, you must not exceed the default Pulse frequency nor use cables longer than 25 m.
- The MICROMASTER inverters are intended **exclusively for professional applications**. Therefore, they do not fall within the scope of the harmonics emissions specification EN 61000-3-2.
- Maximum mains supply voltage when filters are fitted is 460 V.

Table 7-5 Compliance Table

Model	Remarks
Class 1 – General Industrial	
6SE6420-2U***-**A1	Units without filters, all voltages and performances. The product norm EN 61800-3 +A11 for "Variable-speed electrical drives, Part 3: EMC product standard including specific test methods" specifies limits for conducted emissions which cannot be complied with by unfiltered inverters in the second environment. Filtered inverters (as described under Class 2) must be installed for drive systems in C3 installations. The use of unfiltered inverters in industrial environments is allowed only if they are part of a system which is equipped with line filters on the higher-level supply side.
Class 2 – Filtered Industrial	
6SE6420-2A***-**A0	All units with integral Class A filters
6SE6420-2A***-**A0 with 6SE6400-2FA00-6AD0	Frame size A units 400-480 V with external Class A footprint filters
Class 3 – Filtered for residential, commercial and light industry	
6SE6420-2U***-**A0 with 6SE6400-2FB0*-***0	Unfiltered units fitted with external Class B footprint filters.
6SE6420-2A***-**A1 with 6SE6400-2FS0*-***0 or 6SE6400-2FL0*-***0	Units with fitted Class A filters and additional external Class B filters.
6SE6420-2U***-**A1 with 6SE6400-2FA0*-***0 6SE6420-2A***-**A1	Unfiltered units fitted with external Class B filters All units with fitted Class A filters. For drive systems in category C2 installations, the following warning notice is necessary: In residential environments, this product may cause radio-frequency disturbances which may necessitate interference suppression measures.
* denotes any value is allowed.	

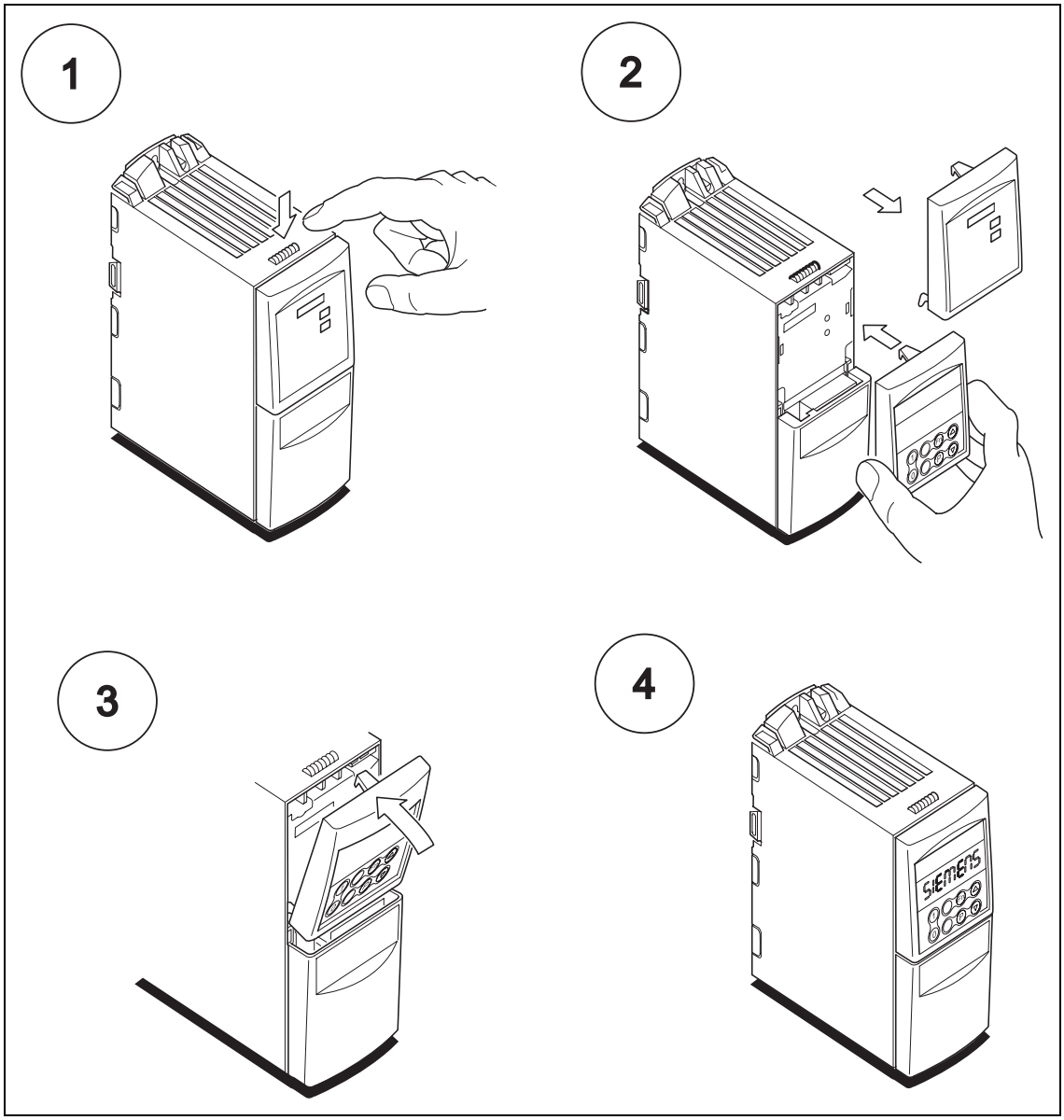
Category C3: Drive system (PDS) with rated voltage < 1000 V.
For use in second environment.

Category C2: Drive system (PDS) with rated voltage < 1000 V. For use in first environment. Installation and commissioning by EMC expert only.

Category C1: Drive system (PDS) with rated voltage < 1000 V.
For use in first environment.

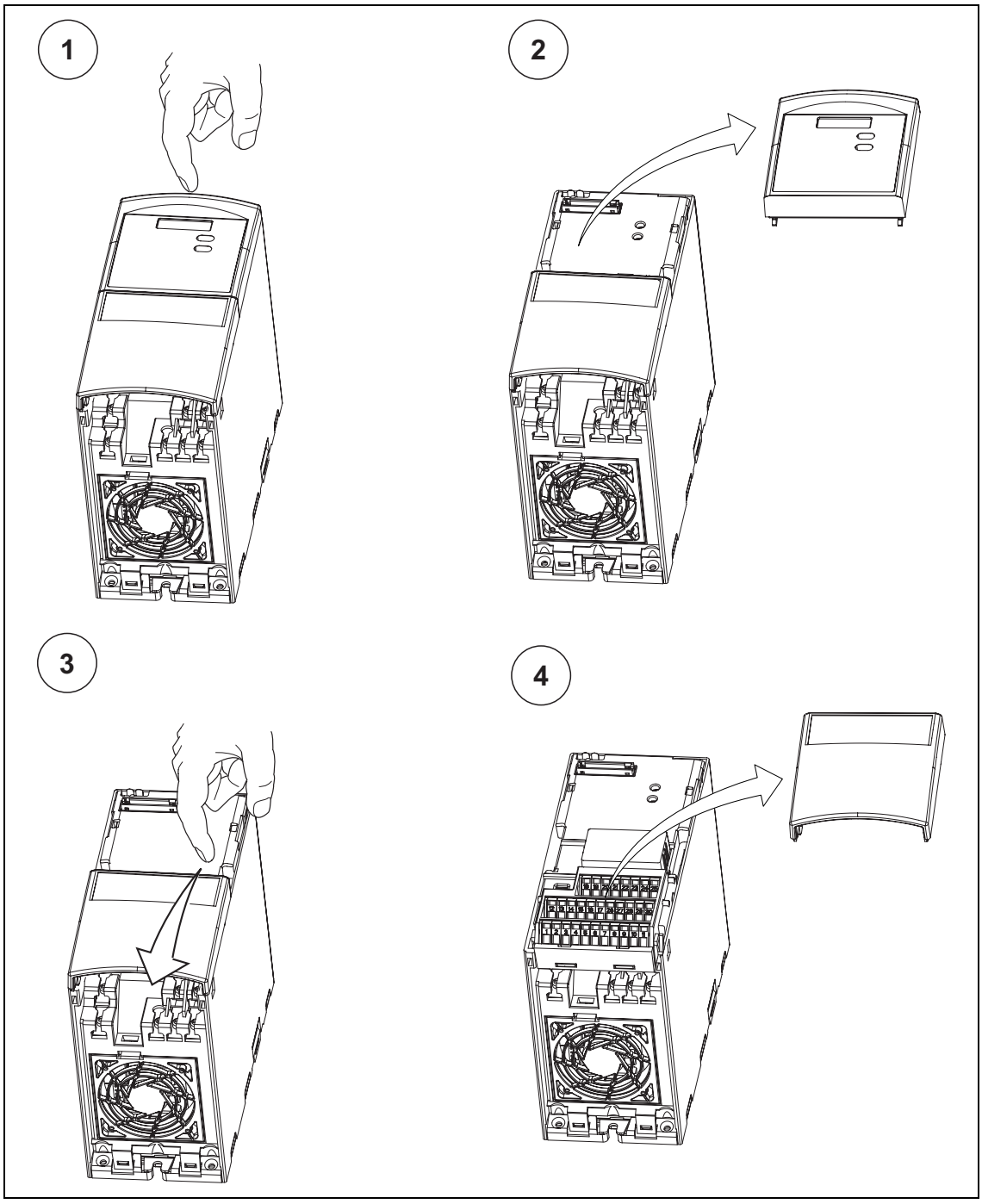
Appendices

A Changing the Operator Panel

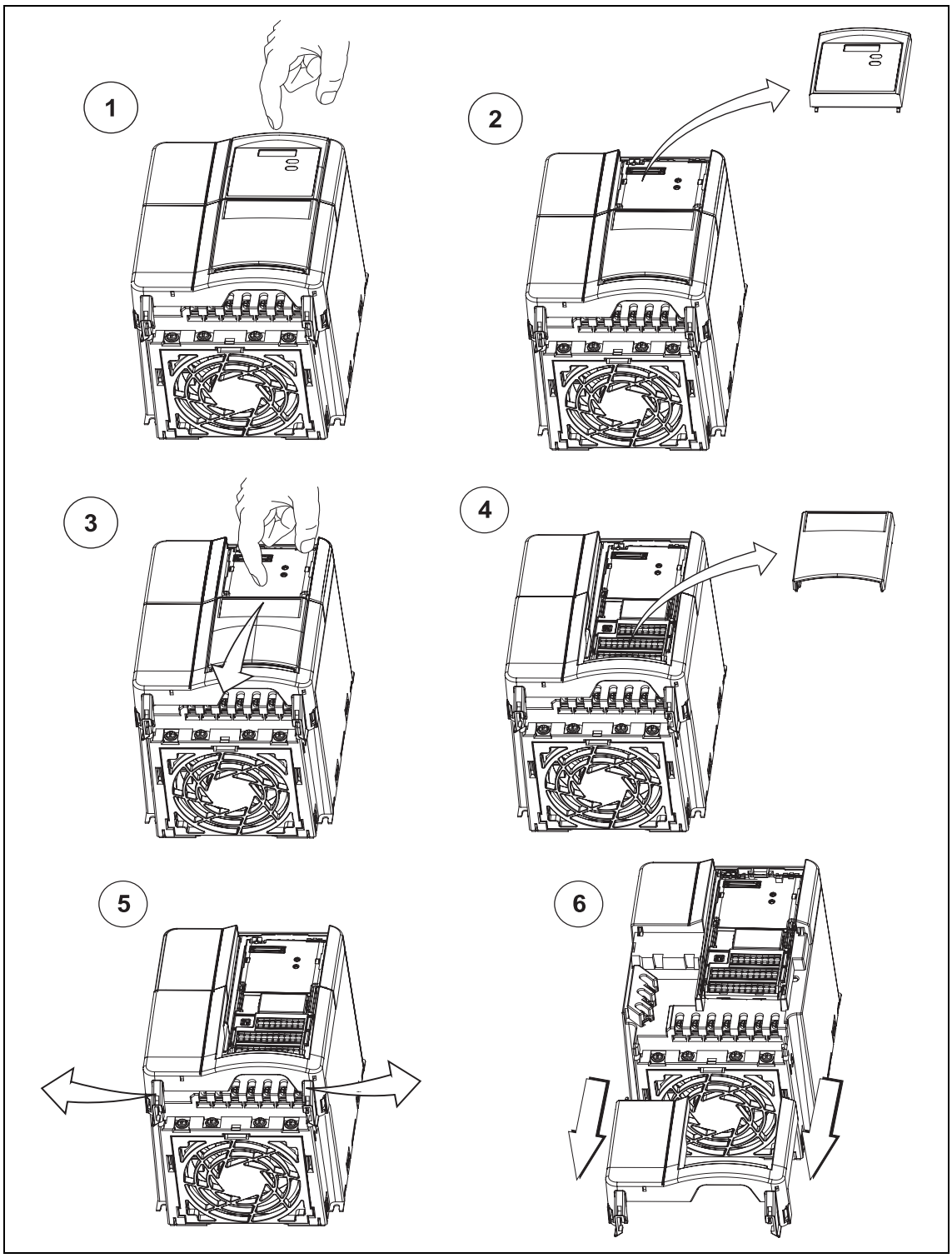


B Removing Covers

B.1 Removing Covers Frame Size A

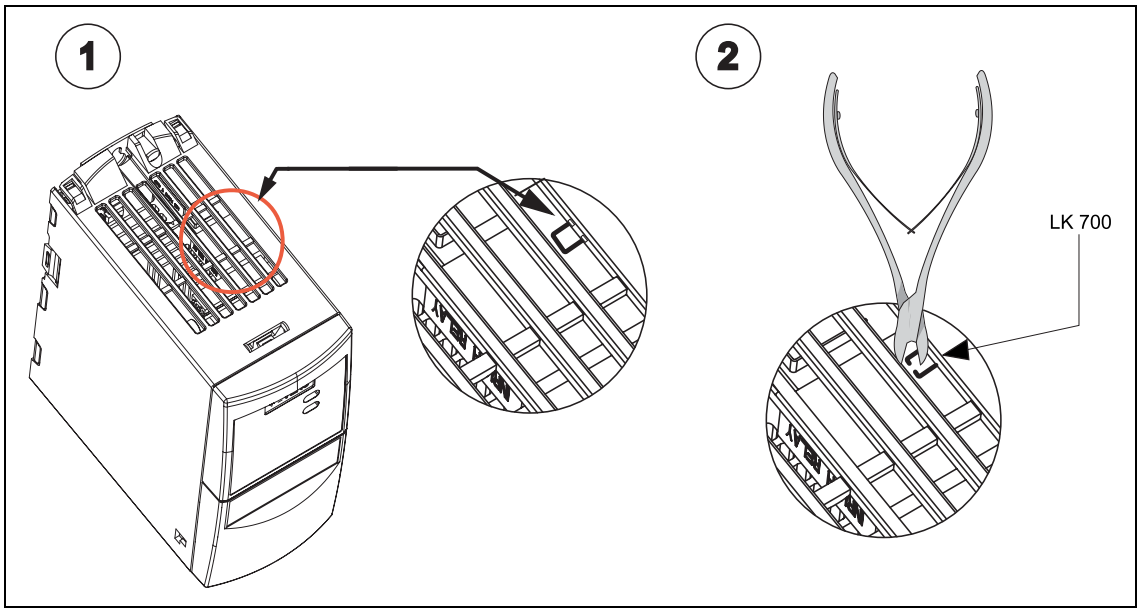


B.2 Removing Covers Frame Size B and C

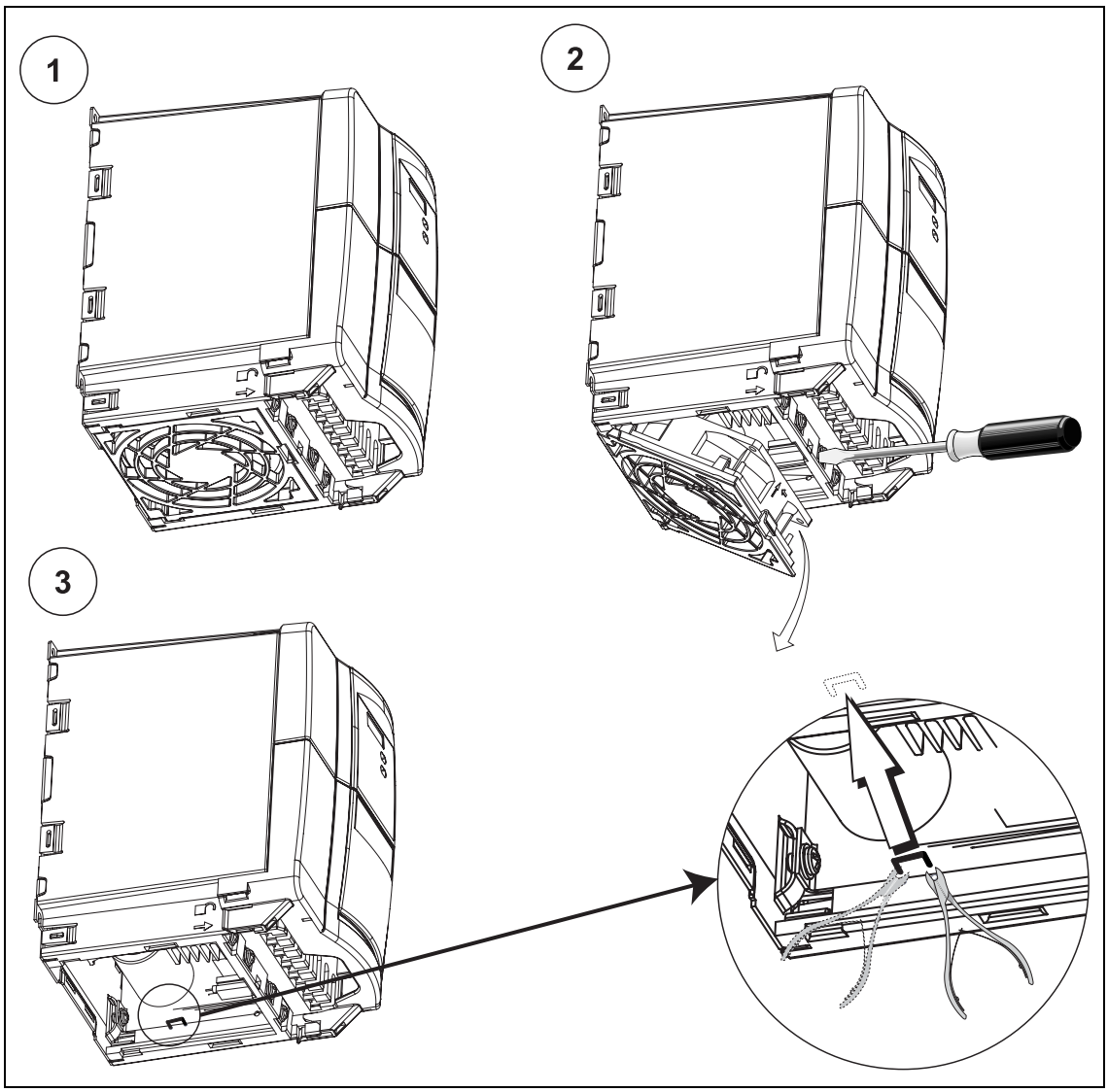


C Removing 'Y' Cap

C.1 Removing 'Y' Cap Frame Size A

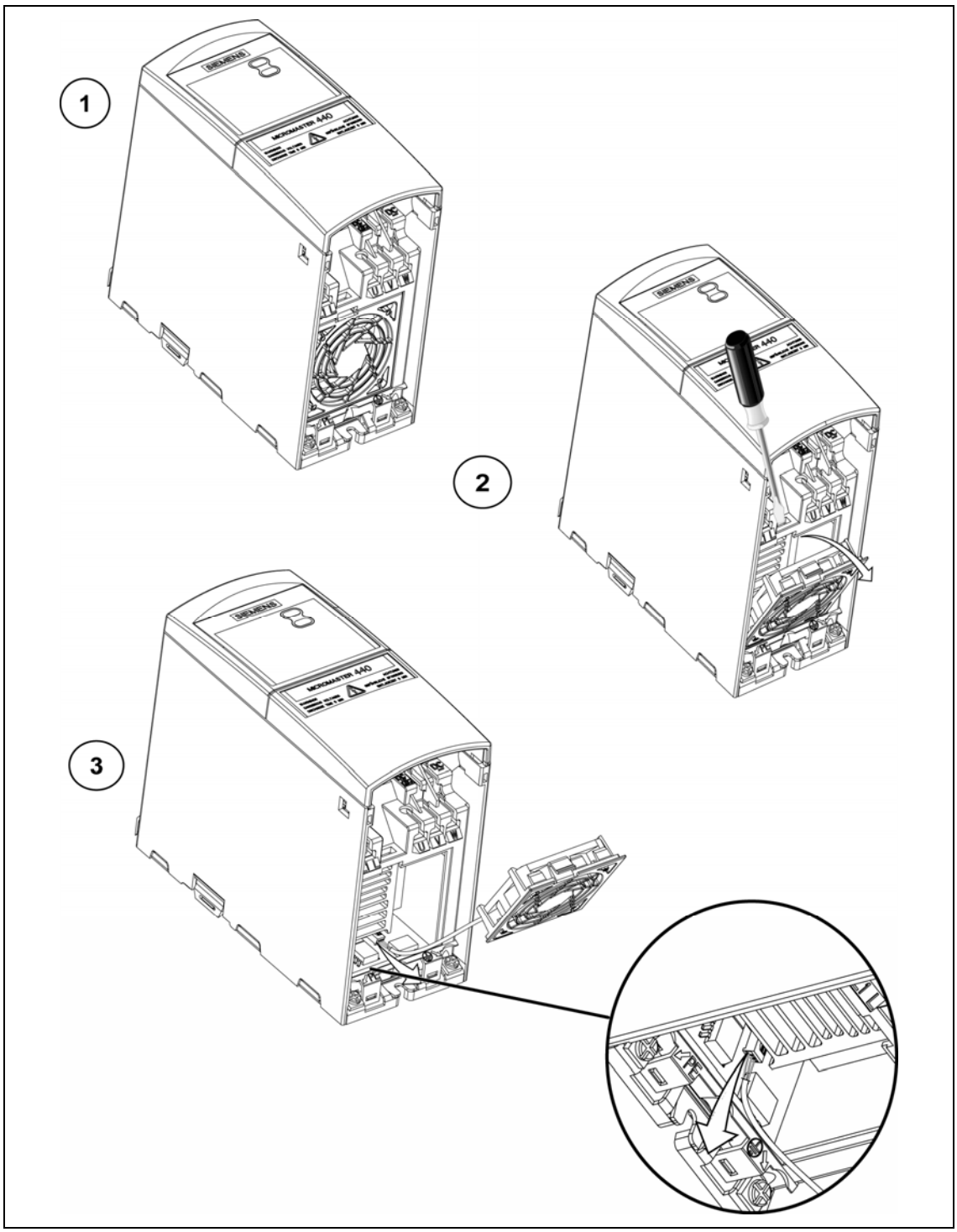


C.2 Removing 'Y' Cap Frame Size B and C

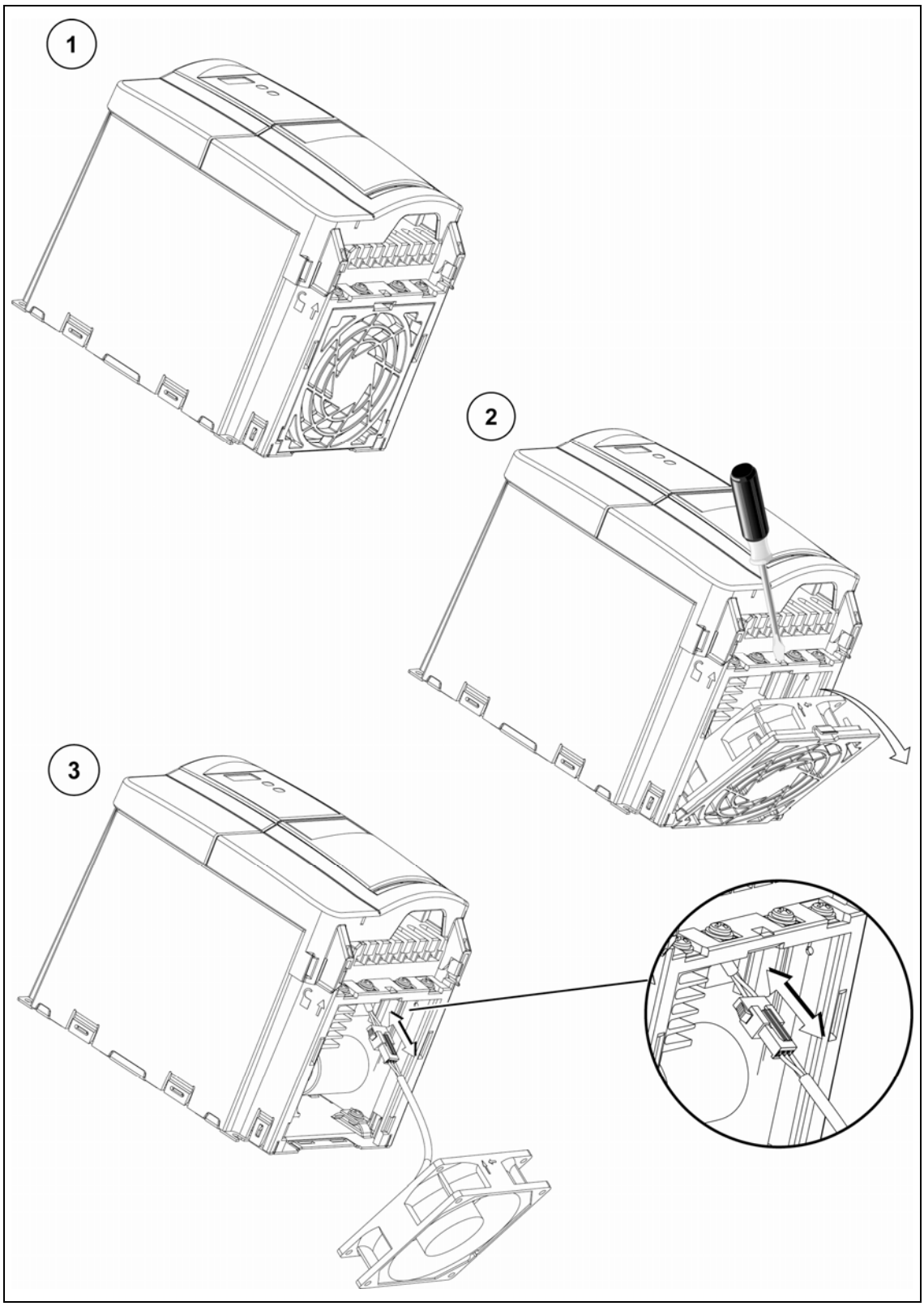


D Removing fan

D.1 Removing fan, Frame Size A



D.2 Removing fan, Frame Sizes B and C



E Applicable Standards

European Low Voltage Directive

The MICROMASTER product range complies with the requirements of the Low Voltage Directive 73/23/EEC as amended by Directive 98/68/EEC. The units are certified for compliance with the following standards:

EN 61800-5-1	Adjustable speed electrical power drive systems, Part 5-1: Safety requirements – Electrical, thermal and energy
EN 60204-1	Safety of machinery - Electrical equipment of machines

European Machinery Directive

The MICROMASTER inverter series does not fall under the scope of the Machinery Directive. However, the products have been fully evaluated for compliance with the essential Health & Safety requirements of the directive when used in a typical machine application. A Declaration of Incorporation is available on request.

European EMC Directive

When installed according to the recommendations described in this manual, the MICROMASTER fulfils all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN61800-3.

Underwriters Laboratories

UL and CUL LISTED POWER CONVERSION EQUIPMENT

ISO 9001

Siemens plc operates a quality management system, which complies with the requirements of ISO 9001.

F Short circuit current rating (SCCR)

Frame Size C

The equipment has a "standard SCCR" value of 10 kA, which complies with the requirements of UL508C.

In addition to the "standard SCCR" a "high SCCR" is available which can be used for industrial control panel installations in line with the National Electrical Code (NEC) article 409 (edition 2005) and Underwriters Laboratories UL508A (effective April 2006).

The uL certification of MICROMASTER 420 allows the drives to adopt a high SCCR equal to the interupt current rating of the branch-circuit protection (BCP) device protecting the drive.

Hence by selection of the correct uL listed BCP device with appropriate interrupt rating for the application, any high SCCR rating can be achieved for MICROMASTER 420, including SCCR values above 10 kA.

The above statements are valid for the respective maximum voltage of the drive when protected by a UL recognised/listed H, J or K type fuse, a circuit breaker or self-protected combination motor controller.

G List of Abbreviations

AC	Alternating current
AD	Analog digital converter
ADC	Analog digital converter
ADR	Address
AFM	Additional frequency modification
AG	Automation unit
AIN	Analog input
AOP	Advanced operator panel
AOUT	Analog output
ASP	Analog setpoint
ASVM	Asymmetric space vector modulation
BCC	Block check character
BCD	Binary-coded decimal code
BI	Binector input
BICO	Binector / connector
BO	Binector output
BOP	Basic operator panel
C	Commissioning
CB	Communication board
CCW	Counter-clockwise
CDS	Command data set
CFM	Cubic feet per minute (1 l/s ≅ 2,1 CFM)
CI	Connector input
CM	Configuration management
CMD	Commando
CMM	Combimaster
CO	Connector output
CO/BO	Connector output / Binector output
COM	Common (terminal that is connected to NO or NC)
COM-Link	Communication link
CT	Commissioning, ready to run
CT	Constant torque
CUT	Commissioning, run, ready to run
CW	Clockwise
DA	Digital analog converter
DAC	Digital analog converter
DC	Direct current
DDS	Drive data set

DIN	Digital input
DIP	DIP switch
DOUT	Digital output
DS	Drive state
EEC	European Economic Community
EEPROM	Electrical erasable programmable read-only memory
ELCB	Earth leakage circuit breaker
EMC	Electro-magnetic compatibility
EMF	Electromotive force
EMI	Electro-magnetic interference
ESB	Equivalent circuit
FAQ	Frequently asked questions
FB	Function block
FCC	Flux current control
FCL	Fast current limit
FF	Fixed frequency
FFB	Free function block
FOC	Field orientated control
FSA	Frame size A
GSG	Getting started guide
GUI ID	Global unique identifier
HIW	Main actual value
HSW	Main setpoint
HTL	High-threshold logic
I/O	Input and output
IBN	Commissioning
IGBT	Insulated gate bipolar transistor
IND	Sub-index
JOG	Jog
KIB	Kinetic buffering
LCD	Liquid crystal display
LED	Light emitting diode
LGE	Length
MHB	Motor holding brake
MM4	MICROMASTER 4th. Generation
MOP	Motor potentiometer
NC	Normally closed
NO	Normally open
OPI	Operating instructions
PDS	Power drive system
PID	PID controller (proportional, integral, derivative)
PKE	Parameter ID
PKW	Parameter ID value
PLC	Programmable logic controller

PLI	Parameter list
PPO	Parameter process data object
PTC	Positive temperature coefficient
PWE	Parameter value
PWM	Pulse-width modulation
PX	Power extension
PZD	Process data
QC	Quick commissioning
RAM	Random-access memory
RCCB	Residual current circuit breaker
RCD	Residual current device
RFG	Ramp function generator
RFI	Radio-frequency interference
RPM	Revolutions per minute
SCL	Scaling
SDP	Status display panel
SLVC	Sensorless vector control
STW	Control word
STX	Start of text
SVM	Space vector modulation
TTL	Transistor-transistor logic
USS	Universal serial interface
VC	Vector control
VT	Variable torque
ZSW	Status word
ZUSW	Additional setpoint

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Suggestions and/or Corrections

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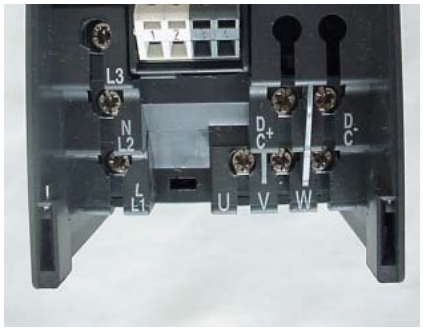
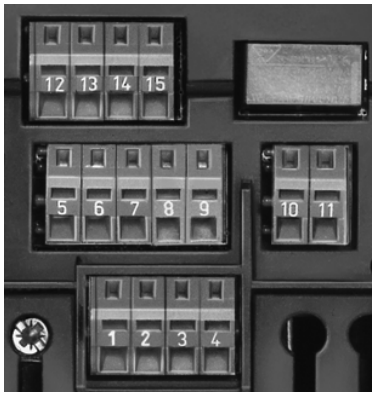
User Documentation

Operating Instructions

Order Number:
6SE6400-5AA00-0BP0

Date of Issue: 10/06

Should you come across any printing errors when reading this publication, please notify us on this sheet. Suggestions for improvement are also welcome.</td>
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View of Unit	**Frame Size A**	**Frame Size B & C**
SDP fitted		
Power Terminal Connections		
Control Terminal Connections		
Access to "Y Cap "		

Siemens AG
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Geschäftsgebiet Standard Drives (SD)
Postfach 3269, D-91050 Erlangen
Federal Republic of Germany

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