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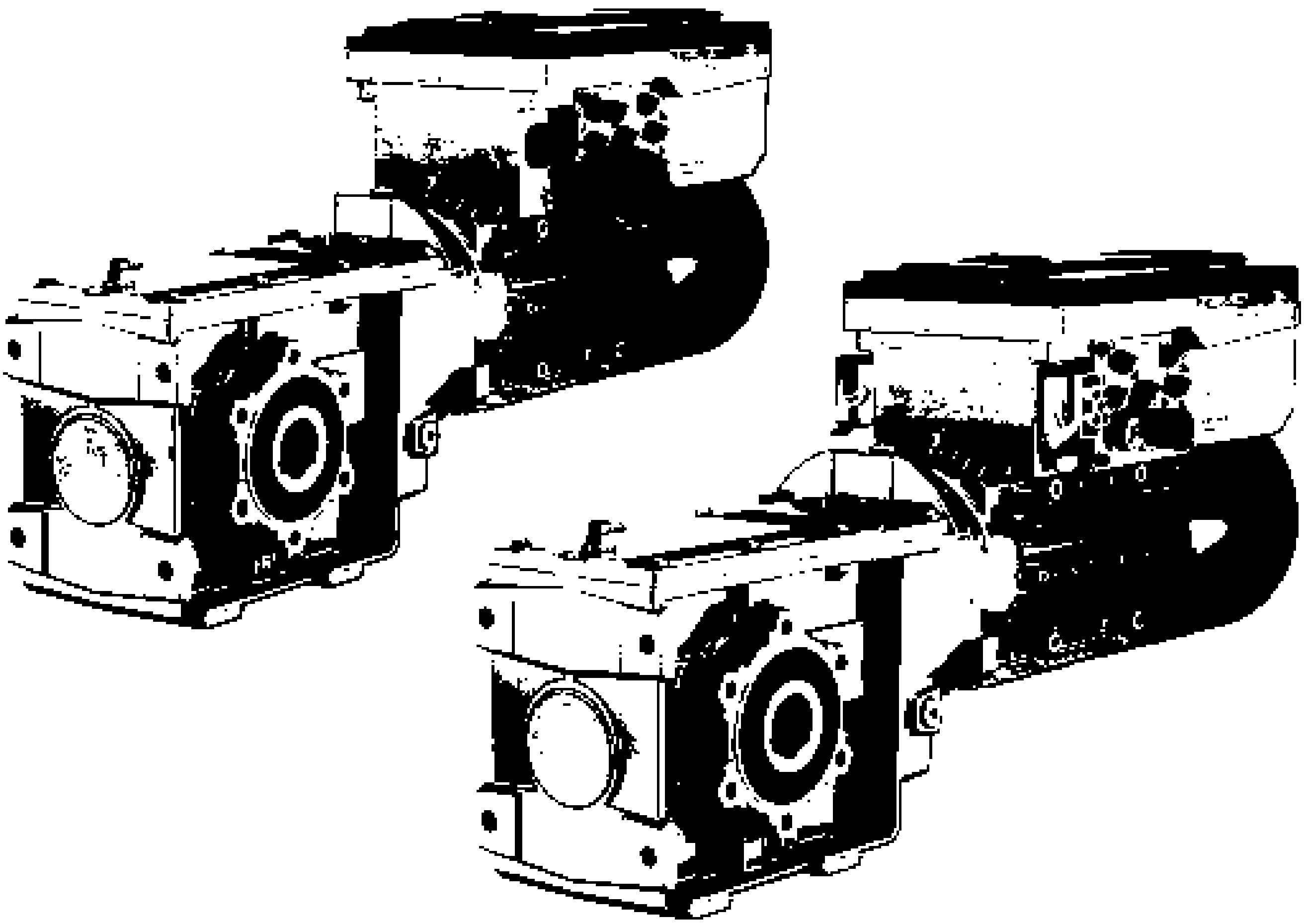

SINAMICS

SINAMICS G110M

Distributed converter for SIMOGEAR geared motors

Operating Instructions

Edition 02/2014

Answers for industry.

SIEMENS

SINAMICS

SINAMICS G110M SINAMICS G110M Operating Instructions

Operating Instructions

Edition 02/2014, Firmware V4.6

02/2014, FW V4.6
A5E31298649B AA

Legal information

Warning notice system

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

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

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

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

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

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

Qualified Personnel

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

Proper use of Siemens products

Note the following:

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

Trademarks

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Disclaimer of Liability

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

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Ⓟ 02/2014 Technical data subject to change

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Safety instructions

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1.1 General safety instructions

DANGER

Danger to life due to live parts and other energy sources

Death or serious injury can result when live parts are touched.

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

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify all those who will be affected by the procedure.
2. Disconnect the machine from the supply.
   - Switch off the machine.
   - Wait until the discharge time specified on the warning labels has elapsed.
   - Check that it really is in a no-voltage condition, from phase conductor to phase conductor and phase conductor to protective conductor.
   - Check whether the existing auxiliary supply circuits are de-energized.
   - Ensure that the motors cannot move.
3. Identify all other hazardous energy sources, e.g. compressed air, hydraulic systems, water.
4. Isolate or neutralize all hazardous energy sources, e.g. by closing switches, grounding or short-circuiting or closing valves.
5. Secure the energy sources against switching on again.
6. Make sure that the machine is completely locked ... and that you have the right machine.

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

WARNING

Danger to life through a hazardous voltage when connecting an unsuitable power supply

Death or serious injury can result when live parts are touched in the event of a fault.

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

WARNING

Danger to life when live parts are touched on damaged devices

Improper handling of devices can cause damage.

Hazardous voltages can be present at the housing or exposed components on damaged devices.

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

⚠WARNING

Danger to life through electric shock due to unconnected cable shields

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

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

⚠WARNING

Danger to life due to electric shock when not grounded

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

- Ground the device in compliance with the applicable regulations.

⚠WARNING

Danger to life due to electric shock when opening plug connections in operation

When opening plug connections in operation, arcs can result in severe injury or death.

- Only open plug connections when the equipment is in a no-voltage state, unless it has been explicitly stated that they can be opened in operation.

⚠WARNING

Danger to life due to fire spreading if housing is inadequate

Fire and smoke development can cause severe personal injury or material damage.

- Install devices without a protective housing in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire inside and outside the device is prevented.
- Additionally, select the installation site so that an uncontrolled spreading of smoke can be avoided in the case of a fire.
- Ensure that smoke can escape via designated paths.

WARNING

Danger to life through unexpected movement of machines when using mobile wireless devices or mobile phones

Using mobile wireless devices or mobile phones with a transmitter power > 1 W closer than approx. 2 m to the components may cause the devices to malfunction and influence the functional safety of machines, therefore putting people at risk or causing material damage.

- Switch the wireless devices or mobile phones off in the immediate vicinity of the components.

WARNING

Danger to life due to the motor catching fire in the event of insulation overload

There is a greater load on the motor insulation through a ground fault in an IT system. A possible result is the failure of the insulation with a risk for personnel through smoke development and fire.

- Use a monitoring device that signals an insulation fault.
- Correct the fault as quickly as possible so the motor insulation is not overloaded.

WARNING

Danger to life due to fire if overheating occurs because of insufficient ventilation clearances

Inadequate ventilation clearances can cause overheating with a risk for personnel through smoke development and fire. This can also result in increased downtime and reduced service lives for devices / systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component. They can be found in the dimension drawings or in the "Product-specific safety instructions" at the start of the respective section.

WARNING

Danger of an accident occuring due to missing or illegible warning labels

Missing or illegible warning labels can result in death or serious injury.

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

NOTICE

Device damage caused by incorrect voltage/insulation tests

Incorrect voltage/insulation tests can damage the device.

- Before carrying out a voltage/insulation test, disconnect the system/machine.

All converters and motors are subject to a high voltage test in the manufacturer's facility. As a consequence, it is not necessary to carry out additional tasks in the system/machine.

⚠ WARNING

Danger to life when safety functions are inactive

Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death.

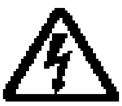
- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted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

Note

Important safety notices for safety functions

If you want to use safety functions, you must observe the safety notices in the safety manuals.

1.2 Safety instructions for electromagnetic fields (EMF)



⚠ WARNING

Danger to life from electromagnetic fields

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment such as transformers, converters or motors.

People with pacemakers or implants are at a special risk in the immediate vicinity of these devices/systems.

- If affected by this, keep a distance of at least 2 m.

1.3 Handling electrostatic sensitive devices (ESD)

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

NOTICE

Damage through electric fields or electrostatic discharge

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

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

1.4 Industrial security

Note

Industrial security

Siemens provides automation and drive products with industrial security functions that support the secure operation of plants or machines. They are an important component in a holistic industrial security concept. With this in mind, our products undergo continuous development. We therefore recommend that you keep yourself informed with the latest information and updates of our product.

Information and newsletters can be found at:

http://support.automation.siemens.com

To ensure the secure operation of a plant or machine, it is also necessary to take suitable preventive action (e.g. cell protection concept) and to integrate the automation and drive components into a state-of-the-art holistic industrial security concept for the entire plant or machine. Any third-party products used must also be taken into account.

For more detailed information, go to:

http://www.siemens.com/industrialsecurity

WARNING

Danger as a result of unsafe operating states resulting from software manipulation

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can lead to death, severe injuries and/or material damage.

- Keep the software up to date.

  Information and newsletters can be found at:

  http://support.automation.siemens.com
- Incorporate the automation and drive components into a state-of-the-art, integrated industrial security concept for the installation or machine.

  For more detailed information, go to:

  http://www.siemens.com/industrialsecurity
- Make sure that you include all installed products into the integrated industrial security concept.

1.5 Residual risks of power drive systems

The control and drive components of a drive system are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used.

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety instructions on the components and in the associated technical user documentation.

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

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage
2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, e.g.:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions outside of the specification
   - External influences / damage

   Inverters of the Open Type / IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that the contact with fire inside and outside the inverter is not possible.
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions outside of the specification
   - Condensation / conductive contamination
   - External influences / damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc. if they are too close.
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly.

Note

The components must be protected against conductive contamination (e.g. by installing them in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12).

Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

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

Introduction 2

2.1 About this manual

Who requires the operating instructions and what for?

These operating instructions primarily address fitters, commissioning engineers and machine operators. The operating instructions describe the devices and device components and enable the target groups being addressed to install, connect-up, set, and commission the converters safely and in the correct manner.

What is described in the operating instructions?

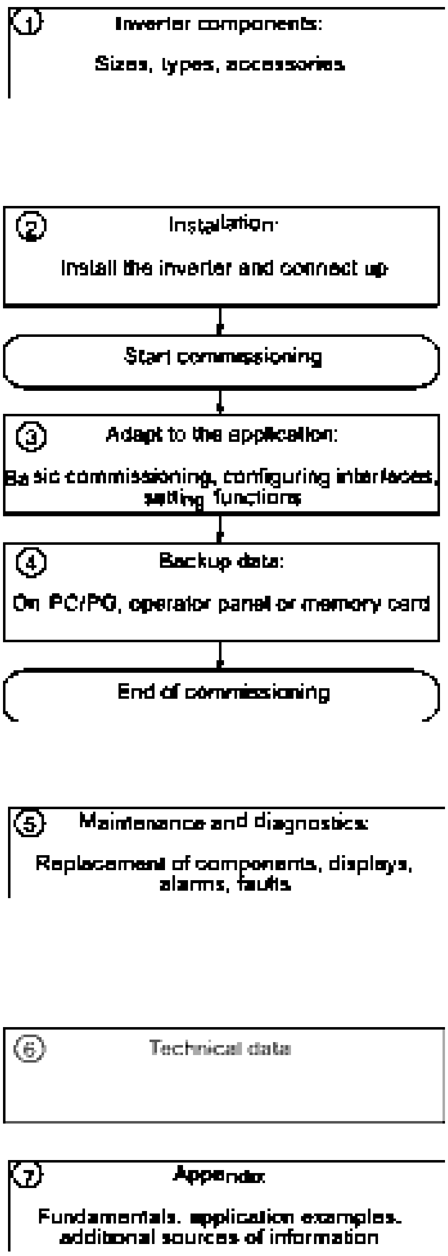
These operating instructions provide a summary of all of the information required to operate the converter under normal, safe conditions.

The information provided in the operating instructions has been compiled in such a way that it is sufficient for all standard applications and enables drives to be commissioned as efficiently as possible. Where it appears useful, additional information for entry level personnel has been added.

The operating instructions also contain information about special applications. Since it is assumed that readers already have a sound technical knowledge of how to configure and parameterize these applications, the relevant information is summarized accordingly. This relates, e.g. to operation with fieldbus systems and safety-related applications.

2.2 Guide through this manual

In this manual, you will find background information on your inverter, as well as a full description of the commissioning procedure:



① Here you will find information about the hardware of your inverter and the commissioning tools:

- Basic commissioning (Page 79)

② • Installation (Page 37)

All information relating to the commissioning of your inverter is located in the following chapters:

③ • Adapt inputs and outputs (Page 123)
- Basic commissioning (Page 79)
- Configure fieldbus (Page 131)
- Functions (Page 169)

④ • Data backup and series commissioning (Page 235)

⑤ Information regarding the maintenance and diagnostics of your inverter is located in the following chapters:

- Service and maintenance (Page 253)
- Alarms, faults and system messages (Page 259)

⑥ The most important technical data for your inverter is located in this chapter:

- Technical data (Page 275)

⑦ The appendix contains some background information and explanatory examples:

- Application examples (Page 290)

2.3 Product Support

If you have further questions

You can find additional information on the product and more in the Internet under: Product Support (http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo2&aktprim=99&lang=en).

In addition to our documentation, under this address we offer our complete knowledge base online: You can find the following information:

- Actual product information (Update), FAQ (frequently asked questions), downloads.
- The Newsletter contains the latest information on the products you use.
- The Knowledge Manager (Intelligent Search) helps you find the documents you need.
- Users and specialists from around the world share their experience and knowledge in the Forum.
- You can find your local representative for Automation & Drives via our contact database under "Contact & Partner".
- Information about local service, repair, spare parts and much more can be found under "Services".

Description 3

3.1 Identifying the components of the system

The SINAMICS G110M is a complete converter system for controlling the speed of a three-phase motor.

Each part of the system is shown in the following figure.

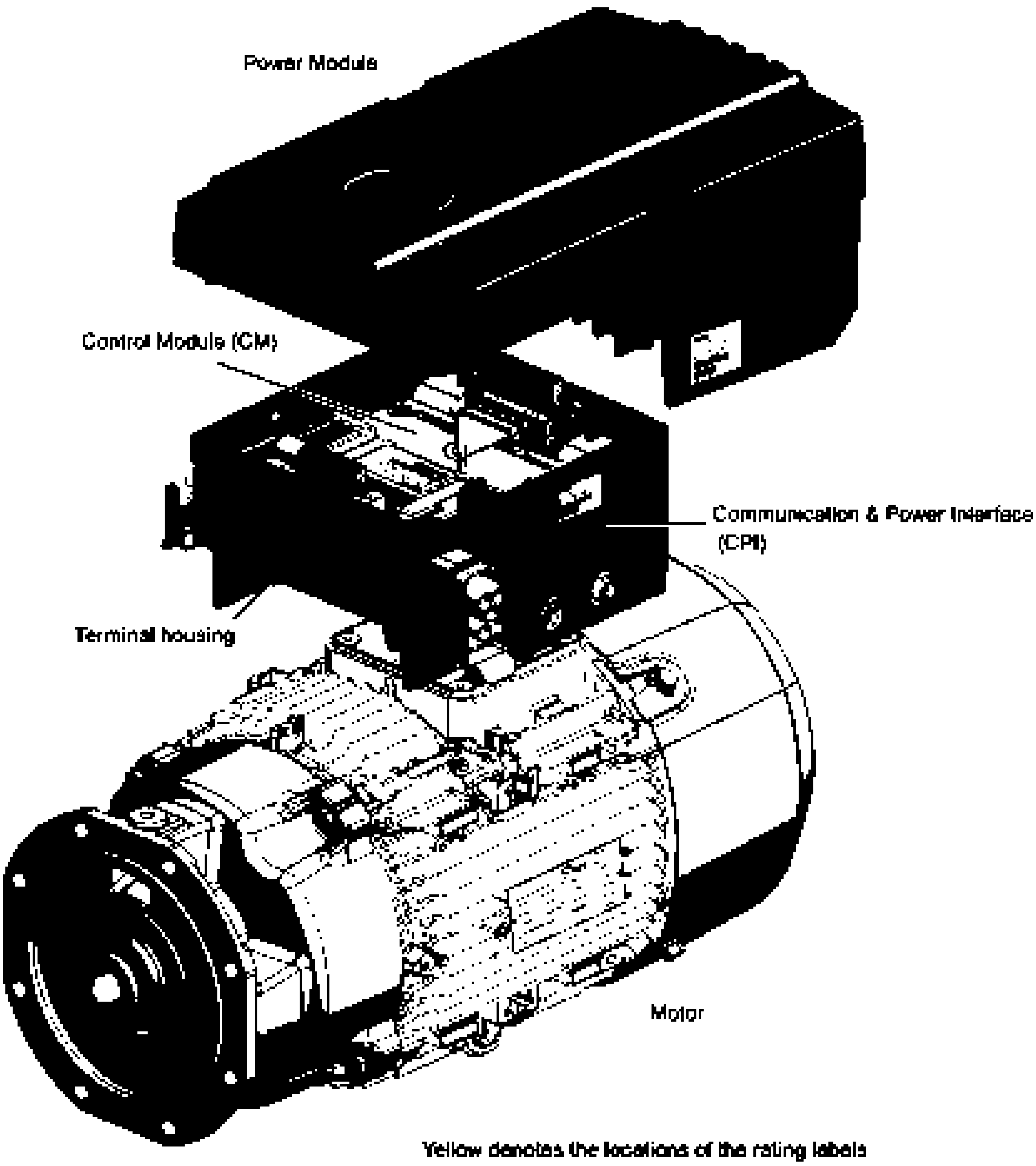


Figure 3-1 Identifying the components of the system

3.2 SINAMICS G110M Inverter

Overview

The SINAMICS G110M system consists of the following components:

- Terminal Housing (including the Control Module)
- Power Module
- Three-phase motor.

The Power Modules are designed for a specific power range and the terminal housings are designed to work with specific motors. The terminal housing not only allows the direct mounting onto a motor but specific cable glands and mains connectors are specified. All the various combinations of Power Modules, terminal housings (including the Control Modules) and Options are given in the tables below.

Table 3- 1 PM240M Power Modules - 3AC, 400 V, Class A, IP66

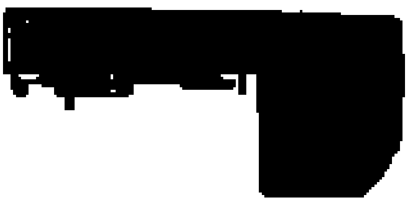
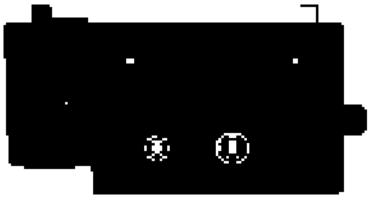
	Frame size	Rated output power (kW)	Rated output current (A)	Order number
		based on High Overload (HO)		
	FSA	0.37	1.3	6SL3517-1BE11-3AM0
	FSA	0.75	2.2	6SL3517-1BE12-3AM0
	FSA	1.1	3.1	6SL3517-1BE13-3AM0
	FSA	1.5	4.1	6SL3517-1BE14-3AM0
	FSB	2.2	5.6	6SL3517-1BE16-3AM0
	FSB	3.0	7.3	6SL3517-1BE17-7AM0
	FSB	4.0	8.8	6SL3517-1BE21-0AM0

Table 3- 2 CU240M Terminal Housing (including the Control Module)

	Comms	Motor frame size	Mains / 24 V DC connections	Order number
	USS	FS71	Cable glands	6SL3544-0LB02-1BA0
	USS	FS80/90	Cable glands	6SL3544-0MB02-1BA0
	USS	FS100/112	Cable glands	6SL3544-0NB02-1BA0
	PROFIBUS	FS71	Cable glands	6SL3544-0LB02-1PA0
	PROFIBUS	FS80/90	Cable glands	6SL3544-0MB02-1PA0
	PROFIBUS	FS100/112	Cable glands	6SL3544-0NB02-1PA0
	PROFIBUS	FS71	HanQ 4/2 / 7/8"	6SL3544-0TB02-1PA0
	PROFIBUS	FS80/90	HanQ 4/2 / 7/8"	6SL3544-0PB02-1PA0
	PROFIBUS	FS100/112	HanQ 4/2 / 7/8"	6SL3544-0QB02-1PA0
	PROFINET	FS71	Cable glands	6SL3544-0LB02-1FA0
	PROFINET	FS80/90	Cable glands	6SL3544-0MB02-1FA0
	PROFINET	FS100/112	Cable glands	6SL3544-0NB02-1FA0
	PROFINET	FS71	HanQ 4/2 / 7/8"	6SL3544-0TB02-1FA0
	PROFINET	FS80/90	HanQ 4/2 / 7/8"	6SL3544-0PB02-1FA0
	PROFINET	FS100/112	HanQ 4/2 / 7/8"	6SL3544-0QB02-1FA0

Every SINAMICS G110M is delivered with the following accessories:

All variants

- PTC connection cable - this is the extension cable used to connect the PTC wires from the motor to the connection on the CPI board.
- EM brake cable - this the extension cable used to connect the EM brake wires from the motor to the mains connector when the EM brake wire is too short.
- Pre-wired motor terminal cables ready for connecting to the motor terminals on the motor.
- Earthing cable for earthing the motor to the terminal housing.

SINAMICS G110M PROFIBUS variant

PROFIBUS Communications cable for connecting the CPI board to the communications connection on the Control Module.

SINAMICS G110M PROFINET variant

PROFINET Communications cable for connecting the CPI board to the communications connection on the Control Module.

SINAMICS G110M HanQ 4/2 variant

- Male and female HanQ connectors, one of which is pre-wired with pins crimped on the other end ready for assembly.
- Blanking cap for users not wishing to utilize the power-through daisy chain.

Table 3- 3 SINAMICS G110M Options

Option	Description	Order number
24 V Power supply	Internal 24 V DC power supply for the CU240M	6SL3555-0PV00-0AA0
Internal braking resistor (FSA)	10% duty cycle with 5% peak braking power, peak power 75 W, instantaneous power 1.9 kW, average power 7.5 W, resistance 350 Ohms.	6SL3501-0BE18-8AA0
Internal braking resistor (FSB)	10% duty cycle with 5% peak braking power, peak power 200 W, instantaneous power 3.8 kW, average power 20 W, resistance 175 Ohms.	6SL3501-0BE22-0AA0
Glanded connector kit	Comprises the following connectors: • M20 screw gland - used for 24 V power supply daisy chain • M25 plastic gland - used for the 3-phase mains daisy chain • M12 plastic gland - used for the EM-brake cable entry.	6SL3566-2VA00-0GA0
HanQ connector kit	Comprises the following connectors: • Connector cap 7/8th internal thread - used for the 24 V power blanking cap • HanQ blanking cap - used for the mains input blankingcap • M12 plastic gland - used for the EM-brake cable entry.	6SL3566-2LA00-0GA0

Compatible motors for the SINAMICS G110M system

The following tables detail the motors that are compatible with the SINAMICS G110M system.

Due to the unique nature of the SINAMICS G110M system, there are a number of restrictions regarding the type of options and devices used with the motors. These are listed below:

- No encoders can be used.
- The brake lever cannot be used in the "12 O'Clock" position; this is not possible because of the position of the terminal housing of the Inverter.
- The use of only 180 Vdc brakes are permissible.
- 230/400 Vac brake voltage is not allowed.
- Standby heating of the motor is not allowed.
- An external motor fan cannot be fitted if the terminal housing is in the "12 O'Clock" position.

Rules for the use of the motors:

- Rated output current of the Inverter >= rated input current of the motor.
- Mechanical adaptation for the Inverter terminal housing; the terminal housing can only be used in conjunction with 1LA FS71 or 1LE FS80, FS90, FS100 or FS112 motors.
- The terminal box of the motor must only be Non-Drive End (NDE) configuration. This is an option available when choosing the motor; for 1LE motor choose option H08, or for 1LA motors choose option M64.

Table 3- 4 2-pole, 400 VAC, 50 Hz motors

SINAMICS G110M characteristics			Motor characteristics				
HO power (kW)	**Rated output current (A)**	**Frame size**	**Order number**	**Power (kW)**	**Frame size**	**Rated current (A)**	**Efficiency**
0.37	1.30	FSA	1LA9070-2KA	0.37	71M	0.95	IE2
		FSA	1LA7070-2AA	0.37	71M	0.99	IE1
0.75	2.20	FSA	1LA7070-2AA	0.37	71M	0.99	IE1
		FSA	1LA9070-2KA	0.37	71M	0.95	IE2
		FSA	1LE1001-0DA2	0.75	80M	1.67	IE2
1.1	3.10	FSA	1LA7070-2AA	0.37	71M	0.99	IE1
		FSA	1LA9070-2KA	0.37	71M	0.95	IE2
		FSA	1LE1001-0DA2	0.75	80M	1.67	IE2
		FSA	1LE1001-0DA3	1.10	80M	2.40	IE2
1.5	4.10	FSA	1LA7070-2AA	0.37	71M	0.99	IE1
		FSA	1LA9070-2KA	0.37	71M	0.95	IE2
		FSA	1LE1001-0DA2	0.75	80M	1.67	IE2
		FSA	1LE1001-0DA3	1.10	80M	2.40	IE2
		FSA	1LE1001-0EA0	1.50	90S	3.15	IE2
2.2	5.60	FSB	1LA7070-2AA	0.37	71M	0.99	IE1
		FSB	1LA9070-2KA	0.37	71M	0.95	IE2
		FSB	1LE1001-0DA2	0.75	80M	1.67	IE2

SINAMICS G110M characteristics			Motor characteristics				
HO power (kW)	Rated output current (A)	Frame size	Order number	Power (kW)	Frame size	Rated current (A)	Efficiency
		FSB	1LE1001-0DA3	1.10	80M	2.40	IE2
		FSB	1LE1001-0EA0	1.50	90S	3.15	IE2
		FSB	1LE1001-0EA4	2.20	90L	4.50	IE2
3.0	7.30	FSB	1LA7070-2AA	0.37	71M	0.99	IE1
		FSB	1LA9070-2KA	0.37	71M	0.95	IE2
		FSB	1LE1001-0DA2	0.75	80M	1.67	IE2
		FSB	1LE1001-0DA3	1.10	80M	2.40	IE2
		FSB	1LE1001-0EA0	1.50	90S	3.15	IE2
		FSB	1LE1001-0EA4	2.20	90L	4.50	IE2
		FSB	1LE1001-1AA4	3.00	100L	6.10	IE2
4.0	8.80	FSB	1LA7070-2AA	0.37	71M	0.99	IE1
		FSB	1LA9070-2KA	0.37	71M	0.95	IE2
		FSB	1LE1001-0DA2	0.75	80M	1.67	IE2
		FSB	1LE1001-0DA3	1.10	80M	2.40	IE2
		FSB	1LE1001-0EA0	1.50	90S	3.15	IE2
		FSB	1LE1001-0EA4	2.20	90L	4.50	IE2
		FSB	1LE1001-1AA4	3.00	100L	6.10	IE2
		FSB	1LE1001-1BA2	4.0	112M	7.80	IE2

Table 3- 5 4-pole, 400 VAC, 50 Hz motors

SINAMICS G110M characteristics			Motor characteristics				
HO power (kW)	Rated output current (A)	Frame size	Order number	Power (kW)	Frame size	Rated current (A)	Efficiency
0.37	1.30	FSA	1LA7073-4AB	0.37	71M	1.04	IE1
		FSA	1LA9073-4KA	0.37	71M	0.96	IE2
0.75	2.20	FSA	1LA7073-4AB	0.37	71M	1.04	IE1
		FSA	1LA9073-4KA	0.37	71M	0.96	IE2
		FSA	1LE1001-0DB3	0.75	80M	1.79	IE2
1.1	3.10	FSA	1LA7073-4AB	0.37	71M	1.04	IE1
		FSA	1LA9073-4KA	0.37	71M	0.96	IE2
		FSA	1LE1001-0DB3	0.75	80M	1.79	IE2
		FSA	1LE1001-0EB0	1.10	90S	2.50	IE2
1.5	4.10	FSA	1LA7073-4AB	0.37	71M	1.04	IE1
		FSA	1LA9073-4KA	0.37	71M	0.96	IE2
		FSA	1LE1001-0DB3	0.75	80M	1.79	IE2
		FSA	1LE1001-0EB0	1.10	90S	2.50	IE2
		FSA	1LE1001-0EB4	1.50	90L	3.30	IE2
2.2	5.60	FSB	1LA7073-4AB	0.37	71M	1.04	IE2
		FSB	1LA9073-4KA	0.37	71M	0.96	IE2
		FSB	1LE1001-0DB3	0.75	80M	1.79	IE2
		FSB	1LE1001-0EB0	1.10	90S	2.50	IE2
		FSB	1LE1001-0EB4	1.50	90L	3.30	IE2
		FSB	1LE1001-1AB4	2.20	100L	4.65	IE2
3.0	7.30	FSB	1LA7073-4AB	0.37	71M	1.04	IE1
		FSB	1LA9073-4KA	0.37	71M	0.96	IE2

SINAMICS G110M characteristics			Motor characteristics				
HO power (kW)	Rated output current (A)	Frame size	Order number	Power (kW)	Frame size	Rated current (A)	Efficiency
		FSB	1LE1001-0DB3	0.75	80M	1.79	IE2
		FSB	1LE1001-0EB4	1.50	90L	3.30	IE2
		FSB	1LE1001-1AB4	2.20	100L	4.65	IE2
		FSB	1LE1001-1AB5	3.00	100L	6.20	IE2
4.0	8.80	FSB	1LA7073-4AB	0.37	71M	1.04	IE1
		FSB	1LA9073-4KA	0.37	71M	0.96	IE2
		FSB	1LE1001-0DB3	0.75	80M	1.79	IE2
		FSB	1LE1001-0EB0	1.10	90S	2.50	IE2
		FSB	1LE1001-0EB4	1.50	90L	3.30	IE2
		FSB	1LE1001-1AB4	2.20	100L	4.65	IE2
		FSB	1LE1001-1AB5	3.00	100L	6.20	IE2
		FSB	1LE1001-1BB2	4.00	112M	8.20	IE2

3.3 Commissioning tools

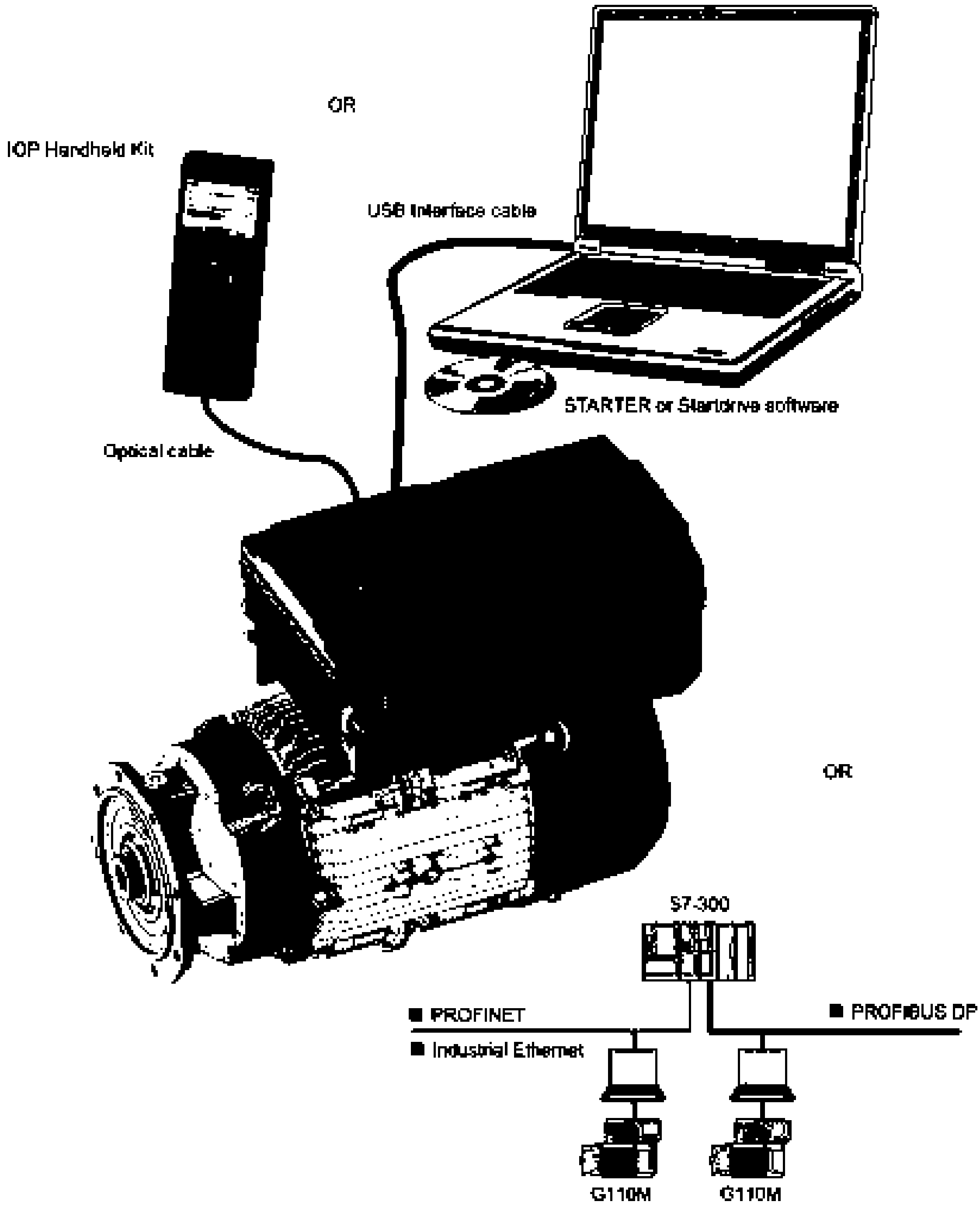
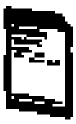


Figure 3-2 Commissioning tools - PC or IOP Handheld Kit

Table 3- 6 Components and tools for commissioning and data backup

Component or tool			Order number
Operator Panel	IOP Handheld Kit - Version 1.5 or later		6SL3255-0AA00-4HA0
Optical cable	Required for using IOP Handheld Kit with CU240M		3RK1922-2BP00
STARTER	Commissioning tool (PC software) - Version 4.3.3 or later		You can obtain STARTER on a DVD (Order number: 6SL3072-0AA00-0AG0) and it can be downloaded: STARTER download (http://support.automation.siemens.com/WW/view/en/26233208)
StartDrive	Commissioning tool (PC software) - Version 12 or later		You can obtain StartDrive on a DVD (6SL3072-4CA02-1XG0) and it can be downloaded: StartDrive download (http://support.automation.siemens.com/WW/view/en/68034568)
PC Connection Kit	Comprising STARTER DVD and USB cable.		6SL3255-0AA00-2CA0
	Optional memory card for storing and transferring the converter settings	SD card	6SL3054-7EF00-2BA0

3.4 General layout SINAMICS G110M system

Introduction

The locations and description of the various interface connections of the CU240M Terminal housing (including the Control Module (CM)) and the PM240M Power Module (PM) are detailed in the figure and table below.

The connections on the terminal housing are delivered with either HAN Q (pluggable) or Glanded connectors depending on the variant that has been ordered.

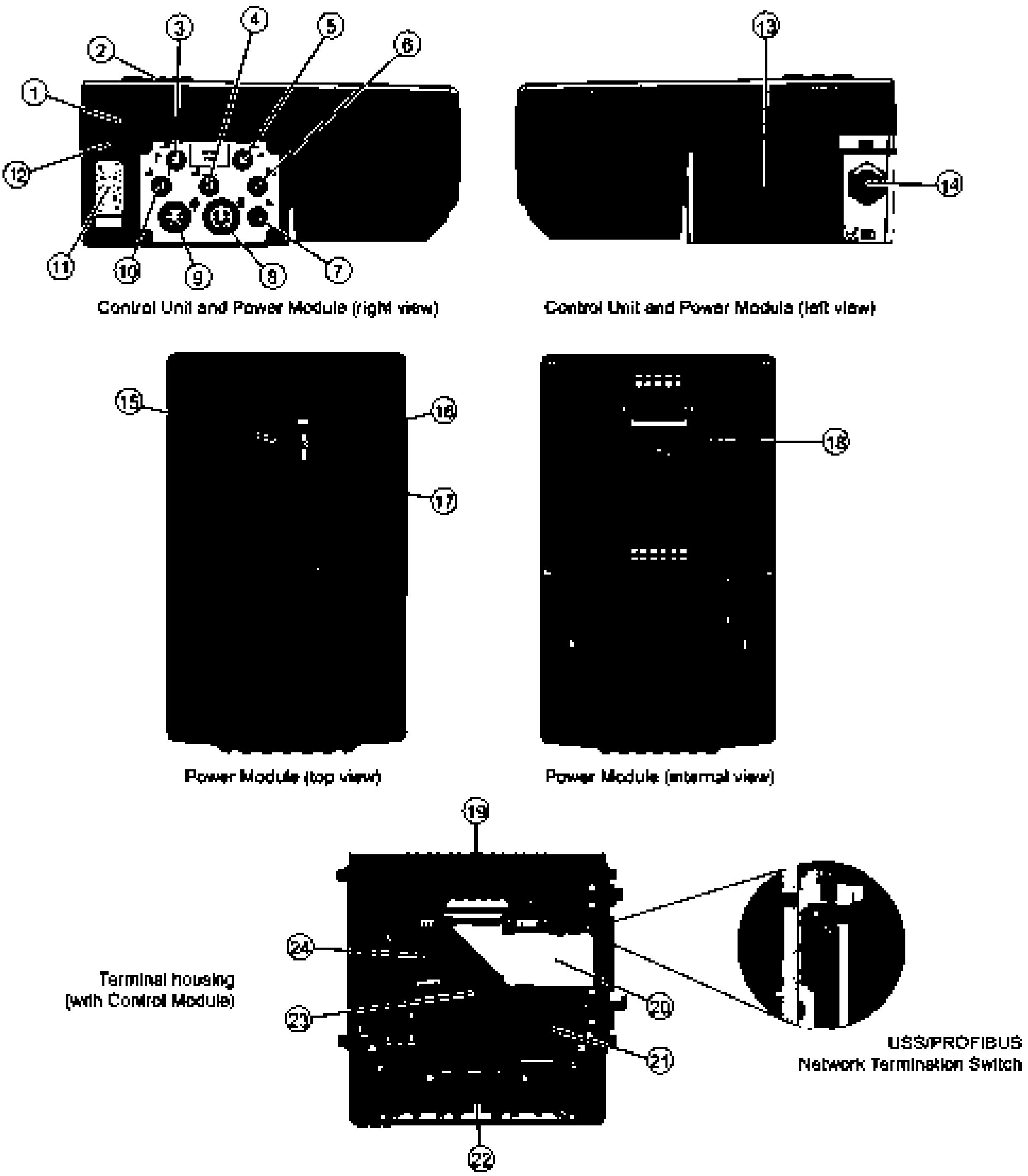


Figure 3-3 General layout of the system

Table 3- 7 Description and location of interfaces

Item	Description	Item	Description
1	Power Module	13	Blanking plate - to seal the opposite side of the Terminal Housing from which the CPI has been fitted.
2	Interface cover	14	Cable gland or HANQ connections for left-side mounting or daisy chaining the mains supply
3	Communications port 1	15	Potentiometer
4	Digital input 2 and digital input 3	16	Optical I/O connection
5	Communications port 2	17	Mini USB connection
6	Digital output 0 and digital output 1	18	Memory card reader
7	Analog input 0 and analog input 1	19	Braking resistor & motor connection terminals
8	External 24 Vdc OUT	20	Communications & Power Interface (CPI) interface ribbon cable
9	External 24 Vdc IN	21	PROFIBUS address and Commissioning DIP switches 1 and 2
10	Digital input 0 and digital input 1	22	EM Brake & mains supply connection terminals
11	Mains supply connection	23	Control Module (CM)
12	Terminal housing	24	PROFIBUS/PROFINET communications cable

Installation

4

⚠ DANGER
Operation with ungrounded (IT) mains supplies can produce extremely dangerous conditions
The converter must always be grounded. If the converter is not grounded correctly, extremely dangerous conditions may arise within the inverter which could prove potentially fatal.
The converter can only be used on TT and TN mains supplies.

⚠ DANGER
Risk of burns and fire due to high temperatures
During operation and for a short time after switching the converter off, the surfaces reach temperatures that can inflict burns or start fires!
Before attempting to touch the surfaces of the converter, ensure that enough time is given to allow the converter to cool down to a safe temperature to avoid personal injury.
Remove any flammable materials from around the converter to reduce the risk of fire.

⚠ WARNING
Direct current on the PE conductor
This product can cause a direct current on the PE conductor.
If the wrong type of protection device is used, then the expected protection by such a device could fail to provide the expected protection.
If a residual current device (RCD) is used to provide protection in case of direct or indirect contact, **only a type B RCD** may be used on the power supply side of this product.

4.1 Mechanical Installation

4.1.1 Dimensions of converters and motors

Dimensions of the system

The converter has two frame sizes. Frame size A (FSA) and Frame size B (FSB), the dimensions of each frame size is given in the figure and table below.

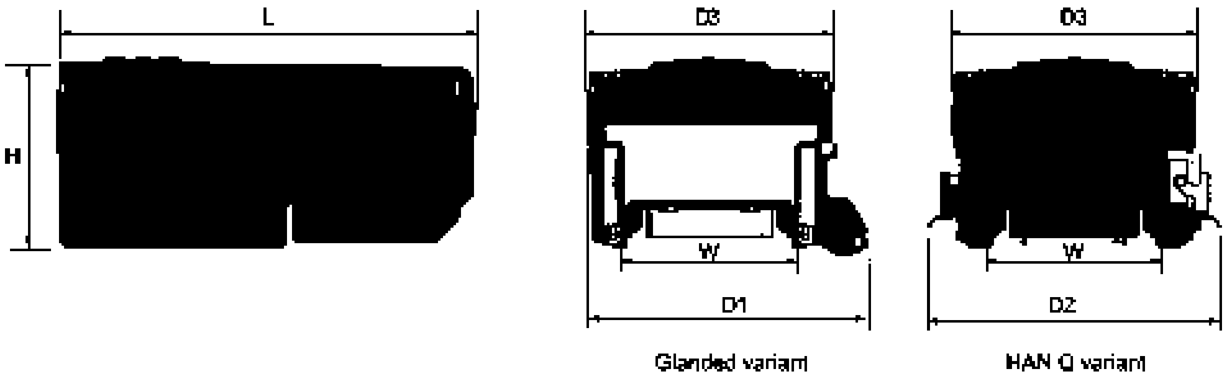


Figure 4-1 Dimensions of the converter

Table 4- 1 Converter dimensions

Frame size	H (mm)	L (mm)	D1 (mm)	D2 (mm)	D3 (mm)	W (mm) without glands
A	135	270	208	216	161	132
B	135	309	208	216	181	132

Terminal housing dimensions and fixing points

The terminal housing of the G110M system replaces the existing terminal housing on the connected motor. There are three different types of the terminal housings and they are shown in the following figure. All three terminal housings have the same external dimensions:

- Height: 92 mm.
- Width: 161 mm
- Depth: 171 mm

Please note that the fixing points (for securing the terminal housing to the motor) are indicated in RED. The FS 80/90 terminal housing has six fixing two of which are marked in GREEN and indicated by the ground symbol. These fixing points provide the correct earthing between the terminal housing and the motor and MUST be used.

All fixing bolts for the terminal housing are supplied with each terminal housing.

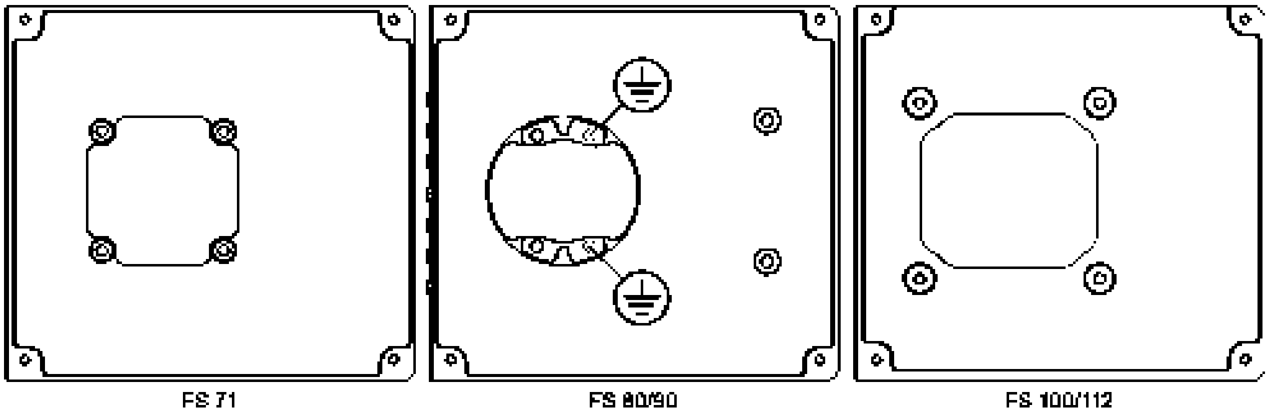


Figure 4-2 Terminal housing dimensions

Motor dimensions

There are a large number of motors associated with the G110M system, with each motor being uniquely configured for the user requirements.

To ensure that the correct motor is selected the following sources of information should be consulted:

- The relevant system catalog, for example the SINAMICS G120 catalog.
- The relevant motor catalog.
- The Siemens "Configurator" online software application for dimensioning motors (Siemens motor configurator (https://eb.automation.siemens.com/goos/catalog/Pages/ProductData.aspx?catalogRegion=WW&language=en&nodeid=10028832&tree=CatalogTree&regionUrl=%2F&autoopen=false&activetab=product#topAnch&activetab=config&))

The "Configurator" tool allows the user to precisely configure a motor with all the accessories and options that are required, then generate dimensional data, including 2D and 3D CAD models, which can be downloaded to the users local system.

The figure below shows an example of the type of data available.

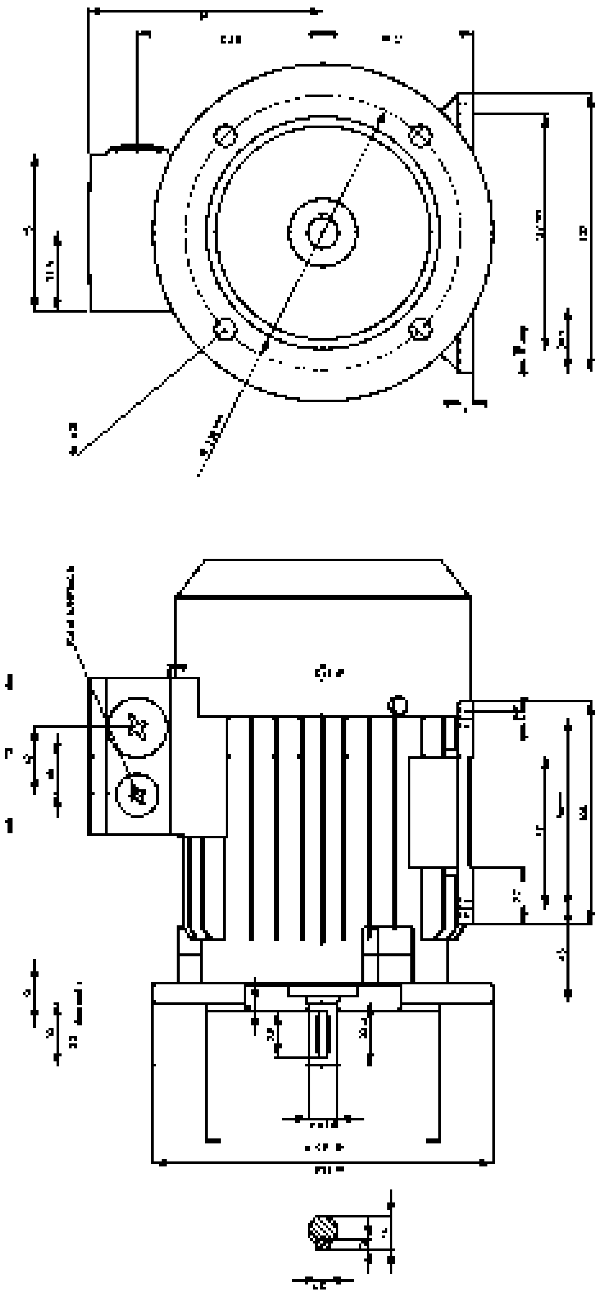


Figure 4-3 Example of the data available from the Sizer program

Mounting orientation

The G110M system has been designed to operate in any orientation depending on the motor mounting configuration.

4.2 System Installation

Overview

The SINAMICS G110M is generally delivered as a complete system, which comprises a Power Module, a terminal housing (which includes the Control Module) and a motor/geared motor. If the system is delivered as a complete system, then it is delivered totally assembled and all that is required is the external wiring of the system.

It is also possible that the SINAMICS G110M system is delivered as separate components, which will require the system to be fitted together before installation and commissioning can take place.

To perform the complete assembly of the system, the procedures in the following sections should be performed.

⚠ DANGER

Risk of electrical shock

When the converter and motor are powered-up, high voltages are present in the electrical components of the system, any contact with these components could result in severe personal injury or death.

During the installation procedure, the mains supply and external power sources should not be applied to the system.

⚠ CAUTION

Potential damage to the Control and Power Interface (CPI) by the internal braking resistor

The internal braking resistor, when used, generates a large amount of heat. This heat has the potential to overheat the electrical components of the CPI.

The internal braking resistor must be fitted on the opposite side of the terminal housing from the CPI.

⚠ CAUTION

Risk of damage to wiring/cables in the Communications and Power Interface (CPI)

The terminal housing has two sets of terminals which are supported on two posts. The terminals are secured when the Control Module (CM) is screwed into place.

If any cables or wires are routed behind the terminal posts, the downward pressure from the terminal post clamps has the potential to damage any wire or cable routed behind the terminal support posts.

Do not route any cables or wires behind the terminal posts.

⚠ CAUTION

Converter must not be used as a step or ledge

The converter has not been designed to support a substantial weight and therefore must not be used as a step or a ledge.

Should substantial weight be placed on the system it could result in severe damage to the equipment which could adversely affect the application and any persons coming into contact with the system.

Note

Diagrams and illustrations

In some of the diagrams and illustrations throughout this section, the colour of components or cables have been selected to make them more visible and do not necessarily reflect the real colour of the component or cable. In some illustrations, components have been removed to enhance the clarity of what is being described.

Note

Use only Non-Drive End (NDE) motor configurations

The SINAMICS G110M has been designed to be used in conjunction with NDE motors. Do not use standard motor terminal box mountings with the SINAMICS G110M systems.

Disassembly procedure

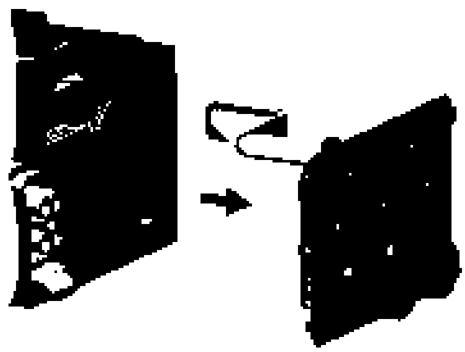
When the SINAMICS G110M is delivered as separate components, the terminal housing must be fitted to the motor. To accomplish this task it is necessary to disassemble the terminal housing to gain access to the motor mounting fixtures in the base of the terminal housing.

To disassemble the terminal housing, the following procedure should be performed.

1. **Remove the Communications & Power Interface (CPI)**
   1. Remove the CPI ribbon cable from the Control Module.
   2. Unscrew the four screws holding the CPI in place on the terminal housing.

   Notes:

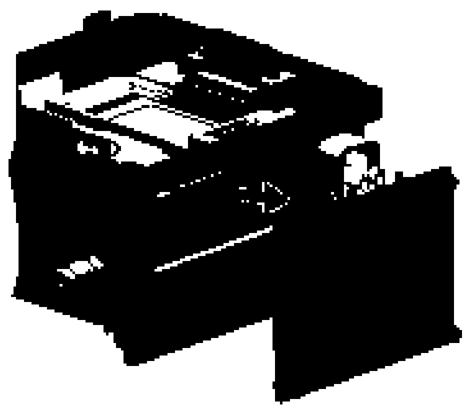
   - The CPI ribbon cable is permanently attached to the CPI board and therefore no attempt should be made to remove it from the CPI board.
   - The seal on the terminal housing behind the CPI is a moulded seal and no attempt to remove them from the terminal housing should be made, as this would permanently damage the seal and significantly reduce the IP rating of the terminal housing.



2. **Remove the blanking plate**
   1. Unscrew the four screws holding the blanking plate in place on the terminal housing.
   2. Do not try and remove the seal on the terminal housing.

   Note:

   The seal on the terminal housing behind the blanking plate is a moulded seal and no attempt to remove them from the Terminal Housing should be made, as this would permanently damage the seal and significantly reduce the IP rating of the terminal housing.

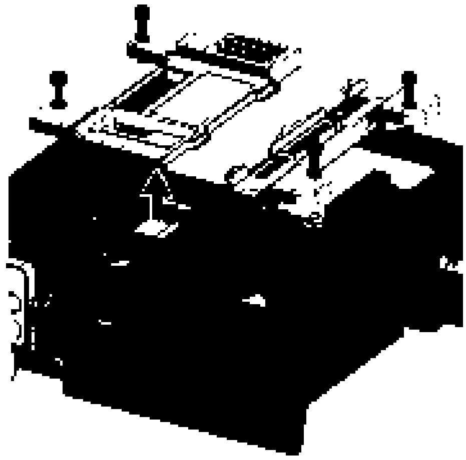


3. Remove the Control Module

1. Unscrew the four self-retaining screws that secure the Control Module in place.
2. Carefully lift the Control Module out of the terminal housing.

Note:

The screws that secure the Control Module in place are self-retaining screws and cannot be fully removed from the Control Module casing.

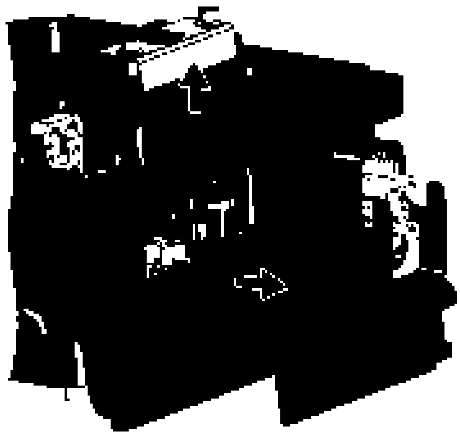


4. Remove the internal braking resistor

1. Remove the internal resistor holding clamp.
2. Disconnect the brake resistor wires from the motor terminals (R2 and R1).
3. Slide the internal braking resistor out from the terminal housing.

Note:

- The internal braking resistor is an optional extra and may not be fitted to the terminal housing.
- The internal braking resistor must not be fitted on the same side as the CPI.



5. Remove the terminal housing terminal connectors

1. Remove the mains terminals connector
2. Remove the motor terminals connector

Notes:

- The terminal connectors are removed to allow easy access to the earthing posts located underneath the individual terminals.
- There are no screws holding down the connectors - they are secured and held in place when the Control Module is fitted.

Installation procedure

Having dismantled the SINAMICS G110M Terminal Housing, the following procedure should be performed to complete the installation of the whole system.

1. **Star and Delta Configuration**

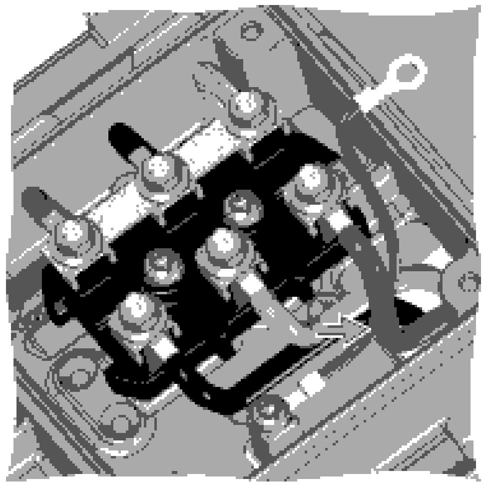
   Configure the motor terminals for either star or delta configuration depending upon the voltage requirement of the application and the mains input voltage.

2. **Fit the earth cable to the motor**

   1. Secure the earth cable to the motor terminal box.
   2. Ensure that the cable is facing in the correct direction to allow connection to the earthing post on the terminal housing.

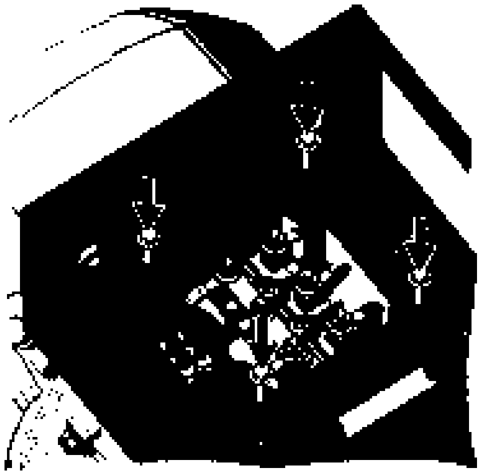
   Note:

   - The earthing cable is supplied with the terminal housing.
   - On the FS80/90 terminal housings there are two additional fixing points which are the earthing points between the terminal housing and the motor. These earthing points must be used and therefore, the earthing cable does not need to be fitted.
   - If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.



3. Fitting the terminal housing to the motor

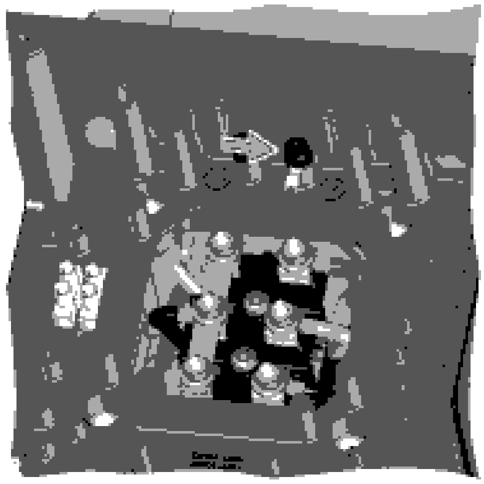
1. Remove the existing motor terminal housing (the terminal housing will become the motor terminal housing).
2. Align the terminal housing with the motor terminal housing.
3. Secure the terminal housing to the motor terminal housing.



Notes:

- Ensure that the terminal housing is fitted to the motor with the Power Module heatsink is over the non-drive end of the motor.
- There are three different terminal housings, please ensure you have the correct terminal housing configuration for the motor to which it is to be fitted.
- All the required fixing bolts are supplied in the packaging with the product.
- On the FS80/90 terminal housings there are two additional fixing points which are the earthing points between the terminal housing and the motor. These earthing points must be used and therefore, the earthing cable does not need to be fitted.
- The FS80/90 terminal housings cannot be fitted directly over the terminal block of the motor - the terminal block of the motor must be removed from the motor, then the terminal housing is fitted to the motor and then the motor terminal block is fitted back onto the motor.
- For the exact dimensions and fixing points of the terminal housing.
- The tightening torques for fitting the terminal housing to the motor terminal box are contained in the Operating Instructions for the motor. For further information, please refer to the following document: LA/LE motors for mounting on SIMOGEAR gearboxes (http://support.automation.siemens.com/WW/view/en/60666508).
- If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.

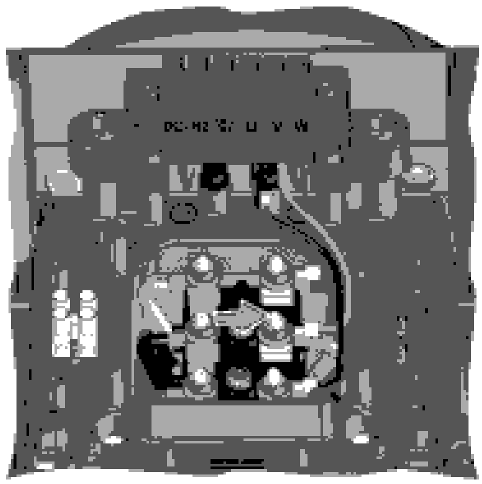
4. **Connect the motor earth cable to the terminal housing**
   1. Feed the motor earth cable through the terminal housing.
   2. Secure the motor earth cable to the terminal housing earthing post (1.5 Nm).



5. **Connect the terminal housing motor terminals to the motor**
   1. Connect the U, V and W terminals of the terminal housing to U1, V1 and W1 terminals of the motor.
   2. Ensure that the cables are routed as to not obstruct access to other components of the system.

   Note:

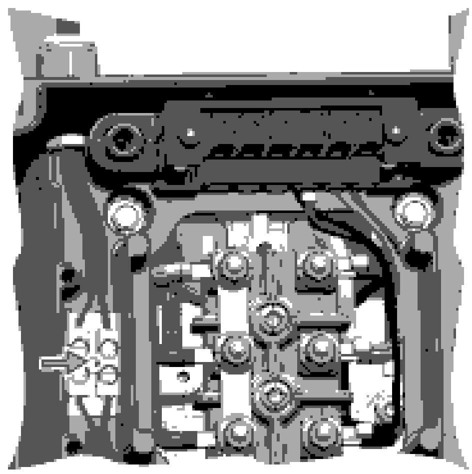
   - The motor terminals on the terminal housing are delivered pre-wired at the correct length for easy fitting.
   - The mains supply and motor terminals have a maximum torque of 0.8 Nm.



6. **Connect the EM brake cables**
   1. Feed the external EM brake cable through the EM brake cable gland.
   2. Connect the external EM brake cable to the EM brake terminal block.
   3. Ensure that the plastic insulation sleeve is fitted correctly to the EM brake terminal block (which is part of the accessories supplied with the product).
   4. Tighten the cable gland to secure the cable in place.

   Notes:

   - Only a 180 Vdc EM brake can be used.
   - If a brake is not used the cable entry must be sealed with a blanking plug to ensure the IP65 rating of the system is maintained.

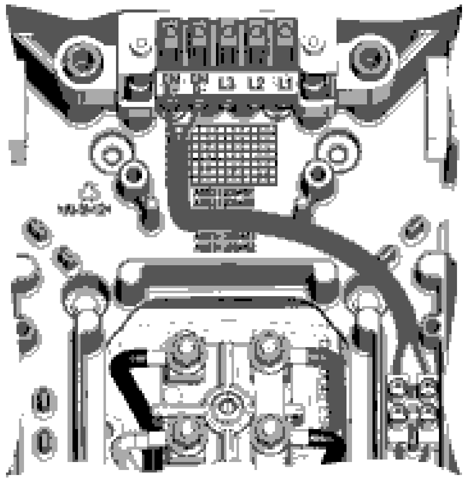


Connect the EM brake cables to the EM brake terminals

1. Connect the EM brake cables to the EM brake terminal block.
2. Connect the EM brake cables to the EMB+ and EMB- terminals on the terminal block.

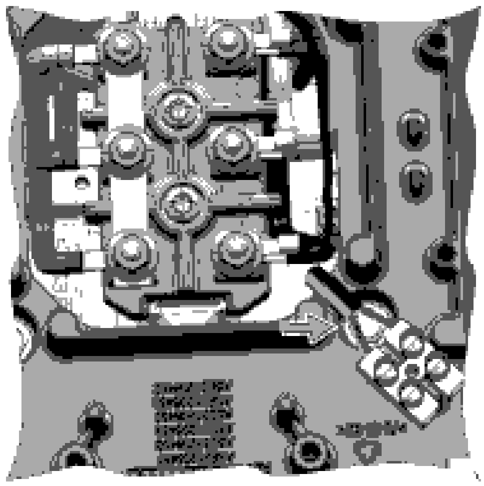
Notes:

- Ensure that the cable is routed under the cable clamp.
- The terminals can accept cable to a maximum size of 4 mm^2.
- The EM brake is an optional extra which is ordered separately.



7. Connect the motor temperature sensor

1. Connect the motor temperature sensor cables to the temperature sensor terminal block.
2. Ensure that the cable is clear of any obstructions and does not restrict access to other cables and connectors within the terminal housing.

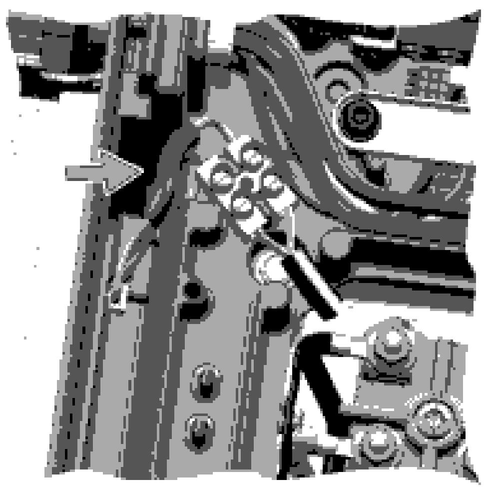


Connect the motor temperature sensor (second part)

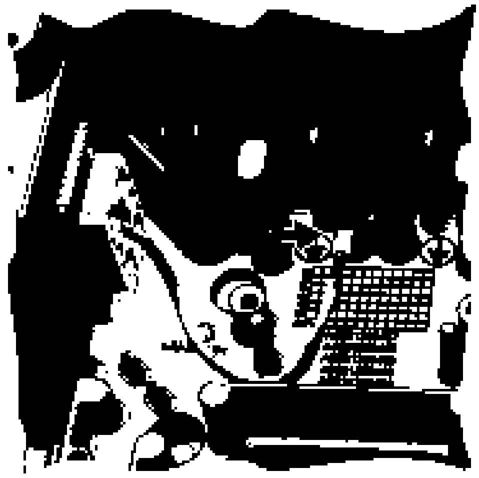
1. Connect the second part of the motor temperature sensor cable to the temperature sensor terminal block.
2. The connector on the second part of the motor temperature sensor is plugged into the Communications and Power Interface (CPI).

Notes:

- The motor temperature sensor terminal block has a diameter of 2.79 mm.
- The final connection of the temperature sensor cannot be completed until the CPI has been fitted. This will be done after the CPI is fitted, as shown later in this procedure.



8. **Connecting the mains earth cable (HANQ variant)**

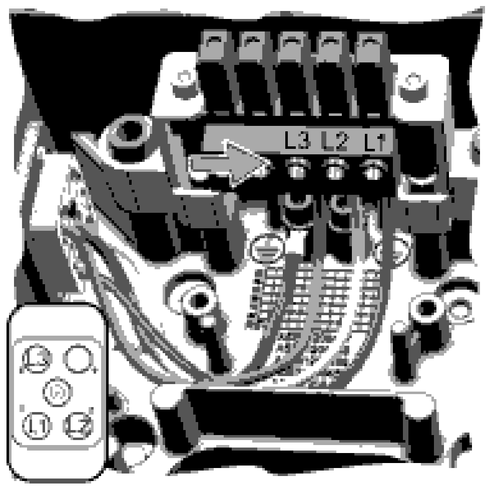


1. Connect the HANQ earth connection to the earthing post of the terminal housing.
2. Tighten the earthing post screw to 1.5 Nm.

Note:

If the SINAMICS G110M is ordered as a complete system, then all mechanical and electrical installation is completed in the factory prior to delivery.

9. **Connecting the mains cables (HANQ variant)**



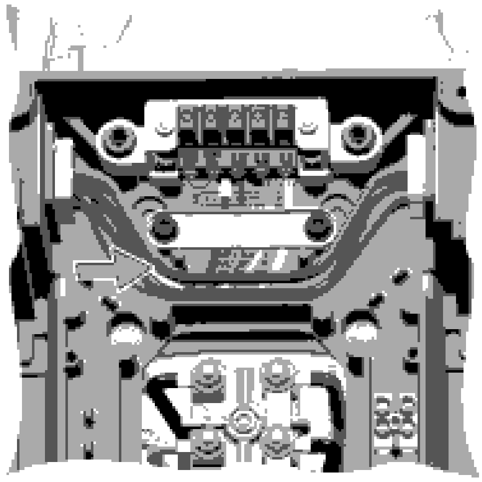
1. Ensure that the cable clamp has been removed.
2. Connect the HANQ L1, L2 and L3 connections to the L1, L2 and L3 connections on the mains connector.
3. When the connections are completed, replace the cable clamp over the cables (ensuring that the cable clamp is the correct way round).

Note:

Tightening torque of the mains terminals are a maximum of 0.8 Nm.

10. Connecting the power-through cables (HANQ variant)

To allow the power provided to one system to supply the power to another system in a daisy-chain, the input power is routed directly from the mains input HANQ connector to the mains output connector in the same terminal housing.



1. Connect the Earth connection from the input HANQ connector to the output HANQ connector.
2. Connect the L1 connection from the input HANQ connector to the output HANQ connector.
3. Connect the L2 connection from the input HANQ connector to the output HANQ connector.
4. Connect the L3 connection from the input HANQ connector to the output HANQ connector.

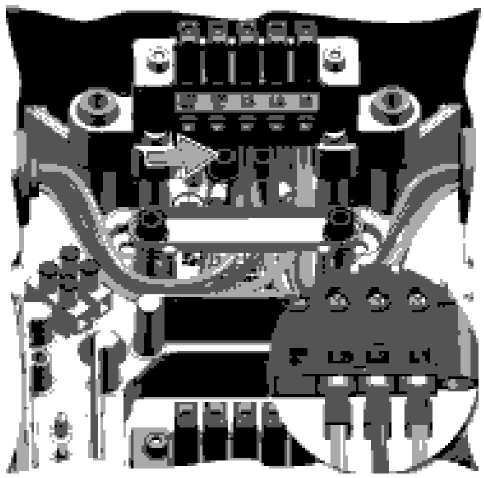
Note:

The power-through cables are provided with the terminal housing and are the correct size and dimensions to allow the power-through connections to be made easily.

11. Connecting the power-through cables (Glanded variant)

In the glanded variant the power-through connections use a different methodology.

The terminal housing terminals L1, L2 and L3 require two cables to be fitted to each terminal - this makes the maximum cable cross-section 2.5 mm². The input and output cables are connected to the terminals through a twin ferrule connector, as shown in the callout in the figure on the right. The twin ferrules are available from Phoenix Connector under order number: 3200836.



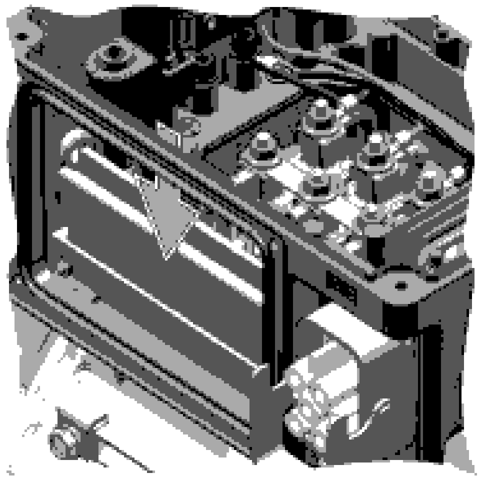
1. Connect the Input cables to the L1, L2 and L3 terminals of the terminal housing.
2. Connect the Input earth cable to the first earthing post of the terminal housing.
3. Connect the L1, L2 and L3 terminals of the terminal housing to the output cable through the cable gland.

Note:

On the glanded variant no pre-cut cables are provided.

12. Fitting the internal braking resistor

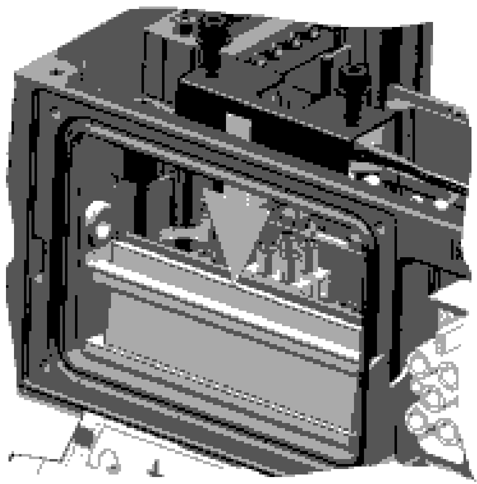
The internal braking resistor is an optional extra and is fitted into the terminal housing.

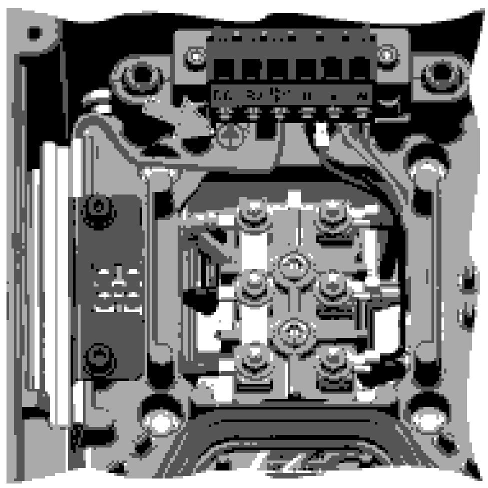


1. Slide the internal braking resistor into place on the opposite side to which the CPI will be fitted.
2. Fit the internal braking resistor securing bracket.
3. Secure the bracket in place using the two screws to a tightening torque of 1.5 Nm.
4. Connect the internal braking resistor cables to the R2 and R1 terminals of the terminal housing motor terminals.

Note:

The internal braking resistor can be fitted on the left or right side of the terminal housing, but must always be fitted on the opposite side of the terminal housing from Communications and Power Interface (CPI).

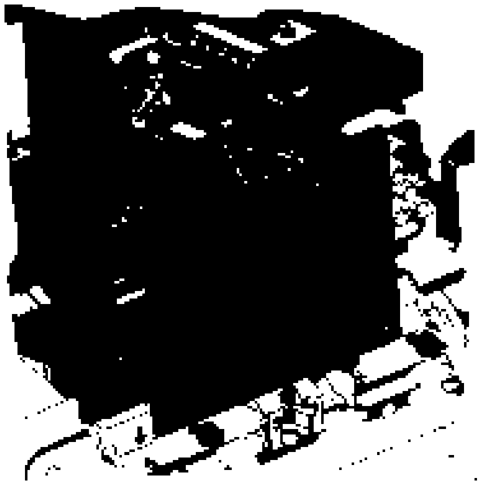




13. **Fitting the blanking plate**
    1. Using the four screws, fit the blank plate to the side of the terminal housing.
    2. Ensure that no cables or components are trapped between the blanking plate and the terminal housing seal, as this would adversely affect the IP rating of the terminal housing.

    Note:

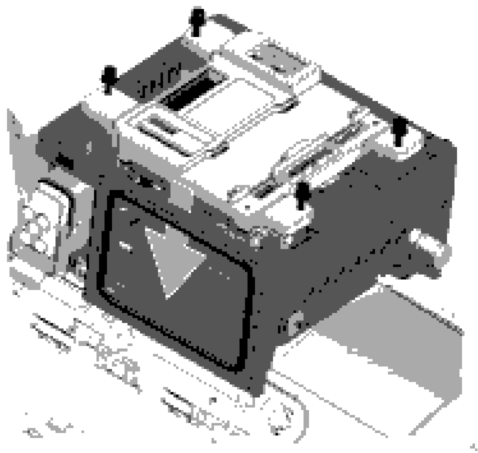
    Screws tightening torque: 1.5 Nm.



14. **Fitting the Control Module**
    1. Ensuring that no wiring is trapped by the Control Module, place the module on the four supporting posts of the terminal housing.
    2. Using the four screws (self-retaining), secure the Control Module into place.

    Note:

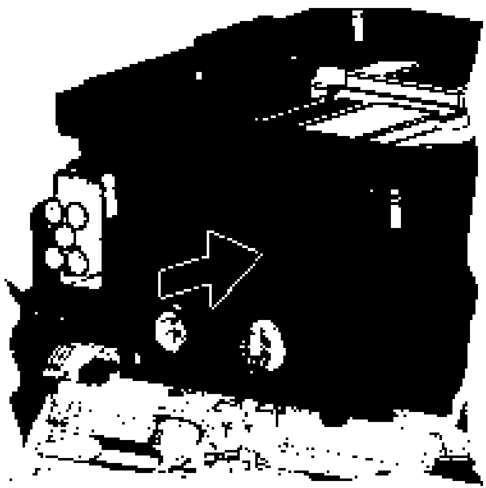
    Screws tightening torque: 1.5 Nm.



15. **Fitting the Communications and Power Interface (CPI)**
    1. Using the four screws, fit the blank plate to the side of the terminal housing.
    2. Ensure that no cables or components are trapped between the CPI and the terminal housing seal, as this would adversely affect the IP rating of the terminal housing.

    Notes:

    - Screws tightening torque: 1.5 Nm.
    - The Communications and Power Interface (CPI) can be fitted on the left or right side of the terminal housing, but must always be fitted on the opposite side of the terminal housing from the internal braking resistor.

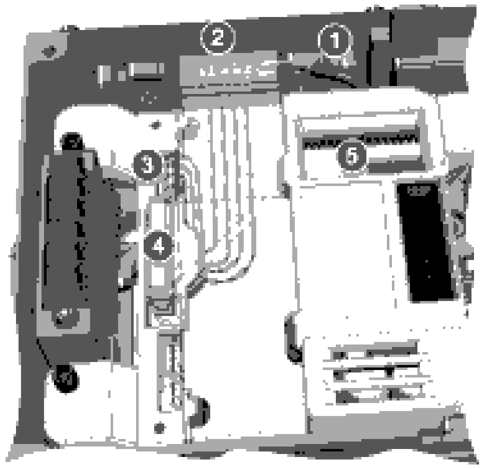


16. **Final connection and adjustments**

    1. Connect the temperature sensor connector into the connector at the top edge of the CPI.
    2. Connect the small communications connector into the connector at the top of the CPI.
    3. Connect the large communications connector into the connector on the top of the Control Module.
    4. Connect the CPI ribbon cable to the connector on the top of the Control Module.
    5. Configure the DIP switches to the requirements of the application (see Step 17 below).

    Note:

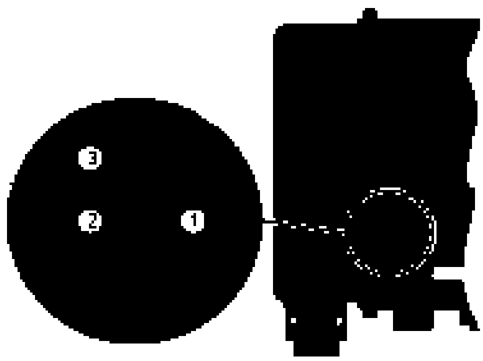
    The PROFIBUS/PROFINET communications cable is not pre-fitted to the Control Module, it is part of the accessories supplied in the product packaging.



17. **PROFIBUS address and basic commissioning DIP-switches**

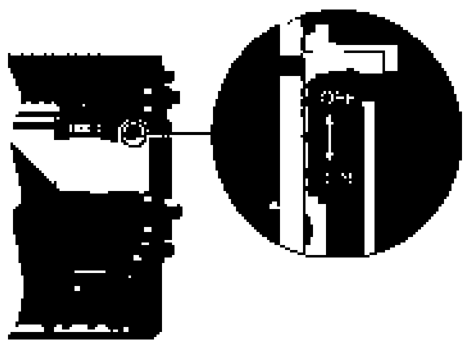
    There are three sets of DIP-switches that allow the user to configure the network device address and perform a basic commissioning of the system.

    For further information, please see Basic Commissioning with DIP switches (Page 88)



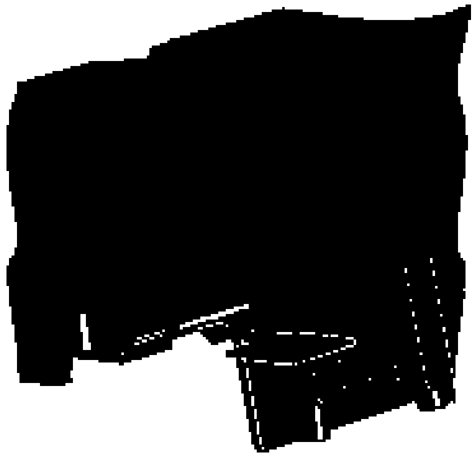
18. **PROFIBUS / USS network termination switch**

    When using the PROFIBUS or USS communications protocols, the last converter on the network must have the network termination switch in the ON position.



19. **Fit memory card into the Power Module**

To allow parameter settings to be stored or copied to the converter, the memory card must be fitted into the memory card reader.



20. **Fit Power Module onto the terminal housing**

The Power Module is fitted on top of the terminal housing and screwed in place with the four self-retaining screws.

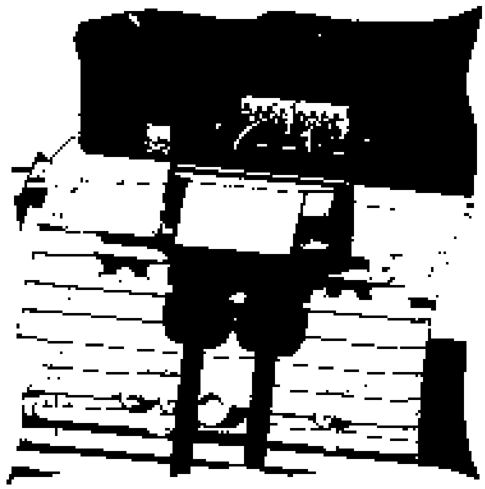
Note:

Screws tightening torque: 2.0 Nm.

21. **Connecting the 24 V external supply (glanded variant)**
    1. Feed the two 4-core cables through the cable glands.
    2. Connect each 4-core cable to the DC 24 V input and the DC 24 V output.
    3. Secure the cable cover to the CPI using the two screws.
    4. Tighten the cable glands to secure the cables in place.

    Notes:

    - The terminals for the 24 V external supply both input and output are as follows:
      - 1 = +24V unswitched
      - 2 = 0V unswitched
      - 3 = +24V switched
      - 4 = 0V switched
    - Screws tightening torque: 1.5 Nm.
    - The cable glands have a diameter of 20 mm
    - Wiring dimensions:
      - 0.25 ... 2.5 mm² without isolated cable ends (ferrels).
      - 0.25 ... 1.5 mm² with isolated cable ends (ferrels).



After the system installation has been completed, the external electrical connections can be performed. See Electrical Installation (Page 59)

Grounding the terminal housing

To ensure that the Inverter is properly grounded and protected, an earthing cable **MUST** be fitted to the terminal housing of the G110M system.

- Connect the PE terminal on the left-hand side of the inverter to appropriate grounding point of the installation.
- Use a short wire connection.
- Clean the connection to the steel construction from paint or dirt.
- Use a ring clamp to terminate the cable to ensure a good physical connection which is resistant to accidental disconnection.

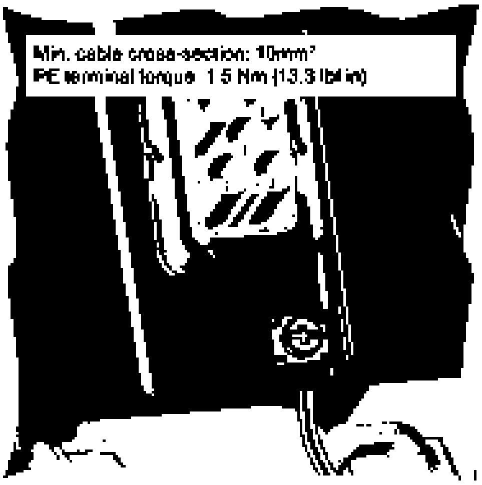


Figure 4-4 Terminal housing PE terminal

4.2.1 Installing the 24V power supply

Introduction

The optional 24V PSU allows the user to draw the necessary 24V to power the internal electronic of the Control Module direct from the converters DC link voltage. This has the advantage that no external cabling is required and therefore, only a 3-phase mains supply cable is required.

The following electronics are powered by the optional 24V PSU:

- Internal circuits in the Control Module (CM).
- Low voltage components in the Power Module (PM).
- All input and output, for example the digital outputs on the Communications and Power Interface (CPI).

At the base of the 24V PSU housing is a cable gland opening (which is sealed with a blanking plug) which provides and entry point for the cables from an external braking resistor.

The optional 24V PSU can be ordered using the following order number:

6SL3555-0PV00-0AA0

A brief description of the layout and the connections of the 24V PSU are given in the following figure.

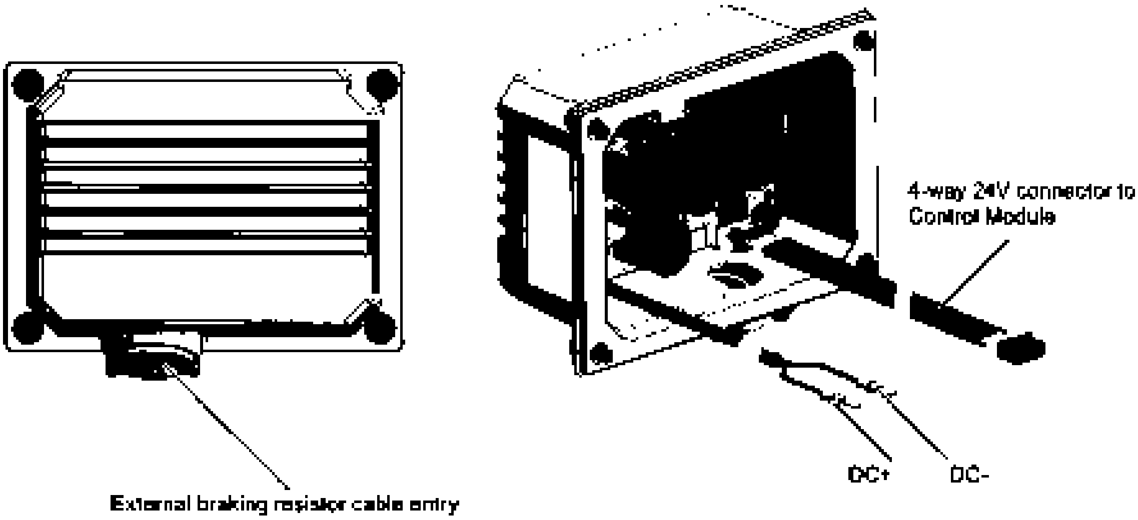


Figure 4-5 24V PSU Layout

Restrictions

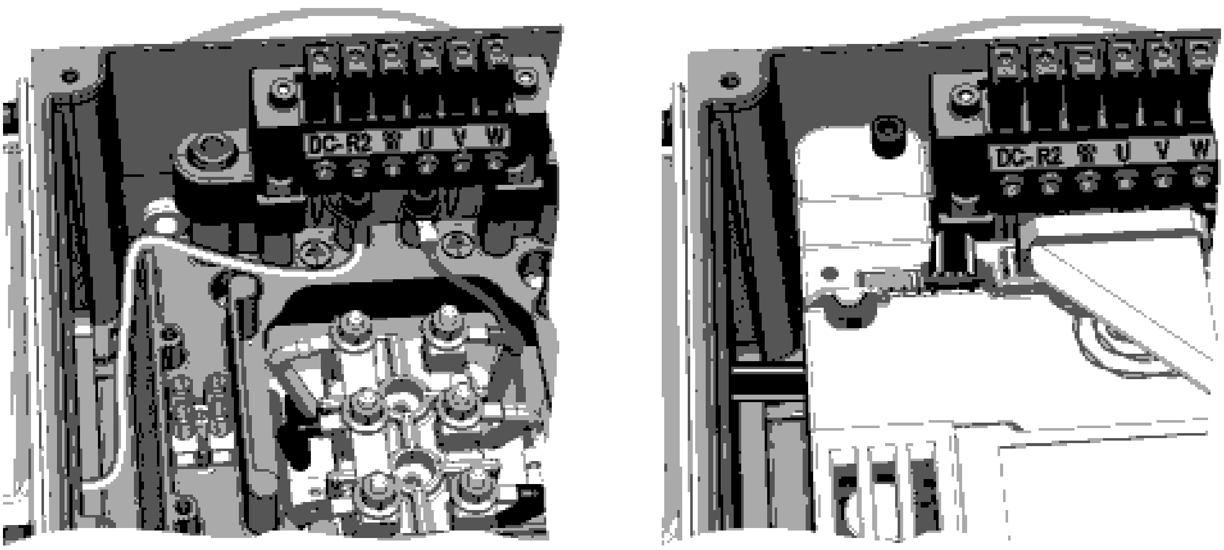
⚠ DANGER
Risk of electrical shock The DC link within the Power Module (PM) carries high voltages which has the potential to cause severe personal injury. Before performing any installation work on the system, it is essential that all power supplies to the system are disconnected. After the power supplies have been disconnected from the system, it is necessary to wait for at least five minutes before accessing any electrical connections of the system, this allows time for the high voltage capacitors within the system to completely discharge.

The following restrictions should be observed when installing the 24V PSU:

- If an external braking resistor is not used, the cable gland opening must be sealed with a blanking plug to maintain the IP rating of the system.
- When using the 24V PSU there is no longer any isolation between the 24V PSU and the digital outputs of the system.
- Since the 24V PSU utilizes the DC link voltage to provide the 24V supply to the Control Module, when the mains supply is disconnected, all power will be lost to the Control Module.

Installation

1. Disconnected all power supplies to the system and wait 5 minutes.
2. Remove the Power Module (PM).
3. Remove the blank plate from the side of the terminal housing.
4. Remove the Control Module (CM).
5. Fit the 24V PSU to the side of the terminal housing, ensuring that no cables or wiring are trapped between the 24V PSU and the terminal housing. Tightening torque: 1.5 Nm.
6. Connect the input cable to the DC link terminals in the terminal housing (black to DC- and red to DC+).
7. The 4-way 24V cable is routed underneath and then over the top of the CM.
8. Fit the 4-way connector as shown in the illustration below.
9. Fit the CM back into place - ensuring that it securely fastened into place.
10. Replace the PM.
11. Fit blanking cap to the 7/8th connector.
12. Power can now be restored to the system.



Fitting the DC+ and DC- inputs to the terminals

Fitting the 24 V cable to the Control Module

Figure 4-6 Fitting the input and output connections

4.3 Electrical Installation

4.3.1 SINAMICS G110M Electrical data

Power Module specifications - 3AC 380 V (-10%) ... 500 V (+6%)

Table 4- 2 Rated Output, Input and Fuses

Product	Frame size	Rated output		HO		Fuse	
				Rated output current	Rated input current		3NA3…
6SL3517-…		kW	hp	A	A	A	Type
1BE11-3AM0	A	0.37	0.5	1.3	1.3	10	803 -
1BE12-3AM0	A	0.75	1.0	2.2	2.0	10	803 -
1BE13-3AM0	A	1.1	1.5	3.1	2.8	10	803 -
1BE14-3AM0	A	1.5	2.0	4.1	3.6	10	803 -
1BE16-3AM0	B	2.2	3.0	5.6	5.3	20	807 -
1BE17-7AM0	B	3.0	4.0	7.3	6.9	20	807 -
1BE21-0AM0	B	4.0	5.0	8.8	8.0	20	807 -

Standby current

The PM240M Power Module has a unique standby current characteristic which needs to be taken into account when calculating the requirements of the line supply.

The standby current is the current that the Power Module requires when the Converter is in the ready-to-run mode. This means that the Converter is powered-up but the motor is not running. The phenomenon of capacitive reactive current standby occurs in all Power Modules and Converters with filter capacitors on the line side.

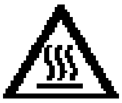
In applications were a number of Converters are connected to one line supply and where only a small proportion of the Converters will be running at any one time, the standby currents in the non-running Converters must be considered when calculating the size of the conductors and selecting the correct protective devices on the line supply of the system.

The Control Module (CM) and the communications input and outputs are normally powered by a Class 2 external 24 V supply, which does not influence the standby current of the Converter. However, the optional 24 V PSU draws it power directly from the DC link of the Power Module (PM), in this case, the standby current of the Converter increases, by an additional current of 15 mA.

The standby currents for all the possible combinations of the SINAMICS G110M are given in the following table:

Table 4- 3 SINAMICS G110M Standby currents

Device	Power supply	Standby current (mA)
G110M FSA (0.37 ... 1.5 kW)	Mains only	325
G110M FSB (2.2 ... 4.0 kW)	Mains only	445
G110 FSA + Optional 24 V PSU	Mains + Optional 24 V PSU	340
G110 FSB + Optional 24 V PSU	Mains + Optional 24 V PSU	460
PROFIBUS / USS CM	External 24 V	235
PROFINET CM	External 24 V	290



CAUTION

Thermal stability of the system

The SINAMICS G110M system is comprised of a motor and a converter which are designed to work together. The system can generate a significant amount of heat which can affect the performance of your application.

If the duty cycles of the system are not calculated properly, it could result in your application not working efficiently and produce nuisance trips from overtemperature faults.

To ensure the thermal stability of the system, duty cycles should be calculated using the lowest rated component of the system - this should be either the motor or the converter depending on the your application.

NOTICE

Line impedance

To ensure trouble free operation we recommend the mains supply impedance is less than 1% (RSC > 100).

NOTICE

UL transient surge suppression requirements

To ensure that the electical installation of this equipment complies with the UL requirements for transient surge protection, the following requirement must be strictly adhered to:

Transient surge suppression shall be installed on the line side of this equpment and shall be rated 480 v (phase to ground), 480 v (phase to phase), suitable for overvoltage category III and shall provide protection for a VPR maximum of 2 kv, type 1 or type 2 SPD application.

4.3.2 EMC installation guidelines

4.3.2.1 Connections and interference suppression

All connections should be made so that they are permanent. Screwed connections on painted or anodized metal components must be made either by means of special contact washers, which penetrate the isolating surface and establish a metallically conductive contact, or by removing the isolating surface on the contact points.

Contactor coils, relays and solenoid valves must have interference suppressors to reduce high-frequency radiation when the contacts are opened (RC elements or varistors for AC current operated coils, and freewheeling diodes for DC current-operated coils). The interference suppressors must be connected directly on each coil.

4.3.2.2 Basic EMC rules

Measures to limit Electromagnetic Interference (EMI)

In the following list are the necessary measures that must be taken to ensure the correct installation of the Converter within a system, which should minimize the effects of EMI.

Cables

- Keep all cable lengths to the minimum possible length; avoid excessive cable lengths.
- Route always signal and data cables, as well as their associated equipotential bonding cables, in parallel and with as short a distance as possible.
- Do not route signal and data cables parallel to the line supply cables.
- Signal and data cables should not cross the line supply cables; if crossing is necessary, they should cross at an angle of 90 °.
- Shield analog and data cables.
- Route particularly sensitive signal cables, such as setpoint and actual value cables, with optimum shield bonding at both ends and without any interruptions of the shield.
- Ground spare wires for signal and data cables at both ends.
- Route all power cables (line supply cables) separately from signal and data cables. The minimum distance should be approximately 25 cm.

Cable shields

- Use shielded cables with finely stranded braided shields. Foil shields are not suitable since they are much less effective.
- Connect shields to the grounded housings at both ends with excellent electrical conductivity and a large contact area.
- Bond the cable shields to the plug connectors of the Converter.
- Don't interrupt cable shields by intermediate terminals.
- In the case of both signal and data cables, the cable shields should be connected by means of suitable EMC glands. The cables must connect the shields to the shield bonding options for cables and the unit housing respectively with excellent electrical conductivity and a large contact area.
- Use only metallic or metallized connector housings for shielded data cables (for example, PROFIBUS cables).

4.3.2.3 Equipotential bonding

Equipotential bonding within the drive system has to be established by connecting all electrical and mechanical drive components (transformer, motor and driven machine) to the grounding system. These connections are established by means of standard heavy-power PE cables, which do not need to have any special high-frequency properties. In addition to these connections, the converter (as the source of the high-frequency interference) and all other components in each drive system (motor and driven machine) must be interconnected with respect to a high-frequency point of view. For this purpose cables with good high-frequency properties must be used.

Grounding and high-frequency equipotential bonding measures

The following figure illustrates all grounding and high-frequency equipotential bonding measures using an example with the SINAMICS G110M.

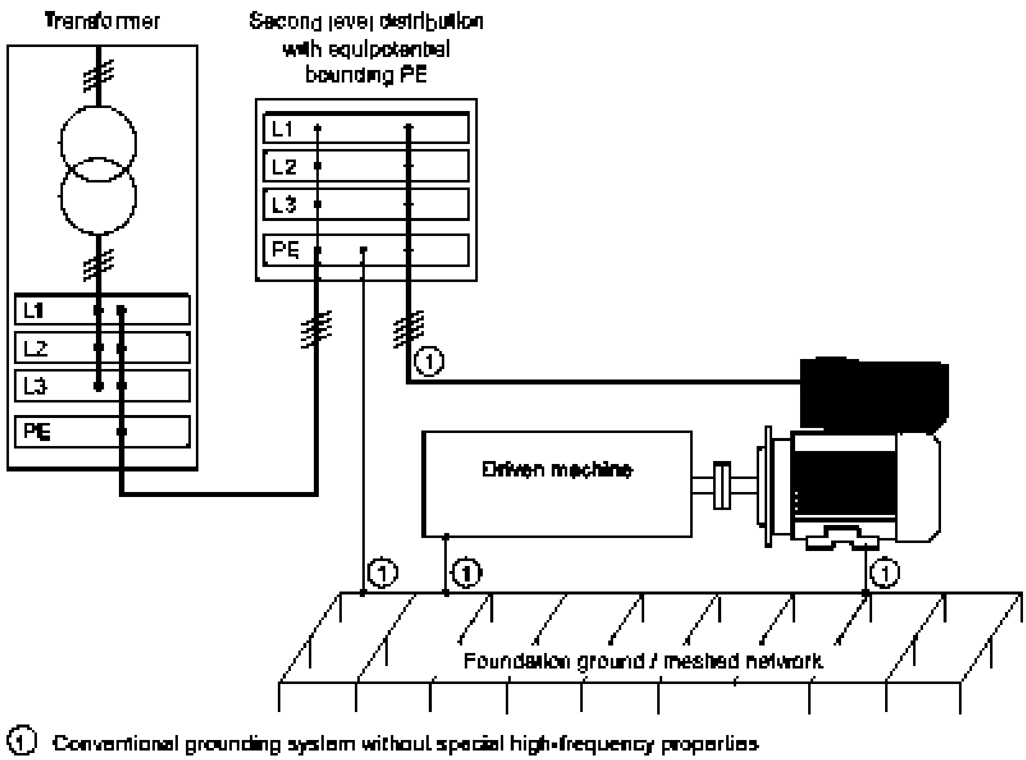


Figure 4-7 Grounding and high-frequency equipotential bonding measures in the drive system and in the plant

The ground connections ① represent the conventional grounding system for the drive components. They are made with standard, heavy-power PE conductors without special high-frequency properties and ensure low frequency equipotential bonding as well as protection against injury.

The line supply cable of the converter can be unshielded. The converter has to be grounded by this cable.

The converter enclosure provides high-frequency equipotential bonding between the converter and the motor.

The connection provides solid bonding for high-frequency currents between the metal body of the converter and the unpainted metal mounting frame. This connection should be made with short, finely stranded, braided copper wires.

Additional measures

Finely stranded, braided copper cables have to be routed in parallel with the cable shields in the following cases:

- Old installations with already existing unscreened cables
- Cables with poor high-frequency properties
- Installations with bad grounding systems

The connections in the following figure provide a solid, high-frequency bonding between the driven machine and the converter.

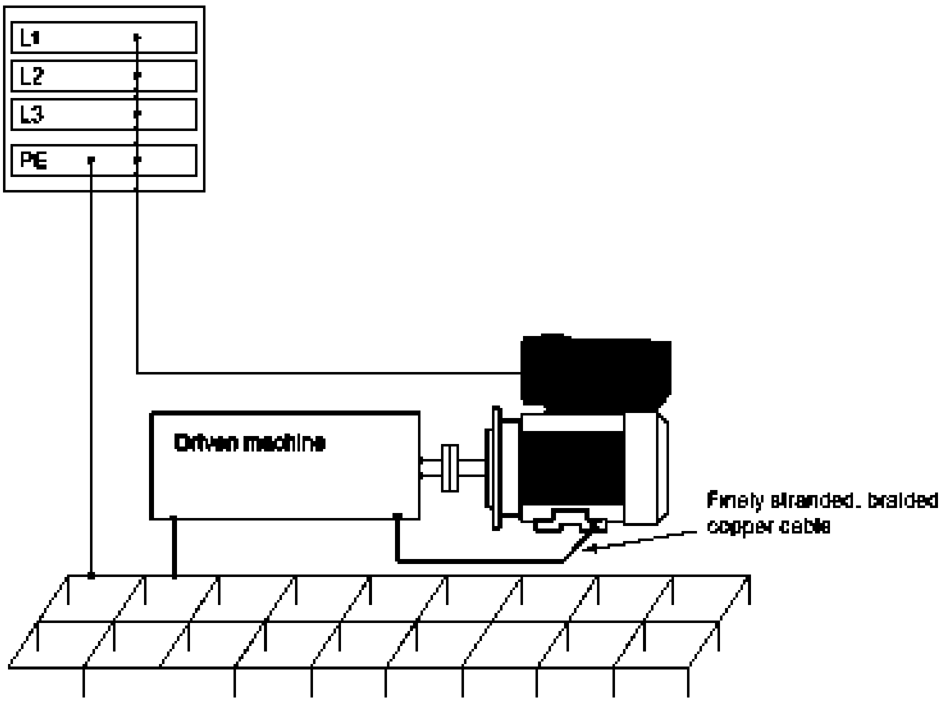


Figure 4-8 Additional high-frequency bonding of the drive system

4.3.3 Connection and cables

Connections and cables

The following block diagrams and tables describe the details and limitations of the connections on the converter.

Wiring stripping

The following components are delivered with pre-prepared cables and no wire stripping is necessary:

- Internal 24 V DC power supply
- Internal braking resistor for FSA
- Internal braking resistor for FSB
- Motor EM brake
- The motor terminals for the terminal housing (for connection to the motor terminals).

All other connections to the Phoenix mains and motor connectors need to be stripped to a length of 10 mm, with a maximum torque of 0.8 Nm.

Cable lengths

The maximum cable lengths for all the converters are shown in the following table.

Table 4- 4 Maximum cable lengths

Cable	Screening	Max. length
Digital inputs	Unscreened	15 m (49 ft)
Digital outputs	Unscreened	15 m (49 ft)
Analog input	screened	15 m (49 ft)

The maximum cable lengths for USS, PROFIBUS and PROFINET are determined by a number of factors, for example, the maximum length of the cable for USS and PROFIBUS are dependent on the data transfer rate being utilized by the network.

In some cases, it is possible to extend the cable length by the use of appropriate repeaters. The maximum cable lengths for the various communications protocols are given in the following table:

Table 4- 5 Maximum cable lengths for USS, PROFIBUS and PROFINET

Communications protocol	Transfer rate or cable type	Maximum cable length
USS		
	9.6 kbit/s	1200 m (3,940 ft)
	19.2 kbit/s	1200 m (3,940 ft)
	38.4 kbit/s	1200 m (3,940 ft)
	187.5 kbit/s	1000 m (3,280 ft)
PROFIBUS-DP		
	9.6 - 187.5 kbit/s	1000 m (3.280 ft)
	500 kbit/s	400 m (1,312 ft)
	1.5 Mbit/s	200 m (656 ft)
	3, 6 and 12 Mbit/s	100 m (328 ft)
PROFINET		
	CAT5 network cable	100 m (328 ft)

Outline block diagram

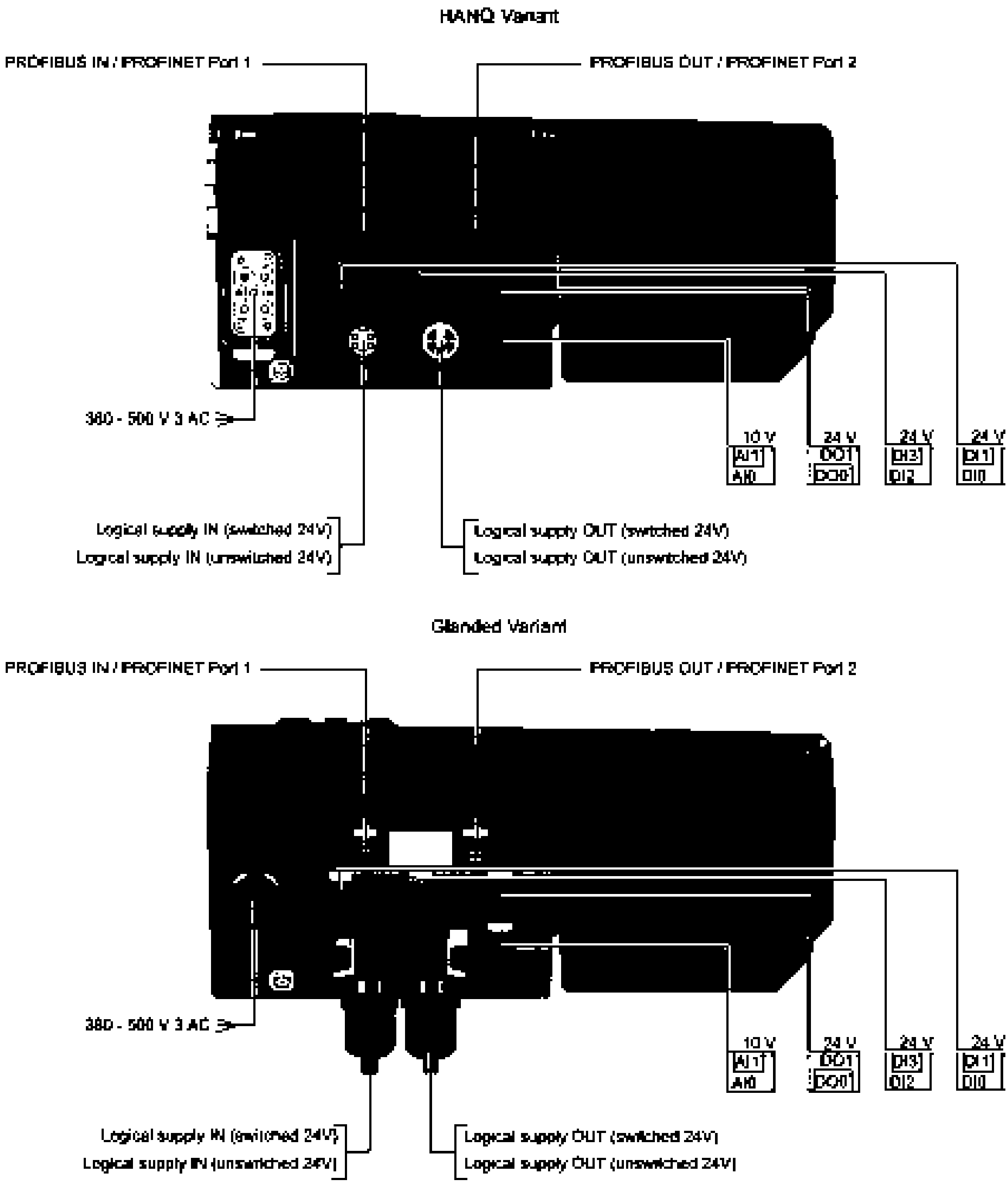


Figure 4-9 Outline block diagram SINAMICS CU240M and PM240M

Cable, connectors and tools specifications

The detailed specifications for the cables, connectors and tools required to manufacture the necessary cables for the SINAMICS G110M are listed in the following documents and can be accessed using the relevant links:

- SINAMICS and motors for Single-Axis Drives D31 catalog
  SINAMICS and motors for Single-Axis Drives D31 catalog (https://intranet.automation.siemens.com/mcms/infocenter/content/en/Pages/order_form.aspx?nodeKey=key_566000&infotype=catalogs&linkit=null)
- Siemens supplementary product information
- Siemens supplementary product information (http://support.automation.siemens.com/WW/view/en/65355810)

The connections that are detailed in this section relate to the physical connections that exist on the converter.

Note

NFPA compatibility

These devices are intended only for installation on industrial machines in accordance with the "Electrical Standard for Industrial Machinery" (NFPA79). Due to the nature of these devices they may not be suitable for installation accordance with the "National Electrical Code" (NFPA70).

Note

Mains supply impedance

To ensure trouble free operation we recommend the mains supply impedance is less than 1% (RSC > 100).

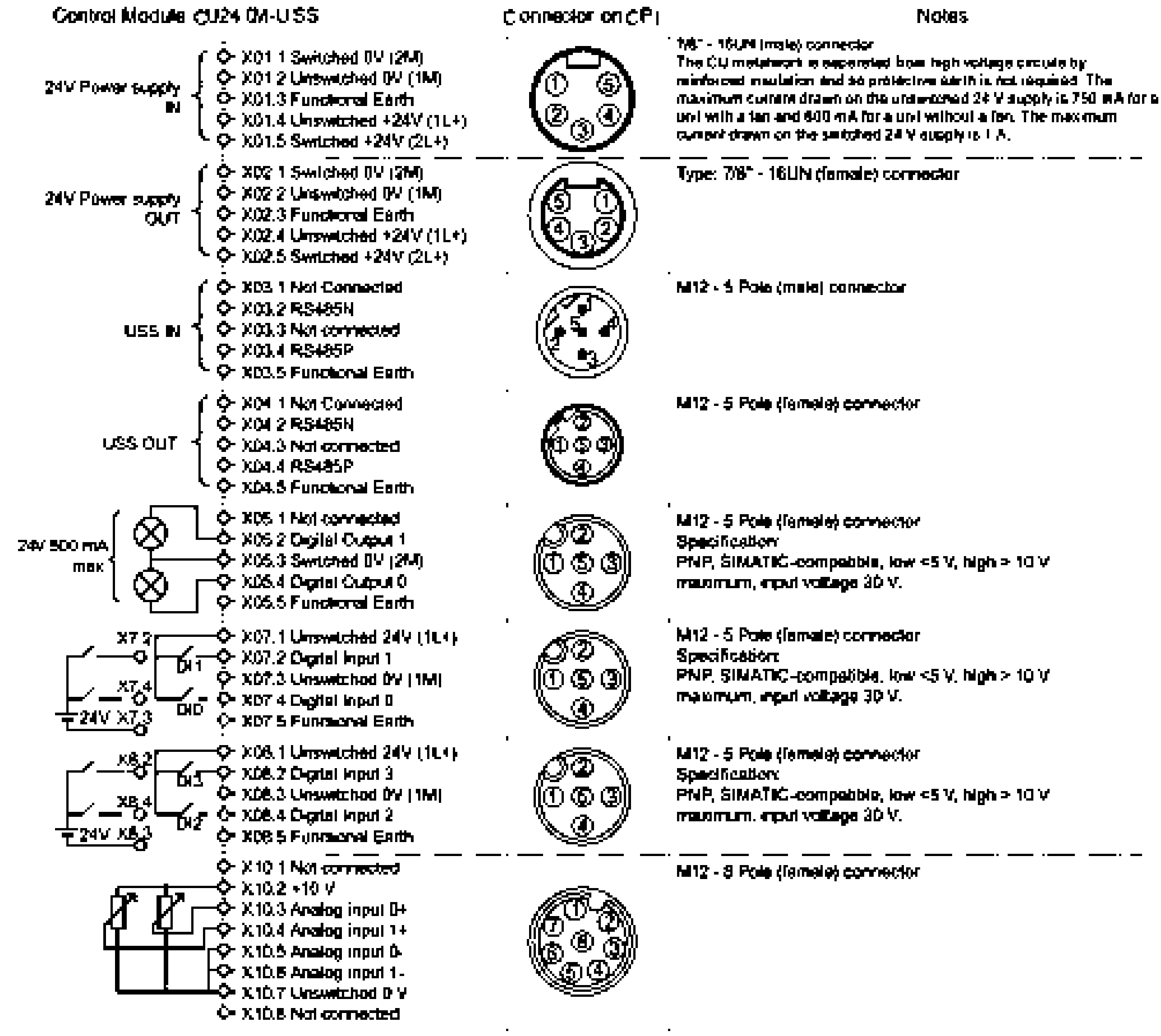
Connection and terminal diagrams

⚠ CAUTION

Orientation of Connectors

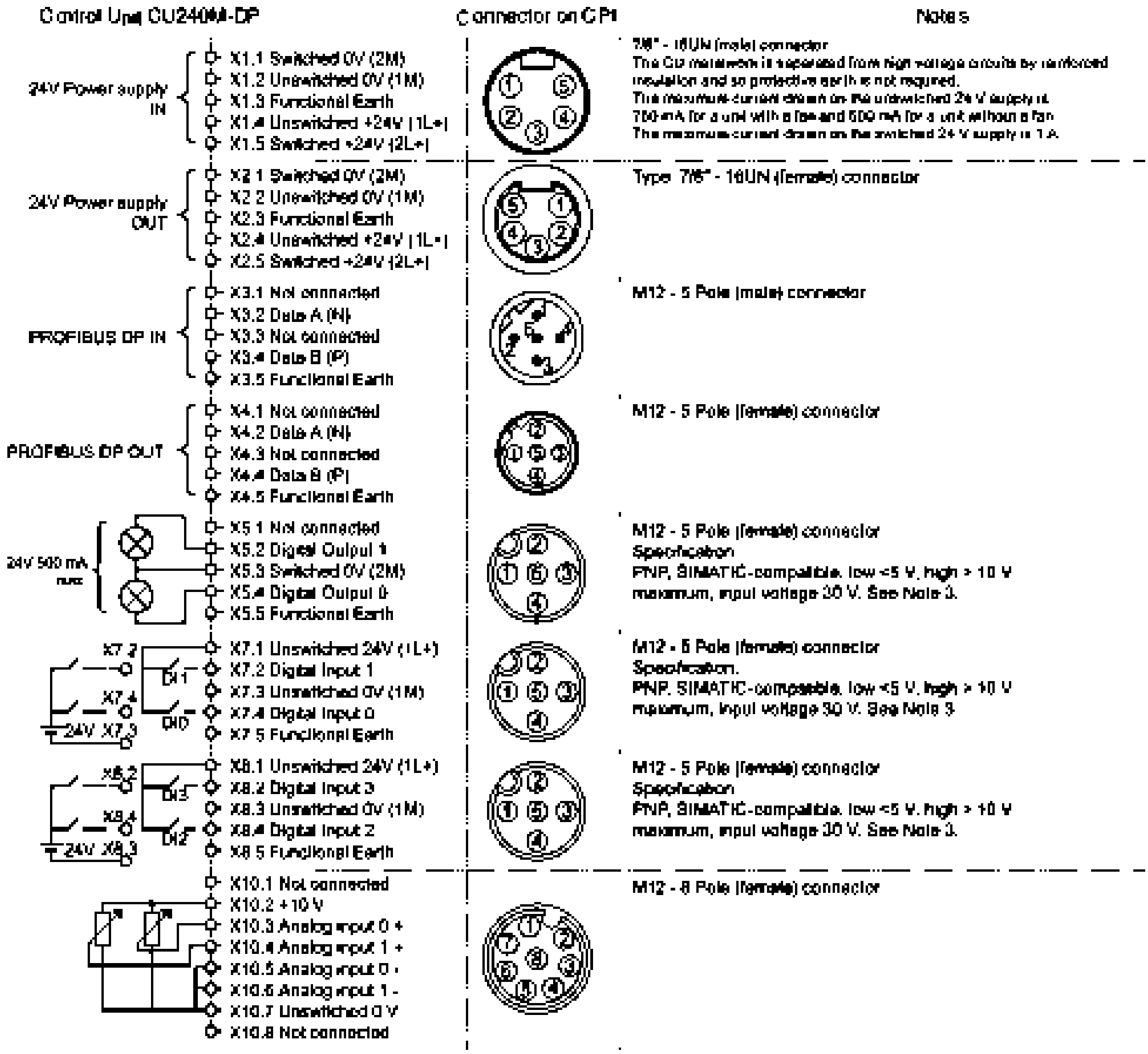
The connection diagrams given in this manual show the physical connections on the Communications and Power Interface (CPI). Different manufacturers of mating connectors may have differing pinout arrangements, it is essential that when making-up the necessary cables and connectors that the connections match those given in the connection diagrams.

For example, the orientation of the key-notch on the CPI connector may not match the key-notch on the mating cable connector being constructed, in this instance the pin numbers on the connector being made needs to be ignored to allow the correct orientation and wiring of the connector to ensure a proper match to the connector on the CPI.



Important:
1 The connection pinouts refer to the actual connectors on the Communications and Power Interface (CPI).
2 The 24 Vdc supply must be Class 2 or limited in voltage/current to ensure no excessive voltage/current can be drawn by the CU.
3 The Control Module (CM) is fitted inside the terminal housing and is connected by ribbon cable to the CPI.
4 The maximum combined current for all digital inputs and outputs is 200 mA and the maximum combined current for all digital outputs is 500 mA.

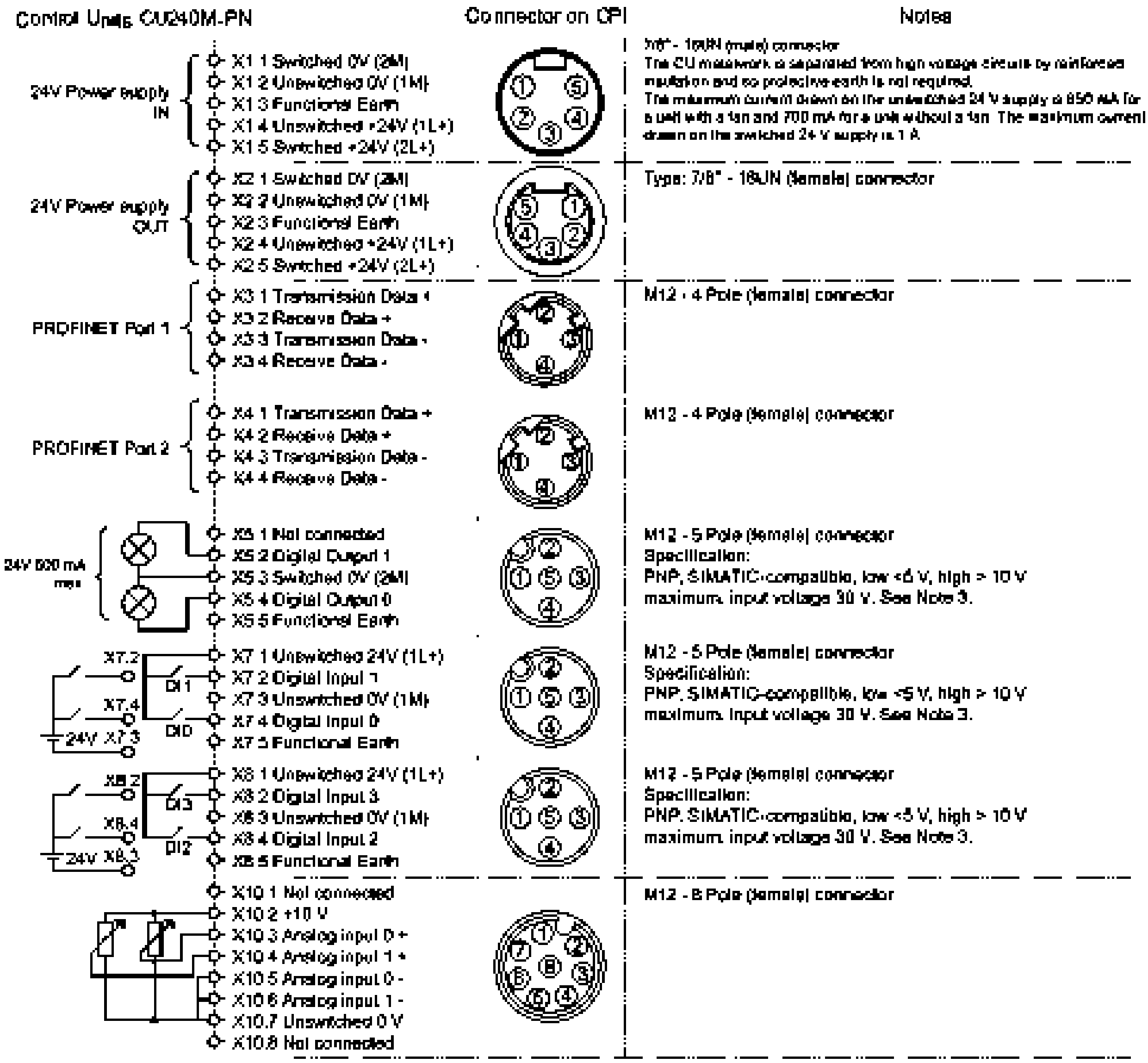
Figure 4-10 SINAMICS G110M CU240M USS terminal diagram



Important:

1. The connection pinouts refer to the actual connectors on the Communications and Power Interface (CPI).
2. The 24 Vdc supply must be Class 2 or limited in voltage/current to ensure no excessive voltage/current can be drawn by the CU
3. The Control Module (CM) is fitted inside the terminal housing and it connected by ribbon cable to the CPI.
4. The maximum combined current for all digital inputs and outputs is 200 mA and the maximum combined current for all digital outputs is 500 mA.

Figure 4-11 SINAMICS G110M CU240M PROFIBUS terminal diagram



Important:
1. The connection pinouts refer to the actual connectors on the Communications and Power Interface (CPI).
2. The 24 Vdc supply must be Class 2 or limited in voltage/current to ensure no excessive voltage/current can be drawn by the CU
3. The Control Module (CM) is fitted inside the terminal housing and is connected by ribbon cable to the CPI.
4. The maximum combined current for all digital inputs and outputs is 200 mA and the maximum combined current for all digital outputs is 500 mA.

Figure 4-12 SINAMICS G110M CU240M PROFINET terminal diagram

When the HAN Q4/2 connector is used on the CPI/terminal housing the mains supply connections are shown in the following figure.

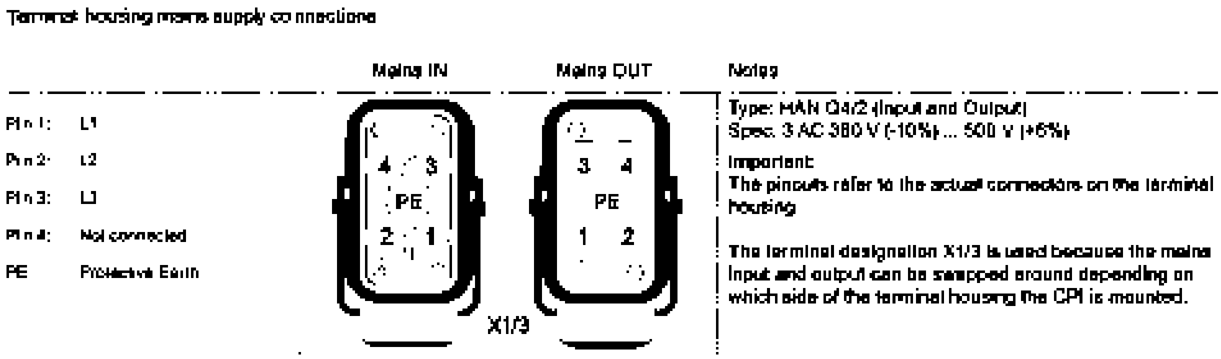


Figure 4-13 SINAMICS G110M PM240M connections diagram

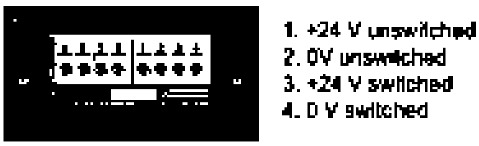


Figure 4-14 24 V glanded input and output connections

Note

Adaption of inputs and outputs

Further adaption of the inputs and outputs of the Inverter are possible, please refer to relevant section in the SINAMICS G110M Operating Instructions for further information.

The internal motor and power connections on the G110M system are located inside the Control Unit and motor housing. The connections are shown in the following figure.

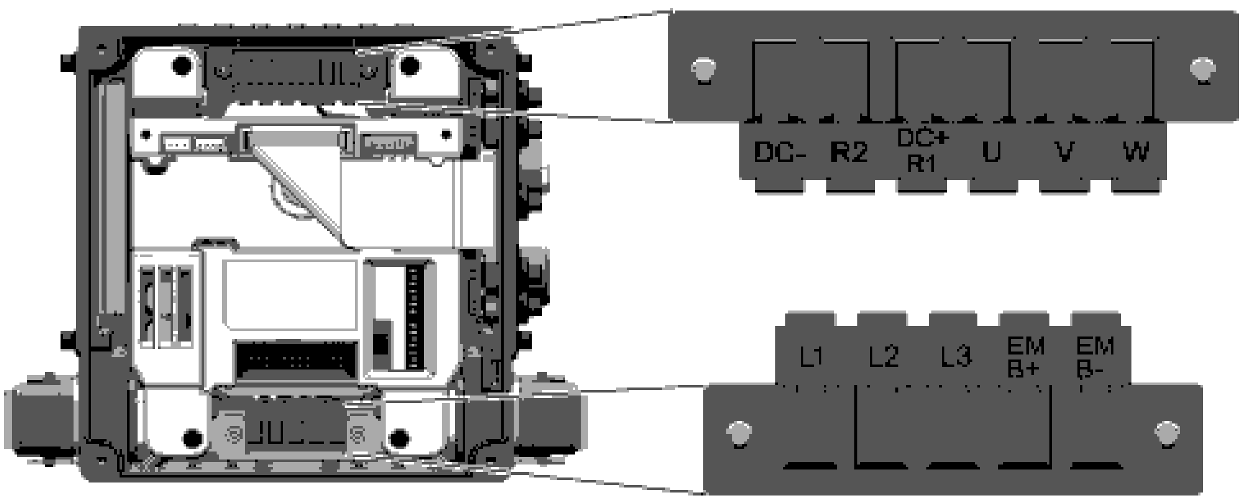


Figure 4-15 Control Unit motor and power connections

See also

Adapt inputs and outputs (Page 123)

4.3.4 Cable protection

Cable protection for individual converters

If you individually protect an Inverter, then you must protect the Inverter feeder cable using a fuse.

Table 4- 6 Individual fuse protection

Rated power	Power Module	Frame size	Fuse	
0.37 kW	6SL3517-1BE11-3AM0	FSA	10 A	3NA3803
0.75 kW	6SL3517-1BE12-3AM0	FSA	10 A	3NA3803
1.1 kW	6SL3517-1BE13-3AM0	FSA	10 A	3NA3803
1.5 kW	6SL3517-1BE14-3AM0	FSA	10 A	3NA3803
2.2 kW	6SL3517-1BE16-3AM0	FSB	20 A	3NA3807
3 kW	6SL3517-1BE17-3AM0	FSB	20 A	3NA3807
4 kW	6SL3517-1BE21-3AM0	FSB	20 A	3NA3807

For additional information, please refer to Catalog D31at the following link:

SINAMICS and motors for Single-Axis Drives D31 catalog (https://intranet.automation.siemens.com/mcms/infocenter/content/en/Pages/order_form.aspx?nodeKey=key_566000&infotype=catalogs&linkit=null)

Installation using power-through daisy chain

The SINAMICS G110M system has been designed to allow a converter to utilize power-through to provide the mains power for a number of converters in a daisy chain.

The maximum current limits for the daisy chain are given below:

- For the HanQ variants the maximum current of the daisy chained converters must not exceed 16 A.
- For the Glanded variants the maximum current on the daisy chained converters must not exceed 12 A.
- For both HanQ and Glanded variants the input for the daisy chained converters can be protected by a 20 A fuse.

It is the users responsibility to ensure that the current limits are not exceeded.

The methodology for daisy chaining a number of Inverter is shown in the following diagram.

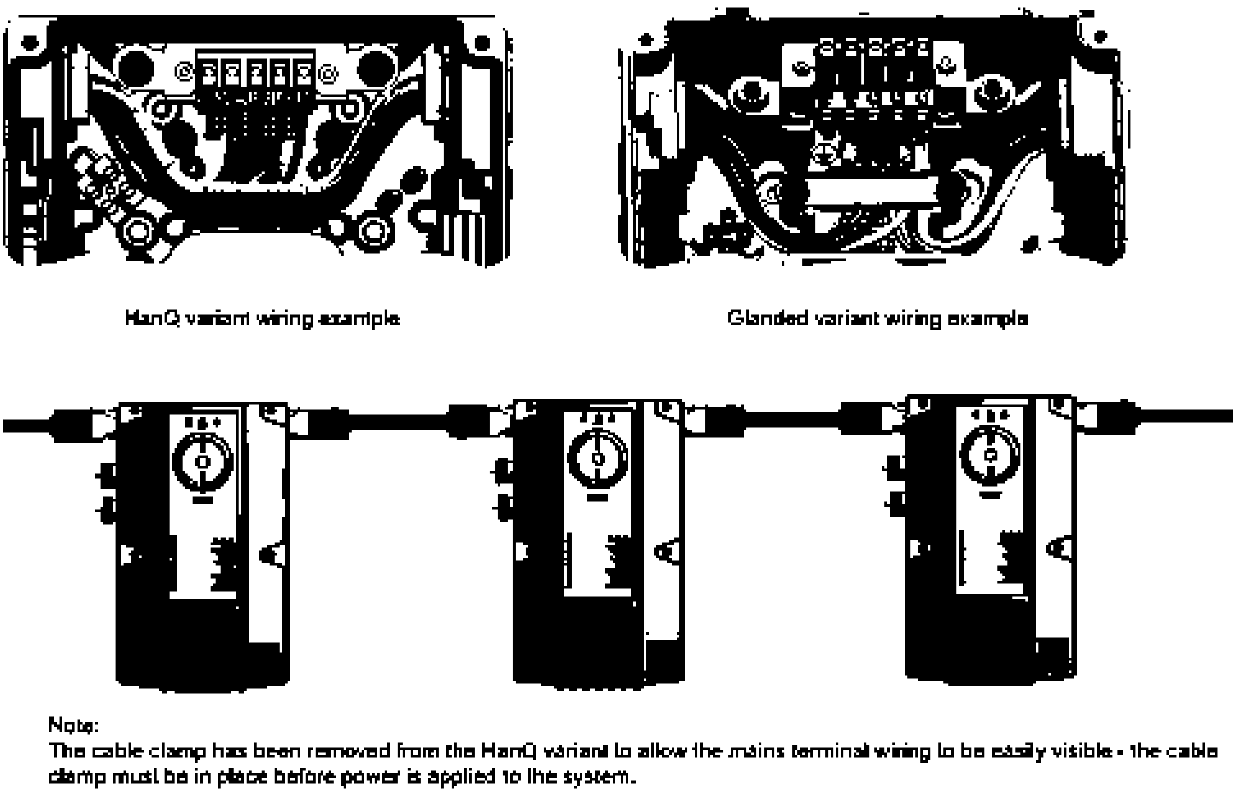


Figure 4-16 Daisy chaining power between Inverters

4.3.5 Connecting the PROFINET interface

Industrial Ethernet Cables and cable length

Listed in the table below are the recommended Ethernet cables.

Table 4- 7 Recommended PROFINET cables

	Max. Cable Length	Order Number
Industrial Ethernet FC TP Standard Cable GP 2 x 2	100 m (328 ft)	6XV1840-2AH10
Industrial Ethernet FC TP Flexible Cable GP 2 x 2	85 m (278 ft)	6XV1870–2B
Industrial Ethernet FC Trailing Cable GP 2 x 2	85 m (278 ft)	6XV1870–2D
Industrial Ethernet FC Trailing Cable 2 x 2	85 m (278 ft)	6XV1840–3AH10
Industrial Ethernet FC Marine Cable 2 x 2	85 m (278 ft)	6XV1840–4AH10

Cable screening

The screen of the PROFINET cable must be connected with the protective earth. The solid copper core must not be scored when the insulation is removed from the core ends.

4.3.6 Terminal assignment dependent on interface configuration

The inputs and outputs of the frequency inverter and the fieldbus interface have specific functions when set to the factory settings.

When you put the frequency inverter into operation, you can change the function of each of its inputs and outputs and the setting of the fieldbus interface.

To make the setting process easier, the inverter has various predefined assignments (macros).

Only the inputs and outputs whose functions change by selecting a specific assignment, are shown on the following pages.

Procedure

To select one of the inverter's pre-assigned settings, proceed as follows:

1. Think about which of the input and output functions you are using in the application.
2. Find the I/O configuration (macro) that best suits your application.
3. Note the macro number of the corresponding default setting.

   You must set this macro number when putting the frequency inverter into operation.

You have found the appropriate inverter pre-assignment.

Macros for the CU240M

The macros that are available for the CU240M Control Modules are shown in the figures below. Macro 7 is the default setting for the CU240M DP and CU240M PN Control Modules and Macro 29 is the default settings for the CU240M USS Control Module.

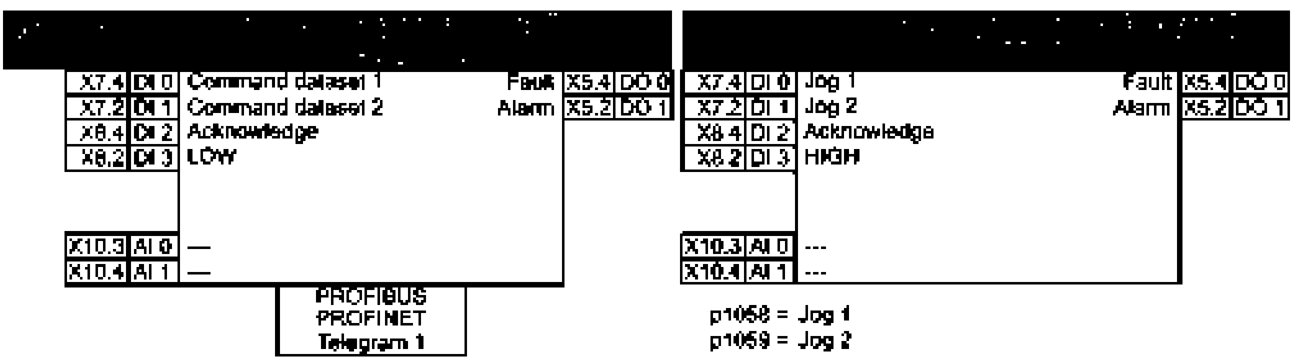


Figure 4-17 Fieldbus communications with Command Dataset selection (default for CU240M DP and CU240M PN)

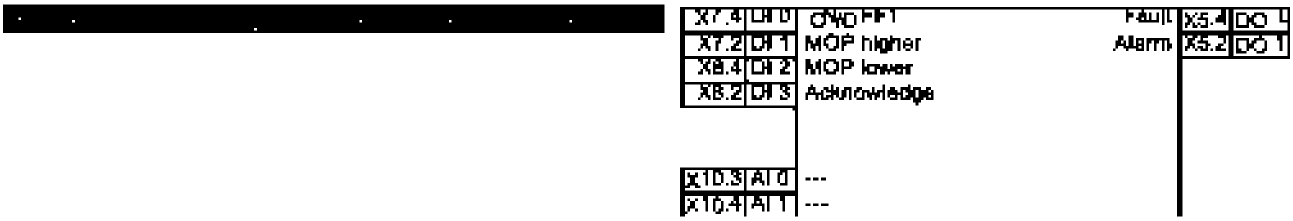


Figure 4-18 Standard input and output with motorized potentiometer

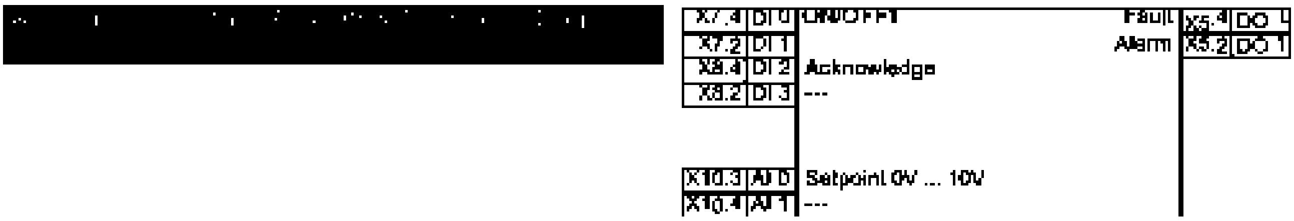


Figure 4-19 Standard input and output with analog setpoint

Figure 4-20 Two-wire control

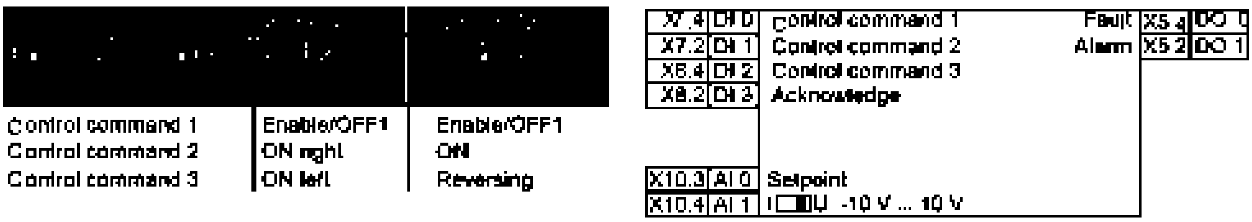


Figure 4-21 Three-wire control

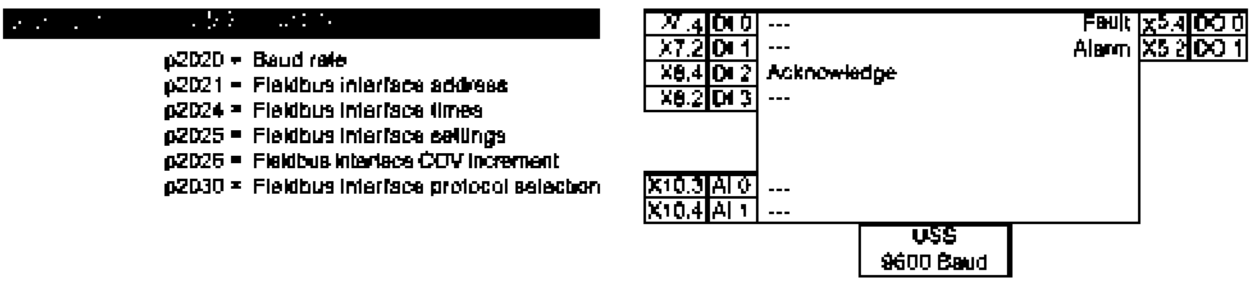


Figure 4-22 USS fieldbus communications

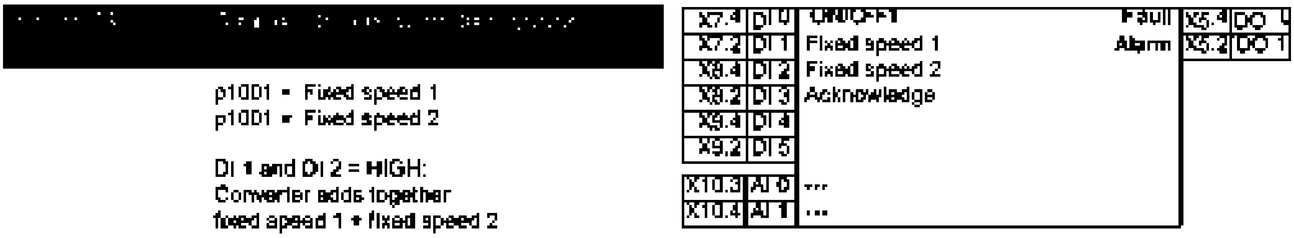


Figure 4-23 Conveyor with two fixed speeds

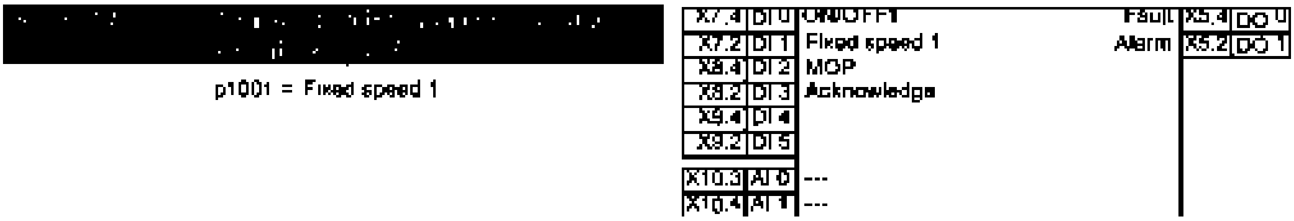


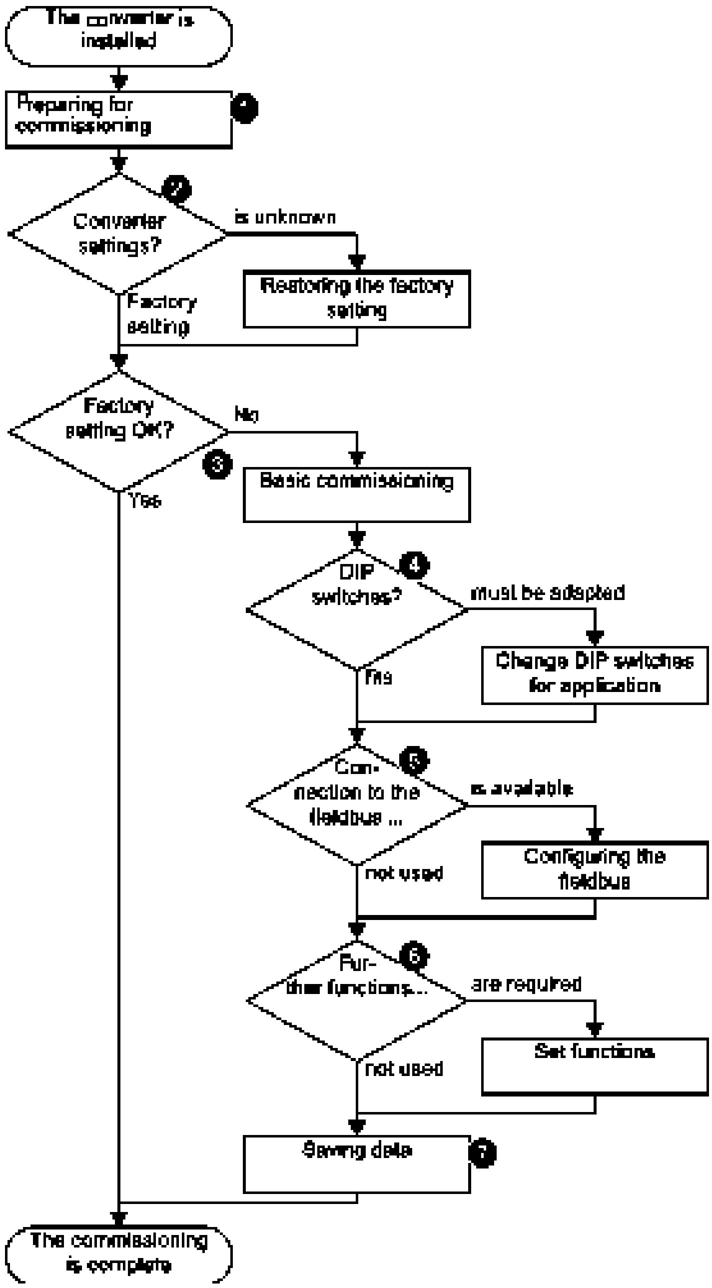
Figure 4-24 Conveyor with potentiometer and one fixed speed (default for the CU240M USS)

Commissioning guidelines 5

We recommend the following procedure:

1. Define the requirements of your application placed on the drive.
   → (Page 79) .
2. Reset the converter when required to the factory setting.
   → (Page 87) .
3. Check whether the factory setting of the converter is appropriate for your application.

   If not, start with the basic commissioning.
   → (Page 79) .
   → (Page 90) .
4. Check whether you need to adapt the commissioning DIP switches.
   → (Page 131).
5. If necessary, adapt the communications interface in the converter.
   → (Page 123) .
6. If necessary, set further functions in the converter.
   → (Page 169) .
7. Save your settings.
   → (Page 235) .



You have fully commissioned the converter.

Basic commissioning 6

6.1 Prepare basic commissioning

Overview

Before starting commissioning, you must know the answer to the following questions:

Inverter

- **What are the data specifications of my inverter?**
  → Figure 3-1 Identifying the components of the system (Page 23).
- **What inverter interfaces are active?**
  → Wiring example for the factory settings (Page 81).
- **How is the inverter integrated in the higher-level control system?**
- **How is my inverter set?**
  → Factory setting of the inverter control (Page 83).
- **What technological requirements must the drive fulfill?**
  → V/f control or speed control (Page 84).
  → Defining additional requirements for the application (Page 85).

6.1.1 Collecting motor data

The SINAMICS G110M system is generally delivered as a completely assembled, Inverter, Power Module and motor, but it may be necessary to input specific motor data depending on the requirements of the users application. All the necessary motor data is displayed on the motor rating label as shown in the following example.

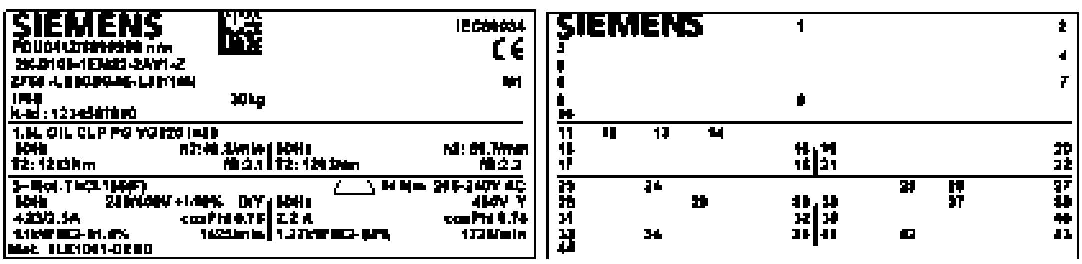


Figure 6-1 SIMOGEAR motor rating label example

1 Matrix code
2 Applied standard
3 Serial No.
FDU = Siemens AG, Bahnhofstr. 40, 72072 Tübingen, Germany
4 CE marking or other marking, if required
5 Order No.
6 Model - Type - Size
7 Mounting position
8 Degree of protection according to IEC 60034-5 or IEC 60529
9 Weight m [kg]
10 Customer ID
11 Oil quantity [l] main gearbox / intermediate gearbox
12 Type of oil
13 Oil viscosity ISO VG class according to DIN 51519 / ISO 3448
14 Total transmission ratio i

Frequency 1

15 Rated frequency f [Hz]
16 Gearbox output speed n_2 [rpm]
17 Geared motor output torque T_2 [Nm]
18 Service factor f_B

Frequency 2

19 Rated frequency f [Hz]
20 Gearbox output speed n2 [rpm]
21 Geared motor output torque T2 [Nm]
22 Service factor f_B

Motor data

23 Phase number and type of current for the motor
24 Temperature class Th.Cl.
25 Symbols (IEC 60617-2): = brake
26 Rated braking torque T_{Br} [Nm]
27 Brake supply voltage U [V]

Frequency 1

28 Rated frequency f [Hz]
29 Rated voltage / range U [V]
30 Circuit, graphical symbols according to DIN EN 60617 Part 6 / IEC 60617-6
31 Rated current I_N [A]
32 Power factor cos φ
33 Rated power P_N [kW], duty type (if ≠ S1)
34 Efficiency class marking according to IEC 60034-30
35 Rated speed n_N [rpm]

Frequency 2

36 Rated frequency f [Hz]

37 Rated voltage / range U [V]

38 Rated current I N [A]

39 Power factor cos φ

40 Circuit, graphical symbols according to DIN EN 60617 Part 6 / IEC 60617-6

41 Rated power P N [kW], duty type (if ≠ S1)

42 Efficiency class marking

43 Rated speed n N [rpm]

44 Motor designation, active part

- If you use the STARTER commissioning tool and a SIEMENS motor, you only need to specify the order number of the motor, otherwise you must note the data from the motor rating label.
- Pay attention to the connection of the motor (star connection [Y] or delta connection [Δ]). Note the appropriate motor data for connecting.
- Motor ambient temperature if it differs from the factory setting = 20° C.

6.1.2 Wiring example for the factory settings

To ensure that the factory setting can be used, you must wire your drive as shown in the following examples.

Factory pre-assignment of the interfaces on the drive

For a complete technical specification of the individual connections, as shown in the following diagram, please refer to following figures:

- Figure 4-10 SINAMICS G110M CU240M USS terminal diagram (Page 68)
- Figure 4-11 SINAMICS G110M CU240M PROFIBUS terminal diagram (Page 69)
- Figure 4-12 SINAMICS G110M CU240M PROFINET terminal diagram (Page 70).

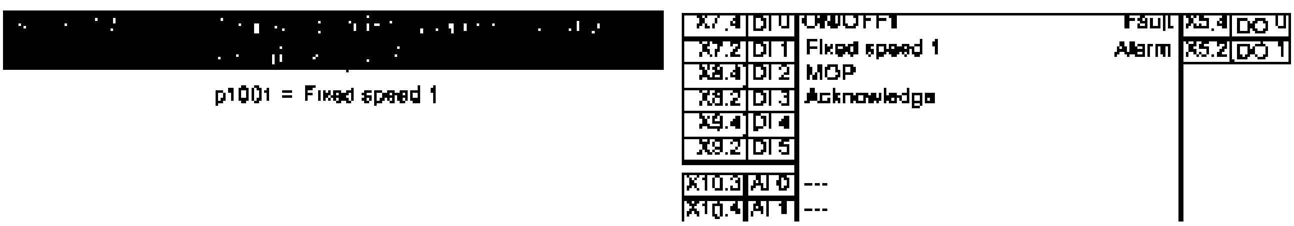


Figure 6-2 Default wiring of the SINAMICS G110M CU240M USS

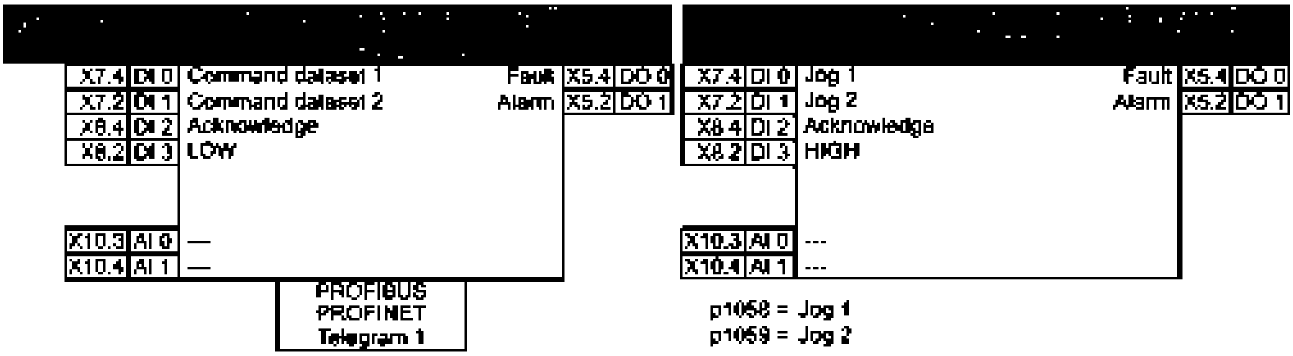


Figure 6-3 Default wiring of the SINAMICS G110M CU240M DP and CU240M PN

Note

Unswitched and switched power supply

The unswitched 24 V power supply (also known as non-switched) on X1.2 and X1.4 provides power to the general electronics of the Control Unit. The switched 24 V power supply on X1.1 and X1.5 supplies power for the two digital outputs (DI0 and DI1). For a complete explanation of the unswitched and switched 24 V supplies and their limitations, please read the FAQ at the following link:

Unswitched and switched 24 V supply (http://support.automation.siemens.com/WW/view/en/26986267)

6.1.3 Factory setting of the inverter control

Switching the motor on and off

The inverter is set in the factory so that after it has been switched on, the motor accelerates up to its speed setpoint in 10 seconds (referred to 1500 rpm). After it has been switched off, the motor also brakes with a ramp-down time of 10 seconds.

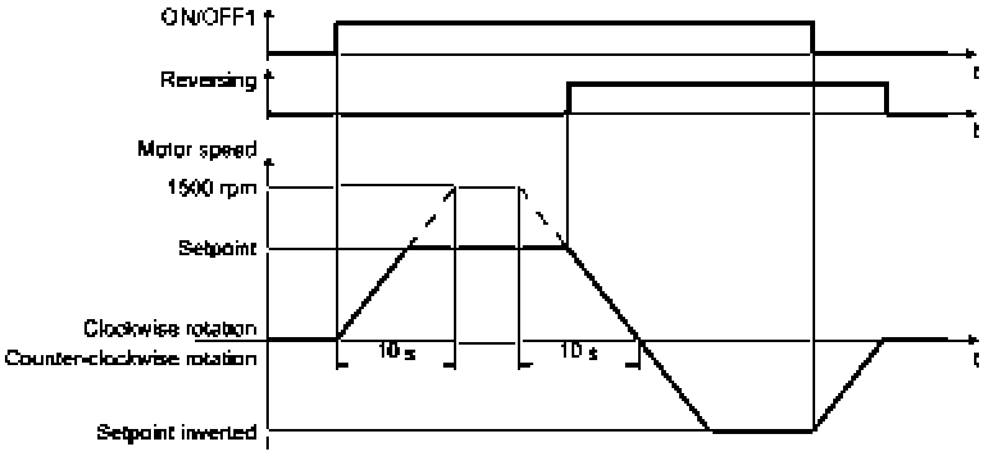


Figure 6-4 Switching on and switching off the motor and reversing in the factory setting

Switching the motor on and off in the jog mode

For inverters with PROFIBUS interface, operation can be switched over using digital input DI 3. The motor is either switched on and off via PROFIBUS – or operated in the jog mode via its digital inputs.

For a control command at the respective digital input, the motor rotates with ±150 rpm. The ramp-up and ramp-down times are also 10 seconds, referred to 1500 rpm.

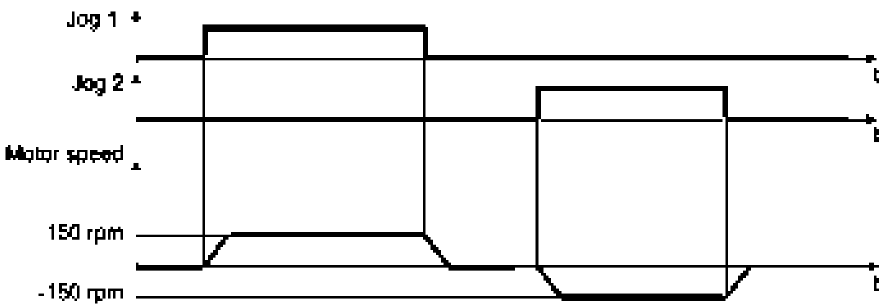


Figure 6-5 Jogging the motor in the factory setting

6.1.4 V/f control or speed control

For induction motors, there are two different open-loop control or closed-loop control techniques:

- V/f control (calculation of the motor voltage using a characteristic curve)
- Closed-loop speed control (also: field-oriented control or vector control)

Criteria for selecting either V/f control or speed control

In many applications, the V/f control suffices to change the speed of induction motors. Examples of typical applications for V/f control include:

- Pumps
- Fans
- Compressors
- Horizontal conveyors

When compared to V/f control, vector control offers the following advantages:

- The speed is more stable for motor load changes.
- Shorter accelerating times when the setpoint changes.
- Acceleration and braking are possible with an adjustable maximum torque.
- Improved protection of the motor and the driven machine as a result of the adjustable torque limiting.
- Torque control is only possible with vector control.

Examples of typical applications in which speed control is used:

- Hoisting gear and vertical conveyors
- Winders
- Extruders

It is not permissible to use speed control in the following cases:

- If the motor is too small in comparison to the converter (the rated motor power must not be less than one quarter of the rated converter power)
- When you operate several motors on one converter
- When the maximum motor speed exceeds the following values:

Converter pulse frequency	2 kHz	4 kHz and higher
Pole number of the motor	4-pole	4-pole
Maximum motor speed [rpm]	4980	7200

6.1.5 Defining additional requirements for the application

What speed limits should be set (minimum and maximum speed)?

- Minimum speed - factory setting 0 [rpm]
  The minimum speed is the lowest speed of the motor independent of the speed setpoint. A minimum speed is, for example, useful for fans or pumps.
- Maximum speed - factory setting 1500 [rpm]
  The inverter limits the motor speed to this value.

What motor ramp-up time and ramp-down time are needed for the application?

The ramp-up and ramp-down time define the maximum motor acceleration when the speed setpoint changes. The ramp-up and ramp-down time is the time between motor standstill and the maximum speed, or between the maximum speed and motor standstill.

6.2 Motor data using p300 and p301

Preassigned motor data using p0300 and p0301

The SINAMICS G110M software has been configured to utilize the input of the motor data using a motor code. There are two parameters associated with this function, they are p0300 (motor type) and p0301 (motor code).

When the SINAMICS G110M is ordered and delivered as a complete system, the motor data is already correctly configured and does not require any adjustment.

When the SINAMICS G110M is ordered and delivered as separate items, the user must install the system and enter the relevant motor data during basic commissioning.

When commissioning of the motor is required, there are two options available to the user:

Commissioning using motor codes

When commissioning using the motor codes, for example, in STARTER utilizing the "Expert List", the follow steps should be performed:

1. Set p0010 = 1.
2. Set p0300 to 100 (1LE1 standard induction motor) or 177 (1LA7 standard induction motor).
3. Enter the relevant motor code into p0301 as shown in the following table:

Motor type	Power rating (kW)	Motor code for p0301
1LA7	0.37	17726
1LE1	0.75	12017
1LE1	1.10	12018
1LE1	1.50	12019
1LE1	2.20	12020

Motor type	Power rating (kW)	Motor code for p0301
1LE1	3.00	12021
1LE1	4.00	12023

When the relevant motor code is entered, the motor data automatically assigned for the selected motor. The user can then complete the commissioning process without the need to perform a motor ID.

Commissioning without using motor codes

When commissioning the system without using motor codes, the following steps must be performed, otherwise the motor will not be commissioned correctly.

1. Set p0010 = 1 (Enter the quick commissioning mode).
2. Set p0300 = 1 (Induction motor [rotating]).
3. Set p0301 = 0 (This disables the automatic motor data assignment).
4. Complete the commissioning process, entering the motor data (from the motor rating label) into the relevant parameters.
5. Set p3900 = 1, 2 or 3 to end quick commissioning, depending on the users requirements.

CAUTION

Parameter p0300 must be set to 0

When commissioning using the manual input of motor data, it is important that p0300 is set to 0.

If p0300 is not set to 0, then even if the motor ID function is selected at the completion of the commissioning process, no motor ID will actually be performed. If the motor ID is not performed it could leave the motor in an unpredictable state and that may adversely affect the users application.

Therefore, it is essential that p0300 is checked to ensure it is actually set to 0.

Commissioning with the Intelligent Operator Panel (IOP)

When using the basic commissioning wizard on the IOP the user will presented with a screen asking for the motor type (p0300) to be entered. Depending on the value that is input into the IOP, there are two different branches to the commissioning wizard.

Action 1(using motor codes):

1. If 100 or 177 is entered, the user is then presented with the motor code screen (p0301).
2. Entered the relevant code for the motor.
3. The motor data is automatically assigned for the motor.
4. The basic commissioning wizard continues but does not ask for any further motor data to be entered.

Action 2 (no motor codes):

1. If 1 is entered (Induction motor), the IOP will automatically set p0301 to 0.
2. The basic commissioning wizard continues and asks for the relevant motor data to be entered during the commissioning process.

6.3 Restoring the factory settings

Sometimes there are cases when the commissioning of the converter goes wrong, for example:

- The line voltage was interrupted during commissioning and the commissioning process could not be completed.
- The user was interrupted during the commissioning process and could not remember what parameters had been changed.
- You do not know whether the converter was already operational.

In cases such as these, resetting the converter to the factory settings is accomplished by setting the following parameters to the shown values:

- Parameter p0010=30.
- Parameter p0970 = 1.

6.4 Basic Commissioning with DIP switches

Overview

The CU240M Control Units have been designed to allow basic commissioning to be performed using a set of three DIP switches. The DIP switches are located on the communications board within the Control Unit housing, as shown in the figure below.

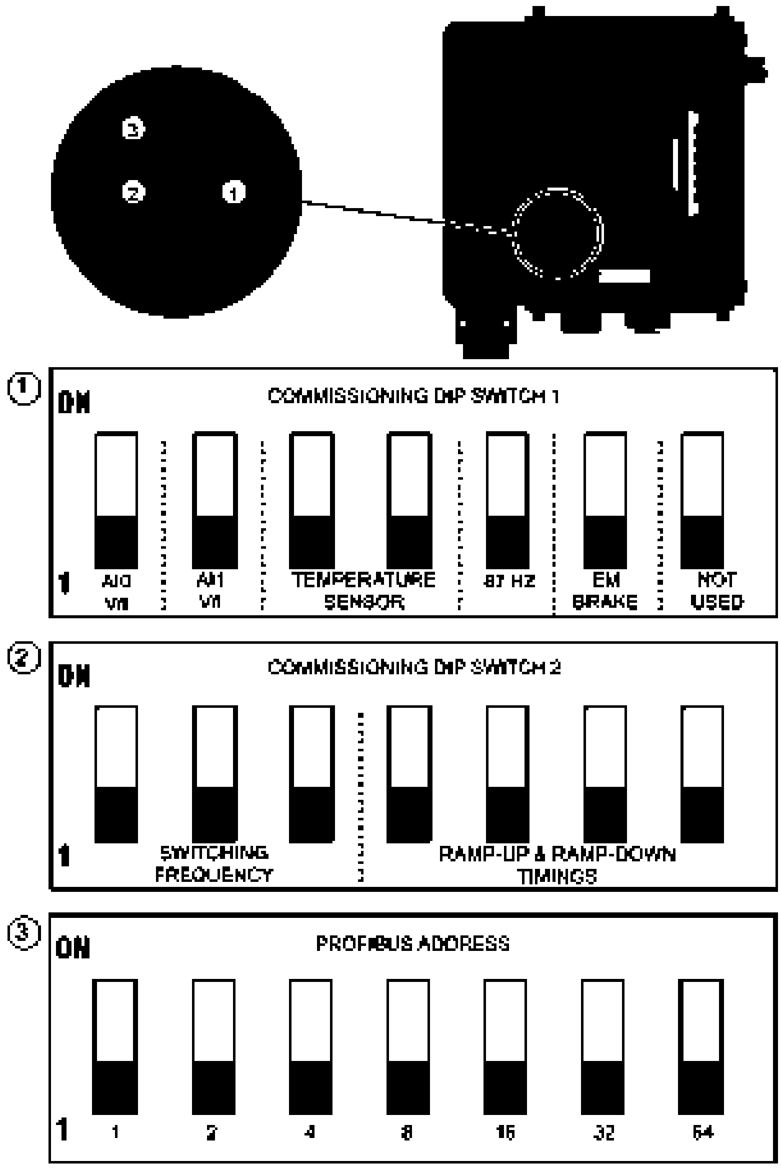


Figure 6-6 DIP Switches location

Accessing the DIP switches

⚠ DANGER
Dangerous voltages and currents are present in the active converter
When power is applied to the converter, even when it is not active, dangerous levels of voltage and current are present in the system. Before attempting the removal of any components of the system the following steps should be taken to ensure that the system is completely safe: 1. Ensure that the converter is not running, if so, the converter must be stopped. 2. Disconnect all mains power supplies to the system. If an external 24 V supply is connected to the system, then this does not have to be disconnected. 3. Wait 5 minutes to allow all the residual current and voltages to dissipate fully.

Generally the G110M system is delivered fully assembled on a motor which prohibits easy access to the DIP switches. To access the DIP switches it is necessary to remove the Power Module; this action is illustrated in the figure below.

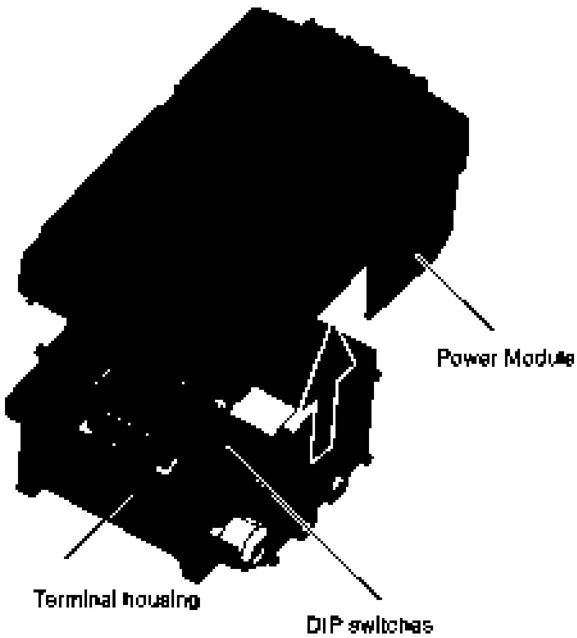


Figure 6-7 Removing the Power Module

Description of the DIP switches functions

When the DIP switches are in the OFF position, the value of the function is defined by the default value of the parameter. If the DIP switch is activated for a specific function, then the parameters for that function cannot be modified by manually editing the parameter value, i.e. ready-only.

The DIP switches allows specific functions of the converter to be set and are shown in the table below.

Table 6- 1 Function of the DIP switches

DIP switch	Function
①	Selects current or voltage input for the analog inputs.
	Temperature sensor - sets the type of temperature sensor fitted to the motor.
	87 Hz characteristic - set "ON" to operate the motor with the 87 Hz characteristic.
	Electromechanical (EM) brake - select on if an EM brake is fitted.
	The final DIP-switch is not used for any function and is not connected.
②	Switching frequency - the user can select one of seven different switching frequencies.
	Ramp-up and ramp-down timings - user can select from 0.1 seconds to 70 seconds
③	PROFIBUS address DIP-switch for use with the PROFIBUS and USS variant of the CU240M.

Examples of the DIP switches and their individual settings are illustrated in the figures below.

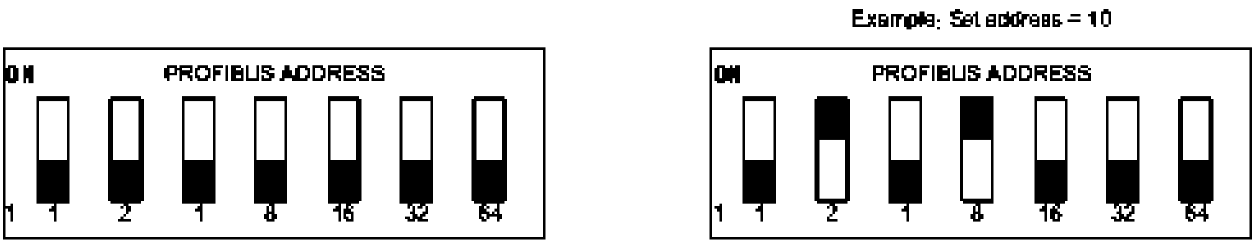


Figure 6-8 PROFIBUS address DIP Switch

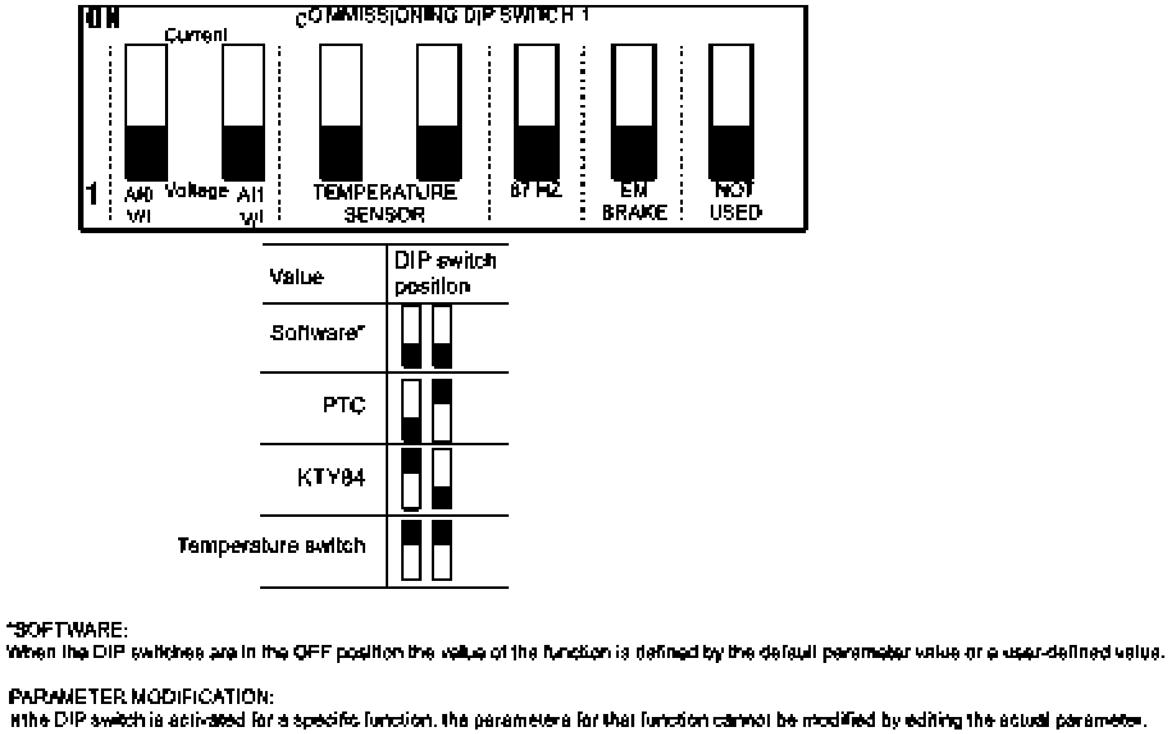


Figure 6-9 Commissioning DIP Switch 1

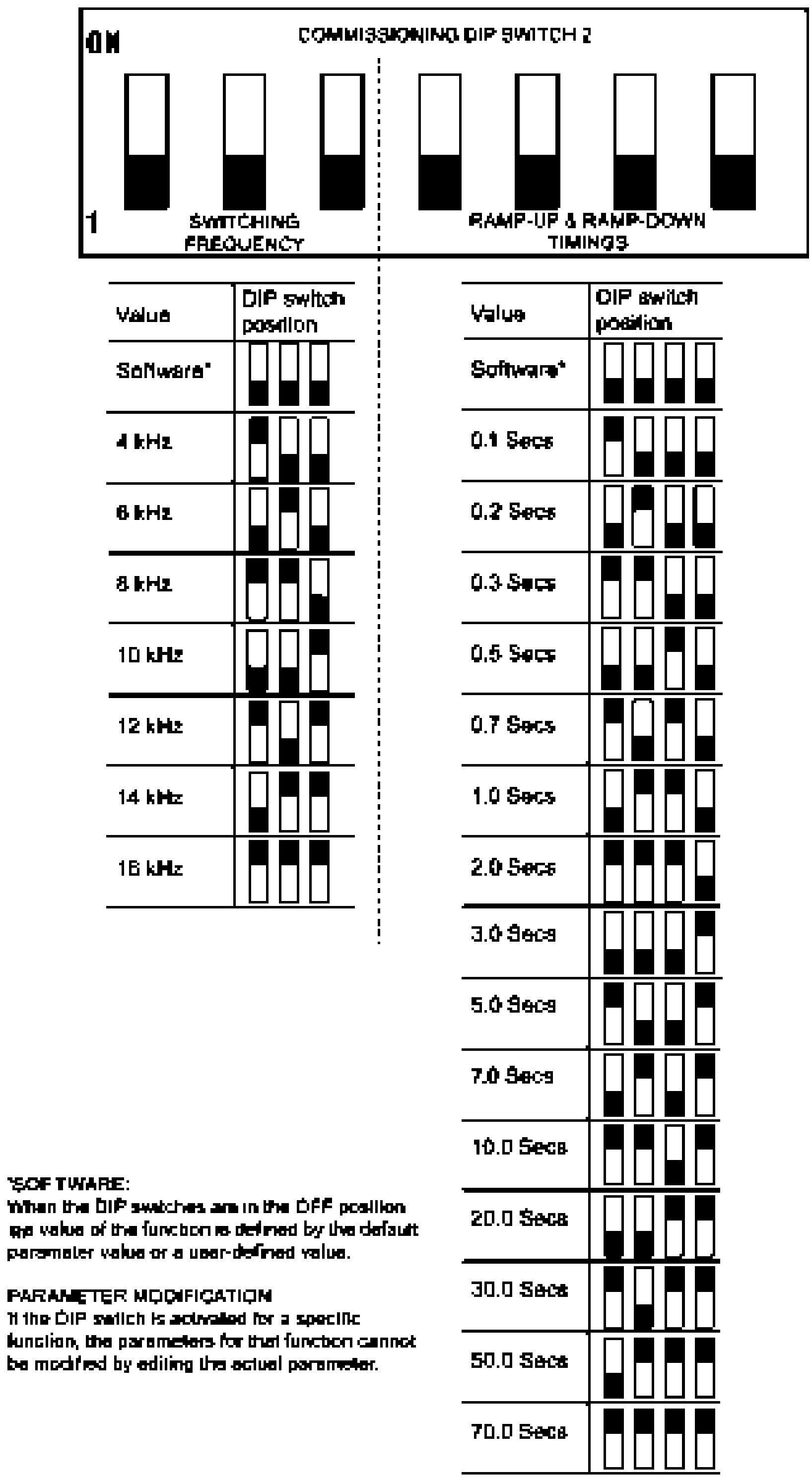


Figure 6-10 Commissioning DIP Switch 2

6.5 Basic commissioning with IOP

Basic commissioning wizard (with P0015)

The Basic Commissioning wizard detailed below is for Control Units with version 4.4 software or higher.

Note

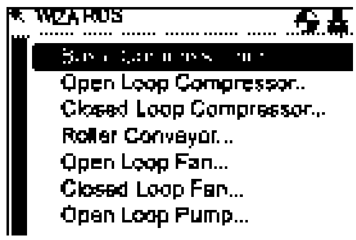
Equipment required to commission system with the IOP

To commission the SINAMICS G110M system using the Intelligent Operator Panel (IOP), the user will require the IOP Hand-held Kit (IOP HHK) and the special optical communications cable. The order details for these items are given below.

- IOP HHK, order number: 6SL3255-0AA00-4HA0
- Optical cable, order number: 3RK1922-2BP00

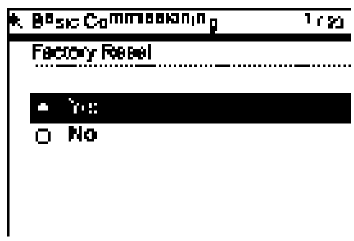
---

1. Select "Basic Commissioning..." from the Wizards menu.

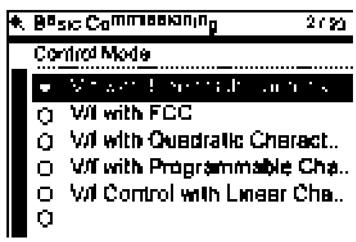


2. Select "Yes" or "No" to a factory reset.

   The factory reset is performed prior to saving all the parameter changes that have been made during the basic commissioning process.

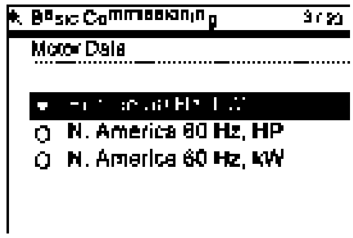


3. Select the Control Mode for the attached motor.



4. Select the correct Motor Data for your Inverter and attached motor.

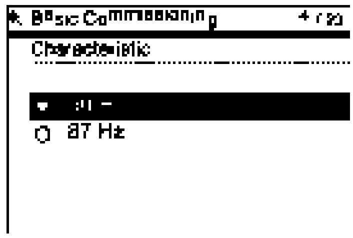
   This data is used to calculate the correct speed and displayed values for the application.



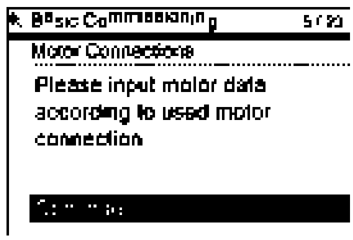
5. Select the correct frequency for your Inverter and attached motor.

   The use of the 87 Hz characteristic allows the motor to operate at 1.73 times of its normal speed.

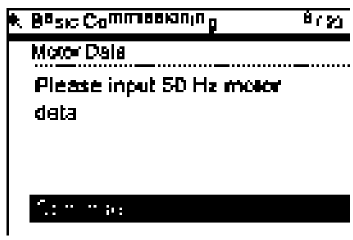
   Note: If the 87 Hz characteristic is select then the user will require to use a Power Module of the next highest power rating. For example, if a 1.5 kW motor is being used, then a 2.2 kW Power Module should be used when utilizing the 87 Hz characteristic.



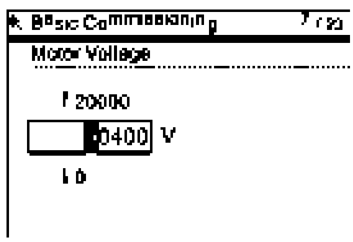
6. At this stage the wizard will begin to ask for the data relating specifically to the attached motor. The data is obtained from the motor rating plate.



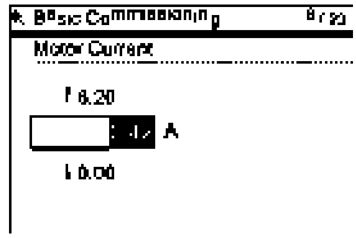
7. The Motor Data screen indicates the frequency characteristic of the attached motor.



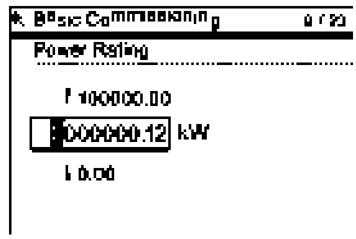
8. Input the correct Motor Voltage from the motor rating plate.



9. Input the correct Motor Current from the motor rating plate.

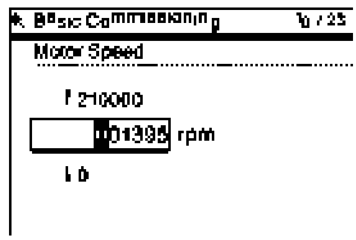


10. Input the correct Power Rating from the motor rating plate.



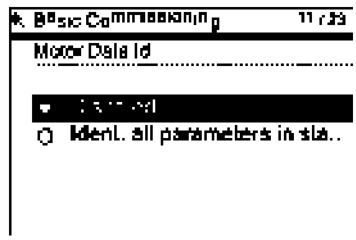
11. Input the correct Motor Speed from the motor rating plate.

    This value is given in RPM.

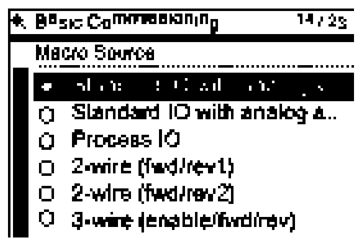


12. Select to run or disable Motor Data Identification function.

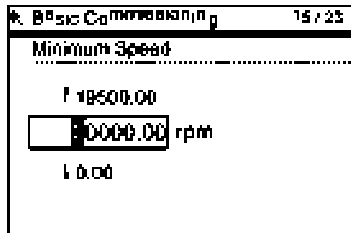
    This function, if active, will not start until the first run command is given to the Inverter.



13. Select the macro that is suitable for your application. Once selected all inputs, outputs, command sources and setpoints will be automatically configured by the software.

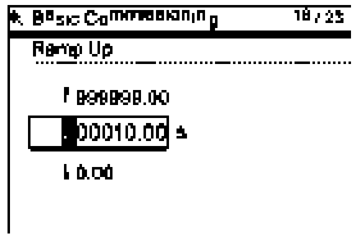


14. Set the Minimum Speed at which the attached motor should run.



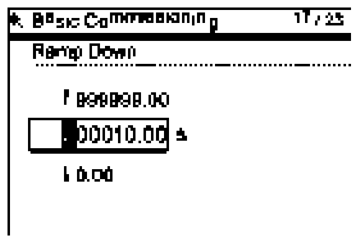
15. Set the Ramp Up time in seconds.

    This is the time the Inverter/motor system will take from being given the run command, to reaching the selected motor speed.



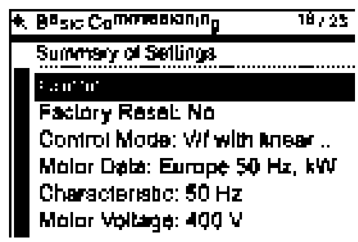
16. Set the Ramp Down time in seconds.

    This is the time the Inverter/motor system will take from being given the OFF1 command, for the motor to reach a standstill.



17. A summary of all the settings is displayed.

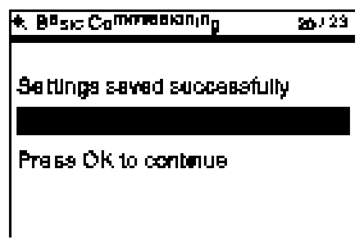
    If the settings are correct, select Continue.



18. The final screen gives two options:

    - Save settings
    - Cancel Wizard

    If save is selected, a factory reset will be performed then the settings are saved to the Inverter memory. The location of saved data is assigned using the "Parameter saving mode" function in "Parameter settings" in "Menu".



6.6 Basic commissioning with Startdrive

Overview

The Startdrive software allows the user to commission the converter and motor for their specific application. The software will also allow you to configure the drive system as part of a larger industrial network. In this section you will be taken through the procedure to perform the basic commissioning of the converter and the motor.

Before performing the basic commissioning, the follow preconditions must be fulfilled:

- A pre-installed drive (converter and motor).
- A computer running Windows XP, Vista or Windows 7.
- Startdrive software version 12 or higher pre-installed on your computer.
- A sub-USB cable to connect the Converter to the PC.

Once the basic commissioning has been completed, the user can go online from the PC to the converter using either the USB connector on the Control Unit or using the fieldbus communications protocols of the Control Unit.

Note

Example screenshots

The Startdrive screenshots shown in this section are for example purposes only. The screenshots are not related to any specific drive and are used purely to demonstrate the procedure that is required to successfully complete the basic commissioning of the converter and motor. The Startdrive software has extensive online help, which can be accessed at any time during the commissioning process.

Basic commissioning procedure

When the Startdrive software is opened successfully, it will present the user with the option open and existing project or create a new project. The following procedure assumes that a new project is required to be created by the user.

To perform the basic commissioning process, the following procedures should be performed:

Create a new project

1. Click "Create new project".
2. Enter the following information:
   – Project name
   – Path (the default path is shown; this can be changed by user if required)
   – Author (if required)
   – Comments (if required).
3. Click "Create".
4. The "Creating project" dialogue window is displayed.

When the project has been created, the First Steps window is displayed.

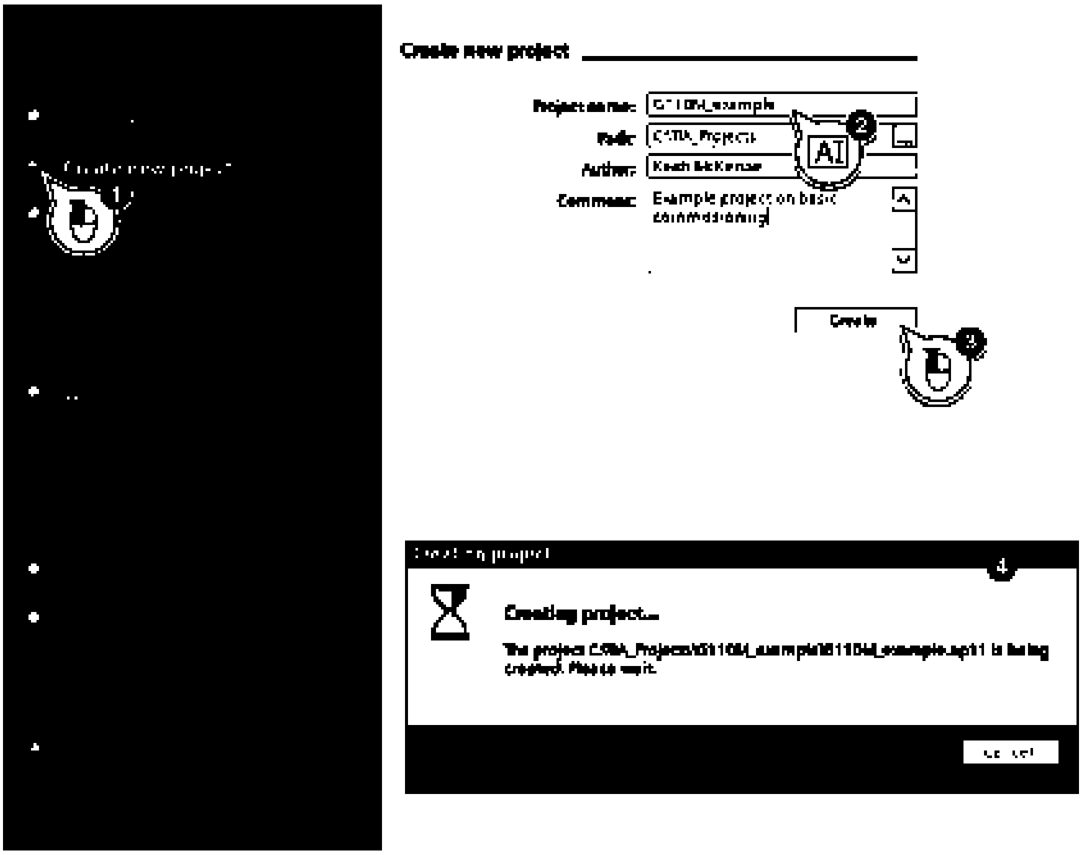


Figure 6-11 Create project

Configure a device

1. Click "Configure a device".
2. Click "Add new device"
3. Click "Drives"
4. Enter a new drive name for your device (if required).
5. Select the required device from the device list (in this case a CU240M Control Unit).
6. Click "Add".

The Control Unit now displayed in the device view of the project screen.

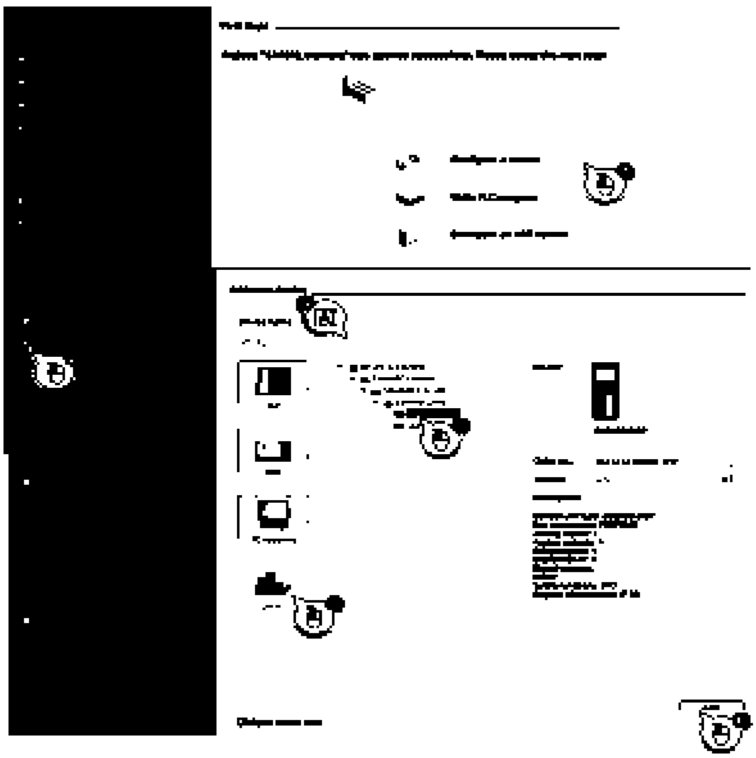


Figure 6-12 Configure device

Select Power Module

1. Select the required Power Module from the device catalog window.
2. Drag the selected Power Module from the device catalog to the Control Unit in the device view.
3. Release the left mouse button and drop the Power Module beside the Control Unit.

With the required Control Unit and Power Module selected, the basic commissioning wizard can now be activated.

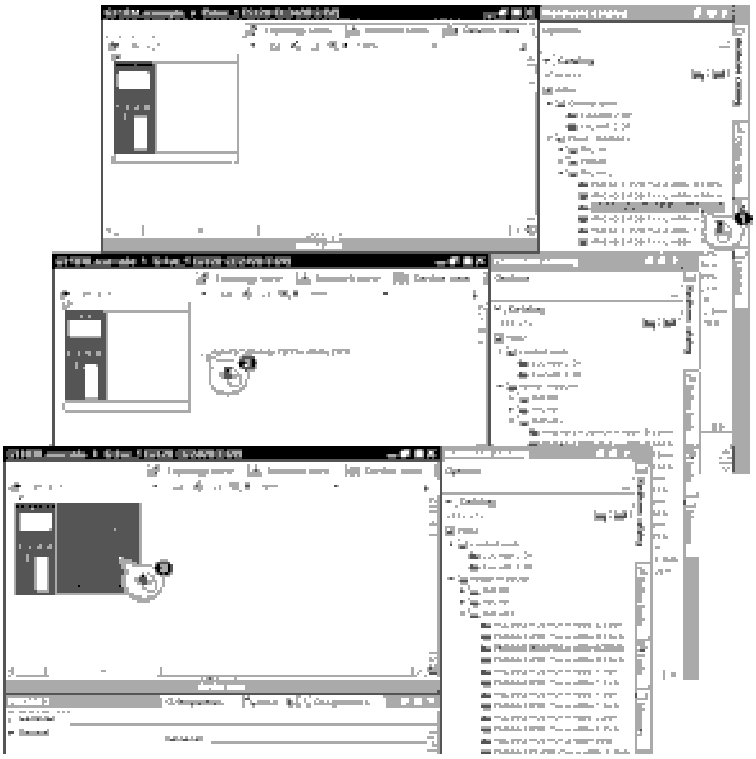


Figure 6-13 Select power module

Starting the commissioning wizard

1. Double-click "Parameter" in the devices window of the project tree.
2. Select "Commissioning".

The wizard will automatically start and display a series of dialogs to prompt the user for the necessary data and the selection of various options to commission the converter with its default settings.

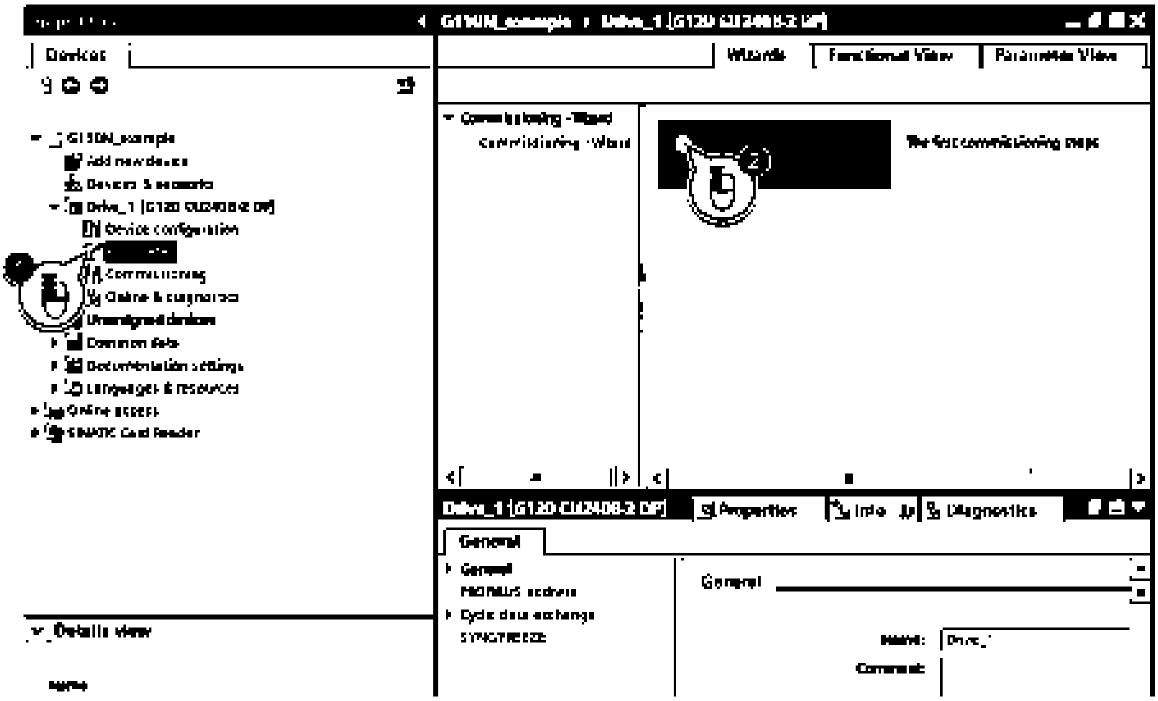


Figure 6-14 Commissioning wizard

Data sets

1. Select the required command data set.
2. Select the required drive data set.
3. Click "Next".

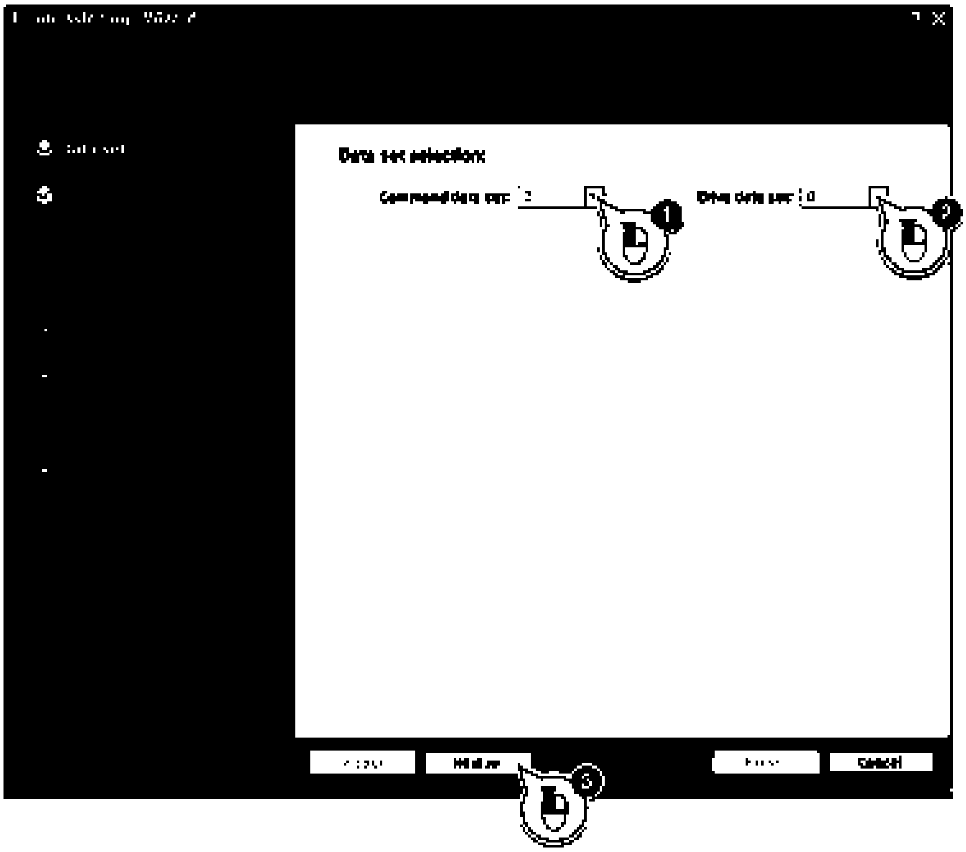


Figure 6-15 Commissioning wizard Datasets

Open-loop/closed-loop control type

1. Select the required control method from the drop-down list.
2. Click "Next".

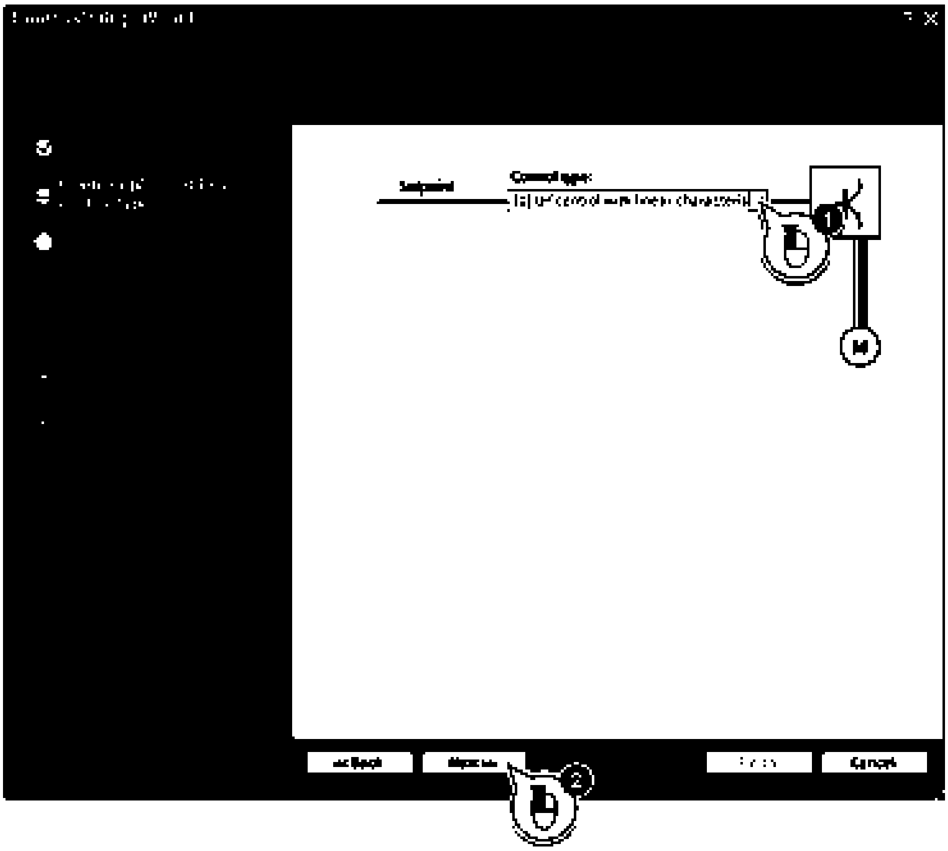


Figure 6-16 Commissioning wizard open-loop and closed-loop control type

Setpoints and command sources

1. Select the source for the setpoint and command signals from the drop-down list.
2. Click "Accept".
   – A summary of the interconnection of the inputs and outputs are displayed.
3. Click "Next"

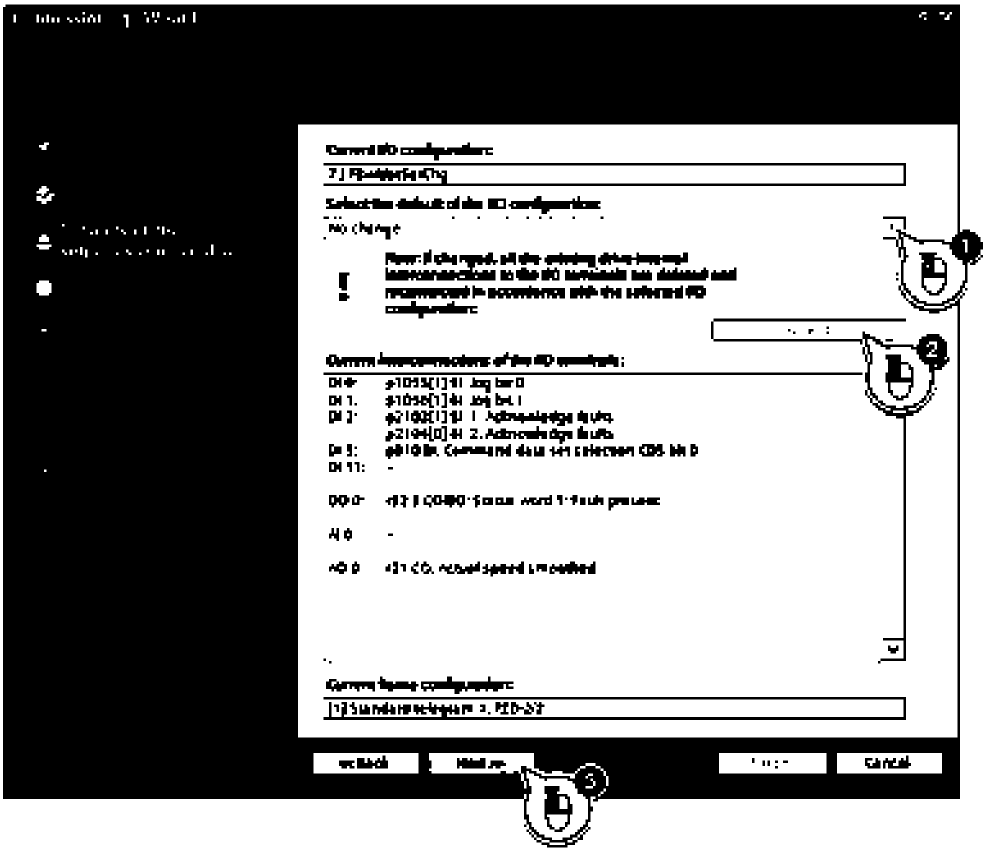


Figure 6-17   Commissioning wizard setpoints and command sources

Drive setting

1. Select the required motor properties from the drop-down list.
2. Select the required load duty cycle from the drop-down list.
3. Click "Next"

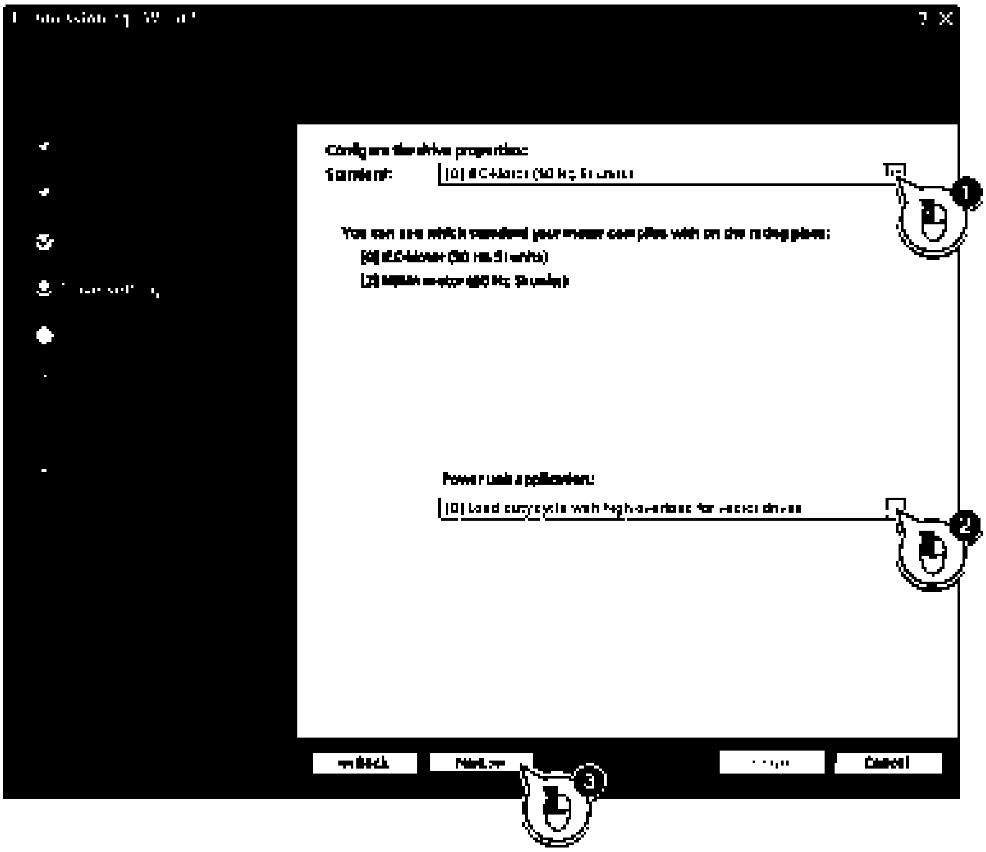


Figure 6-18 Commissioning wizard drive settings

Motor

1. Select the correct motor type from the drop-down list.
2. Enter the correct motor data.
   – The information can be found on the rating plate of the motor.
3. If required, select the 87 Hz characteristic.
   – The 87 Hz characteristic allows the motor to run faster than its nominal RPM. If the 87 Hz characteristic is used, the attached motor must be connected in delta (Δ). The Power Module must be sized to the next largest Power Module, for example, if a 1.5 kW motor is being used, then the Power Module needs to be upgraded to a 2.2 kW Power Module to use the 87 Hz characteristic.
4. "Parallel motor connection" is not available for the SINAMICS G110M system.
   – Parallel motor connection allows an converter to run two or more motors simultaneously.
5. Since parallel motor connection is not available on the SINAMICS G110M system, this number should be left as 1.
   – The converter must have the necessary power to run the selected number of motors. For example, two 1.5 kW motors would require the minimum of a 3 kW converter.
6. Click "Next".

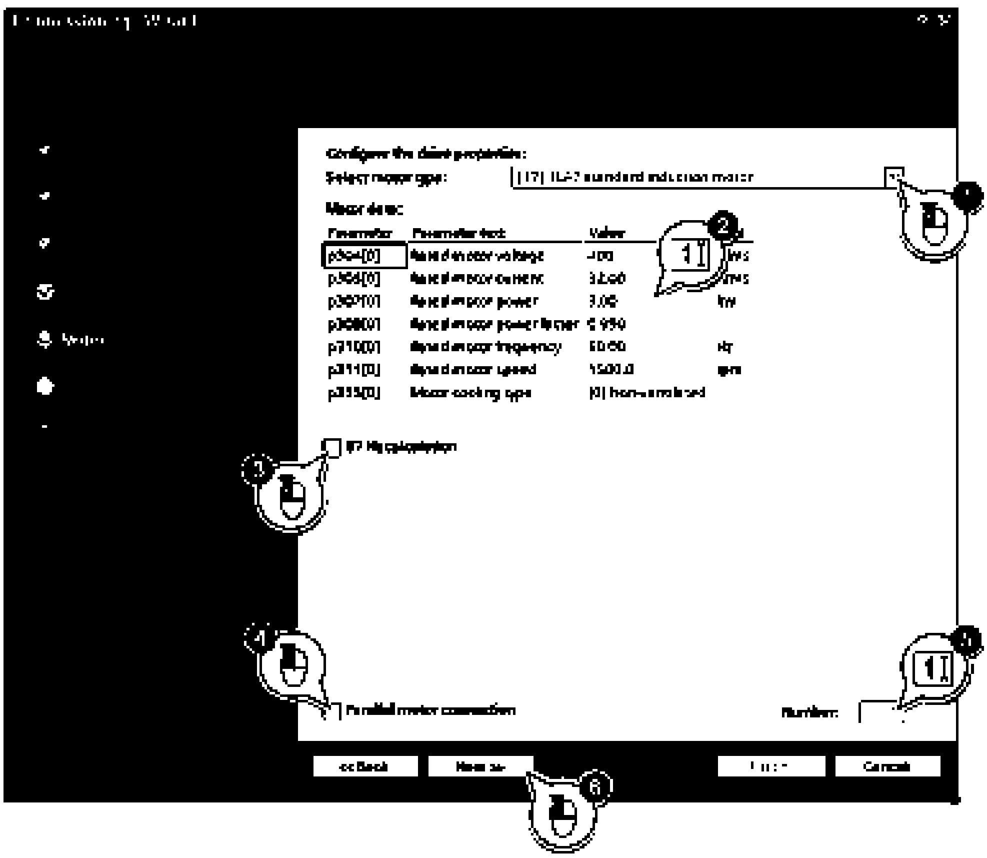


Figure 6-19 Commissioning wizard motor type and motor data

Important parameters

These parameters influence the dynamic response of the motor and are the default values and those values calculated from the motor data that was entered on the previous screen.

1. If required, modified the parameter values.
2. Click "Next".

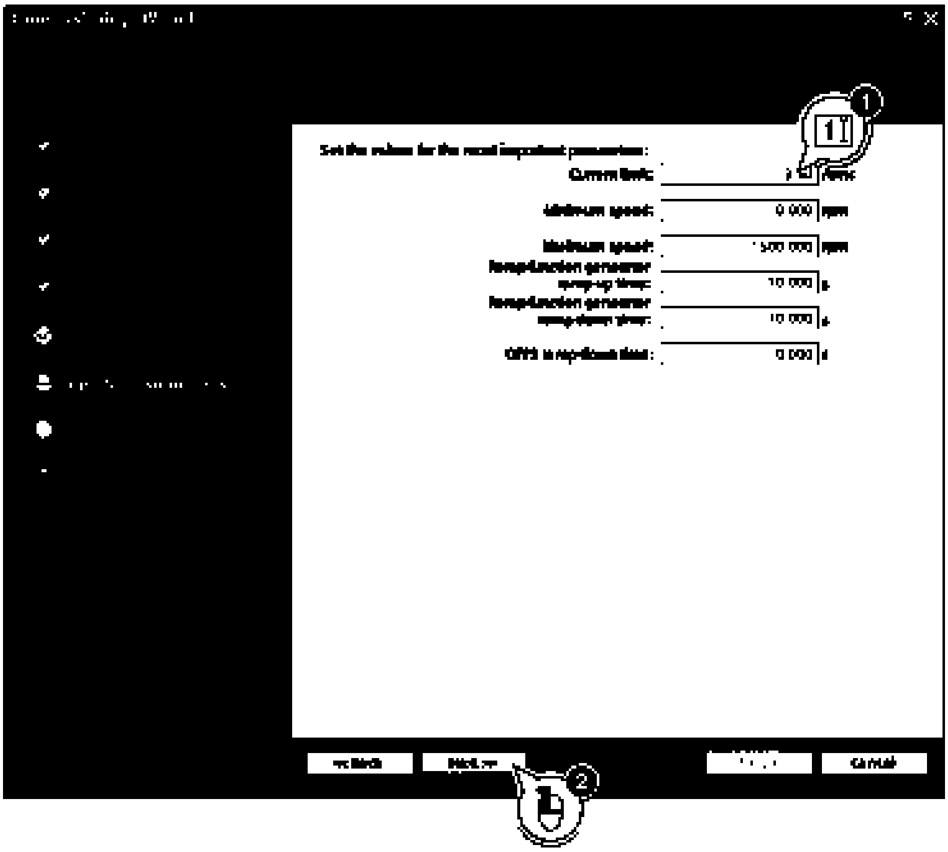


Figure 6-20 Commissioning wizard important parameters

Drive functions

1. Select the motor identification function required from the drop-down list.
2. Select "no calculation" or "complete calculation".
   – If "complete calculation" is selected, the motor identification will be performed the first time that the drive is given a run command.
3. Click "Next".

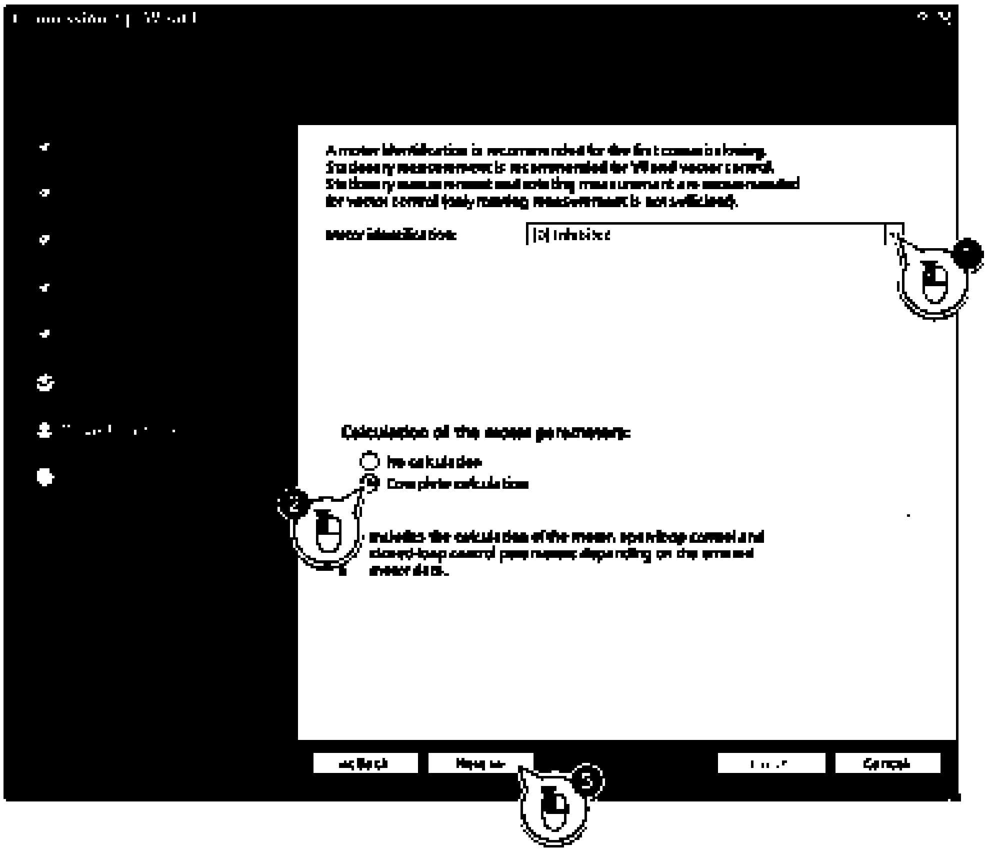


Figure 6-21 Commissioning wizard drive functions

Summary

On completion of the commissioning wizard a summary of all the configuration information is displayed.

Click "Finish" to exit the commission wizard.

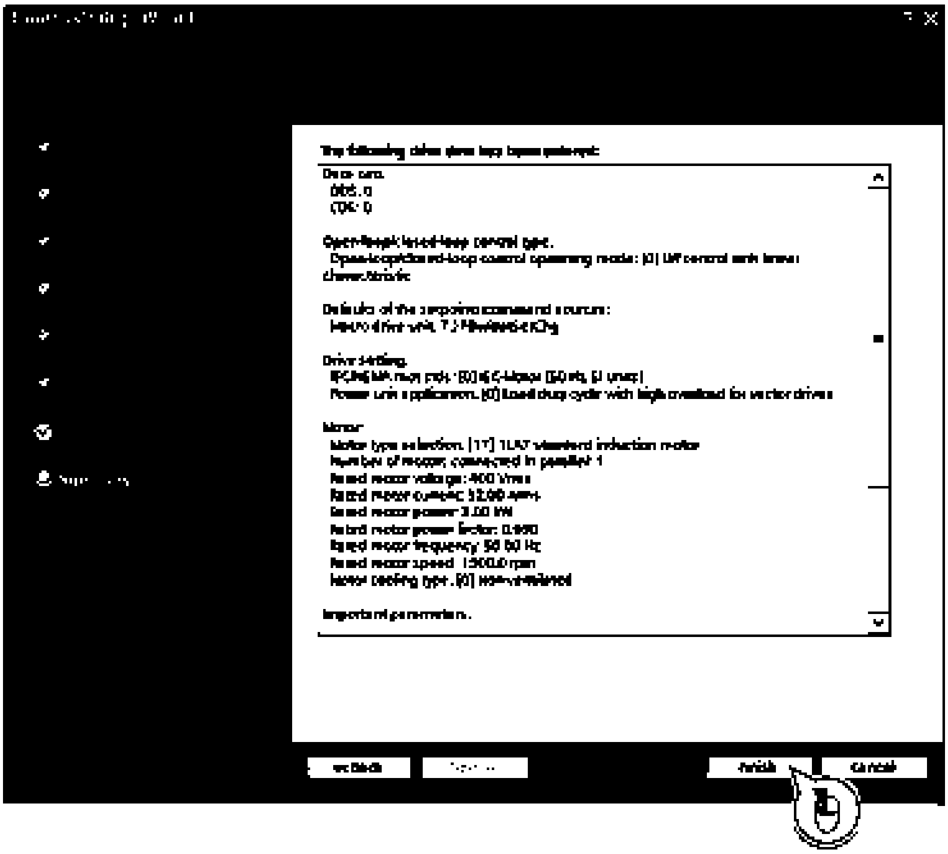


Figure 6-22 Commissioning wizard summary of settings

Going online

When the commissioning has been completed it is necessary to go online to the converter and transfer the parameter settings to the memory of the converter.

To go online the following procedure should be performed:

1. Click "Go online" on the upper toolbar of the project window.
   – The "Go online" dialog window will be displayed.
2. Configure the communications settings for the converter.
3. Select the type of interface to be used to communicate with the converter.
4. If required, select "show all accessible devices".
5. If required, select a device from the target subnet.

6. Click "Go online".
7. Click "upload" icon on the upper toolbar of the project window.

The parameter settings will now be transfered to the converter memory.

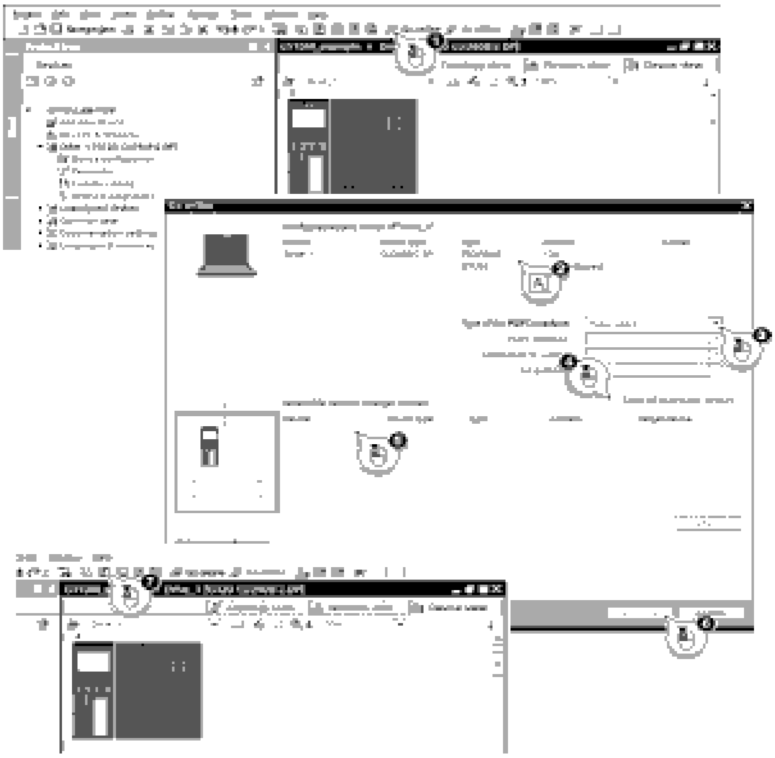


Figure 6-23 Going online with the drive

If further configuration changes or parameter changes are necessary, this can be accomplished by navigating to the appropriate area of the project window.

6.7 Basic commissioning with STARTER

STARTER and STARTER screen forms

STARTER is a PC-based tool to commission Siemens inverters. The graphic user interface of STARTER supports you when commissioning your inverter. Most inverter functions are combined in screen forms in STARTER.

The STARTER screen forms that are shown in this manual show general examples. You may therefore find that a screen contains more or fewer setting options than are shown in these instructions. A commissioning step may also be shown using an inverter other than the one you are using.

Overview: Commission the inverter in the online mode

We recommend that you commission the inverter using STARTER in the online mode. STARTER offers two options of going online with an inverter:

- Via the USB interface
- Via PROFIBUS or PROFINET

Precondition

You require the following to commission the inverter using STARTER:

- A pre-installed drive (motor and inverter)
- A computer with Windows XP or Windows 7, on which STARTER V4.3 or higher is installed.

  You can find updates for STARTER in the Internet under: Download STARTER (http://support.automation.siemens.com/WW/view/en/10804985/133100)

Procedure

Proceed as follows to carry out the basic commissioning of the inverter online using STARTER:

1. Adapt the inverter and PC interfaces:
   - Go online via USB:Adapting the USB interface (Page 112)
   - Go online via PROFINET:

     What do you need for communication via PROFINET? (Page 143)

     Configure the communication between inverter and PC.
2. Create a STARTER project (Page 113).
3. Go online and commission the inverter using the wizards (Page 114).

This means that you have completed the basic commissioning.

Commissioning using STARTER

The following interfaces - which are control unit dependent - are available:

Table 6- 2 Connection possibilities for STARTER

Type	USB	PROFIBUS	PROFINET
PC connected to CU using	USB cable	PROFIBUS interface	PROFINET interface
Interface	Mini-USB	M12 - 5 pole connector	M12 - 4 pole connector
Restrictions	-	up to 125 slaves	None

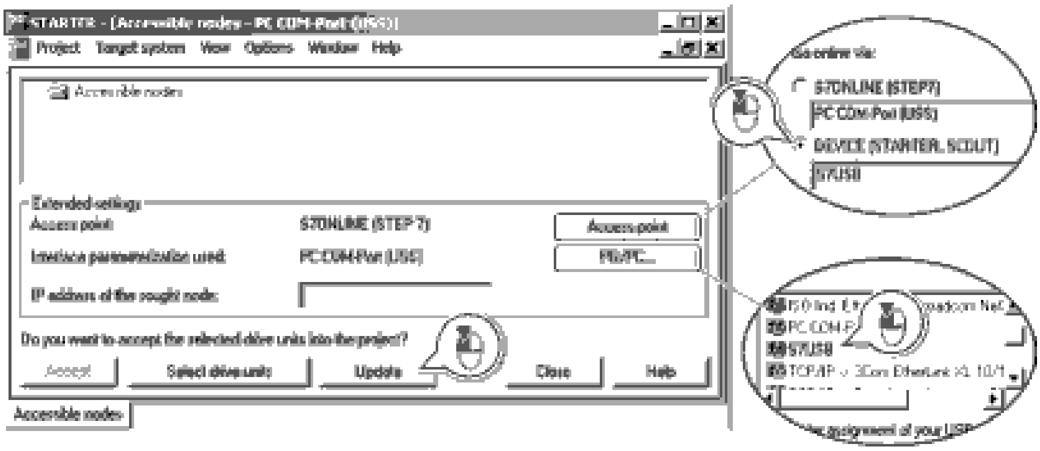
In the following the commissioning via USB is described.

6.7.1 Adapting the USB interface

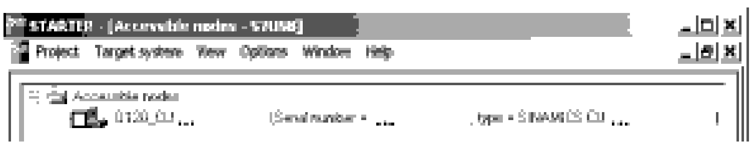
Procedure

Proceed as follows to set the USB interface:

1. Switch on the converter power supply and connect the converter to the PC via USB.
2. The USB drivers are installed if you are connecting the converter and PC together for the first time. Windows 7 automatically installs the drivers without you having to take any action. For older Windows versions, acknowledge the corresponding screen forms with OK.
3. Start the STARTER commissioning software.
4. If you are using STARTER for the first time, you must check the USB interface setting. To do this, click in STARTER on ("Accessible nodes").
   If the interface is appropriately set, then the "Accessible nodes" screen form lists the converters, which are connected via the USB interface. In this case, go to Point 7.
   If incorrectly set, then the "No additional nodes found" message is displayed.
5. Acknowledge this message, and set the "Access point" to "DEVICE (STARTER, Scout)" and the "PG/PC interface" to "S7USB".



6. Then click on "Update". The connected converters are now displayed in "Accessible nodes".



7. Close this screen form without selecting the converter(s) that has/have been found.
8. Create your STARTER project (Page 113).

You have set the USB interface.

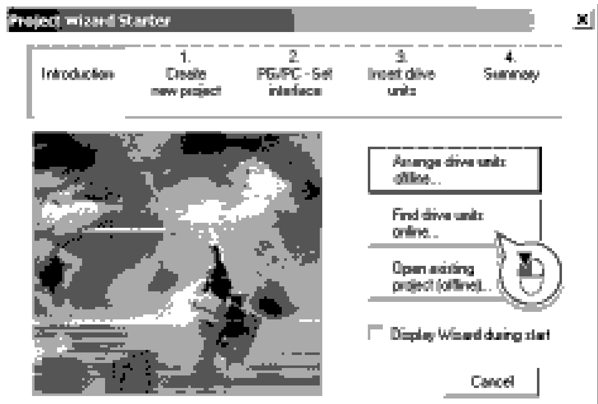
6.7.2 Generating a STARTER project

Creating a STARTER project using project wizards

Procedure

To create a project with the STARTER project Wizards, proceed as follows:

1. Using "Project / New with wizard" create a new project.
2. To start the wizard, click on "Search online for drive units ...".
3. Follow the instructions of the Wizard, and set everything that you require for your particular project.

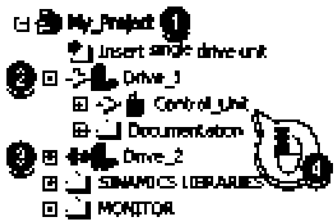


You have created your STARTER project.

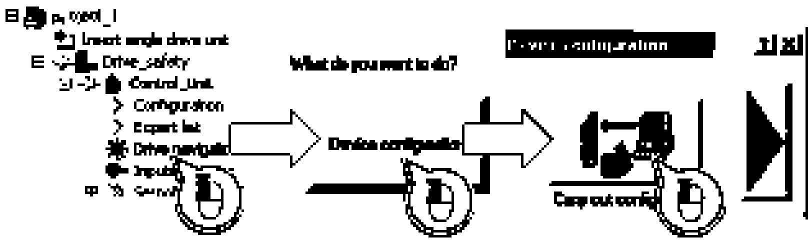
6.7.3 Go online and start wizard for basic commissioning

Procedure

Proceed as follows to start the basic commissioning online with the converter:



1. Select your project and go online: .
2. Select the device or the devices with which you wish to go online.
3. Download the hardware configuration found online in your project (PG or PC). STARTER shows you which converter it is accessing online and which offline:
   ② The converter is online
   ③ The converter is offline
4. When you are online, double-click on "Control Unit".
5. Start the wizard for basic commissioning.



You are online and have started basic commissioning.

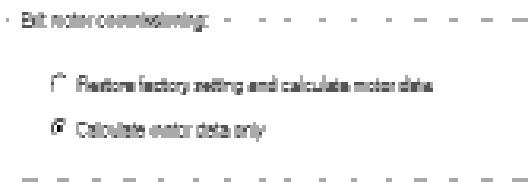
2. Select the default setting of the inverter interfaces.
3. Select the application for the inverter:
   Low overload for applications that only require a low dynamic performance, e.g. pumps or fans.
   High overload for applications requiring a high dynamic performance, e.g. conveyor systems.
4. Select your motor.
5. Enter the motor data according to the rating plate of your motor.
   If you have selected a motor based on its order number, the data has already been entered.
6. If you have set the "Speed control" control mode, then we recommend setting "[1] Identify motor data at standstill and with motor rotating".

   With this setting, the inverter optimizes its speed controller.

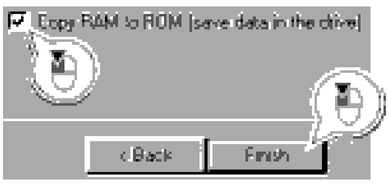
   

   If one of the following cases is applicable, select the setting "[2] Identify motor data at standstill":

   - You have selected "Speed control" as control mode, however the motor cannot freely rotate, e.g. for mechanically limited traversing sections.
   - You have set "V/f control" as control mode.
7. Set the most important parameters to suit your application.
8. We recommend the setting "Calculate motor data only".

9. Set the check mark for "RAM to ROM (save data in the drive)" in order to save your data in the inverter so that it is not lost when the power fails.

   Exit basic commissioning.

You have entered all of the data that is necessary for the basic commissioning of your inverter.

6.7.4 Identifying motor data

Preconditions

- In the basic commissioning, you have selected the motor identification (MOT ID). In this case, after the basic commissioning has been completed, the converter issues the alarm A07991.
- The motor has cooled down to the ambient temperature.

  If the motor is too hot, the motor data identification will provide incorrect values and the closed-loop speed control will become unstable.

DANGER

Risk of injury or material damage as a result of machine movements when switching on the motor

Switching on the motor for identification purposes may result in hazardous machine movements.

Secure dangerous machine parts before starting motor data identification:

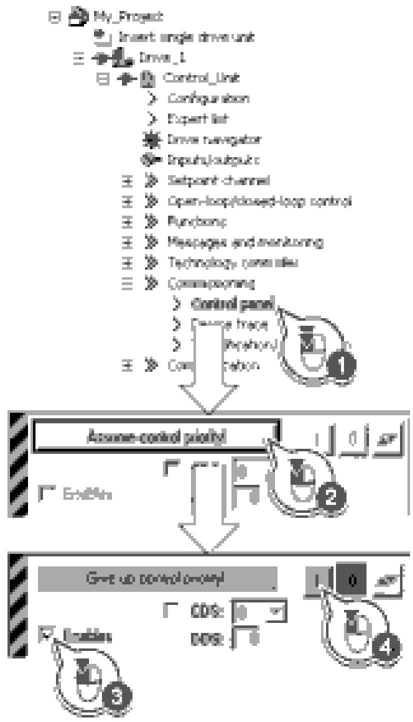
- Before switching on, check that no parts are loose on the machine or can be spun out.
- Before switching on, ensure that nobody is working on the machine or located within its working area.
- Secure the machine's work area against unintended access.
- Lower hanging/suspended loads to the floor.

Procedure

To initiate motor data identification and optimization of the motor control, proceed as follows:

1. Open by double-clicking on the control panel in STARTER.
2. Assume master control for the converter.
3. Set the "Enable signals"
4. Switch on the motor.

   The converter starts the motor data identification. This measurement can take several minutes. After the measurement, the converter switches off the motor.
5. Relinquish the master control after the motor data identification.
6. Click the Save (RAM to ROM) button.



You have now completed motor data identification.

Self-optimization of the closed-loop control

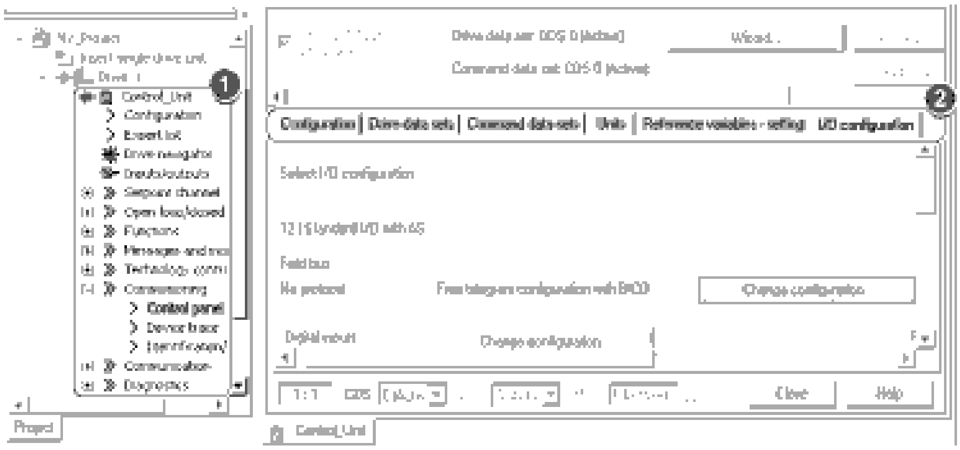
If you have also selected a rotating measurement with self-optimization of the speed control in addition to the motor data identification, then you must switch on the motor again as described above and wait for the optimization run to be completed.

6.7.5 Change settings

After the basic commissioning, you can adapt the inverter to your application as described in the Adapt inputs and outputs section.

STARTER offers two options:

- Change the settings using the appropriate screen forms - **our recommendation**.
  ① Navigation bar: For each inverter function, select the corresponding screen form.
  ② tabs: Switch between screen forms.
  If you change the settings using screen forms you do not need to know the parameter numbers.



- You change the settings using the parameters in the expert list.
  If you wish to change the settings using the expert list, you need to know the corresponding parameter number and its significance.

Saving settings so that they are not lost when the power fails

The inverter initially only saves changes temporarily. You must do the following so that the inverter saves your settings securely in the event of a power failure.

Procedure

Proceed as follows to save your settings in the inverter so that they are not lost when the power fails:

1. Mark the appropriate drive in the project navigator.
2. Click the Save (RAM to ROM) button.

You have saved your settings securely in the inverter in case of a power failure.

Go offline

You can now exit the online connection after the data backup (RAM to ROM) with "Disconnect from target system".

6.7.6 Optimize the drive using the trace function

Description

The trace function is used for inverter diagnostics and helps to optimize the behavior of the drive. Start the function in the navigation bar using "... Control_Unit/Commissioning/Device trace".

In two settings that are independent of one another, using you can interconnect eight signals each. Each signal that you interconnect is active as standard

You can start a measurement as often as required; the results are temporarily stored (until you exit STARTER) under the "Measurements" tab, together with the date and time. When terminating STARTER or under the "Measurements" tab, you can save the measurement results in the *.trc format.

If you require more than two settings for your measurements, you can either save the individual traces in the project or export them in the *.clg format – and if necessary, load or import.

Recording

Recording is performed in a CU-dependent basic clock cycle. The maximum recording duration depends on the number of recorded signals and the trace clock cycle.

You can extend the recording duration by increasing the trace clock cycle by multiplying with an integer factor and then accepting the displayed maximum duration with . Alternatively, you can also specify the measurement period and then calculate the trace clock cycle of STARTER using .

Recording individual bits for bit parameters

You can record individual bits of a parameter (e.g. r0722) by allocating the relevant bit using "bit track" ( ).

Mathematical function

Using the mathematical function ( ) you can define a curve, for example the difference between the speed setpoint and the actual speed value.

Note

If you use the "record individual bits" or "mathematical functions" option, then this is displayed under signal No. 9.

Trigger

You can create your own start condition (trigger) for the trace. With the factory setting (default setting) the trace starts as soon as you press the button (Start Trace). Using the button , you can define another trigger to start the measurement.

Using pretrigger, set the time for the recording before the trigger is set. As a consequence, the trigger condition traces itself.

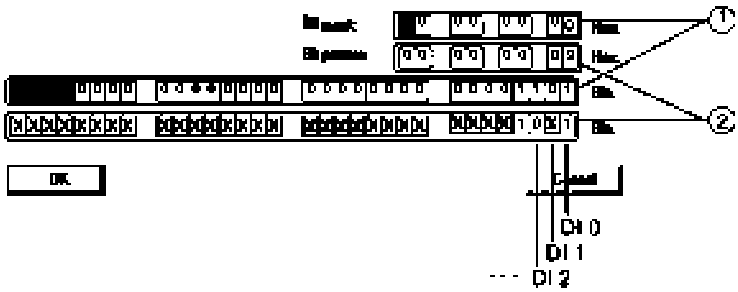
Example of a bit pattern as trigger:

You must define the pattern and value of a bit parameter for the trigger. To do so, proceed as follows:

Using , select "Trigger to variable - bit pattern"

Using , select the bit parameter

Using , open the screen form in which you set the bits and their values for the start condition



① Select the bits for the trace trigger, upper row hex format, lower row binary format

② Define the bits for the trace trigger, upper row hex format, lower row binary format

Figure 6-24 Bit pattern

In the example, the trace starts if DI0 and DI3 are high and DI2 is low. The state of the other digital inputs is not relevant for the start of the trace.

Further, you can either set an alarm or fault as start condition.

Display options

In this area, you can set how the measurement results are displayed.

- Repeating measurements
  This places the measurements that you wish to perform at different times above one other.
- Arrange the curves in tracks
  This means you define whether the trace of all measured values is displayed with respect to a common zero line – or to separate zero lines.
- Measuring cursor on
  This allows you to analyze the measuring intervals in more detail.

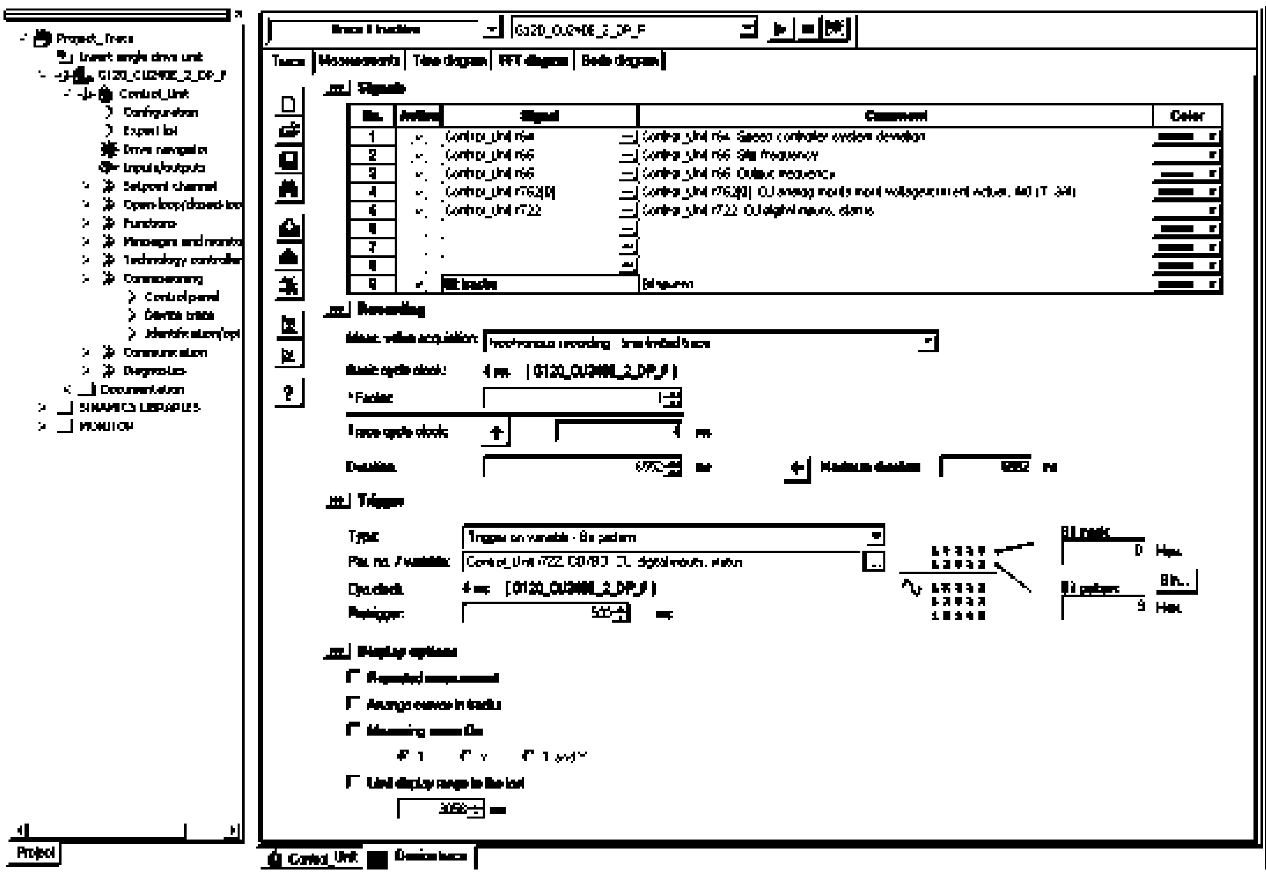


Figure 6-25 Trace dialog box

Adapt inputs and outputs

7

This chapter describes how you adapt the function of individual inputs and outputs of the inverter.

If you adapt the function of an input or output, you overwrite the settings made during the basic commissioning.

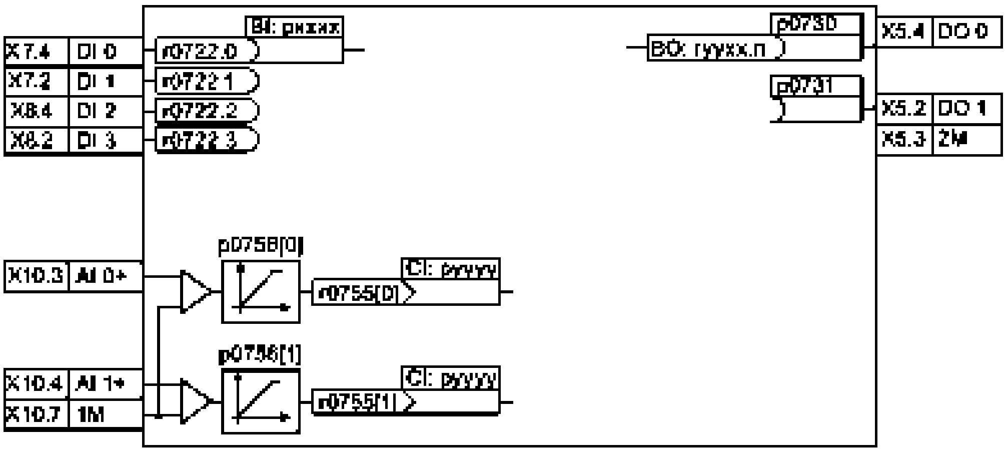


Figure 7-1 Internal interconnection of the inputs and outputs

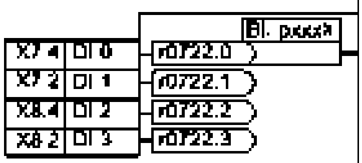
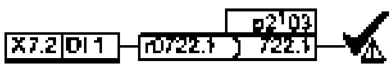
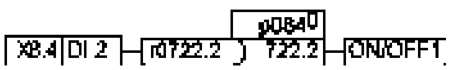
Digital inputs	Changing the function of the digital input
	Interconnect the status parameter of the digital input with a binector input of your choice. Binector inputs are marked with "BI" in the parameter list of the List Manual.

Table 7- 1 Binector inputs (BI) of the inverter (selection)

BI	Significance	BI	Significance
p0810	Command data set selection CDS bit 0	p1036	Motorized potentiometer, setpoint, lower
p0840	ON/OFF1	p1055	Jog bit 0
p0844	OFF2	p1056	Jog bit 1
p0848	OFF3	p1113	Setpoint inversion
p0852	Enable operation	p1201	Flying restart enable signal source
p0855	Unconditionally release holding brake	p2103	1. Acknowledge faults
p0856	Enable speed controller	p2106	External fault 1
p0858	Unconditionally close holding brake	p2112	External alarm 1
p1020	Fixed speed setpoint selection bit 0	p2200	Technology controller enable
p1021	Fixed speed setpoint selection bit 1	p3330	Two-wire/three-wire control, control command 1
p1022	Fixed speed setpoint selection bit 2	p3331	Two-wire/three-wire control, control command 2
p1023	Fixed speed setpoint selection bit 3	p3332	Two-wire/three-wire control, control command 3
p1035	Motorized potentiometer, setpoint, raise		

A complete list of the binector outputs is provided in the List Manual.

Table 7- 2 Examples:

<table>
<tr><td></td><td>With operator panel</td><td>In STARTER</td></tr>
<tr><td>Acknowledge fault with digital input 1

</td><td>Set p2103 = 722.1</td><td rowspan="2">Go online and choose "Inputs/Outputs". Change the function of the input via the according screen form.</td></tr>
<tr><td>Switch-on motor with digital input 2

</td><td>Set p0840 = 722.1</td></tr>
</table>

Advanced settings

You can debounce the digital input signal using parameter p0724.

For more information, see the parameter list and the function block diagrams 2210 ff of the List Manual.

Analog inputs as digital inputs

When required, you can use the analog inputs as additional digital inputs.

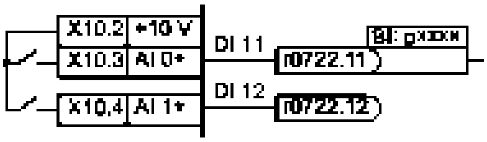


Figure 7-2 Additional digital inputs

7.1 Digital outputs

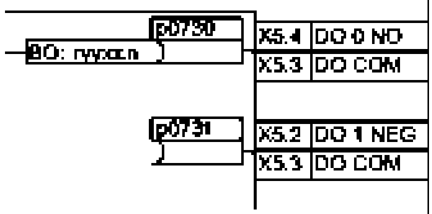
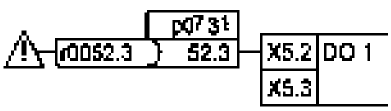
Digital output	Changing the function of the digital output
	Interconnect the digital output with a binector output of your choice. Binector outputs are marked with "BO" in the parameter list of the List Manual.

Table 7- 3 Binector outputs of the inverter (selection)

0	Deactivating digital output	r0052.9	Process data control
r0052.0	Drive ready	r0052.10	f_actual >= p1082 (f_max)
r0052.1	Drive ready for operation	r0052.11	Alarm: Motor current/torque limit
r0052.2	Drive running	r0052.12	Brake active
r0052.3	Drive fault active	r0052.13	Motor overload
r0052.4	OFF2 active	r0052.14	Motor CW rotation
r0052.5	OFF3 active	r0052.15	Inverter overload
r0052.6	Closing lockout active	r0053.0	DC braking active
r0052.7	Drive alarm active	r0053.2	f_actual > p1080 (f_min)
r0052.8	Setpoint/actual value discrepancy	r0053.6	f_actual ≥ setpoint (f_setpoint)

A complete list of the binector outputs is provided in the List Manual.

Table 7- 4 Example:

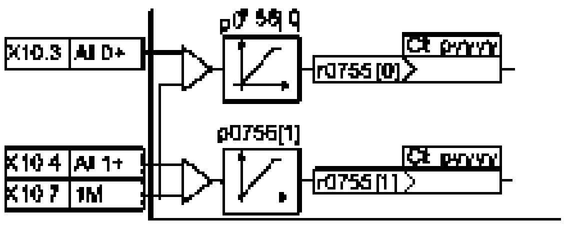
	With operator panel	In STARTER
Signal fault via digital output 1. 	Set p0731 = 52.3	Go online and choose "Inputs/Outputs". Change the function of the output via the according screen form.

Advanced settings

You can invert the signal of the digital output using parameter p0748.

For more information, see the parameter list and the function block diagram 2241 of the List Manual.

7.2 Analog inputs

Analog inputs	Changing the function of the analog input
	1. Define the analog input type using parameter p0756 and the DIP switches on the Control Unit for current or voltage input. 2. Specify the function of the analog input by interconnecting parameter p0755 with a connector input CI of your choice, for example as a speed setpoint.

Define the analog input

⚠ WARNING

Maximum voltage for analog input

The maximum voltage difference between the individual analog input connections and the ground must not exceed 35 V. If the system is operated when the load resistor is switched on (DIP switch set to "A"), the voltage between differential the individual analog inputs must not exceed 10 V or the injected 80 mA current otherwise the input will be damaged.

⚠ CAUTION

Analog DIP switch and parameter settings

The selection of current (I) or voltage (V) input can be accomplished using the DIP switched on the Control Unit. Parameter p0756 must also be modified to ensure that the p0756 reflects the settings of the DIP switch. If there is a difference between the two settings the motor may run faster or slower than expected if the analog input is used as a setpoint source.

The converter offers a set of DIP switches were the type of analog input can be selected. This is shown in the following figure:

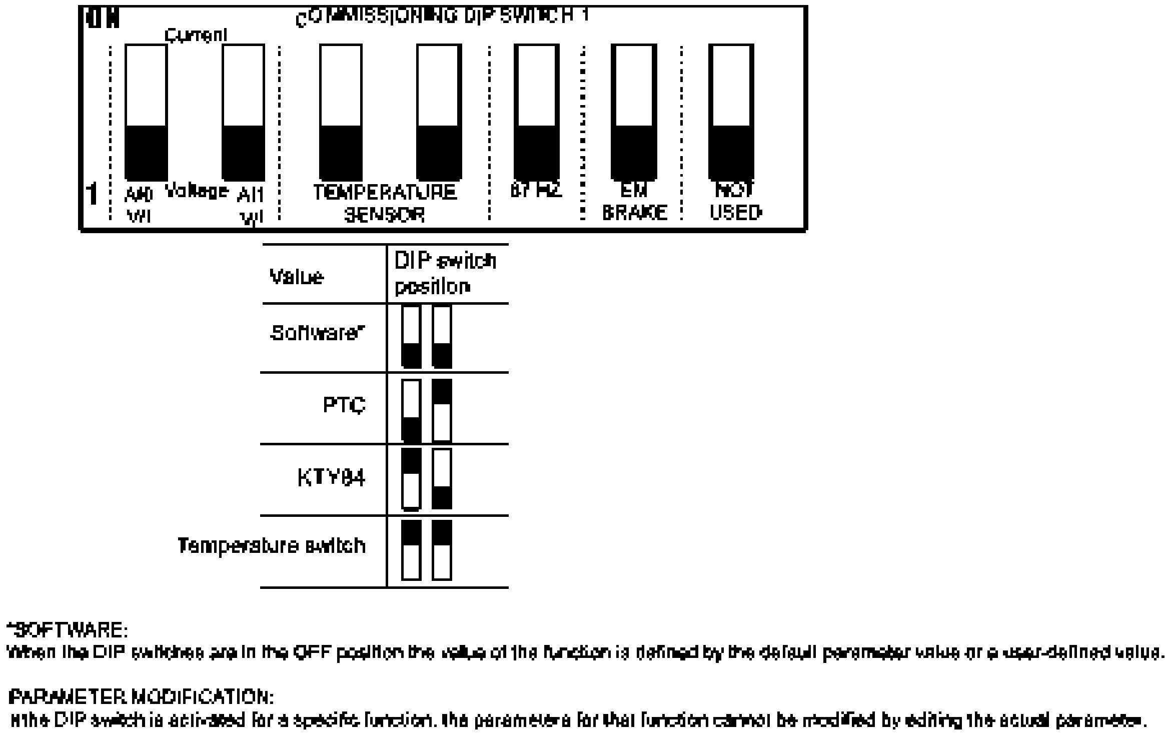


Figure 7-3 Commissioning DIP Switch 1

For further information on commissioning using the DIP switch, see Basic Commissioning with DIP switches (Page 88).

As previously mentioned, parameter p0756 can be modified to change the type of analog input. The default settings for parameter p0756 and its default settings are given in the following table.

Analog input		Value range	Parameter default settings
AI0	Unipolar voltage input	0 V ... +10 V	p0756 [0] = 0
AI1	Unipolar voltage input	0 V ... + 10 V	p0756 [1] = 0

The complete settings available for parameter p0756 are shown below.

0:	Unipolar voltage input	0 V ... +10 V
1:	Unipolar voltage input monitored	+2 V ... +10 V
2:	Unipolar current input	0 mA ... +20 mA
3:	Unipolar current input monitored	+4 mA ... +20 mA
9:	Unipolar voltage input	0 V ... +3 V

You can define your own characteristic that matches your particular application. The linear scaling characteristic is defined using two points (p0757, p0758) and (p0759, p0760). Parameters p0757 … p0760 are assigned to an analog input via their index, e.g. parameters p0757[0] … p0760[0] belong to analog input 0.

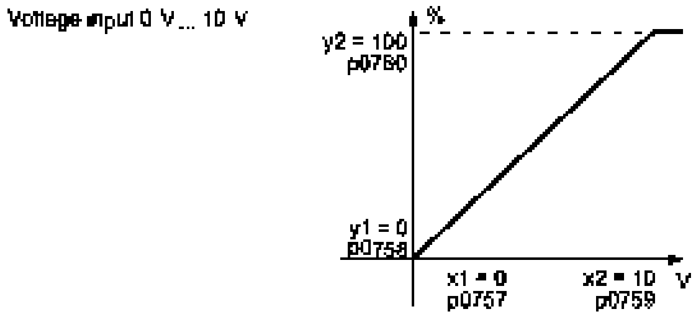


Figure 7-4 Scaling characteristics

Table 7- 5 Parameters for the scaling characteristic and wire break monitoring

Parameter	Description
p0757	**x-coordinate of 1st characteristic point [V]**
p0758	**y coordinate of the 1st characteristic point [% of p200x]** p200x are the parameters of the reference variables, e.g. p2000 is the reference speed.
p0759	**x-coordinate of 2nd characteristic point [V]**
p0760	**y-coordinate of 2nd characteristic point [% of p200x]**
p0761	**Wire breakage monitoring response threshold**

Defining the analog input function

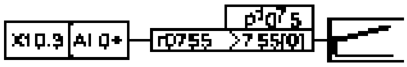
You define the analog input function by interconnecting a connector input of your choice with parameter p0755 . Parameter p0755 is assigned to the particular analog input via its index, e.g. parameter p0755[0] is assigned to analog input 0.

Table 7- 6 Connector inputs (CI) of the inverter (selection)

CI	Significance	CI	Significance
p1070	Main setpoint	p1522	Torque limit, upper
p1075	Supplementary setpoint	p2253	Technology controller setpoint 1
p1503	Torque setpoint	p2264	Technology controller actual value
p1511	Supplementary torque 1		

A complete list of the connector inputs is provided in the List Manual.

Table 7- 7 Example:

	With operator panel	In STARTER
Analog input 0 is the source for the supplementary setpoint. 	Set p1075 = 755[0]	Go online and choose "Inputs/Outputs". Change the function of the input via the according screen form.

Advanced settings

Signal smoothing

When required, you can smooth the signal, which you read-in via an analog input, using parameter p0753.

For more information, see the parameter list and in the function block diagrams 9566 ff of the List Manual.

Specify deadband

Small signals of a few millivolts are often corrupted by interference in the cable. To be able to enter a setpoint of exactly 0 V via an analog input, you must specify a deadband.

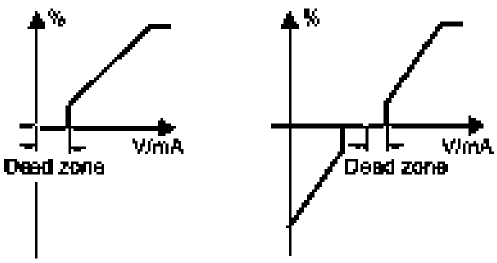


Figure 7-5 Deadband of the analog input

7.3 Deadband of the analog inputs

Table 7- 8 Settings of the deadband of the analog inputs

Parameter	**Description**
p0764 [0]	**Deadband of the analog input AI0** (factory setting: 0)
p0764 [1]	**Deadband of the analog input AI1** (Factory setting: 0)

Configure fieldbus 8

8.1 Communications via USS

The USS protocol is a serial-data connection between one master and one or more slaves. A master is, for example:

- A programmable logic controller (e.g. SIMATIC S7-200)
- A PC

The inverter is always a slave.

A maximum of 31 slaves is possible.

The maximum cable length is 100 m.

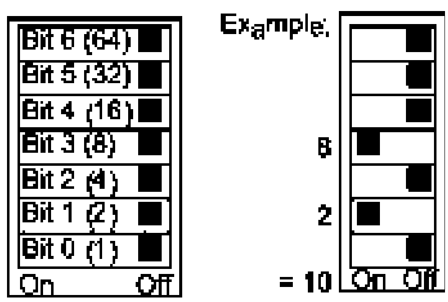
8.1.1 Basic communication settings

Setting the address

You set the bus address of the inverter using the address switches on the Control Unit, using parameter p2021 or in STARTER.

Valid address range: 1 … 30

If you have specified a valid address using the address switches, this address will always be the one that takes effect, and parameter p2021 (factory setting: 0) will not be able to be changed.



Procedure

To change the bus address, proceed as follows:

1. Set the new address:
   – using the address switches
   – from an operator panel in parameter p2021
   – in STARTER using screen form "Control Unit/Communication/Fieldbus", or using the expert list in parameter p2021
2. Switch on the inverter power supply and, if available, the 24 V power supply for the Control Unit.
3. Switch on the voltages again after all LEDs at the inverter have gone dark.

You have so changed the bus address.

Additional settings

Parameter	Description
p0015 = 21	**Drive device macro** Select the I/O configuration (USS fieldbus)
p0791[0 … 1]	**Fieldbus analog outputs** Parameter to interconnect the analog outputs for control via the fieldbus
p2030 = 1	Fieldbus telegram selection 1: USS
p2020	**Baud rate** Factory setting = 38400 bit/s
p2022	**Fieldbus interface USS PZD number** Sets the number of 16-bit words in the PZD part of the USS telegram Setting range: 0… 8 (0 … 8 words)
p2023	**Fieldbus interface USS PIV number** Sets the number of 16-bit words in the PIV part of the USS telegram Setting range: • 0, 3, 4: 0, 3 or 4 words • 127: variable length
r2029	**Fieldbus fault statistics** Displays receive faults on the fieldbus interface
p2040	**Fieldbus monitoring time** 0 ms … 1999999 ms, factory setting = 100 ms. The more slaves that are connected in the network, the longer the fieldbus monitoring time must be. If process data is not transferred within one cycle of the fieldbus monitoring time, then the inverter shuts down with fault F01910. p2040 = 0 ⇒ bus monitoring deactivated.

8.1.2 Telegram structure

Overview

A USS telegram comprises a series of elements with a defined sequence. Each element contains 11 bits.

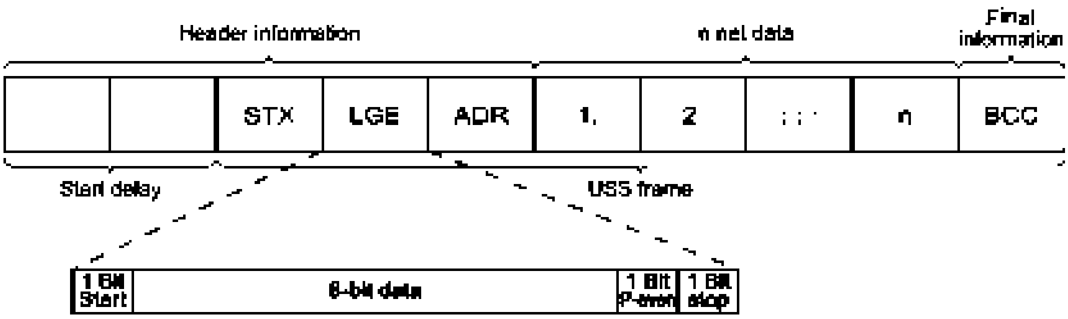
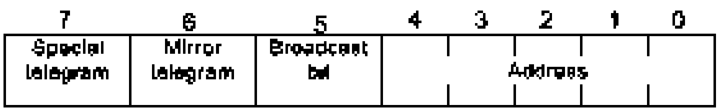


Figure 8-1 Structure of a USS telegram

Telegram part	Description
Start delay / response delay	There is always a start and/or response delay between two telegrams (see alsoTelegram examples (Page 138))
STX	An ASCII character (02 hex) indicates the beginning of the message.
LGE	The telegram length "LGE" is calculated as follows: LGE = user data (n bytes) + ADR (1 byte) + BCC (1 byte)
ADR	 • Bit 7 = 0: Normal data exchange. Bit 7 =1, to transfer telegrams that require a net data structure different from the device profile. • Bit 6 = 0: Normal data exchange. Bit 6 = 1: Testing the bus connection: The converter returns the telegram unchanged to the master. • Bit 5 = 0: Normal data exchange. (Bit 5 = 1: Not supported in the converter.) • Bits 0 ... 4: Address of the converter.
Net data	See section User data range of the USS telegram (Page 134).
BCC	Checksum (exclusive or) across all telegram bytes – with the exception of BCC.

8.1.3 User data range of the USS telegram

The user data area consists of the following elements:

- Parameter channel (PIV) for writing and reading parameter values
- Process data (PZD) for controlling the drive.

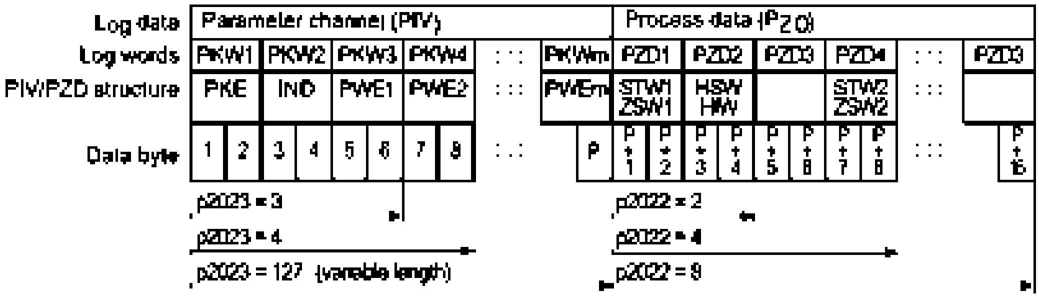


Figure 8-2 USS telegram - user data structure

Parameter channel

In parameter p2023 you specify the parameter channel length.

Parameter channel with fixed and variable length

- p2023 = 0
  With this setting, no parameter values are transferred.
- p2023 = 3
  You can select this setting if you only want to read or write 16-bit data or alarm signals.
- p2023 = 4:
  If you want to read or write 32-bit values (for example indexed parameters or bit parameters, e.g. r0722.2), then this setting is required. In this case, the send or receive telegram always contains four words, even if only three would be required. The values are enter right-justified in the 4th word.
- p2023 = 127:
  If you set p2023 = 27 (variable length), the send and response telegrams are as long as the task actually requires.

Process data

Parameter p2022 defines the length for the process data. You can transfer up to eight process data items in one telegram (p2022 = 0 … 8). For p2022 = 0, no process data is transferred.

8.1.4 USS parameter channel

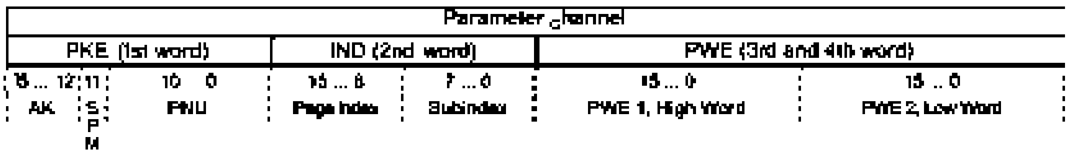
Structure of the parameter channel

Depending on the setting in p2023, the parameter channel has a fixed length of three or four words, or a variable length, depending on the length of the data to be transferred.

1. and 2nd word contain the parameter number and index as well as the type of job (read or write). The other words of the parameter channel contain parameter contents. The parameter contents can be 8-bit values, 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters). The parameter contents are entered right justified in the word with the highest number. Words that are not required are assigned 0.

Bit 11 in the 1st word is reserved and is always assigned 0.

The diagram shows a parameter channel that is four words long.



You can find examples of telegrams at the end of this section.

Request and response IDs

Bits 12 to 15 of the 1st word of the parameter channel contain the request and response identifier.

Table 8- 1 Request identifiers, control → inverter

Request identifier	Description	Response identifier	
		positive	negative
0	No request	0	7 / 8
1	Request parameter value	1 / 2	7 / 8
2	Change parameter value (word)	1	7 / 8
3	Change parameter value (double word)	2	7 / 8
4	Request descriptive element [1)]	3	7 / 8
6[2)]	Request parameter value (field) [1)]	4 / 5	7 / 8
7[2)]	Change parameter value (field, word) [1)]	4	7 / 8
8[2)]	Change parameter value (field, double word) [1)]	5	7 / 8
9	Request number of field elements	6	7 / 8

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

2) The following request IDs are identical: 1 ≡ 6, 2 ≡ 7 3 ≡ 8.
We recommend that you use identifiers 6, 7, and 8.

Table 8- 2 Response identifiers, inverter → control

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1]
4	Transfer parameter value (field, word) [2]
5	Transfer parameter value (field, double word) [2]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the control, refer to the following table.
8	No master controller status / no authorization to change parameters of the parameter channel interface

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

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

Table 8- 3 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist.)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element error value that cannot be changed)
0B hex	**No master control** (change request but with no master control, see also p0927.)
0C hex	**Keyword missing**
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the inverter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → inverter")

No.	Description
6B hex	**No change access for a controller that is enabled**. (operating status of the inverter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating status of the inverter prevents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (example: a parameter value is too large for the inverter power)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

Parameter number

Parameter numbers < 2000	PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).
Parameter numbers ≥ 2000	PNU = parameter number - offset. Write the parameter number minus the offset into the PNU (PKE bit 10 … 0). Write the offset in the page index (IND bit 15 … 8).

Table 8- 4 Offset and page index of the parameter numbers

Parameter number	Offset	Page index								
		Hex	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as hex value into the subindex (IND bit 7 … 0).

Parameter contents

Parameter contents can be parameter values or connector parameters. You require two words for connector parameters. You can find more information on interconnecting connector parameters in the operating instructions of the Control Unit in the section "Interconnecting signals in the inverter".

Enter the parameter value in the parameter channel right-justified as follows:

- 8-bit values: Low word, bits 0 … 7, bits 8 … 15 are zero.
- 16-bit values: Low word, bits 0 … 15,
- 32-bit values: Low word and high word

Enter a connector parameter right-justified as follows:

- Number of the connector parameter: High word
- Drive object of the connector parameter: Low word, bits 10 … 15
- The index or bit field number of the connector parameter: Low word, bits 0 … 9

8.1.4.1 Telegram examples

Read request: Read out serial number of the Power Module (p7841[2])

To obtain the value of the indexed parameter p7841, you must fill the telegram of the parameter channel with the following data:

- **PKE, bit 12 … 15 (AK): = 6** (request parameter value (field))
- **PKE, bit 0 … 10 (PNU): = 1841** (Parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 … 15 (page index): = 90 hex** (offset 6000 ≙ 90 hex)
- **IND, bit 0 … 7 (subindex): = 2** (Index of the parameter)
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

Parameter channel							
PKE (1st word)			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 … 12	11	10 … 0	15 … 8	7 … 0	15 … 0	15 … 10	9 … 0
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	1 0 0 1 0 0 0 0	0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 8-3 Telegram for a read request from p7841[2]

Write request: Changing the automatic restart mode (p1210)

Parameter p1210 defines the automatic restart mode:

- **PKE, bit 12 … 15 (AK): = 7** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 4BA hex** (1210 = 4BA hex, no offset, as 1210 < 1999)

- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **IND, bit 0 … 7 (subindex): = 0 hex** (parameter is not indexed)
- **PWE1, bit 0 … 15: = 0 hex**
- **PWE2, bit 0 … 15: = 1A hex** (26 = 1A hex)

Parameter channel						
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word
15 … 12	11	10 … 0	15 … 8	7 … 0	15 … 0	15 … 0
AK		Parameter number	Page index	Subindex	Parameter value (bit 16 … 31)	Parameter value (bit 0 … 15)
0 1 1 1	0	1 0 0 1 0 1 1 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0

Figure 8-4 Telegram, to activate the automatic restart with p1210 = 26

Write request: Assign digital input 2 with the function ON/OFF1 (p0840[1] = 722.2)

In order to link digital input 2 with ON/OFF1, you must assign parameter p0840[1] (source, ON/OFF1) the value 722.2 (DI 2). To do this, you must fill the telegram of the parameter channel as follows:

- **PKE, bit 12 … 15 (AK): = 7 hex** (change, parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)
- **IND, bit 8 … 15 (page index): = 0 hex** (offset 0 ≙ 0 hex)
- **IND bit 0 … 7 (subindex): = 1 hex** (command data set, CDS1 = index1)
- **PWE1, bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)
- **PWE2, bit 10 … 15: = 3f hex** (drive object - for SINAMICS G120, always 63 = 3f hex)
- **PWE2, bit 0 … 9: = 2 hex** (index or bit number of the parameter: DI 2 = r0722.2)

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 … 12	11	10 … 0	15 … 8	7 … 0	15 … 0	15 … 10	9 … 0
AK		Parameter number	Page index	Subindex	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 8-5 Telegram, to assign DI 2 with ON/OFF1

8.1.5 USS process data channel (PZD)

Description

The process data channel (PZD) contains the following data depending on the transmission direction:

- Control words and setpoints for the slave
- Status words and actual values for the master.

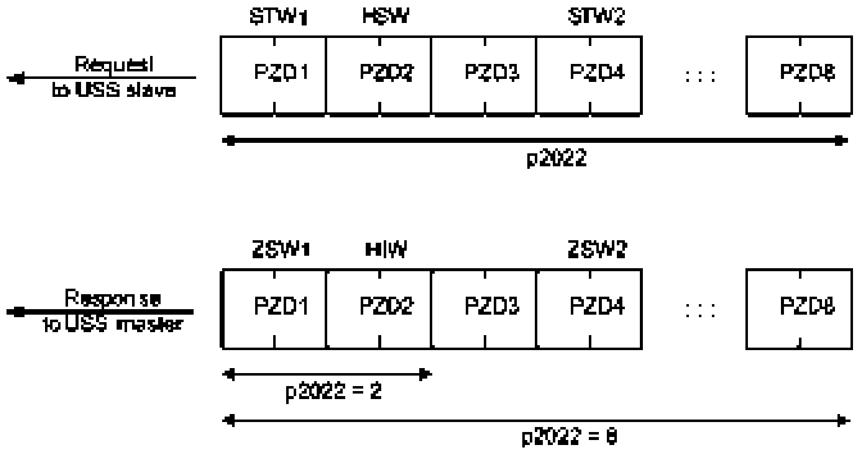


Figure 8-6 Process data channel

The first two words are:

- Control 1 (STW1) and main setpoint (HSW)
- Status word 1 (ZSW1) and main actual value (HIW)

If p2022 is greater than or equal to 4, then the converter receives the additional control word (STW2).

You define the sources of the PZD using parameter p2051.

For further information, please refer to the List Manual.

8.1.6 Time-out and other errors

You require the telegram runtimes in order to set the telegram monitoring. The character runtime is the basis of the telegram runtime:

Table 8- 5 Character runtime

Baud rate in bit/s	Transmission time per bit	Character run time (= 11 bits)
9600	104.170 µs	1.146 ms
19200	52.084 µs	0.573 ms
38400	26.042 µs	0.286 ms
115200	5.340 µs	0.059 ms

The telegram runtime is longer than just purely adding all of the character runtimes (=residual runtime). You must also take into consideration the character delay time between the individual characters of the telegram.

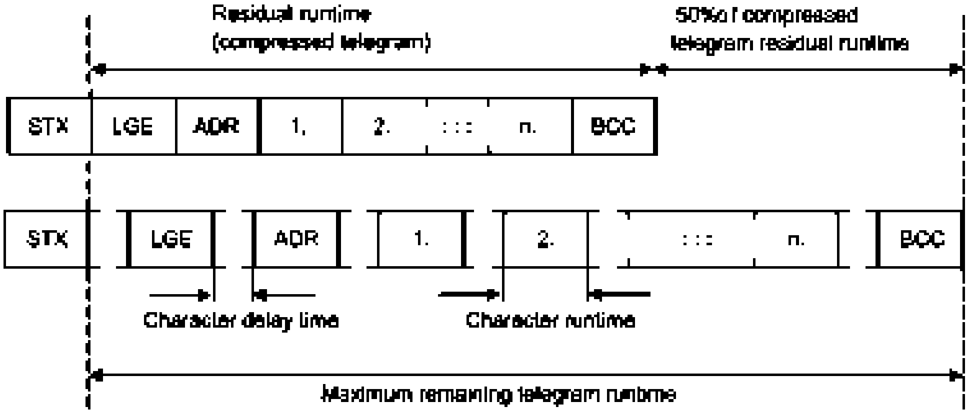


Figure 8-7 Telegram runtime as the sum of the residual runtime and character delay times

The total telegram runtime is always less than 150% of the pure residual runtime.

Before each request telegram, the master must maintain the start delay. The start delay must be > 2 × character runtime.

The slave only responds after the response delay has expired.

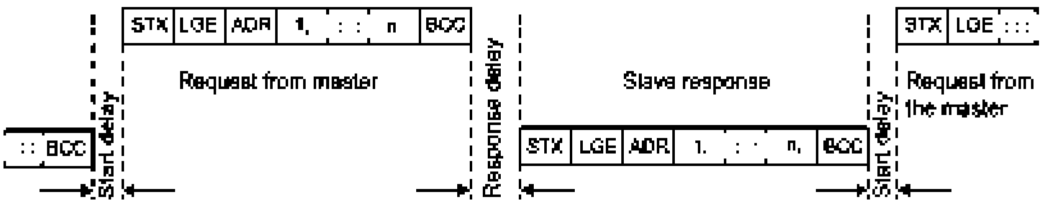


Figure 8-8 Start delay and response delay

The duration of the start delay must at least be as long as the time for two characters and depends on the baud rate.

Table 8- 6 Duration of the start delay

Baud rate in bit/s	Transmission time per character (= 11 bits)	Min. start delay
9600	1.146 ms	> 2.291 ms
19200	0.573 ms	> 1.146 ms
38400	0.286 ms	> 0.573 ms
57600	0.191 ms	> 0.382 ms
115200	0.059 ms	> 0.117 ms

Note: The character delay time must be shorter than the start delay.

Telegram monitoring of the master

With your USS master, we recommend that the following times are monitored:

- Response delay: Response time of the slave to a request from the master
  The response delay must be < 20 ms, but longer than the start delay
- Telegram runtime: Transmission time of the response telegram sent from the slave

Telegram monitoring of the converter

The converter monitors the time between two requests of the master. Parameter p2040 defines the permissible time in ms. If a time p2040 ≠ 0 is exceeded, then the converter interprets this as telegram failure and responds with fault F01910.

150% of the residual runtime is the guide value for the setting of p2040, i.e. the telegram runtime without taking into account the character delay times.

For communication via USS, the converter checks bit 10 of the received control word 1. If the bit is not set when the motor is switched on ("Operation"), the converter responds with fault F07220.

8.2 Communication via PROFINET

8.2.1 Communications using PROFINET

The Control Unit provides the following functions:

IRT without isochronous mode	
MRP	Media redundancy, not bumpless with 200 ms Precondition: Ring topology
MRPD	Media redundancy, bumpless Precondition: IRT and the ring topology created in the control
Diagnostic alarms	According to error classes specified in the PROFIdrive profile. See Activating diagnostics via the control (Page 144).
Device replacement without removable data storage medium	Requirement: Topology created in the control

The Control Units have two M12 sockets, which you can use to implement a line topology. You can implement all topologies by using switches.

Additional PROFINET information on the Internet

General information about PROFINET can be found at Industrial Communication (http://support.automation.siemens.com/WW/view/en/19292127).

The configuration of the functions is described in the PROFINET system description (http://www.automation.siemens.com/mcms/automation/en/industrial-communications/profinet/Pages/Default.aspx) manual.

8.2.2 What do you need for communication via PROFINET?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the converter via the fieldbus.

Questions	Answer/description
Is the converter correctly connected to the PROFINET?	See: Connect the converter to PROFINET (Page 143)
Do the IP address and device name in the converter and controller match?	See Configuring communication to the control (Page 143)
Is the same telegram set in the converter as in the higher-level controller?	Set the telegram in the converter, see: Select telegram (Page 144)
Are the signals that the converter and the controller exchange via PROFINET correctly interconnected?	PROFIdrive-compliant interconnection in the converter, see: PROFIdrive profile for PROFIBUS and PROFINET (Page 148)

8.2.3 Connect the converter to PROFINET

Connecting up

Connect the converter and your PG/PC to the control system using sockets X03 and X04.

8.2.4 Configuring communication to the control

Loading GSDML

In order to establish communication between the inverter and control system via PROFINET, you need the device file of the inverter "GSDML" for your control. You can then configure the communication.

Procedure

Proceed as follows to load the GSDML of the inverter:

Load the GSDML of the inverter into the PROFINET-Controller, i.e. into your control system. You can load the GSDML of your inverter in two ways:

- You can find the GSDML of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
- The GSDML is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the GSDML will be written to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card as a compressed file (PNGSD.ZIP).

  Unpack the GSDML before you use the device file.

You have loaded the GSDML of the inverter.

8.2.5 Select telegram

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Basic commissioning (Page 79).

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

You have set a specific telegram in the inverter.

The following telegrams are available:

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram.	
p0922	**PROFIdrive Telegram selection** Set the send and receive telegram, also see Cyclic communication (Page 148)	
	1: 20: 350: 352 353: 354: 999:	Standard telegram 1, PZD-2/2 (factory setting) Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4 Extend telegrams and change signal interconnection (Page 154)

8.2.6 Activating diagnostics via the control

The converter provides the functionality to transmit fault and alarm messages (diagnostic messages) to the higher-level control according to the PROFIdrive error classes.

The functionality must be selected in the higher-level control (see example of STEP 7) and activated by powering up.

8.3 Communication via PROFIBUS

8.3.1 What do you need for communication via PROFIBUS?

Check the communication settings using the following table. If you answer "Yes" to the questions, you have correctly set the communication settings and can control the inverter via the fieldbus.

Questions	Description
Is the inverter correctly connected to the PROFIBUS?	See Section: Connect the converter to PROFIBUS (Page 145).
Have you configured the communication between the inverter and the higher-level controller?	See Section: Configuring communication to the control (Page 145)
Do the addresses in the inverter and the higher-level controller match?	See Section: Settings PROFIBUS DP address with DIP switches (Page 146).
Is the same telegram set in the higher-level controller and in the inverter?	Adapt the telegram in the inverter. See Section: Select telegram (Page 147).
Are the signals that the inverter and the controller exchange via PROFIBUS correctly interconnected?	Adapt the interconnection of the signals in the controller to the inverter. For the PROFIdrive-compliant interconnection in the inverter, see also Section: PROFIdrive profile for PROFIBUS and PROFINET (Page 148).

8.3.2 Connect the converter to PROFIBUS

Connecting up

Connect the converter and your PG/PC to the control system using sockets X03 and X04.

8.3.3 Configuring communication to the control

To configure communication between the inverter and control system, you generally require the description file GSD of the inverter.

When STEP 7 and STARTER are installed, you do not need GSD.

Procedure

Proceed as follows to configure communication to the control system using GSD:

1. Obtain the GSD file of the inverter.
   You have two options:
   – You can find the GSD of the SINAMICS inverter on the Internet (http://support.automation.siemens.com/WW/view/en/22339653/133100).
   – The GSD is saved in the inverter. If you insert the memory card in the inverter and set p0804 = 12 , the inverter writes the GSD to the /SIEMENS/SINAMICS/DATA/CFG folder on the memory card.
2. Import the GSD into the configuring tool of your control system.
3. Configure the communication between the control and the inverter in your control.

   See also Section: Configuring the PROFIBUS communication with STEP 7 (Page 290).

You have configured the communication to the control system.

8.3.4 Settings PROFIBUS DP address with DIP switches

Setting the PROFIBUS DP address

Prior to using the PROFIBUS DP interface, the address of the node (Inverter) must be set using the seven PROFIBUS DP address DIP switches on the Control Unit.

The PROFIBUS DP address can be set between 1 and 126.

Note

The address is taken from P0918 if all PROFIBUS DP address DIP switches are in the OFF position, otherwise the DIP switch setting is valid.

NOTICE
External 24 V power supply must be disconnected
The external 24 V power supply must be switched off before the DIP switch settings are changed. DIP switch setting changes do not take effect until the Control Unit has been powered-up again.

Setting the PROFIBUS DP address via DIP switches

The PROFIBUS DP address can be set via DIP switch, as shown in the table below.

Table 8- 7 Example address for the PROFIBUS DP interface

DIP switch	1	2	3	4	5	6	7
Add to address	1	2	4	8	16	32	64
Example 1: Address = 3 = 1 + 2							
Example 2: Address = 88 = 8 + 16 + 64							

8.3.5 Select telegram

Precondition

In the basic commissioning, you have selected a setting with fieldbus.

See also Section: Basic commissioning (Page 79).

Procedure

Proceed as follows to set a specific telegram in the inverter:

Using STARTER or an operator panel, set parameter p0922 to the appropriate value.

You have set a specific telegram in the inverter.

The following telegrams are available:

Parameter	Description	
p0015	**Macro drive unit** Configure the interface in basic commissioning, and select a telegram.	
p0922	**PROFIdrive Telegram selection** Set the send and receive telegram, also see Cyclic communication (Page 148)	
	1: 20: 350: 352 353: 354: 999:	Standard telegram 1, PZD-2/2 (factory setting) Standard telegram 20, PZD-2/6 SIEMENS telegram 350, PZD-4/4 SIEMENS telegram 352, PZD-6/6 SIEMENS telegram 353, PZD-2/2, PKW-4/4 SIEMENS telegram 354, PZD-6/6, PKW-4/4 Extend telegrams and change signal interconnection (Page 154)

8.4 PROFIdrive profile for PROFIBUS and PROFINET

8.4.1 Cyclic communication

The send and receive telegrams of the inverter for the cyclic communication are structured as follows:

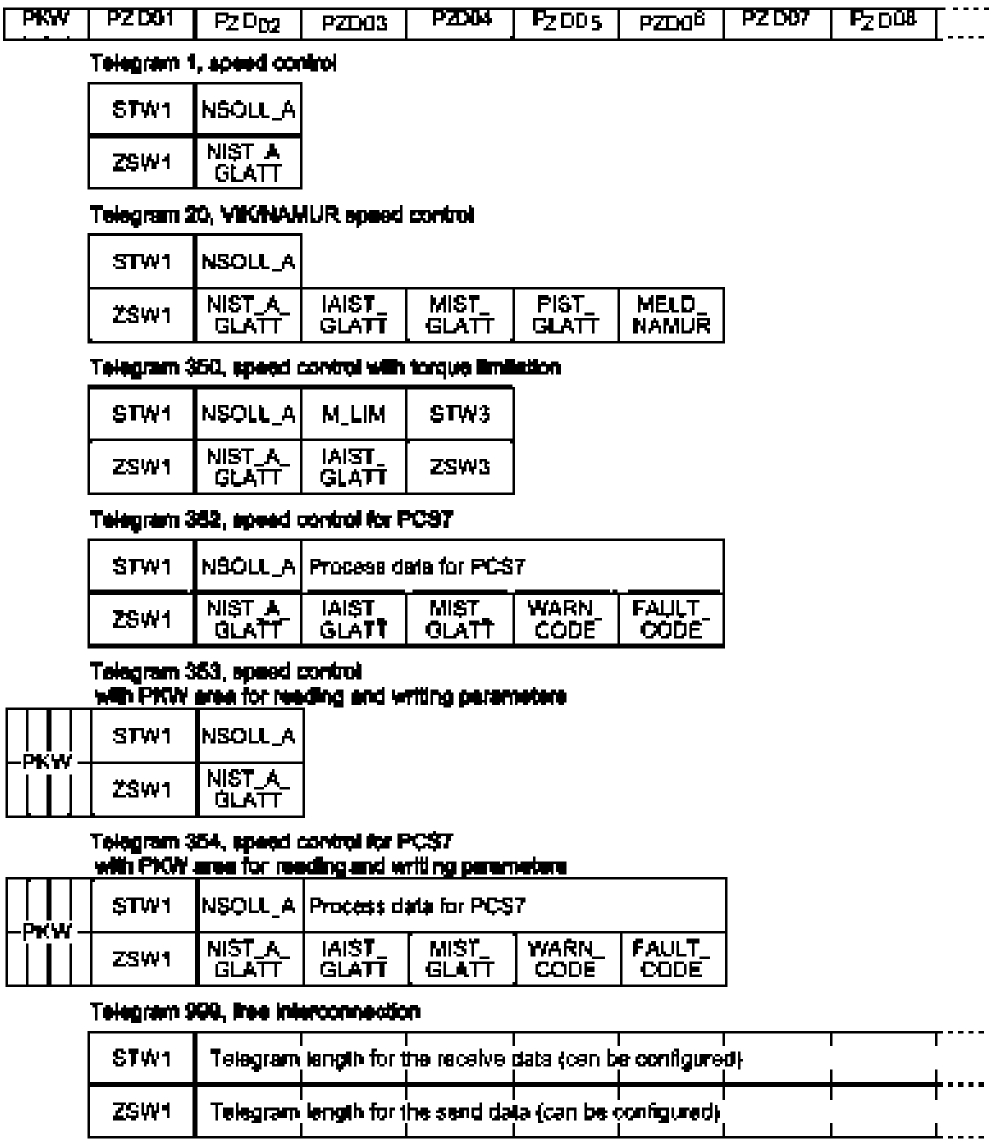


Figure 8-9 Telegrams for cyclic communication

Table 8- 8 Explanation of the abbreviations

Abbreviation	Explanation	Abbreviation	Explanation
STW1	Control word 1	MIST_GLATT	Current torque
ZSW1	Status word 1	PIST_GLATT	Current active power
STW3	Control word 3	M_LIM	Torque limit value
ZSW3	Status word 3	FAULT_CODE	Fault number
NSOLL_A	Speed setpoint	WARN_CODE	Alarm number
NIST_A_GLATT	Smoothed actual speed value	MELD_NAMUR	Fault word according to VIK-NAMUR definition
IAIST_GLATT	Smoothed actual current value		

Interconnection of the process data

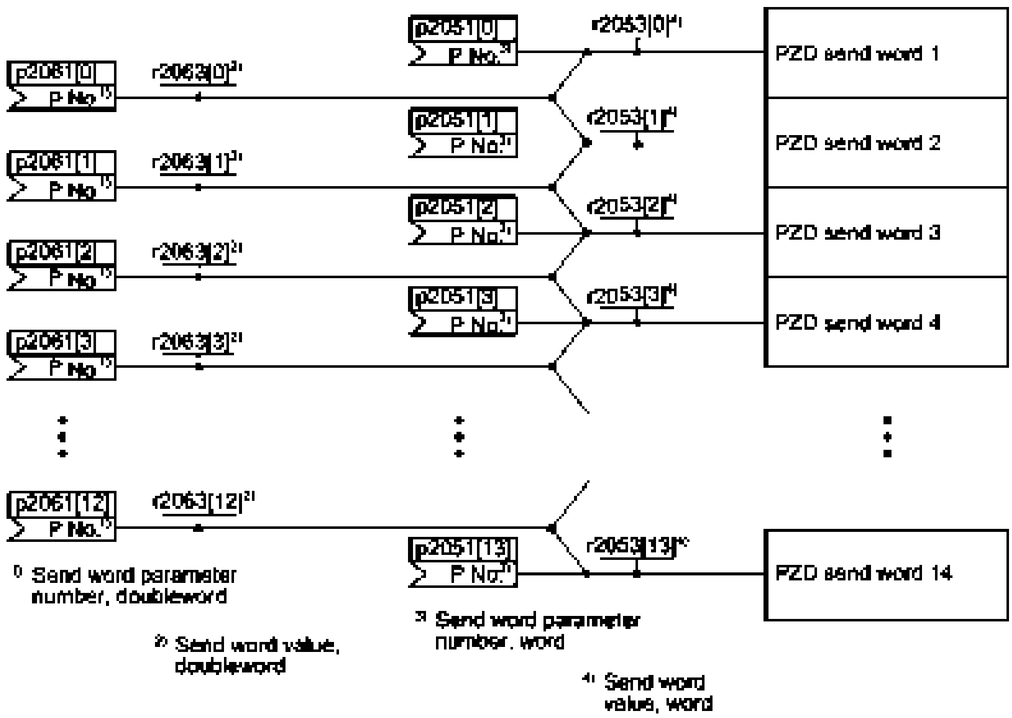


Figure 8-10 Interconnection of the send words

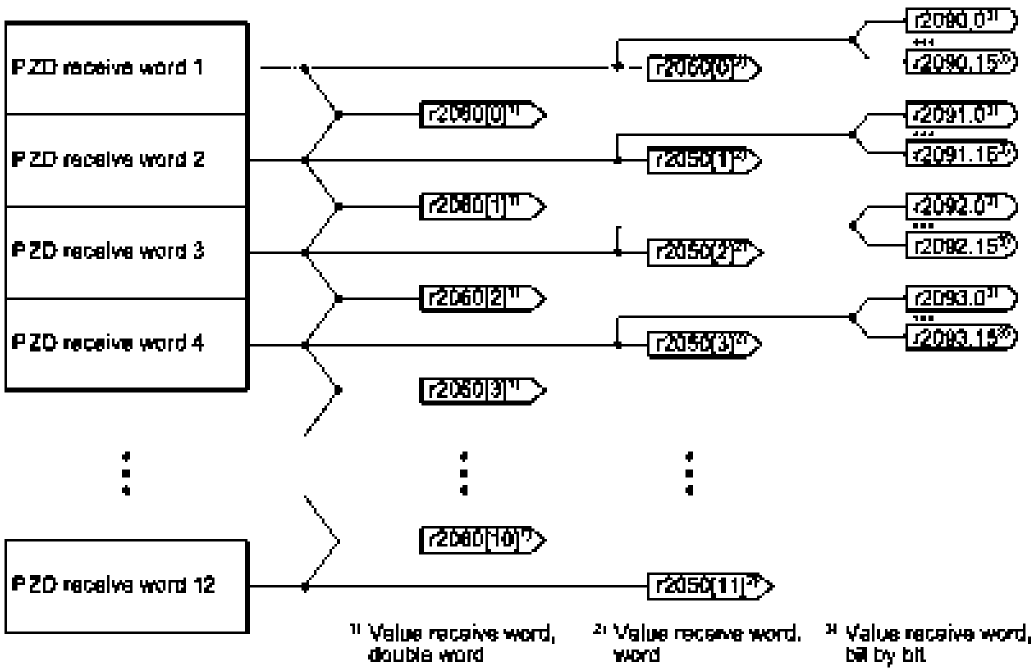


Figure 8-11 Interconnection of the receive words

The telegrams use - with the exception of telegram 999 (free interconnection) - the word-by-word transfer of send and receive data (r2050/p2051).

If you require an individual telegram for your application (e.g. for transferring double words), you can adjust one of the predefined telegrams via parameters p0922 and p2079. For details, please refer to the List Manual, function diagrams 2420 and 2472.

8.4.1.1 Control and status word 1

The control and status words fulfill the specifications of PROFIdrive profile version 4.1 for the "closed-loop speed controlled" mode.

Control word 1 (STW1)

Control word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter).

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
0	0 = OFF1		The motor brakes with the ramp-down time p1121 of the ramp-function generator. The inverter switches off the motor at standstill.	p0840[0] = r2090.0
	0 → 1 = ON		The inverter goes into the "ready" state. If, in addition bit 3 = 1, then the inverter switches on the motor.	

Bit	Significance		Explanation	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
1	0 = OFF2		Switch off the motor immediately, the motor then coasts down to a standstill.	p0844[0] = r2090.1
	1 = No OFF2		The motor can be switched on (ON command).	
2	0 = Quick stop (OFF3)		Quick stop: The motor brakes with the OFF3 ramp-down time p1135 down to standstill.	p0848[0] = r2090.2
	1 = No quick stop (OFF3)		The motor can be switched on (ON command).	
3	0 = Inhibit operation		Immediately switch-off motor (cancel pulses).	p0852[0] = r2090.3
	1 = Enable operation		Switch-on motor (pulses can be enabled).	
4	0 = Disable RFG		The inverter immediately sets its ramp-function generator output to 0.	p1140[0] = r2090.4
	1 = Do not disable RFG		The ramp-function generator can be enabled.	
5	0 = Stop RFG		The output of the ramp-function generator stops at the actual value.	p1141[0] = r2090.5
	1 = Enable RFG		The output of the ramp-function generator follows the setpoint.	
6	0 = Inhibit setpoint		The inverter brakes the motor with the ramp-down time p1121 of the ramp-function generator.	p1142[0] = r2090.6
	1 = Enable setpoint		Motor accelerates with the ramp-up time p1120 to the setpoint.	
7	0 → 1 = Acknowledge faults		Acknowledge fault. If the ON command is still active, the inverter switches to"closing lockout" state.	p2103[0] = r2090.7
8, 9	Reserved			
10	0 = No control via PLC		Inverter ignores the process data from the fieldbus.	p0854[0] = r2090.10
	1 = Control via PLC		Control via fieldbus, inverter accepts the process data from the fieldbus.	
11	---[1)]	0 = Direction reversal	Invert setpoint in the inverter.	p1113[0] = r2090.11
12	Not used			
13	---[1)]	1 = MOP up	Increase the setpoint saved in the motorized potentiometer.	p1035[0] = r2090.13
14	---[1)]	1 = MOP down	Reduce the setpoint saved in the motorized potentiometer.	p1036[0] = r2090.14
15	CDS bit 0	Reserved	Changes over between settings for different operation interfaces (command data sets).	p0810 = r2090.15

[1)] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

Status word 1 (ZSW1)

Status word 1 (bits 0 … 10 in accordance with PROFIdrive profile and VIK/NAMUR, bits 11 … 15 specific to the inverter).

Bit	Significance		Comments	Signal interconnection in the inverter
	Telegram 20	All other telegrams		
0	1 = Ready to start		Power supply switched on; electronics initialized; pulses locked.	p2080[0] = r0899.0
1	1 = Ready		Motor is switched on (ON/OFF1 = 1), no fault is active. With the command "Enable operation" (STW1.3), the inverter switches on the motor.	p2080[1] = r0899.1
2	1 = Operation enabled		Motor follows setpoint. See control word 1, bit 3.	p2080[2] = r0899.2
3	1 = Fault active		The inverter has a fault. Acknowledge fault using STW1.7.	p2080[3] = r2139.3
4	1 = OFF2 inactive		Coast down to standstill is not active.	p2080[4] = r0899.4
5	1 = OFF3 inactive		Quick stop is not active.	p2080[5] = r0899.5
6	1 = Closing lockout active		It is only possible to switch on the motor after an OFF1 followed by ON.	p2080[6] = r0899.6
7	1 = Alarm active		Motor remains switched on; no acknowledgement is necessary.	p2080[7] = r2139.7
8	1 = Speed deviation within the tolerance range		Setpoint / actual value deviation within the tolerance range.	p2080[8] = r2197.7
9	1 = Master control requested		The automation system is requested to accept the inverter control.	p2080[9] = r0899.9
10	1 = Comparison speed reached or exceeded		Speed is greater than or equal to the corresponding maximum speed.	p2080[10] = r2199.1
11	0 = I, M or P limit reached		Comparison value for current, torque or power has been reached or exceeded.	p2080[11] = r1407.7
12	---[1)]	1 = Holding brake open	Signal to open and close a motor holding brake.	p2080[12] = r0899.12
13	0 = Alarm, motor overtemperature		--	p2080[13] = r2135.14
14	1 = Motor rotates clockwise		Internal inverter actual value > 0	p2080[14] = r2197.3
	0 = Motor rotates counterclockwise		Internal inverter actual value < 0	
15	1 = CDS display	0 = Alarm, inverter thermal overload		p2080[15] = r0836.0 / r2135.15

[1)] If you change over from another telegram to telegram 20, then the assignment of the previous telegram is kept.

8.4.1.2 Control and status word 3

The control and status words fulfill the specifications of PROFIdrive profile version 4.1 for the "closed-loop speed controlled" mode.

Control word 3 (STW3)

Control word 3 has the following default assignment. You can change the signal interconnection.

Bit	Value	Significance Telegram 350	Explanation	Signal interconnection in the inverter [1)]
0	1	Fixed setpoint, bit 0	Selects up to 16 different fixed setpoints.	p1020[0] = r2093.0
1	1	Fixed setpoint, bit 1		p1021[0] = r2093.1
2	1	Fixed setpoint, bit 2		p1022[0] = r2093.2
3	1	Fixed setpoint, bit 3		p1023[0] = r2093.3
4	1	DDS selection, bit 0	Changes over between settings for different motors (drive data sets).	p0820 = r2093.4
5	1	DDS selection, bit 1		p0821 = r2093.5
6	–	Not used		
7	–	Not used		
8	1	Technology controller enable	--	p2200[0] = r2093.8
9	1	DC braking enable	--	p1230[0] = r2093.9
10	–	Not used		
11	1	1 = Enable droop	Enable or inhibit speed controller droop.	p1492[0] = r2093.11
12	1	Torque control active	Changes over the control mode for vector control.	p1501[0] = r2093.12
	0	Closed-loop speed control active		
13	1	No external fault	--	p2106[0] = r2093.13
	0	External fault is active (F07860)		
14	–	Not used		
15	1	CDS bit 1	Changes over between settings for different operation interfaces (command data sets).	p0811[0] = r2093.15

[1)] If you switch from telegram 350 to a different one, then the inverter sets all interconnections p1020, … to "0". Exception: p2106 = 1.

Status word 3 (ZSW3)

Status word 3 has the following standard assignment.

Bit	Value	Significance	Description	Signal interconnection in the inverter
0	1	DC braking active	--	p2051[3] = r0053
1	1	|n_act| > p1226	Absolute current speed > stationary state detection	
2	1	|n_act| > p1080	Absolute actual speed > minimum speed	
3	1	i_act ≧ p2170	Actual current ≥ current threshold value	
4	1	|n_act| > p2155	Absolute actual speed > speed threshold value 2	
5	1	|n_act| ≦ p2155	Absolute actual speed < speed threshold value 2	
6	1	|n_act| ≧ r1119	Speed setpoint reached	
7	1	DC link voltage ≦ p2172	Actual DC link voltage ≦ threshold value	
8	1	DC link voltage > p2172	Actual DC link voltage > threshold value	
9	1	Ramping completed	Ramp-function generator is not active.	
10	1	Technology controller output at lower limit	Technology controller output ≦ p2292	
11	1	Technology controller output at upper limit	Technology controller output > p2291	
12		Not used		
13		Not used		
14		Not used		
15		Not used		

8.4.1.3 Extend telegrams and change signal interconnection

When you have selected a telegram, the inverter interconnects the corresponding signals with the fieldbus interface. Generally, these interconnections are protected so that they cannot be changed. With the appropriate inverter settings, these interconnections can be changed.

Extend telegram

Every telegram can be extended, by "attaching" additional signals.

Procedure

Proceed as follows to extend a telegram:

1. Using STARTER or an operator panel, set parameter p0922 = 999.
2. Set parameter p2079 to the appropriate value of the corresponding telegram.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have extended the telegram.

Parameter	Description
p0922	**PROFIdrive telegram selection** 999: Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended** 1: Standard telegram 1, PZD-2/2 20: Standard telegram 20, PZD-2/6 350: SIEMENS telegram 350, PZD-4/4 352: SIEMENS telegram 352, PZD-6/6 353: SIEMENS telegram 353, PZD-2/2, PKW-4/4 354: SIEMENS telegram 354, PZD-6/6, PKW-4/4
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.
p2051[0…11]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.

Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller. For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

Freely selecting the signal interconnection of the telegram

The signals in the telegram can be freely interconnected.

Procedure

Proceed as follows to change the signal interconnection of a telegram:

1. Using STARTER or an operator panel, set parameter p0922 = 999.
2. Using STARTER or an operator panel, set parameter p2079 = 999.
3. Interconnect additional PZD send words and PZD receive words with signals of your choice via parameters r2050 and p2051.

You have freely interconnected the signals transferred in the telegram.

Parameter	Description
p0922	**PROFIdrive telegram selection** 999: Free telegram (message frame) configuration
p2079	**PROFIdrive PZD telegram selection extended** 999: Free telegram (message frame) configuration
r2050[0…11]	**PROFIdrive PZD receive word** Connector output to interconnect the PZD (setpoints) in the word format received from the PROFIdrive controller.
p2051[0…11]	**PROFIdrive PZD send word** Selection of the PZD (actual values) in the word format to be sent to the PROFIdrive controller.

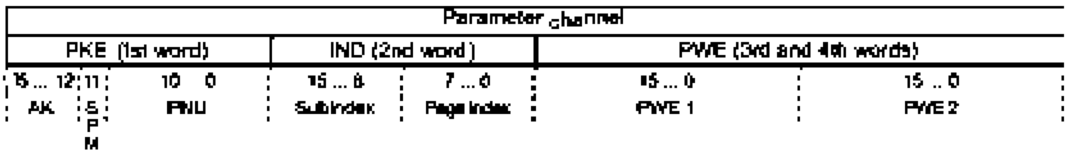
For further information refer to the function block diagrams 2468 and 2470 of the List Manual.

8.4.1.4 Structure of the parameter channel

Structure of the parameter channel

The parameter channel consists of four words. 1. and 2nd word transfer the parameter number and index as well as the type of job (read or write) The 3rd and 4th word contains the parameter contents. The parameter contents can be 16-bit values (such as baud rate) or 32-bit values (e.g. CO parameters).

Bit 11 in the 1st word is reserved and is always assigned 0.



You can find examples of telegrams at the end of this section.

Request and response IDs

Bits 12 to 15 of the 1st word of the parameter channel contain the request and response identifier.

Table 8- 9 Request identifiers, control → inverter

Request identifier	Description	Response identifier	
		positive	negative
0	No request	0	7 / 8
1	Request parameter value	1 / 2	7 / 8
2	Change parameter value (word)	1	7 / 8
3	Change parameter value (double word)	2	7 / 8
4	Request descriptive element [1)]	3	7 / 8
6[2)]	Request parameter value (field) [1)]	4 / 5	7 / 8
7[2)]	Change parameter value (field, word) [1)]	4	7 / 8
8[2)]	Change parameter value (field, double word) [1)]	5	7 / 8
9	Request number of field elements	6	7 / 8

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

2) The following request IDs are identical: 1 ≡ 6, 2 ≡ 7 3 ≡ 8.
We recommend that you use identifiers 6, 7, and 8.

Table 8- 10 Response identifiers, inverter → control

Response identifier	Description
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Transfer descriptive element [1]
4	Transfer parameter value (field, word) [2]
5	Transfer parameter value (field, double word) [2]
6	Transfer number of field elements
7	Inverter cannot process the request. In the most significant word of the parameter channel, the inverter sends an error number to the control, refer to the following table.
8	No master controller status / no authorization to change parameters of the parameter channel interface

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

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

Table 8- 11 Error numbers for response identifier 7

No.	Description
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a subindex that does not exist.)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element error value that cannot be changed)
0B hex	**No master control** (change request but with no master control, see also p0927.)
0C hex	**Keyword missing**
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
65 hex	**Parameter number is currently deactivated** (depending on the mode of the inverter)
66 hex	**Channel width is insufficient** (communication channel is too small for response)
68 hex	**Illegal parameter value** (parameter can only assume certain values)
6A hex	**Request not included / task is not supported** (the valid request identifications can be found in table "Request identifications controller → inverter")

No.	Description
6B hex	**No change access for a controller that is enabled**. (operating status of the inverter prevents a parameter change)
86 hex	**Write access only for commissioning (p0010 = 15)** (operating status of the inverter prevents a parameter change)
87 hex	**Know-how protection active, access locked**
C8 hex	**Change request below the currently valid limit** (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	**Change request above the currently valid limit** (example: a parameter value is too large for the inverter power)
CC hex	**Change request not permitted** (change is not permitted as the access code is not available)

Offset and page index of the parameter numbers

Parameter numbers < 2000	PNU = parameter number. Write the parameter number into the PNU (PKE bit 10 ... 0).
Parameter numbers ≥ 2000	PNU = parameter number - offset. Write the parameter number minus the offset into the PNU (PKE bit 10 … 0). Write the offset in the page index (IND bit 7 … 0).

Parameter number	Offset	Page index								
		Hex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0000 … 1999	0	0 hex	0	0	0	0	0	0	0	0
2000 … 3999	2000	80 hex	1	0	0	0	0	0	0	0
6000 … 7999	6000	90 hex	1	0	0	1	0	0	0	0
8000 … 9999	8000	20 hex	0	0	1	0	0	0	0	0
10000 … 11999	10000	A0 hex	1	0	1	0	0	0	0	0
20000 … 21999	20000	50 hex	0	1	0	1	0	0	0	0
30000 … 31999	30000	F0 hex	1	1	1	1	0	0	0	0
60000 … 61999	60000	74 hex	0	1	1	1	0	1	0	0

Indexed parameters

For indexed parameters, you must write the index as hex value into the subindex (IND bit 15 … 8).

Parameter contents

Parameter contents can be parameter values or connector parameters.

Enter the parameter value, right-justified, as follows in the 4th word of the parameter channel:

- 8-bit values: 4th Word, bits 0 … 7, bits 8 … 15 of the 4th word and the 3rd word are zero.
- 16-bit values: 4th Word, bits 0 … 15, the 3rd word is zero.
- 32-bit values: 3rd and 4th word

Enter a connector parameter as follows:

- Number of the connector parameter: 3rd Word
- Drive object of the connector parameter: 4th Word, bits 10 … 15
- The index or bit field number of the connector parameter: 4th Word, bits 0 … 9

Telegram examples

Read request: Read out serial number of the Power Module (p7841[2])

To obtain the value of the indexed parameter p7841, you must fill the telegram of the parameter channel with the following data:

- **PKE, bit 12 … 15 (AK): = 6** (request parameter value (field))
- **PKE, bit 0 … 10 (PNU): = 1841** (Parameter number without offset)
  Parameter number = PNU + offset (page index)
  (7841 = 1841 + 6000)
- **IND, bit 8 … 15 (subindex): = 2** (Index of the parameter)
- **IND, bit 0 … 7 (page index): = 90 hex** (offset 6000 ≙ 90 hex)
- Because you want to read the parameter value, words 3 and 4 in the parameter channel for requesting the parameter value are irrelevant. They should be assigned a value of 0, for example.

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 … 12	11	10 … 0	15 … 8	7 … 0	15 … 0	15 … 10	9 … 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive object	Index
0 1 1 0	0	1 1 1 0 0 1 1 0 0 0 1	0 0 0 0 0 0 1 0	1 0 0 1 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0

Figure 8-12 Telegram for a read request from p7841[2]

Write request: Assign digital input 2 with the function ON/OFF1 (p0840[1] = 722.2)

In order to link digital input 2 with OFF1/ON, you must assign parameter p0840[1] (source, ON/OFF1) the value 722.2 (DI 2). To do this, you must fill the telegram of the parameter channel as follows:

- **PKE, bit 12 … 15 (AK): = 7 hex** (change, parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 348 hex** (840 = 348 hex, no offset, as 840 < 1999)

- **IND bit 8 … 15 (subindex): = 1 hex** (CDS1 = index1)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 ≙ 0 hex)
- **PWE1, bit 0 … 15**: = **2D2 hex** (722 = 2D2 hex)
- **PWE2, bit 10 … 15: = 3f hex** (drive object - for SINAMICS G120, always 63 = 3f hex)
- **PWE2, bit 0 … 9: = 2 hex** (index of parameter (DI 2 = 2))

Parameter channel							
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word	
15 .. 12	11	10 .. 0	15 .. 8	7 .. 0	15 .. 0	15 .. 10	9 .. 0
AK		Parameter number	Subindex	Page index	Parameter value	Drive Object	Index
0 1 1 1	0	0 1 1 0 1 0 0 1 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 1 1 0 1 0 0 1 0	1 1 1 1 1 1	0 0 0 0 0 0 0 0 1 0

Figure 8-13 Telegram, to assign DI 2 with ON/OFF1

Write request: Change restart mode (p1210)

The restart mode is inhibited in the factory setting (p1210 = 0). In order to activate the automatic restart with "acknowledge all faults and restart for an ON command", p1210 must be set to 26:

- **PKE, bit 12 … 15 (AK): = 7** (change parameter value (field, word))
- **PKE, bit 0 … 10 (PNU): = 4BA hex** (1210 = 4BA hex, no offset, as 1210 < 1999)
- **IND, bit 8 … 15 (subindex): = 0 hex** (parameter is not indexed)
- **IND, bit 0 … 7 (page index): = 0 hex** (offset 0 corresponds to 0 hex)
- **PWE1, bit 0 … 15: = 0 hex**
- **PWE2, bit 0 … 15: = 1A hex** (26 = 1A hex)

Parameter channel						
PKE, 1st word			IND, 2nd word		PWE1 - high, 3rd word	PWE2 - low, 4th word
15 ... 12	11	10 .. 0	15 .. 8	7 .. 0	15 .. 0	15 .. 0
AK		Parameter number	Subindex	Page index	Parameter value (bit 16 ... 31)	Parameter value (bit 0 ... 15)
0 1 1 1	0	1 0 0 1 0 1 1 1 0 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0

Figure 8-14 Telegram, to activate the automatic restart with p1210 = 26

8.4.1.5 Slave-to-slave communication

"Direct data exchange" is sometimes called "slave-to-slave communication" or "data exchange broadcast". Here, slaves exchange data without any direct involvement of the master.

Example: An inverter uses the actual speed value of another inverter as its speed setpoint.

Definitions

- **Publisher:** Slave, which sends data for direct data exchange.
- **Subscriber:** Slave, which receives the data for direct data exchange from the publisher.
- **Links and access points** define the data that is used for direct data exchange.

Restrictions

- Direct data exchange in the current firmware version is only possible for inverters with PROFIBUS communication.
- A maximum of 12 PZDs are permissible for each drive.
- To a publisher, a maximum of 4 links are possible.

Procedure

To configure direct data exchange, proceed as follows:

1. In the control, define:
   – Which inverters operate as publisher (sender) or subscriber (receiver)?
   – Which data or data areas do you use for direct data exchange?
2. In the inverter, define:

   How does the subscriber process the data transferred using direct data exchange?

You have configured direct data exchange.

8.4.2 Acyclic communication

8.4.2.1 Acyclic communication

You can communicate with the inverter both cyclically and acyclically via PROFIBUS and PROFINET.

The inverter supports the following types of acyclic communication:

- Reading and writing parameters via "data set 47" (up to 240 bytes per write or read request)
- Reading-out profile-specific parameters

8.4.2.2 Reading and changing parameters via data set 47

Reading parameter values

Table 8- 12 Request to read parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**01 hex**: Read request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**Attribute** *10 hex:* Parameter value *20 hex:* Parameter description	**Number of indexes** *00 hex ... EA hex* (for parameters without index: 00 hex)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0000 hex ... FFFF hex* (for parameters without index: 0000 hex)		8
	…		…
Address, parameter 2	…		…
…	…		…
Address, parameter m	…		…

Table 8- 13 Inverter response to a read request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a read request)	**01 hex**: Inverter has executed the read request. **81 hex**: Inverter was not able to completely execute the read request.	0
	01 hex	**Number of parameters (m)** (identical to the read request)	2
Values, parameter 1	**Format** 02 hex: Integer8 03 hex: Integer16 04 hex: Integer32 05 hex: Unsigned8 06 hex: Unsigned16 07 hex: Unsigned32 08 hex: FloatingPoint 10 hex OctetString 13 hex TimeDifference 41 hex: Byte 42 hex: Word 43 hex: Double word 44 hex: Error	**Number of index values** or - for a negative response - **number of error values**	4
	Value of the 1st index or - for a negative response - **error value 1** You can find the error values in a table at the end of this section.		6
	…		…
Values, parameter 2	…		

Data block	Byte n	Bytes n + 1	n
…	…		
Values, parameter m	…		

Changing parameter values

Table 8- 14 Request to change parameters

Data block	Byte n	Bytes n + 1	n
Header	**Reference** *01 hex ... FF hex*	**02 hex**: Change request	0
	01 hex	**Number of parameters (m)** *01 hex ... 27 hex*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex ... EA hex* (00 hex and 01 hex have the same significance)	4
	Parameter number *0001 hex ... FFFF hex*		6
	Number of the 1st index *0001 hex ... FFFF hex*		8
	…		…
Address, parameter 2	…		
…	…		…
Address, parameter m	…		
Values, parameter 1	**Format** *02 hex:* Integer 8 *03 hex:* Integer 16 *04 hex:* Integer 32 *05 hex:* Unsigned 8 *06 hex:* Unsigned 16 *07 hex:* Unsigned 32 *08 hex:* Floating Point *10 hex* Octet String *13 hex* Time Difference *41 hex:* Byte *42 hex:* Word *43 hex:* Double word	**Number of index values** *00 hex ... EA hex*	
	Value of the 1st index		
	…		
Values, parameter 2	…		
…	…		
Values, parameter m	…		

Table 8- 15 Response, if the inverter has executed the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**02 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2

Table 8- 16 Response if the inverter was not able to completely execute the change request

Data block	Byte n	Bytes n + 1	n
Header	**Reference** (identical to a change request)	**82 hex**	0
	01 hex	**Number of parameters** (identical to a change request)	2
Values, parameter 1	**Format** 40 hex: Zero (change request for this data block executed) 44 hex: Error (change request for this data block not executed)	**Number of error values** 00 hex or 02 hex	4
	Only for "Error" - **error value 1** You can find the error values in the table at the end of this section.		6
	Only for "Error" - **error value 2** Error value 2 is either zero, or it contains the number of the first index where the error occurred.		8
Values, parameter 2	...		
...	...		...
Values, parameter m	...		

Table 8- 17 Error value in the parameter response

Error value 1	Significance
00 hex	**Illegal parameter number** (access to a parameter that does not exist)
01 hex	**Parameter value cannot be changed** (change request for a parameter value that cannot be changed)
02 hex	**Lower or upper value limit exceeded** (change request with a value outside the value limits)
03 hex	**Incorrect subindex** (access to a parameter index that does not exist)
04 hex	**No array** (access with a subindex to non-indexed parameters)
05 hex	**Incorrect data type** (change request with a value that does not match the data type of the parameter)
06 hex	**Setting not permitted, only resetting** (change request with a value not equal to 0 without permission)
07 hex	**Descriptive element cannot be changed** (change request to a descriptive element that cannot be changed)
09 hex	**Description data not available** (access to a description that does not exist, parameter value is available)
0B hex	**No master control** (change request but with no master control)
0F hex	**Text array does not exist** (although the parameter value is available, the request is made to a text array that does not exist)
11 hex	**Request cannot be executed due to the operating state** (access is not possible for temporary reasons that are not specified)
14 hex	**Inadmissible value** (change request with a value that is within the limits but which is illegal for other permanent reasons, i.e. a parameter with defined individual values)
15 hex	**Response too long** (the length of the actual response exceeds the maximum transfer length)
16 hex	**Illegal parameter address** *(illegal or unsupported value for attribute, number of elements, parameter number, subindex or a combination of these)*
17 hex	**Illegal format** (change request for an illegal or unsupported format)

Error value 1	Significance
18 hex	Number of values not consistent *(number of values of the parameter data to not match the number of elements in the parameter address)*
19 hex	Drive object does not exist (access to a drive object that does not exist)
6B hex	No change access for a controller that is enabled.
6C hex	Unknown unit.
6E hex	Change request is only possible when the motor is being commissioned (p0010 = 3).
6F hex	Change request is only possible when the power unit is being commissioned (p0010 = 2).
70 hex	Change request is only possible for quick commissioning (basic commissioning) (p0010 = 1).
71 hex	Change request is only possible if the inverter is ready (p0010 = 0).
72 hex	Change request is only possible for a parameter reset (restore to factory setting) (p0010 = 30).
73 hex	Change request possible only during commissioning of the safety functions (p0010 = 95).
74 hex	Change request is only possible when a technological application/unit is being commissioned (p0010 = 5).
75 hex	Change request is only possible in a commissioning state (p0010 ≠ 0).
76 hex	Change request is not possible for internal reasons (p0010 = 29).
77 hex	Change request is not possible at download.
81 hex	Change request is not possible at download.
82 hex	Transfer of the control authority (master) is inhibited by BI: p0806.
83 hex	Desired interconnection is not possible (the connector output does not supply a float value although the connector input requires a float value)
84 hex	Inverter does not accept a change request (inverter is busy with internal calculations. See parameter r3996 in the inverter List Manual. See also Section: Further Information (Page 312))
85 hex	No access methods defined.
86 hex	Write access only during commissioning of the data records (p0010 = 15) (operating status of the inverter prevents a parameter change.)
87 hex	Know-how protection active, access locked
C8 hex	Change request below the currently valid limit (change request to a value that lies within the "absolute" limits, but is however below the currently valid lower limit)
C9 hex	Change request above the currently valid limit (example: a parameter value is too large for the inverter power)
CC hex	Change request not permitted (change is not permitted as the access code is not available)

8.5 PROFIenergy profile for PROFINET

PROFIenergy is an energy management system for production plants, based on the PROFINET communication protocol. The functionality is certified and described in the PROFIenergy profile of the PNO.

The inverter supports the PROFIenergy profile V1.1 and the function unit class 3:

PROFIenergy functions of the inverter

The control transfers the PROFIenergy commands in acyclic operation to the inverter in data set 80A0 hex.

Parameters r5600 to p5614 are reserved for PROFIenergy functions in the inverter.

The PROFIenergy status is output in r5600.

The following commands and queries are available for the control:

PROFIenergy control commands

- Start_Pause
  Switches from operating state S1 or S2 (start inhibit or start readiness) to energy-saving mode.
- START_Pause_with_time_response
  Switches from operating state S1 or S2 (start inhibit or start readiness) to energy-saving mode and also specifies the transition times in the command response.
- End_Pause
  Switches from energy-saving mode to the operating state.
  Cancels the switching from the operating state to the energy-saving mode.

PROFIenergy status requests

- List_Energy_Saving_Modes
  Determines all supported energy-saving modes.
- GeLMode
  Determines information about the selected energy-saving mode.
- PEM_Status
  Determines the current PROFienergy status.
- PEM_Status_with_CTTO
  Determines the current PROFienergy status, such as the PEMStatus, together with the regular transition time to the operating state.
- PEIdentify
  Determines the supported PROFienergy commands.
- Query Version
  Shows the implemented PROFienergy profile.
- Get_Measurement_List
  This command returns the measured value IDs that can be accessed using the "Get_Measurement_Values" command.
- Get_Measurement_List_with_object_number
  This command returns the measured value IDs and the associated object number that can be accessed using the "Get_Measurement_Values_with_object_number" command.
- Get_Measurement_ Values
  The command returns the requested measured value using the measured value ID
- Get_Measurement_Values_with_object_number
  The command returns the requested measured values using the measured value ID and the object number. The object number corresponds to the drive object ID.

Displaying

- r5600: Current energy-saving mode
- r5613: Interconnectable display of the PROFIenergy status
- A08800: PROFIenergy energy-saving mode active

General settings for PROFIenergy

- Minimum pause time: p5602
  The inverter enters energy-saving mode only when the pause time sent with the "Start_Pause" command is greater than or equal to the value for p5602.1. If the pause time is less than p5602.1, the inverter ignores the command.
- Maximum pause time: p5606

Block PROFIenergy control commands

If you set p5611.0 = 1, you block the response of the inverter to PROFIenergy control commands. In this case, the inverter ignores the PROFIenergy control commands.

Transition to the energy-saving mode from the PROFIdrive operating state (S4)

If you set p5611.2 = 1, you permit the transition to the energy-saving mode from the PROFIdrive operating state (S4)

You can also set

- p5611.1 = 1: With the transition to the energy-saving mode, the inverter issues an OFF1 command and enters the start-inhibit state (S1).
- p5611.1 = 0: You can use p5614 to interconnect a signal source that switches the inverter off and places it in the start-inhibit state (S1).

PROFIenergy measured values

PROFIenergy				Unit	SINAMICS source parameters		Range of values
Measured value		Accuracy					
ID	Name	Domain	Class		Number	Name	
34	Active power	1	12	W	r0032	Active power smoothed	r2004
166	Power factor	1	12	1	r0038	Smoothed power factor	0 … 1
200	Active energy import	2	11	Wh	r0039[1]	Energy accepted	-

9 Functions

Complete the following commissioning steps before you set the converter functions:

- Basic commissioning (Page 79)

9.1 Overview of converter functions

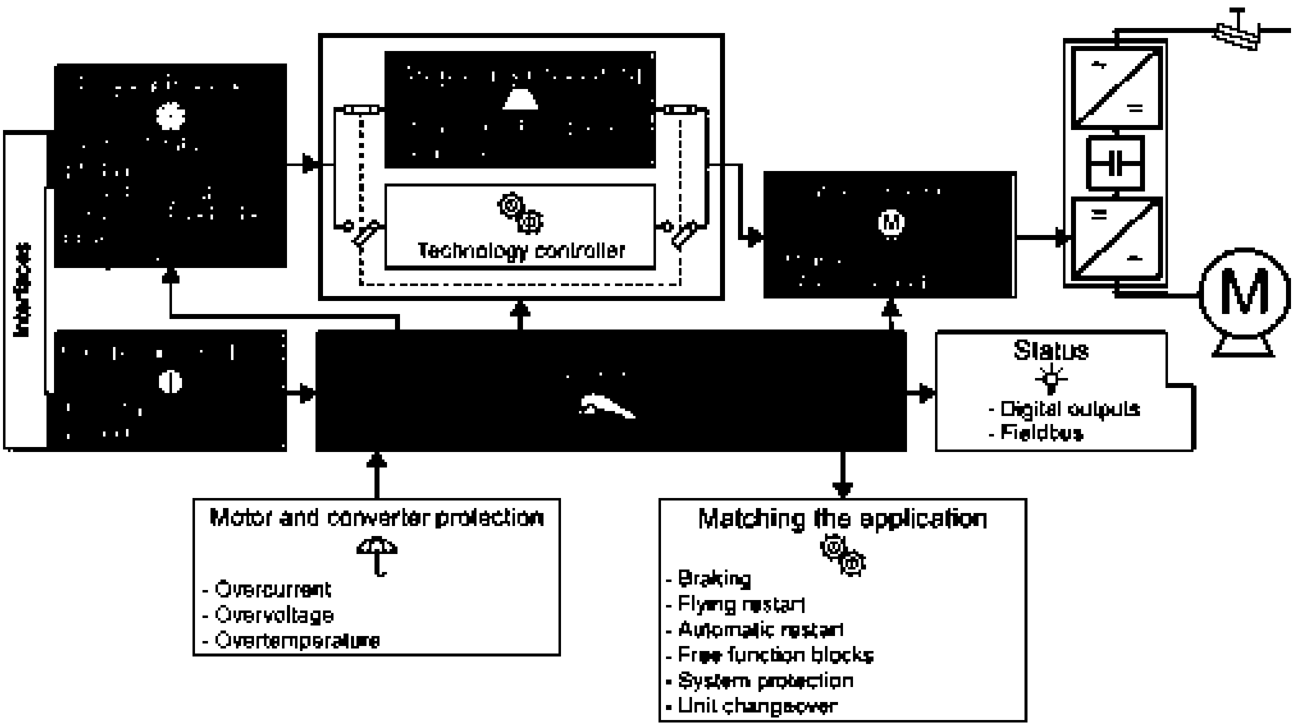
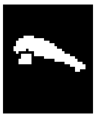


Figure 9-1 Overview of converter functions

Functions relevant to all applications	Functions required in special applications only
The functions that your require in each application are shown in the dark colours in the function overview above. You set these function during basic commissioning, so that in many cases, the motor can be operated without having to make any additional settings.	The functions whose parameter you only need to adapt when they are actually required are shown in white in the function overview above.
Converter control is responsible for all of the other converter functions. Among other things, it defines how the converter responds to external control signals. Inverter control (Page 171)	The **protection functions** avoid overloads and operating states that could cause damage to the motor, converter and driven load. The motor temperature monitoring, for example, is set here. Protection functions (Page 199)
The **command source** defines where the control signals are received from to switch on the motor, for example, using digital inputs or a fieldbus. Command sources (Page 177)	The functions **matching the application** allow you to control a motor holding brake or implement a higher-level pressure or temperature control using the technology controller. Application-specific functions (Page 205)
The **status messages** provide digital and analog signals at the Control Module outputs or using the fieldbus. Examples include the current speed of the motor or fault messages issued by the converter. Status messages (Page 204)	
The **setpoint source** defines how the speed setpoint for the motor is specified, for example, using an analog input or a fieldbus source. Setpoint sources (Page 177)	
The **setpoint calculation** uses a ramp-function generator to prevent speed steps occurring and to limit the speed to a permissible maximum value. Setpoint calculation (Page 184)	
The **motor closed-loop control** ensures that the motor follows the speed setpoint. Motor control (Page 189)	

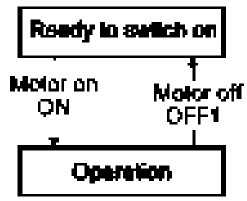
9.2 Inverter control

9.2.1 Switching the motor on and off



After switching on the supply voltage, the inverter normally goes into the "Ready to switch on" state. In this state, the inverter waits for the command to switch-on the motor:

- The inverter switches on the motor with the ON command. The inverter changes to the "Operation" state.
- The inverter brakes the motor after the OFF1 command. The inverter switches off the motor once standstill has been reached. The inverter is again "ready to start".



Inverter states and commands for switching the motor on and off

In addition to the OFF1 command, there are other commands that are used to switch off the motor:

- OFF2 - the inverter immediately switches off the motor without first braking it.
- OFF3 - this command means "quick stop". After OFF3, the inverter brakes the motor with the OFF3 ramp-down time. After reaching standstill, the inverter switches off the motor. The command is frequently used for exceptional operating situations where it is necessary to brake the motor especially quickly. Collision protection is a typical application for this function.

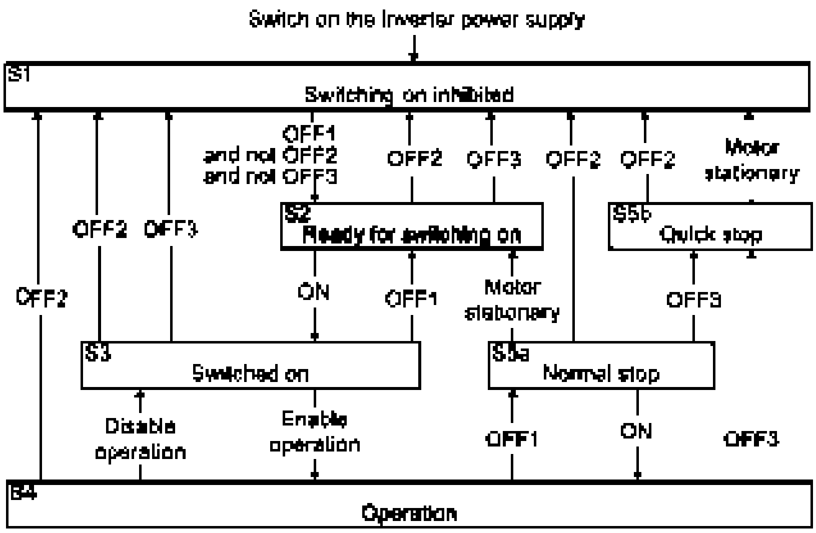


Figure 9-2 Internal sequence control of the inverter when the motor is switched on and off

The abbreviations S1 … S5b to identify the inverter states are defined in the PROFIdrive profile.

Inverter status	Explanation
S1	In this state, the inverter does not respond to the ON command. The inverter goes into this state under the following conditions: • ON was active when switching on the inverter. Exception: When the automatic start function is active, ON must be active after switching on the power supply. • OFF2 or OFF3 is selected.
S2	This state is required to switch on the motor.
S3	The inverter waits for the operating enable. If the inverter is controlled via a fieldbus, then you must set the operating enable in a control word bit. If the inverter is exclusively controlled via its digital inputs, then the operating enable signal is automatically set in the factory setting.
S4	The motor is switched on.
S5a	The motor was switched off with OFF1 and brakes with the ramp-down time of the ramp-function generator.
S5b	The motor was switched off with OFF3 and brakes with the OFF3 ramp-down time.

9.2.2 Running the motor in jog mode (JOG function)

The "Jog" function is typically used to slowly move a machine part, e.g. a conveyor belt.

With the "Jog" function, you switch the motor on and off using a digital input. When the motor is switched on, it accelerates to the jogging setpoint. There are two different setpoints available, e.g. for motor counter-clockwise rotation and clockwise rotation.

The same ramp-function generator acts on the setpoint as for the ON/OFF1 command.

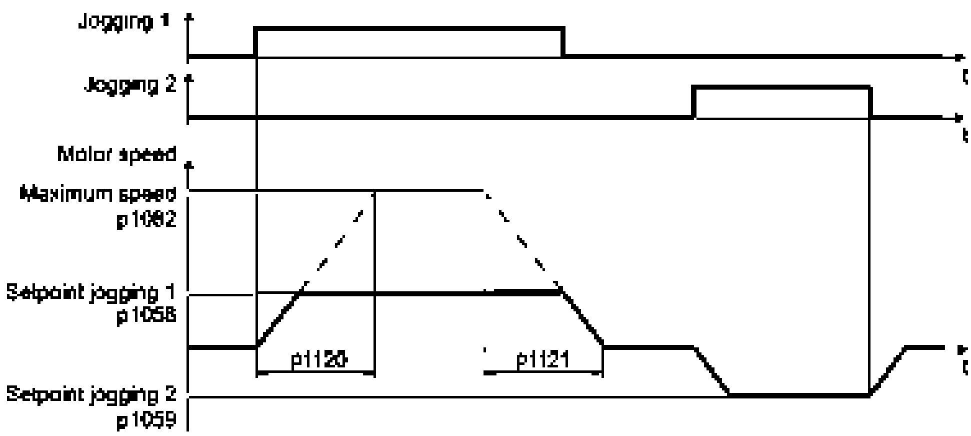
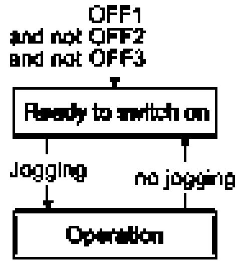


Figure 9-3 Behavior of the motor when "jogging"

The inverter must be ready to start before you issue the "Jog" control command. If the motor is already switched on, then the "Jog" command has no effect.



9.2.3 Switching over the converter control (command data set)

In several applications, the converter must be able to be operated from different, higher-level control systems.

Example: Switchover from automatic to manual operation

You control the motor either from a central control system, using fieldbus or from a local control panel.

Command data set (CDS)

This means that you can set the converter control in various ways and toggle between the settings. For instance, as described above, the converter can either be operated using a fieldbus or using the digital inputs.

The settings in the converter, which are associated with a certain control type of the converter, are called command data set.

Example:

Command data set 0: Controlling the converter using the fieldbus
Command data set 1: Controlling the converter using the digital inputs

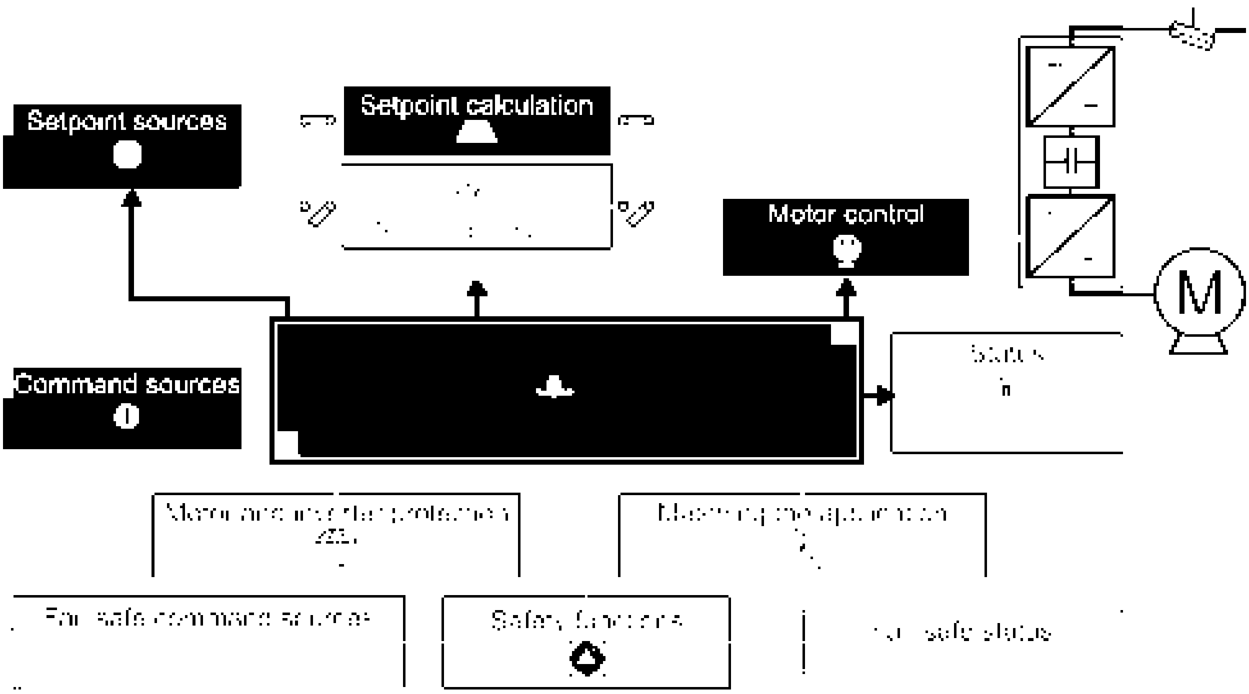


Figure 9-4 Command data sets (CDS): Different setting of the inverter control

You select the command data set using parameter p0810. To do this, you must interconnect parameter p0810 with a control command of your choice, e.g. a digital input.

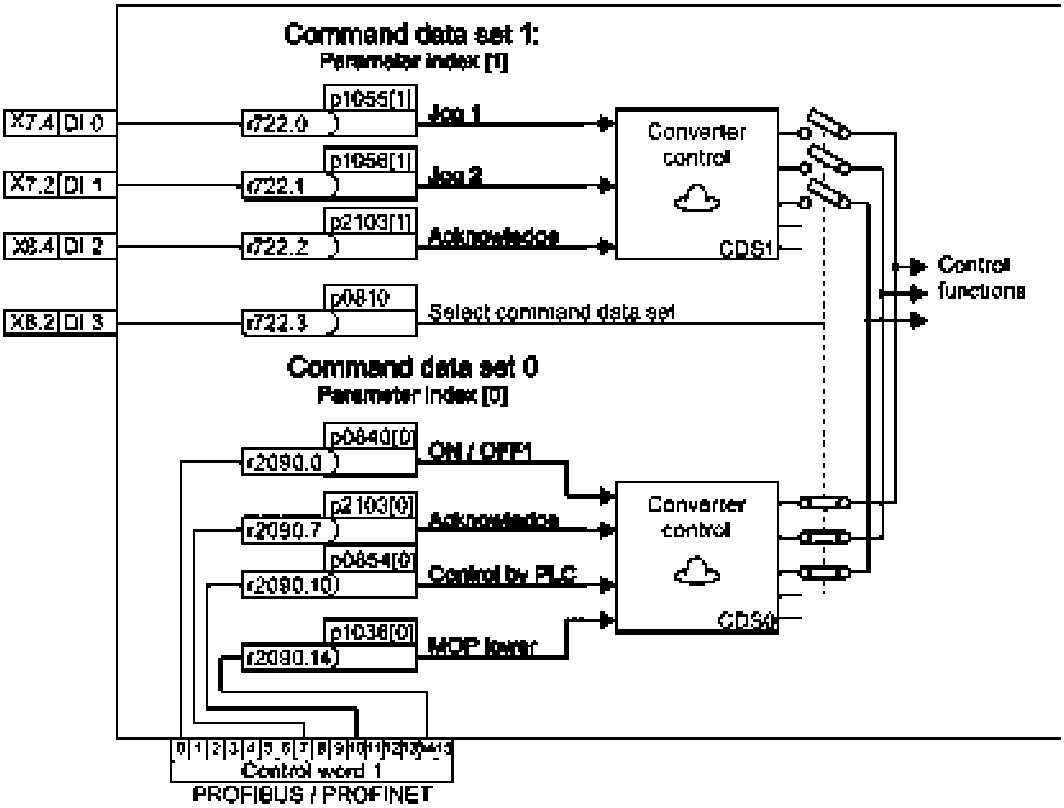


Figure 9-5 Example for the various command data sets

You obtain the interconnection as in the example above, if you configured the interfaces of the inverter with p0015 = 7 in the basic commissioning, also see Section Basic commissioning (Page 79).

An overview of all the parameters that belong to the command data sets is provided in the List Manual.

Note

The converter requires approx. 4 ms to switch over the command data set.

Advanced settings

To change the number of command data sets in STARTER, you must open your STARTER project offline.

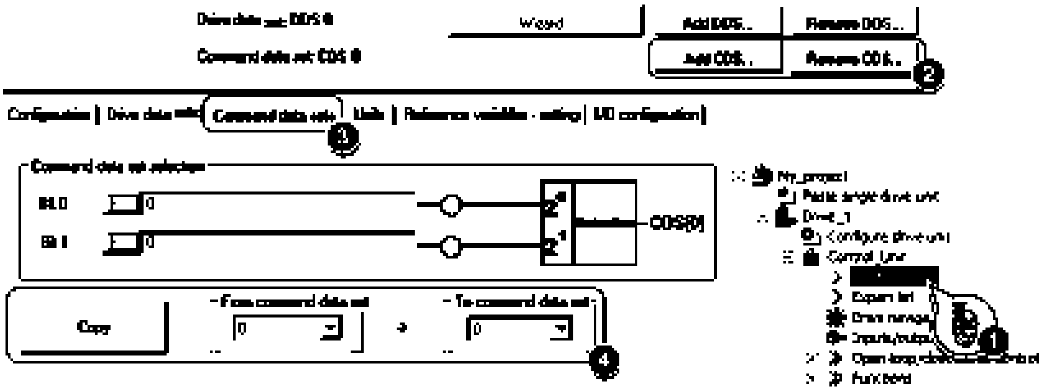


Figure 9-6 Editing command data sets in STARTER

① You can edit command data sets if, in the STARTER project tree, you select "Configuration".

② If you require more than two command data sets, then add command data sets using this button or remove them.

③, ④ To simplify commissioning several command data sets, under the "Command data sets" tab there is a copy function.

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0170	**Number of command data sets** (factory setting: 2) p0170 = 2, 3 or 4
p0010 = 0	**Drive commissioning:** Ready
r0050	**Displaying the number of the CDS that is currently active**
p0809[0]	**Number of the command data set to be copied (source)**
p0809[1]	**Number of the command data set to which the data is to be copied (target)**
p0809[2] = 1	**Copying is started** Once copying has been completed, the inverter sets p0809[2] to 0.
p0810	**Command data set selection CDS bit 0**
p0811	**Command data set selection CDS bit 1**
r0050	**Displaying the number of the CDS that is currently active**

9.3 Command sources

The command source is the interface via which the inverter receives its control commands. You define the assignment of the inverter interfaces when carrying out the basic commissioning.

Change command source

You have two options to change the command sources:

1. Carry out the basic commissioning again and select a different assignment of the inverter interfaces.
2. Adapt the function of individual digital inputs or change the fieldbus interface.

9.4 Setpoint sources

The inverter receives its main setpoint from the setpoint source. The main setpoint generally specifies the motor speed.

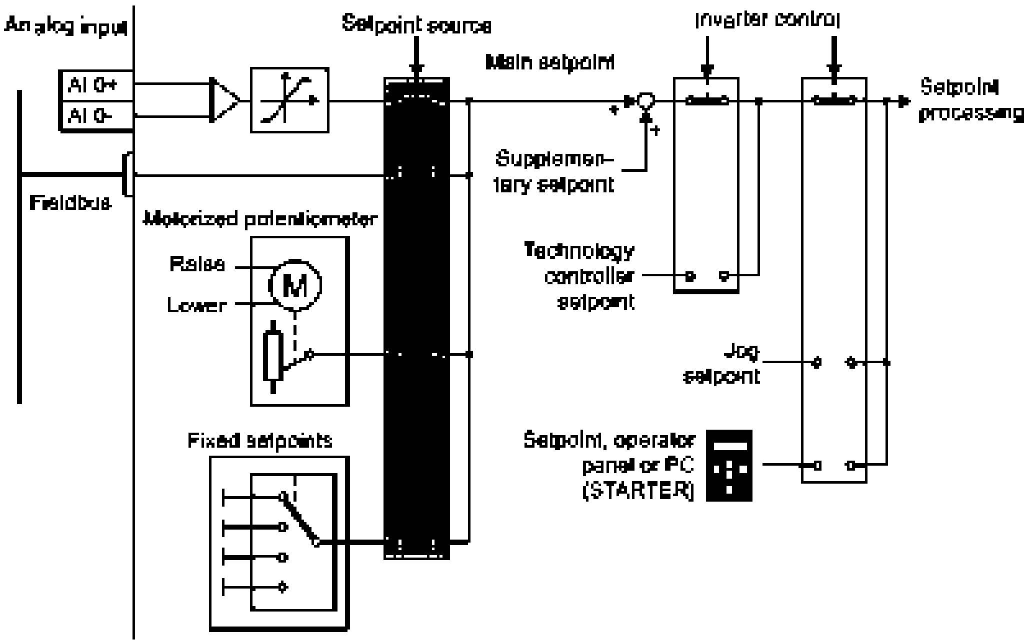


Figure 9-7 Setpoint sources for the inverter

You have the following options when selecting the source of the main setpoint:

- Inverter analog input.
- Inverter fieldbus interface.
- Motorized potentiometer simulated in the inverter.
- Fixed setpoints saved in the inverter.

You have the same selection options when selecting the source of the supplementary setpoint.

Under the following conditions, the inverter switches from the main setpoint to other setpoints:

- When the technology controller is active and appropriately interconnected, its output specifies the motor speed.
- When jogging is active.
- When controlling from an operator panel or the STARTER PC tool.

9.4.1 Analog input as setpoint source

Interconnecting an analog input

If you have selected a pre-assignment without a function of the analog input, then you must interconnect the parameter of the main setpoint with an analog input.

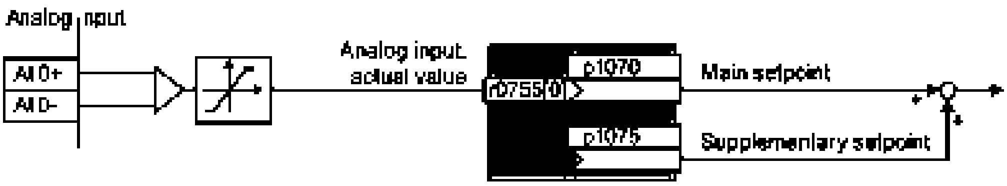


Figure 9-8 Example: Analog input 0 as setpoint source

Table 9- 1 Setting with analog input 0 as setpoint source

Parameter	Remark
p1070 = 755[0]	**Main setpoint** Interconnect the main setpoint with analog input 0
p1075 = 755[0]	**Additional setpoint** Interconnect the additional setpoint with analog input 0

You must adapt the analog input to the connected signal, e.g. ± 10 V or 4 … 20 mA.

9.4.2 Specifying the motor speed via the fieldbus

If you enter the setpoint via a fieldbus, you must connect the converter to a higher-level control.

Interconnecting the fieldbus with the main setpoint

Figure 9-9 Fieldbus as setpoint source

Most standard telegrams receive the speed setpoint as a second process data PZD2.

Table 9- 2 Setting the fieldbus as setpoint source

Parameter	Remark
p1070 = 2050[1]	**Main setpoint** Interconnect the main setpoint with process data PZD2 from the fieldbus.
p1075 = 2050[1]	**Additional setpoint** Interconnect the additional setpoint with process data PZD2 from the fieldbus.

9.4.3 Electromechanical potentiometer

The SINAMICS PM240M power module has a permanently hardwired electromechanical potentiometer.

The potentiometer is permanently active and is, by default the main setpoint source.

When the main setpoint source is set to fieldbus, for example when using PROFIBUS or PROFINET communications, the potentiometer is disabled.

The default setting for the electromechanical potentiometer is Unipolar voltage input (0 V ... +3 V).

Note

Parameters related to parameter p0756 modification

When changing p0756 , the parameters of the scaling characteristic (p0757, p0758, p0759, p0760) are overwritten with the following default values:
For p0756 = 0, 1, 4, p0757 is set to 0.0 V, p0758 = 0.0 %, p0759 = 10.0 V and p0760 = 100.0 %.
For p0756 = 2, p0757 is set to 0.0 mA, p0758 = 0.0 %, p0759 = 20.0 mA and p0760 = 100.0 %.
For p0756 = 3, p0757 is set to 4.0 mA, p0758 = 0.0 %, p0759 = 20.0 mA and p0760 = 100.0 %.

9.4.4 Motorized potentiometer as setpoint source

The "Motorized potentiometer" function emulates an electromechanical potentiometer. The output value of the motorized potentiometer can be continually set using the "up" and "down" control signals.

Interconnecting the motorized potentiometer (MOP) with the setpoint source

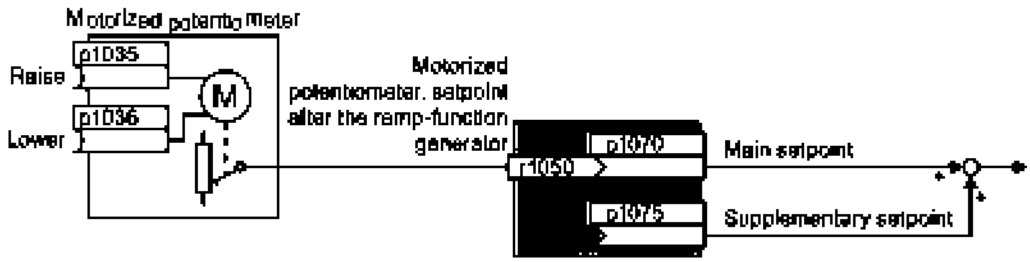


Figure 9-10 Motorized potentiometer as setpoint source

Table 9- 3 Basic setup of motorized potentiometer

Parameter	Description
p1047	**MOP ramp-up time** (factory setting 10 s)
p1048	**MOP ramp-down time** (factory setting 10 s)
p1040	**MOP start value** (factory setting 0 rpm) Defines the start value [rpm], which is effective when first switching on the motor.

Table 9- 4 Setting the MOP as setpoint source

Parameter	Remark
p1070 = 1050	**Main setpoint** Interconnecting the main setpoint with MOP.
p1035	**Motorized potentiometer, increase setpoint** Interconnect this signal, for example with a digital input of your choice: p1035 = 722.1 (digital input 1)
p1036	**Motorized potentiometer, decrease setpoint** Interconnect this signal, for example with a digital input of your choice.

Adapting the behavior of the motorized potentiometer

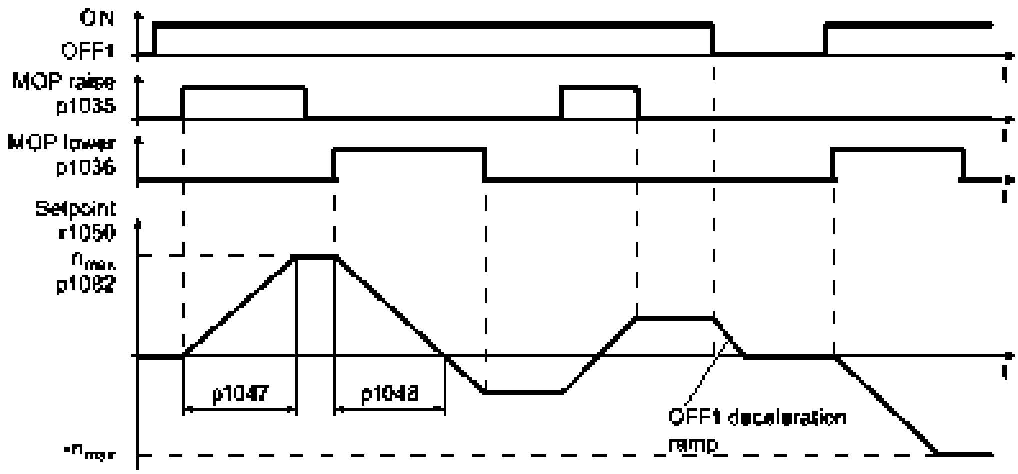


Figure 9-11 Function chart of motorized potentiometer

Table 9- 5 Extended setup of motorized potentiometer

Parameter	Description
p1030	**MOP configuration** (factory setting 00110 bin) **Parameter value with five independently adjustable bits 00 … 04** **Bit 00:** Save setpoint after switching off motor 0: After the motor is switched on, p1040 is specified as the setpoint 1: Setpoint is saved after the motor is switched off and set to the saved value once it is switched on **Bit 01:** Configure ramp-function generator in automatic mode (1-signal via BI: p1041) 0: Without ramp-function generator in the automatic mode (ramp-up/ramp-down time = 0) 1: With ramp-function generator in the automatic mode In manual mode (0-signal via BI: p1041) the ramp-function generator is always active **Bit 02:** Configure initial rounding 0: Without initial rounding 1: With initial rounding. Using the initial rounding function it is possible to enter very small setpoint changes **Bit 03:** Store setpoint in power-independent manner 0: No power-independent saving 1: Setpoint is saved in the event of a power failure (bit 00 = 1) **Bit 04:** Ramp-function generator always active 0: Setpoint is only calculated with enabled pulses 1: The setpoint is calculated independent of the pulse enable.
p1037	**MOP maximum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1038	**MOP minimum speed** (factory setting 0 rpm) Automatically pre-assigned when commissioning
p1043	**Motorized potentiometer, accept setting value** (factory setting 0) Signal source for accepting the setting value
p1044	**MOP setting value** (factory setting 0) Signal source for the setting value.

For more information about the motorized potentiometer, refer to function diagram 3020 in the List Manual.

9.4.5 Fixed speed as setpoint source

In many applications after switching on the motor, all that is needed is to run the motor at a constant speed or to switch between different speeds.

Example: After it has been switched on, a conveyor belt only runs with two different velocities.

Interconnecting the fixed speeds with a main setpoint

Figure 9-12 Fixed speeds as setpoint source

Table 9- 6 Setting the fixed speed as a setpoint source

Parameter	Remark
p1070 = 1024	**Main setpoint** Interconnecting the main setpoint with fixed speeds.
p1075 = 1024	**Additional setpoint** Interconnecting the additional setpoint with fixed speeds

Select direct or binary fixed setpoint

The inverter has up to 16 different fixed setpoints. The superior controller selects the appropriate fixed setpoints via digital inputs or the fieldbus.

The inverter distinguishes between two methods for selecting the fixed setpoints:

1. Direct selection:
   You set four different fixed setpoints. By adding one or more of the four fixed setpoints, up to 16 different resulting setpoints are obtained.
   Direct selection is the most suitable method for controlling the inverter via the digital inputs.

   Additional information about direct selection can be found in function diagram 3011 in the List Manual.
2. Binary selection:
   You set 16 different fixed setpoints. You precisely select one of these fixed setpoints by a combination of four selection bits.
   The binary selection is the suitable method of controlling the inverter via a fieldbus.
   Additional information about binary selection can be found in function diagram 3010 of the List Manual.

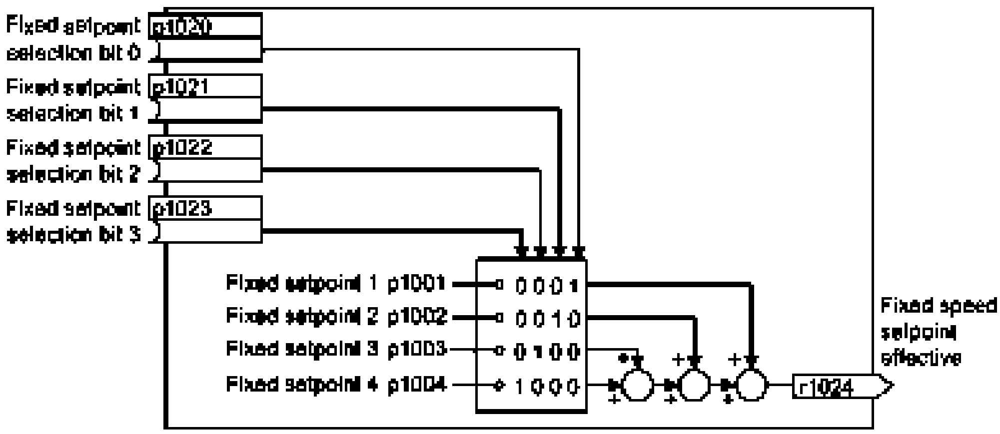


Figure 9-13 Simplified function diagram for directly selecting fixed setpoints

Example: Select two fixed setpoints directly

The motor should operate at different speeds as follows:

- The signal on digital input 0 switches the motor on and accelerates it to 300 rpm.
- The signal at digital input 1 accelerates the motor to 2000 rpm.
- The signals at the two digital inputs accelerate the motor to 2300 rpm.

Table 9- 7 Settings for the example

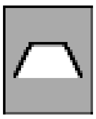
Parameter	Description
p1001 = 300.000	**Fixed speed setpoint 1** [rpm]
p1002 = 2000.000	**Fixed speed setpoint 2** [rpm]
p0840 = 722.0	**ON/OFF1:** Switch on motor with digital input 0
p1070 = 1024	**Main setpoint:** Interconnect the main setpoint with the fixed speed setpoint.
p1020 = 722.0	**Fixed speed setpoint selection bit 0:** Interconnect fixed setpoint 1 with digital input 0 (DI 0).
p1021 = 722.1	**Fixed speed setpoint selection bit 1:** Interconnect fixed setpoint 2 with DI 1.
p1016 = 1	**Fixed speed setpoint mode:** Select direct selection of the fixed setpoints.

Table 9- 8 Resulting fixed setpoints for the example above

Fixed setpoint selected by	Resulting setpoint
DI 0 = LOW	Motor stops
DI 0 = HIGH and DI 1 = LOW	300 rpm
DI 0 = HIGH and DI 1 = HIGH	2300 rpm

9.5 Setpoint calculation

9.5.1 Overview of setpoint processing



The setpoint can be modified as follows using the setpoint processing:

- Invert setpoint to reverse the motor direction of rotation (reversing).
- Inhibit positive or negative direction of rotation, e.g. for conveyor belts, pumps or fans.
- Minimum speed to avoid standstill when the motor is switched on.
- Limit to a maximum speed to protect the motor and mechanical system.
- Ramp-function generator to accelerate and brake the motor with an optimum torque.

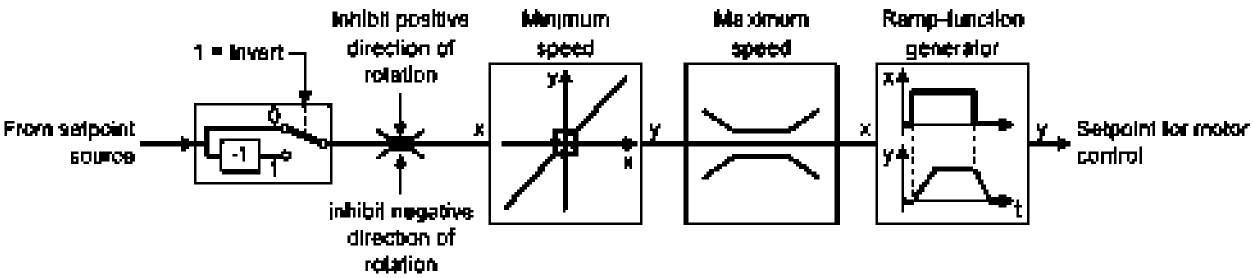


Figure 9-14 Setpoint processing in the inverter

9.5.2 Invert setpoint

Procedure

Interconnect parameter p1113 with a binary signal, e.g. digital input 1.

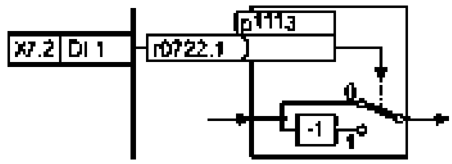


Table 9- 9 Examples of settings to invert the setpoint

Parameter	Remark
p1113 = 722.1	**Setpoint inversion** Digital input 1 = 0: Setpoint remains unchanged. Digital input 1 = 1: Converter inverts the setpoint.
p1113 = 2090.11	Invert setpoint via control word 1, bit 11.

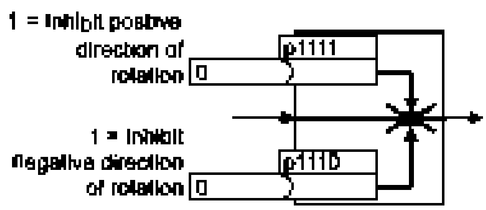
9.5.3 Inhibit direction of rotation

In the factory setting of the inverter, both motor directions of rotation are enabled.

Procedure

Proceed as follows to permanently lock a direction of rotation:

Set the corresponding parameter to a value = 1.



You have permanently locked the appropriate direction of rotation.

Table 9- 10 Examples of settings to inhibit the direction of rotation

Parameter	Remark
p1110 = 1	**Inhibit negative direction** Negative direction is permanently inhibited.
p1110 = 722.3	**Inhibit negative direction** Digital input 3 = 0: Negative direction of rotation is enabled. Digital input 3 = 1: Negative direction of rotation is inhibited.

9.5.4 Minimum speed

The inverter prevents continuous motor operation at speeds < minimum speed.

Speeds, where the absolute value is less than the minimum speed, are only possible when accelerating or braking.

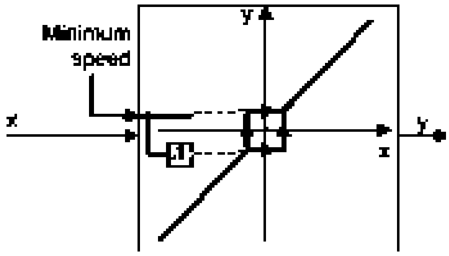


Table 9- 11 Setting the minimum speed

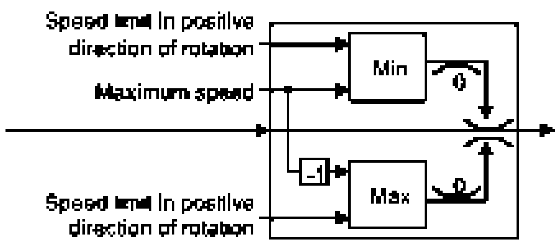
Parameter	Description
p1080	Minimum speed

NOTICE
Material damage caused by motor rotating in the incorrect direction
If you are using an analog input as speed setpoint source, then for a setpoint = 0 V, noise voltages can be superimposed on the analog input signal. After the on command, the motor accelerates up to the minimum frequency in the direction of the random polarity of the noise voltage. A motor rotating in the wrong direction can cause significant material damage to the machine or system.
• Inhibit the motor direction of rotation that is not permissible.

9.5.5 Maximum speed

The maximum speed limits the speed setpoint range for both directions of rotation.

The inverter generates a message (fault or alarm) when the maximum speed is exceeded.



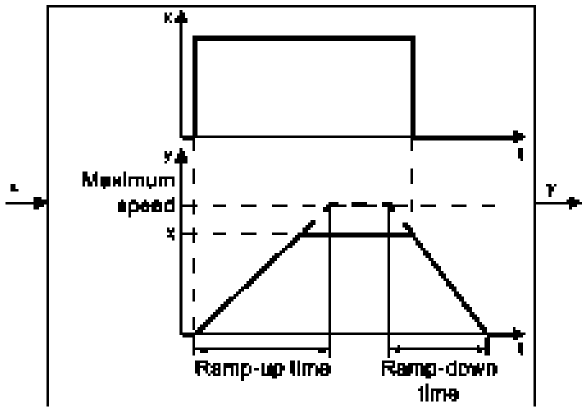
If you must limit the speed depending on the direction of rotation, then you can define speed limits for each direction.

Table 9- 12 Parameters for minimum and maximum speed

Parameter	Description
p1082	**Maximum speed** (factory setting: 1500 rpm)
p1083	**Speed limit, positive direction of rotation** (factory setting: 210,000 rpm)
p1086	**Speed limit, negative direction of rotation** (factory setting: -210,000 rpm)

Basic ramp-function generator

When compared to the extended ramp-function generator, the basic ramp-function generator has no rounding times.



Changing the ramp-up and ramp-down times in operation

Using a scaling factor, the ramp-up and ramp-down times of the ramp-function generator can be changed in operation. You have the following options of entering a scaling value:

- Using an analog input
- Using a fieldbus

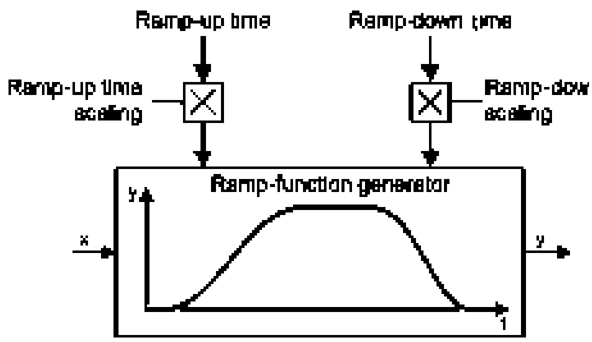


Table 9- 13 Parameters for setting the scaling

Parameter	Description
p1138	**Up ramp scaling** (factory setting: 1) Signal source for scaling the up ramp.
p1139	**Down ramp scaling** (factory setting: 1) Signal source for scaling the down ramp.

Example

In the following example, the higher-level control sets the ramp-up and ramp-down times of the inverter via PROFIBUS.

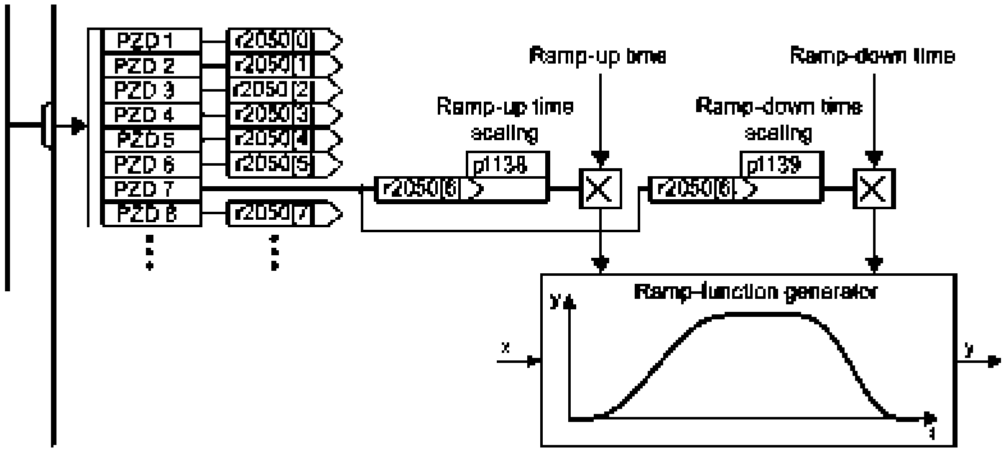


Figure 9-15 Example for changing the ramp-function generator times in operation

Preconditions

- You have commissioned the communication between the inverter and the control system.
- Free telegram 999 has been set in the inverter and in your higher-level control system. See also Section: Extend telegrams and change signal interconnection (Page 154).
- The controller sends the scaling value to the inverter in PZD 7.

Procedure

To interconnect the scaling of the ramp-up and ramp-down times with PZD receive word 7 from the fieldbus in the inverter, proceed as follows:

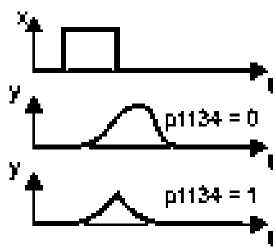
1. Set p1138 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-up time with PZD receive word 7.
2. Set p1139 = 2050[6].

   This means that you have interconnected the scaling factor for the ramp-down time with PZD receive word 7.

The inverter receives the value for scaling the ramp-up and ramp-down times via PZD receive word 7.

Table 9- 14 Additional parameters to set the extended ramp-function generator

Parameter	Description
p1115	**Ramp-function generator selection** (factory setting: 1) Select ramp-function generator: 0: Basic ramp-function generator 1: Extended ramp-function generator
p1120	**Ramp-function generator, ramp-up time** (factory setting: 10 s) Accelerating time in seconds from zero speed up to the maximum speed p1082
p1121	**Ramp-function generator, ramp-down time** (factory setting: 10 s) Braking time in seconds from the maximum speed down to standstill
p1130	**Ramp-function generator initial rounding time** (factory setting: 0 s) Initial rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1131	**Ramp-function generator final rounding time** (factory setting: 0 s) Final rounding for the extended ramp-function generator. The value applies for ramp up and ramp down.
p1134	**Ramp-function rounding type** (factory setting: 0) 0: Continuous smoothing 1: Discontinuous smoothing 
p1135	**OFF3 ramp-down time** (factory setting 0 s) The quick stop (OFF3) has its own ramp-down time.
p1136	**OFF3 initial rounding time** (factory setting: 0 s) Initial rounding for OFF3 for the extended ramp-function generator.
p1137	**OFF3 final rounding time** (factory setting: 0 s) Final rounding for OFF3 for the extended ramp-function generator.

You can find more information in function diagram 3070 and in the parameter list of the List Manual.

9.6 Motor control

Decision-making criteria for the control mode that is suitable for your application is provided in Section Selecting U/f characteristic.

9.6.1 V/f control

U/f control sets the voltage at the motor terminals on the basis of the specified speed setpoint.

The relationship between the speed setpoint and stator voltage is calculated using characteristic curves. The required output frequency is calculated on the basis of the speed setpoint and the number of pole pairs of the motor (f = n * number of pole pairs / 60, in particular: f_{max} = p1082 * number of pole pairs / 60).

The inverter provides the two most important characteristics (linear and square-law). User-defined characteristic curves are also supported.

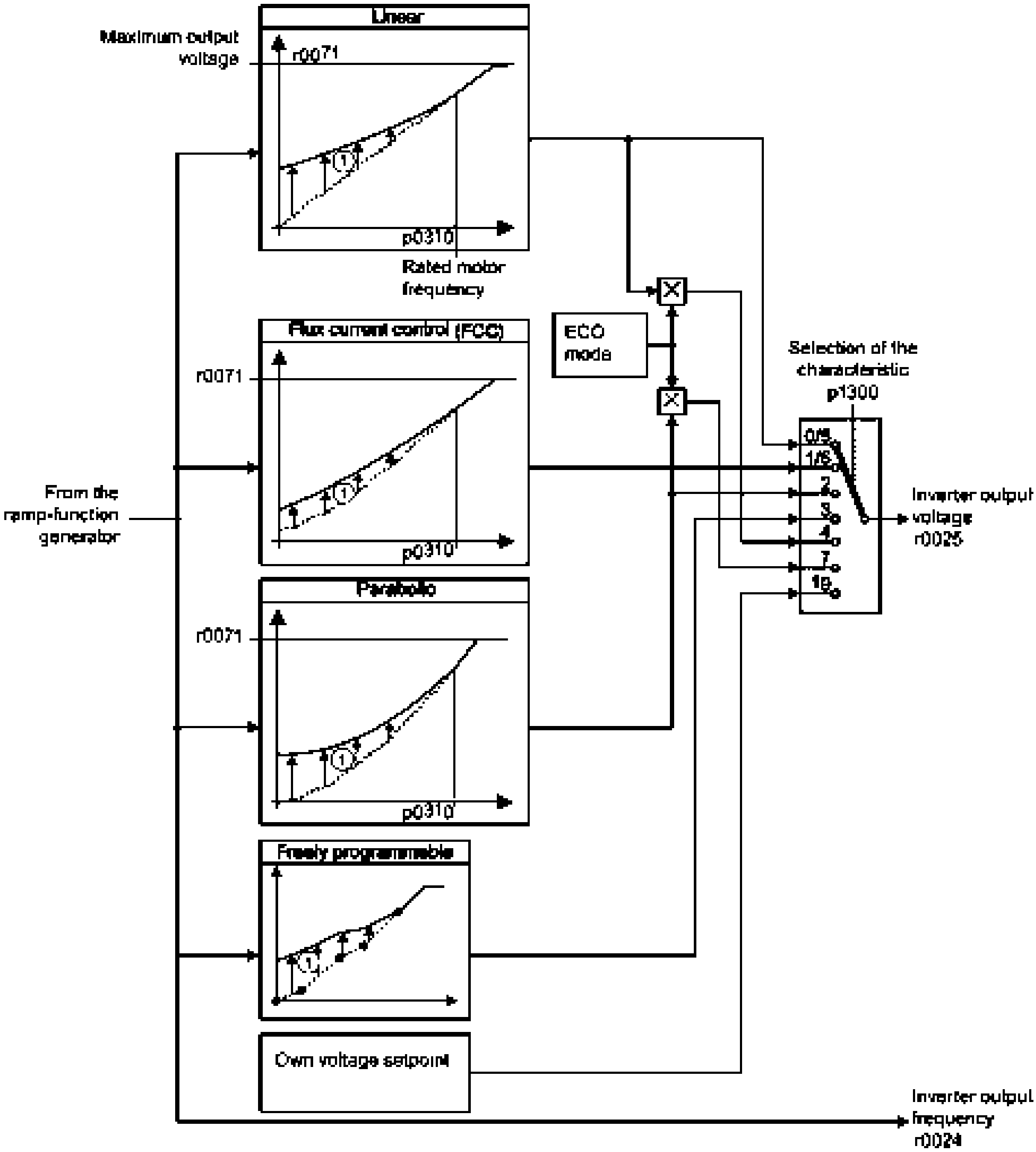
U/f control is not a high-precision method of controling the speed of the motor. The speed setpoint and the speed of the motor shaft are always slightly different. The deviation depends on the motor load.

If the connected motor is loaded with the rated torque, the motor speed is below the speed setpoint by the amount of the rated motor slip. If the load is driving the motor (i.e. the motor is operating as a generator), the motor speed is above the speed setpoint.

Parameter p1300 sets the characteristic curve.

9.6.1.1 Characteristics of U/f control

The inverter has several U/f characteristics. Based on the characteristic, as the frequency increases, the inverter increases the voltage at the motor.



① The voltage boost of the characteristic improves motor behavior at low speeds. The voltage boost is effective for frequencies < rated frequency

Figure 9-16 U/f characteristics of the inverter

The inverter increases its output voltage – also above the motor rated speed up to the maximum output voltage. The higher the line voltage, the greater the maximum inverter output voltage.

If the inverter has reached its maximum output voltage, then it can only increase its output frequency. From this point onwards, the motor is operated in field weakening; this means that the available torque linearly decreases with increasing speed.

The value of the motor voltage at the rated motor frequency also depends on the following variables:

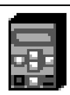
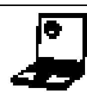
- Ratio between the inverter size and the motor size
- Line voltage
- Line impedance
- Actual motor torque

The maximum possible motor voltage as a function of the input voltage is provided in the technical data, also see Section Technical data (Page 275).

9.6.1.2 Selecting the U/f characteristic

Procedure

Proceed as follows to select a U/f characteristic:

	
1. Go into the menu "PARAMS". 2. As parameter filter, select "EXPERT". 3. Set p1300 to the appropriate value.	1. Go online. 2. Select the U/f characteristic curve in one of the screen forms "speed controller" or "U/f control".

You have selected a U/f characteristic.

Table 9- 15 Linear and parabolic characteristics

Requirement	Application examples	Remark	Characteristic	Parameter
The required torque is independent of the speed	Conveyor belts, roller conveyors, chain conveyors, eccentric worm pumps, compressors, extruders, centrifuges, agitators, mixers	-	Linear	p1300 = 0
		The inverter equalizes the voltage drops across the stator resistance. Recommended for motors less than 7.5 kW. Precondition: You have set the motor data according to the rating plate and have performed the motor identification after the basic commissioning.	Linear with Flux Current Control (FCC)	p1300 = 1
The required torque increases with the speed	Centrifugal pumps, radial fans, axial fans	Lower losses in the motor and inverter than for a linear characteristic.	Parabolic	p1300 = 2

Table 9- 16 Characteristics for special applications

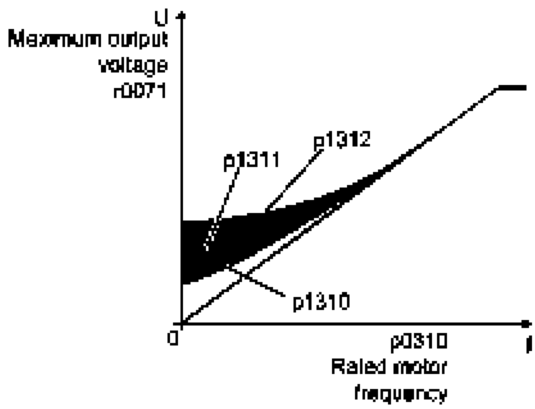
Requirement	Application examples	Remark	Characteristic	Parameter
Applications with a low dynamic response and constant speed	Centrifugal pumps, radial fans, axial fans	The ECO mode results in additional energy saving when compared to the parabolic characteristic. If the speed setpoint is reached and remains unchanged for 5 seconds, the inverter again reduces its output voltage.	ECO mode	p1300 = 4 or p1300 = 7
The inverter must keep the motor speed constant under all circumstances.	Drives in the textile sector	When the maximum current limit is reached, the inverter only reduces the stator voltage but not the speed.	Precise frequency characteristic	p1300 = 5 or p1300 = 6
Freely adjustable U/f characteristic	Operating the inverter with a synchronous motor	-	Adjustable characteristic	p1300 = 3
U/f characteristic with independent voltage setpoint	-	The interrelationship between the frequency and voltage is not calculated in the inverter, but is specified by the user.	Independent voltage setpoint	p1300 = 19

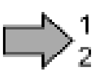
Additional information on U/f characteristics can be found in the parameter list and in the function diagrams 6300 ff of the List Manual.

9.6.1.3 Optimizing with a high break loose torque and brief overload

Setting the voltage boost for U/f control

The voltage boost acts on every U/f characteristic. The adjacent diagram shows the voltage boost using a linear characteristic as example.





Procedure

Proceed as follows to set the voltage boost:

Only increase the voltage boost in small steps. Excessively high values in p1310 ... p1312 can cause the motor to overheat and switch off (trip) the inverter due to overcurrent.

1. Power-up the motor with an average speed.
2. Reduce the speed to just a few revolutions per minute.

3. Check whether the motor rotates smoothly.
4. If the motor does not rotate smoothly, or even remains stationary, increase the voltage boost p1310 until you are satisfied with the motor behavior.
5. Accelerate the motor to the maximum speed with maximum load and check as to whether the motor follows the setpoint.
6. If, when accelerating, the motor stalls, increase the voltage boost p1311 until the motor accelerates to the maximum speed without any problems.

To achieve satisfactory motor behavior, you must increase the parameter p1312 only in applications with a significant breakaway torque.

You will find more information about this function in the parameter list and in function diagram 6300 of the List Manual.

You have set the voltage boost.

Parameter	Description
p1310	**Permanent voltage boost** (factory setting 50%) Compensates voltage drops as a result of long motor cables and the ohmic losses in the motor.
p1311	**Voltage boost when accelerating** (factory setting 0%) Provides additional torque when the motor accelerates.
p1312	**Voltage boost when starting** (factory setting 0%) Provides additional torque, however, only when the motor accelerates for the first time after it has been switched on ("break loose torque").

9.6.2 Closed loop speed control

9.6.2.1 Characteristics of the closed loop speed control

Sensorless vector control

Using a motor model, the speed control calculates the load and the motor slip. As a result of this calculation, the inverter controls its output voltage and frequency so that the motor speed follows the setpoint, independent of the motor load.

Speed control is possible without directly measuring the motor speed and is therefore also called "sensorless vector control".

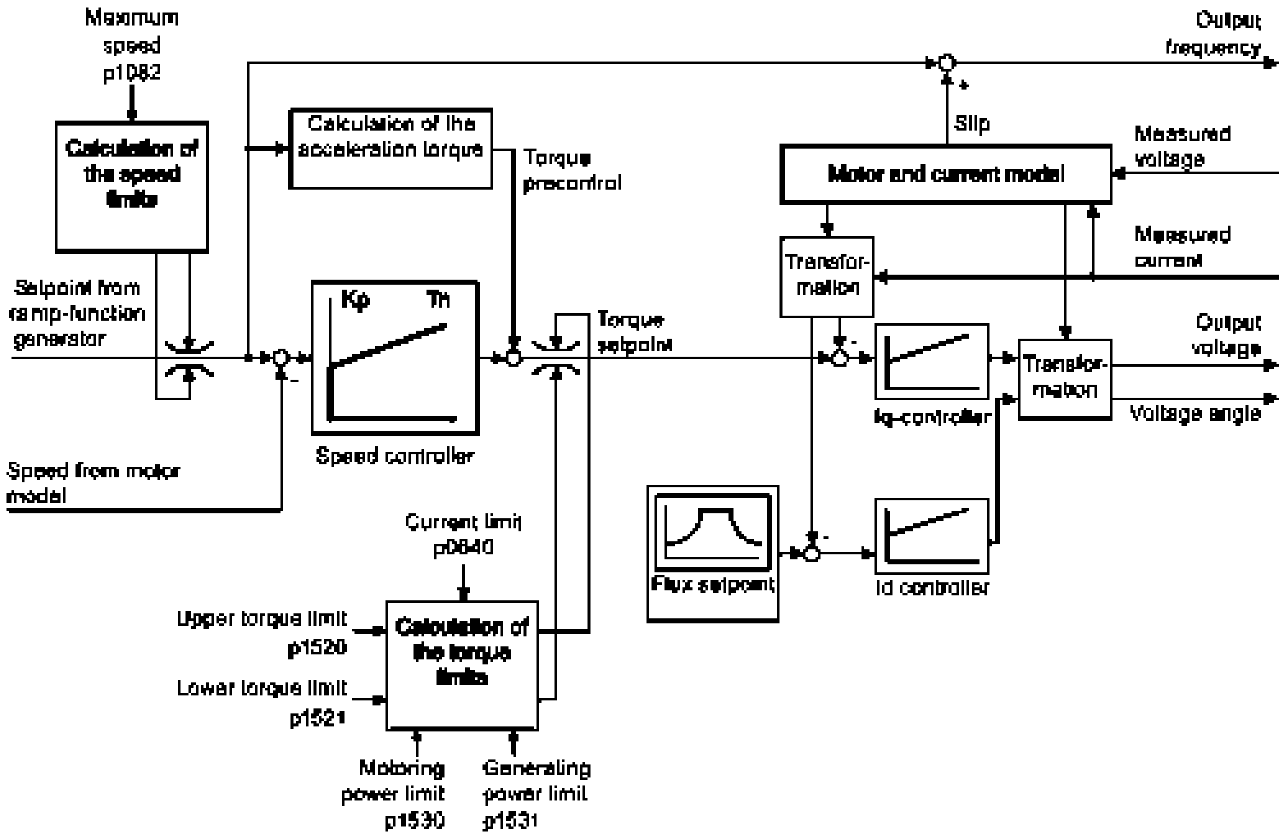


Figure 9-17 Simplified function diagram of sensorless vector control

You can find additional information on speed control in the function diagrams 6020 ff. of the List Manual.

9.6.2.2 Select motor control

Speed control is already preset

To achieve a good controller response, you must adapt the elements marked in gray in the figure in the overview diagram above. If you selected speed control as control mode in the basic commissioning, you will already have set the following:

- The maximum speed for your application.
- The motor and current model: If the motor data in the inverter correspond to the motor data on the rating plate, then the motor and current model in the inverter are correct and the vector control can operate satisfactorily.

- The inverter calculates the torque limits matching the current limit that you have set for the basic commissioning.
  Regardless of it, you can also set additional positive and negative torque limits or limit the power of the motor.
- The inverter has a preset speed controller with self-optimization (rotating measurement).
  If you want to continue to optimize this setting, follow the instructions further down in this chapter.

Select encoderless vector control

Procedure

Proceed as follows to select encoderless vector control:

1. In the "Parameters" menu, go to p1300 2. Set p1300 = 20.	1. Go online 2. Select speed control without encoder in the "Speed controller" or "U/f control" mask.

You have selected encoderless vector control.

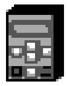
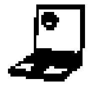
9.6.2.3 Re-optimize the speed controller

In the following cases you will need to manually optimize the speed controller:

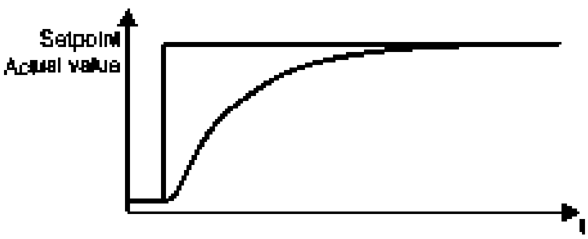
- Your application does not permit self-optimization because the motor cannot rotate freely.
- You are dissatisfied with the result of the inverter self-optimization.
- The inverter interrupted the self-optimization with a fault.

Procedure

To manually optimize the speed controller, proceed as follows:

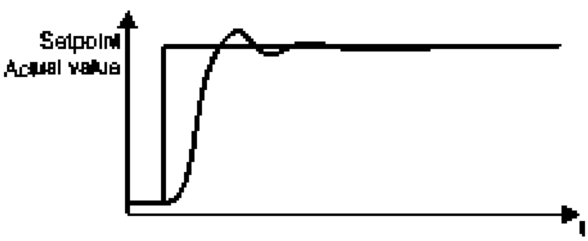
	
1. Set the ramp-up and ramp-down times of the ramp-function generator p1120 = 0 and p1121 = 0. 2. Set the pre-control of the speed controller p1496 = 0. 3. Enter a setpoint step and observe the associated actual value. 4. Optimize the speed controller by changing controller parameters K_P and T_N until the drive runs optimally (see the diagrams below). – K_P = p1470 – T_N = p1472 5. Set the ramp-up and ramp-down times of the ramp-function generator p1120 and p1121 back to their original value. 6. Set the pre-control of the speed controller p1496 = 100%.	1. Go online, and in the "Ramp-function generator" screen form, set the times = 0 . 2. Go online, and in the "Speed controller" screen form, set the pre-control = 0 . 3. Enter a setpoint step and monitor the associated actual value, e.g. using the trace function in STARTER. 4. Go online and optimize the controller in the "Speed controller" screen form by changing the controller parameters K_P and T_N until the drive runs optimally (refer to the diagrams below). 5. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value. 6. Set the pre-control of the speed controller back to 100%.

You have optimized the speed controller.



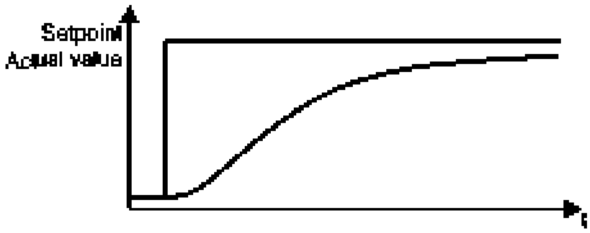
Optimum control response for applications that do not permit any overshoot.

The actual value approaches the setpoint, without any significant overshoot.



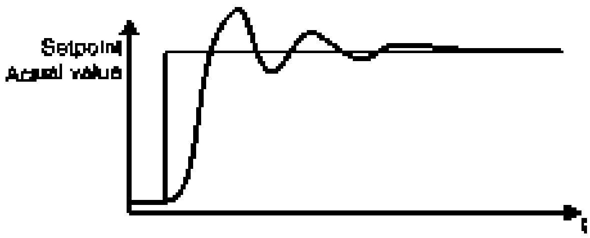
Optimum control response for fast correction and quick compensation of noise components.

The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).



The actual value only slowly approaches the setpoint.

- Increase the proportional component K_P and reduce the integration time T_N.



The actual value quickly approaches the setpoint, but overshoots too much

- Decrease the proportional component K_P and increase the integration time T_N.

9.6.2.4 Torque control

Torque control is part of the vector control and normally receives its setpoint from the speed controller output. By deactivating the speed controller and directly entering the torque setpoint, the closed-loop speed control becomes closed-loop torque control. The inverter then no longer controls the motor speed, but the torque that the motor generates.

Typical applications for torque control

The torque control is used in applications where the motor speed is specified by the connected driven load. Examples of such applications include:

- Load distribution between master and slave drives:
  The master drive is speed controlled, the slave drive is torque controlled.
- Winding machines

Commissioning the torque control

The torque control only functions error-free if, during the basic commissioning, you correctly set the motor data and performed the motor data identification with the motor in the cold state.

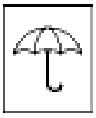
Table 9- 17 The most important torque control parameters

Parameter	Description
p1300	**Control mode:** 20: Vector control without speed encoder 22: Torque control without speed encoder
p0300 … p0360	**Motor data** is transferred from the rating plate during basic commissioning and calculated with the motor data identification
p1511	**Additional torque**

Parameter	Description
p1520	Upper torque limit
p1521	Lower torque limit
p1530	Motoring power limit
p1531	Regenerative power limit

Additional information about this function is provided in the parameter list and in function diagrams 6030 onwards in the List Manual.

9.7 Protection functions



The frequency inverter offers protective functions against overtemperature and overcurrent for both the frequency inverter as well as the motor. Further, the frequency inverter protects itself against an excessively high DC link voltage when the motor is regenerating.

9.7.1 Inverter temperature monitoring

The converter protects itself against overtemperature with different monitoring functions:

1. I^2t monitoring (alarm A07805, fault F30005)
   The I^2t monitoring measures the actual utilization on the basis of a current reference value. Parameter r0036 [%] displays the actual utilization as a percentage. As long as the actual current does not exceed the reference value, then the utilization in r0036 = 0.
2. Monitoring the chip temperature of the power unit (alarm A05006 - fault F30024)
   The converter monitors the difference in temperature between the power chip (IGBT) and the heat sink. The measured values are in r0037[1] [°C].
3. Heat sink monitoring (alarm A05000, fault F30004)
   The converter monitors the heat sink temperature of the Power Module. The values are in r0037[0] [°C].

Converter response

The converter temperature is essentially determined by the resistive losses of the output current and the switching losses which occur when pulsing the motor. Parameter p0290 defines how the converter responds to an excessively high temperature.

Parameter	Description
p0290	**Power unit overload response** (Default factory setting p0290 = 2) Setting the reaction to a thermal overload of the power unit: 0: Reduce output current (in vector control mode) or speed (in V/f mode) 1: No reduction, shutdown when overload threshold is reached (F30024) 2: Reduce pulse frequency and output current (in vector control mode) or pulse frequency and speed (in V/f mode) 3: Reduce pulse frequency
p0292	**Power unit temperature warning threshold** (factory setting Heat sink [0] 5° C, power semiconductor [1] 15° C) The value is set as a difference to the shutdown temperature.

9.7.2 Motor temperature monitoring using a temperature sensor

You can use one of the following sensors to protect the motor against overtemperature:

- Temperature switch (e. g. bi-metal switch)
- PTC sensor
- KTY 84 sensor

Connect the motor's temperature sensor through the motor output cable on the Power Module.

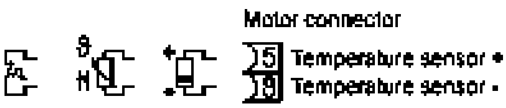


Figure 9-18 Connect the motor's temperature sensor to the Power Module

Temperature switch

The inverter interprets a resistance ≥ 100 Ω as being an opened temperature switch and responds according to the setting for p0610.

PTC sensor

The inverter interprets a resistance > 1650 Ω as being an overtemperature and responds according to the setting for p0610.

The inverter interprets a resistance < 20 Ω as being a short-circuit and responds with alarm A07015. If the alarm is present for longer than 100 milliseconds, the inverter shuts down with fault F07016.

KTY84 sensor

Use a KTY sensor to monitor the motor temperature and the sensor itself for wire-break or short-circuit.

NOTICE
Motor destruction through overheating If a KTY sensor is connected with the incorrect polarity, the motor can be destroyed due to overheating, as the inverter cannot detect a motor overtemperature condition. Connect the KTY sensor with the correct polarity.

- Temperature monitoring:
  The inverter uses a KTY sensor to evaluate the motor temperature in the range from -48° C ... +248° C.
  Use the p0604 or p0605 parameter to set the temperature for the alarm and fault threshold.
  - Overtemperature alarm (A07910):
    - motor temperature > p0604 and p0610 = 0
  - Overtemperature fault (F07011):
    The inverter switches off with fault in the following cases:
    - motor temperature > p0605
    - motor temperature > p0604 and p0610 ≠ 0
- Sensor monitoring (A07015 or F07016):
  - Wire-break:
    The inverter interprets a resistance > 2120 Ω as a wire-break and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.
  - Short-circuit:
    The inverter interprets a resistance < 50 Ω as a short-circuit and outputs the alarm A07015. After 100 milliseconds, the inverter changes to the fault state with F07016.

Setting parameters for the temperature monitoring

Parameter	Description
p0335	**Specify the motor cooling** 0: Natural cooling - with fan on the motor shaft (factory setting) 1: Forced ventilation - with a separately driven fan 2: Liquid cooling 128: No fan
p0601	**Motor-temperature sensor type** 0: No sensor (factory setting) 1: PTC (→ p0604) 2: KTY84 (→ p0604, p0605) 4: Temperature switch
p0604	**Motor temperature alarm threshold** (factory setting 130° C)
p0605	**Motor temperature fault threshold** (factory setting 145° C) Setting for KTY84 sensor. The parameter has no significance for a PTC sensor.

Parameter	Description
p0610	**Motor-overtemperature response** Determines the response when the motor temperature reaches the alarm threshold p0604. 0: Alarm (A07910), no fault. 1: Alarm (A07910); current limit is reduced and timer is started. Shutdown with fault (F07011). 2: Alarm (A07910); timer is started. Shutdown with fault (F07011). 12: As for 2 but the last shutdown temperature is used to calculate the motor temperature (factory setting).
p0640	**Current limit** (input in A)

Additional information on the motor temperature monitoring can be found in function diagram 8016 of the List Manual.

9.7.3 Protecting the motor by calculating the motor temperature

The temperature calculation is only possible in the vector control mode (p1300 ≥ 20) and functions by calculating a thermal motor model.

Table 9- 18 Parameters for temperature acquisition without using a temperature sensor

Parameter	Description
p0621= 1	**Motor-temperature acquisition after restart** 0: No temperature measurement (factory setting) 1: Temperature measurement after the motor is switched on for the first time 2: Temperature measurement each time that the motor is switched on
p0622	**Magnetization time of the motor for temperature measurement after starting** *(set automatically as the result of motor data identification)*
p0625 = 20	**Ambient motor temperature** Enter the ambient motor temperature in °C at the instant that the motor data is acquired (factory setting: **20° C**). The difference between the motor temperature and motor environment (p0625) must lie within a tolerance range of approx. ± 5° C.

9.7.4 Overcurrent protection

The vector control ensures that the motor current remains within the set torque limits.

If you use U/f control, you cannot set any torque limits. The U/f control prevents too high a motor current by influencing the output frequency and the motor voltage (I-max controller).

I_max controller

Requirements

The torque of the motor must decrease at lower speeds, which is the case, for example, with fans.

The load must not drive the motor continuously, e.g. when lowering hoisting gear.

Function

The I-max controller influences the output frequency and the motor voltage.

If the motor current reaches the current limit during acceleration, the I-max controller extends the acceleration operation.

If the load of the motor is so large during stationary operation that the motor current reaches the current limit, the I-max controller reduces the speed and the motor voltage until the motor current is in the permissible range again.

If the motor current reaches the current limit during deceleration, the I-max controller extends the deceleration operation.

Settings

You only have to change the factory settings of the I-max controller if the drive tends to oscillate when it reaches the current limit or if it is shut down due to overcurrent.

Table 9- 19 I-max controller parameters

Parameter	Description
p0305	Rated motor current
p0640	Motor current limit
p1340	Proportional gain of the I-max controller for speed reduction
p1341	Integral time of the I-max controller for speed reduction
r0056.13	Status: I-max controller active
r1343	Speed output of the I-max controller Shows the amount to which the I-max controller reduces the speed.

For more information about this function, see function diagram 6300 in the List Manual.

9.7.5 Limiting the maximum DC link voltage

How does the motor generate overvoltage?

An induction motor operates as a generator if it is driven by the connected load. A generator converts mechanical power into electrical power. The electrical power flows back into the inverter and causes V_{DC} in the inverter to increase.

Above a critical DC-link voltage both the inverter and the motor will be damaged. Before harmful voltages occur, the inverter switches off the connected motor with the fault

"DC-link overvoltage".

Protecting the motor and inverter against overvoltage

The Vdc_max control can be used with the PM230, PM240, PM240-2 and PM330 Power Modules. To the extent the application permits, the Vdc_max control prevents the DC-link voltage from reaching critical levels. The Vdc_max control increases the ramp-down time of the motor during braking, so that the motor feeds back only as little power to the inverter as is covered by the losses in the inverter.

The Vdc_max control is not suitable for applications where the motor is continuously in the generator mode. This includes, for example, cranes or applications involving braking large moments of inertia. Further information on inverter braking methods can be found in Section Braking functions of the inverter (Page 210).

Table 9- 20 V_{DCmax} controller parameters

Parameter for U/f control	Parameter for vector control	Description
p1280 = 1	p1240 = 1	**V_{DC} controller or V_{DC} monitoring configuration**(factory setting: 1)1: Enable V_{DCmax} controller
r1282	r1242	**V_{DCmax} controller switch-on level** Shows the value of the DC-link voltage above which the V_{DCmax} controller is active
p1283	p1243	**V_{DCmax} controller dynamic factor** (factory setting: 100 %) scaling of the control parameters P1290, P1291 and P1292
p1294	p1254	**V_{DCmax}-controller automatic recording ON-signal level**(factory setting p1294: 0, factory setting p1254: 1)Activates or deactivates automatic detection of the switch-on levels of the V_{DCmax}controller. 0: Automatic detection disabled 1: Automatic detection enabled
p0210	p0210	**Unit supply voltage** If p1254 or p1294 = 0, the inverter uses this parameter to calculate the intervention thresholds of the V_{DCmax} controller. Set this parameter to the actual value of the input voltage.

For more information about this function, see the List Manual (function diagrams 6320 and 6220).

9.8 Status messages

Information about the inverter state (alarms, faults, actual values) can be output via inputs and outputs and also via the communication interface.

Details on evaluating the inverter state via inputs and outputs are provided in Section Adapt inputs and outputs.

The evaluation of the inverter state via the communication interface is realized using the inverter status word.

9.8.1 System runtime

By evaluating the system runtime of the inverter, you can decide whether you must replace components subject to wear such as fans, motors and gear units.

Principle of operation

The system runtime is started as soon as the Control Unit power supply is switched-on. The system runtime stops when the Control Unit is switched off.

The system runtime comprises r2114[0] (milliseconds) and r2114[1] (days):

System runtime = r2114[1] × days + r2114[0] × milliseconds

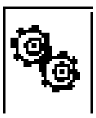
If r2114[0] has reached a value of 86,400,000 ms (24 hours), r2114[0] is set to the value 0 and the value of r2114[1] is increased by 1.

Using system runtime, you can track the sequence of faults and alarms over time. When a corresponding message is triggered, parameter values r2114 are transferred unchanged to the corresponding parameters of the alarm or fault buffer.

Parameters	Description
r2114[0]	System runtime (ms)
r2114[1]	System runtime (days)

You cannot reset the system runtime.

9.9 Application-specific functions



The inverter offers a series of functions that you can use depending on your particular application, e.g.:

- Switching over units
- Braking functions
- Automatic restart and flying restart
- Basic process control functions
- Logical and arithmetic functions using function blocks that can be freely interconnected
- Energy-saving display for pumps and fans

Refer to the following sections for detailed descriptions.

9.9.1 Unit changeover

Description

With the unit changeover function, you can adapt the inverter to the line supply (50/60 Hz) and also select US units or SI units as base units.

Independent of this, you can define the units for process variables or change over to percentage values.

Specifically, you have the following options:

- Changing over the motor standard (Page 207) IEC/NEMA (adaptation to the line supply)
- Changing over the unit system (Page 207)
- Changing over units for the technology controller (Page 208)

Note

The motor standard, the unit system as well as the process variables can only be changed offline.

The procedure is described in Section Switching units with STARTER (Page 208).

Restrictions for the unit changeover function

- The values on the rating plate of the inverter or motor cannot be displayed as percentage values.
- Using the unit changeover function several times (for example, percent → physical unit 1 → physical unit 2 → percent) may lead to the original value being changed by one decimal place as a result of rounding errors.
- If the unit is changed over into percent and the reference value is then changed, the percentage values relate to the new reference value.
  Example:
  - For a reference speed of 1500 rpm, a fixed speed of 80% corresponds to a speed of 1200 rpm.
  - If the reference speed is changed to 3000 rpm, then the value of 80% is kept and now means 2400 rpm.

Reference variables for unit changeover

p2000 Reference frequency/speed

p2001 Reference voltage

p2002 Reference current

p2003 Reference torque

r2004 Reference power

9.9.1.1 Changing over the motor standard

You change over the motor standard using p0100. The following applies:

- p0100 = 0: IEC motor (50 Hz, SI units)
- p0100 = 1: NEMA motor (60 Hz, US units)
- p0100 = 2: NEMA motor (60 Hz, SI units)

The parameters listed below are affected by the changeover.

Table 9- 21 Variables affected by changing over the motor standard

P no.	Designation	Unit for p0100 =		
		0*)	1	2
r0206	Power Module rated power	kW	HP	kW
p0307	Rated motor power	kW	HP	kW
p0316	Motor torque constant	Nm/A	lbf ft/A	Nm/A
r0333	Rated motor torque	Nm	lbf ft	Nm
r0334	Motor torque constant, actual	Nm/A	lbf ft/A	Nm/A
p0341	Motor moment of inertia	kgm^2	$lb\ ft^2$	kgm^2
p0344	Motor weight (for thermal motor type)	kg	Lb	kg
r1969	Speed_cont_opt moment of inertia determined	kgm^2	$lb\ ft^2$	kgm^2

*) Factory setting

9.9.1.2 Changing over the unit system

You change over the unit system using p0505. The following selection options are available:

- p0505 = 1: SI units (factory setting)
- p0505 = 2: SI units or % relative to SI units

- p0505 = 3: US units
- p0505 = 4: US units or % relative to US units

Note

Special features

The percentage values for p0505 = 2 and for p0505 = 4 are identical. For internal calculation and for the output of physical variables, it is, however, important whether the conversion is made to SI or US units.

In the case of variables for which changeover to % is not possible, the following applies:
p0505 = 1 ≙ p0505 = 2 and p0505 = 3 ≙ p0505 = 4.

In the case of variables whose units are identical in the SI system and US system, and which can be displayed as a percentage, the following applies:
p0505 = 1 ≙ p0505 = 3 and p0505 = 2 ≙ p0505 = 4.

Parameters affected by changeover

The parameters affected by changing over the unit system are grouped according to unit. An overview of the unit groups and the possible units can be found in the List Manual in the Section "Unit group and unit selection".

9.9.1.3 Changing over units for the technology controller

Note

We recommend that the units and reference values of the technology controller are coordinated and harmonized with one another during commissioning.

Subsequent modification in the reference variable or the unit can result in incorrect calculations or displays.

Changing over process variables of the technology controller

You change over the process variables of the technology controller using p0595. For physical values, you define the reference variable in p0596.

The parameters affected by changing over units of the technology controller belong to unit group 9_1. For details, please refer to the section titled "Unit group and unit choice" in the List Manual.

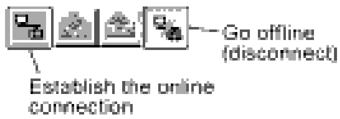
9.9.1.4 Switching units with STARTER

Precondition

The inverter must be in the offline mode in order to change over the units.

STARTER shows whether you change settings online in the inverter or change offline in the PC (Online mode / Offline mode).

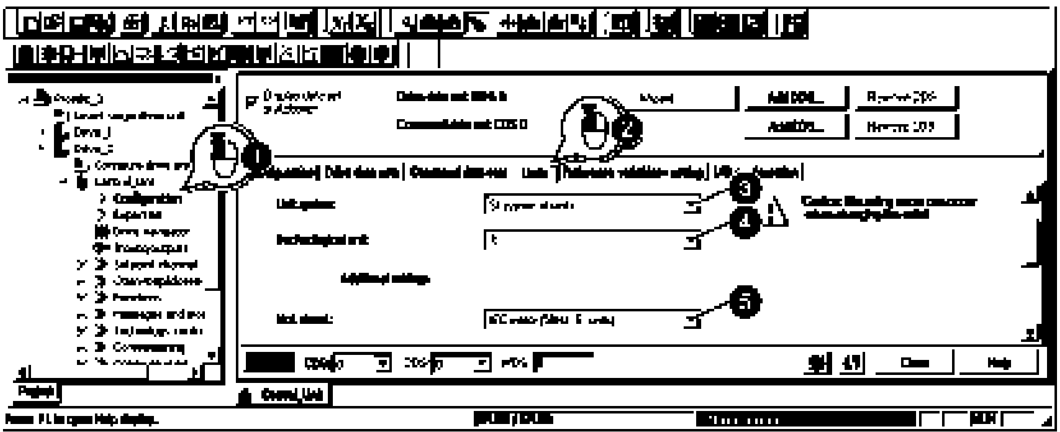
You switch over the mode using the adjacent buttons in the menu bar.



Procedure

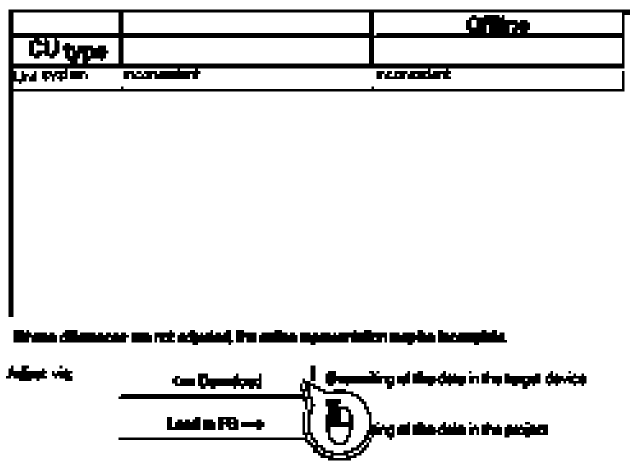
To change over the units with STARTER, proceed as follows:

1. Select the configuration
2. Go to the "Units" tab in the configuration screen form to change over the units
3. Changing over the system of units
4. Select process variables of the technology controller
5. Adapting to the line supply



6. Save your settings.
7. Go online.

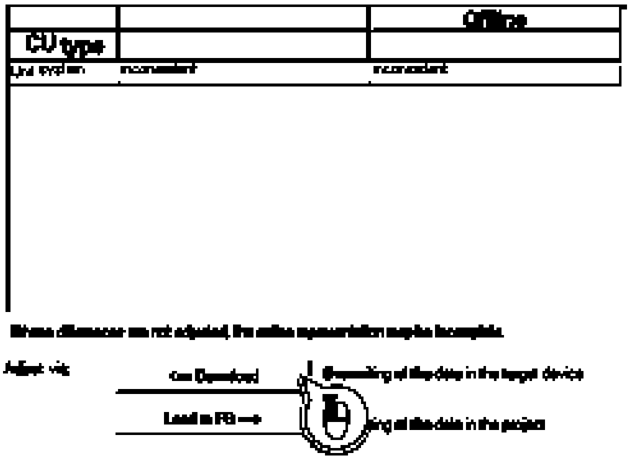
   The inverter signals that offline, other units and process variables are set than in the inverter itself.
8. Accept these settings in the inverter.



You have changed over the units.

6. Save your settings.
7. Go online.

   The inverter signals that offline, other units and process variables are set than in the inverter itself.
8. Accept these settings in the converter.



You have changed over the units.

9.9.2 Braking functions of the inverter

A differentiation is made between mechanically braking and electrically braking a motor:

- Mechanical brakes are generally motor holding brakes that are closed when the motor is at a standstill. Mechanical operating brakes, that are closed while the motor is rotating are subject to a high wear and are therefore often only used as an emergency brake.
  If your motor is equipped with a motor holding brake, then you should use the inverter functions to control this motor holding brake, see Section Motor holding brake (Page 215).
- The motor is electrically braked by the inverter. An electrical braking is completely wear-free. Generally, a motor is switched off at standstill in order to save energy and so that the motor temperature is not unnecessarily increased.

9.9.2.1 Electrical braking methods

Regenerative power

If an induction motor electrically brakes the connected load and the mechanical power exceeds the electrical losses, then it operates as a generator. The motor converts mechanical power into electrical power. Examples of applications, in which regenerative operation briefly occurs, include:

- Grinding disk drives
- Fans

For certain drive applications, the motor can operate in the regenerative mode for longer periods of time, e.g.:

- Centrifuges
- Hoisting gear and cranes
- Conveyor belts with downward movement of load (vertical or inclined conveyors)

9.9.2.2 DC braking

DC braking is used for applications without regenerative feedback into the line supply, where the motor can be more quickly braked by impressing a DC current than along a braking ramp.

Typical applications for DC braking include:

- Centrifuges
- Saws
- Grinding machines
- Conveyor belts

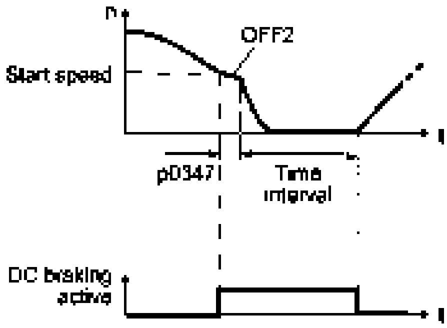
Function

NOTICE
Motor damage caused by overheating The motor can overheat if it is braked for long periods of time or frequently using DC braking. This may damage the motor. • Monitor the motor temperature. • If the motor gets too hot during operation you must select another braking method or give the motor more time to cool down.

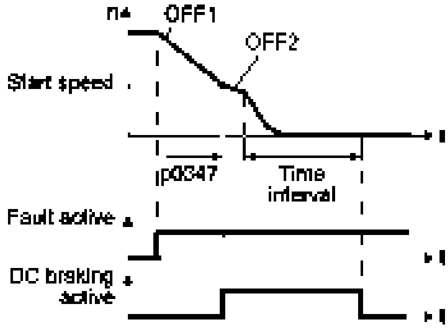
With DC braking, the inverter outputs an internal OFF2 command for the time that it takes to de-energize the motor p0347 - and then impresses the braking current for the duration of the DC braking.

The DC-braking function is possible only for induction motors.

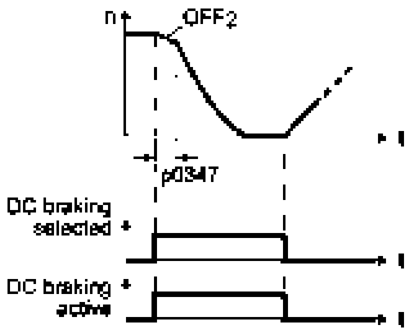
DC braking when falling below a start speed
Precondition: p1230 = 1 and p1231 = 14



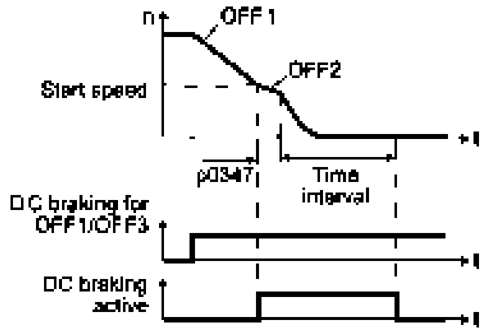
DC braking when a fault occurs
Precondition: Fault number and fault response are assigned using p2100 and p2101



DC braking initiated using a control command
Precondition: p1231 = 4 and p1230 = control command, e.g. p1230 = 722.3 (control command via DI 3)



DC braking when switching off the motor
Precondition: p1231 = 5 or p1230 = 1 and p1231 = 14



DC braking when falling below a starting speed

1. The motor speed has exceeded the starting speed.
2. The inverter activates the DC braking as soon as the motor speed falls below the starting speed.

DC braking when a fault occurs

1. A fault occurs, which initiates DC braking as response.
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

DC braking initiated by a control command

1. The higher-level control issues the command for DC braking, e.g. using DI3: p1230 = 722.3.
2. DC braking starts.

If the higher-level control withdraws the command during DC braking, the inverter interrupts DC braking and the motor accelerates to its setpoint.

DC braking when the motor is switched off

1. The higher-level control switches off the motor (OFF1 or OFF3).
2. The motor brakes along the down ramp to the speed for the start of DC braking.
3. DC braking starts.

Settings for DC braking

Parameter	Description
p0347	**Motor de-excitation time** (calculated after the basic commissioning) The inverter can trip due to an overcurrent during DC braking if the de-excitation time is too short.
p1230	**DC braking activation** (factory setting: 0) Signal source to activate DC braking • 0 signal: Deactivated • 1 signal: Active
p1231	**Configuring DC braking** (factory setting: 0) 0 No DC braking 4 General release for DC braking 5 DC braking for OFF1/OFF3 14 DC braking below the starting speed
p1232	**DC braking braking current** (factory setting 0 A)
p1233	**DC braking duration** (factory setting 1 s)
p1234	**DC braking start speed** (factory setting 210000 rpm)
r1239	**DC braking status word** .08 DC braking active .10 DC braking ready .11 DC braking selected .12 DC braking selection internally locked .13 DC braking for OFF1/OFF3

Table 9- 22 Configuring DC braking when faults occur

Parameter	Description
p2100	**Set fault number for fault response** (factory setting 0) Enter the fault number for which DC braking should be activated, e.g. p2100[3] = 7860 (external fault 1).
p2101 = 6	**Fault response setting** (factory setting 0) Assigning the fault response: p2101[3] = 6.
The fault is assigned an index of p2100. Assign the same index of p2100 or p2101 to the fault and fault response. The inverter's List Manual lists in the "Faults and alarms" list the possible fault responses for every fault. The "DCBRAKE" entry means that it is permissible to set DC braking as response for this particular fault.	

DC braking voltages

The line supply voltage available to the Inverter determines the amount of rectified brake voltage available for DC braking function. Listed in the following table are examples of the correlation between the input AC voltage to the available DC voltage for the DC braking function.

Line voltage	380 V AC	400 V AC	440 V AC	480 V AC	500 V AC
Rectified brake voltage	171 V DC	180 V DC	198 V DC	216 V DC	225 V DC

The following formula can be use a guide to the rectified brake voltage that is available from the line voltage:

Line voltage x 0.45 = Brake coil voltage

For example: 400 V AC x 0.45 = 180 V DC.

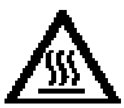
9.9.2.3 Dynamic braking

Typical applications for dynamic braking include:

- Horizontal conveyors
- Vertical and inclined conveyors
- Hoisting gear

For these applications, dynamic motor behavior with different speeds or continuous change of direction is required.

Principle of operation



CAUTION

Burns when touching a hot braking resistor

A braking resistor reaches high temperatures during operation. Touching the braking resistor may result in burns.

- Do not touch a braking resistor during operation.

The inverter controls the braking chopper depending on its DC-link voltage. The DC-link voltage increases as soon as the inverter absorbs the regenerative power when braking the motor. The braking chopper converts this power into heat in the braking resistor. This prevents the DC-link voltage from increasing above the limit value $U_{DC\ link,\ max}$.

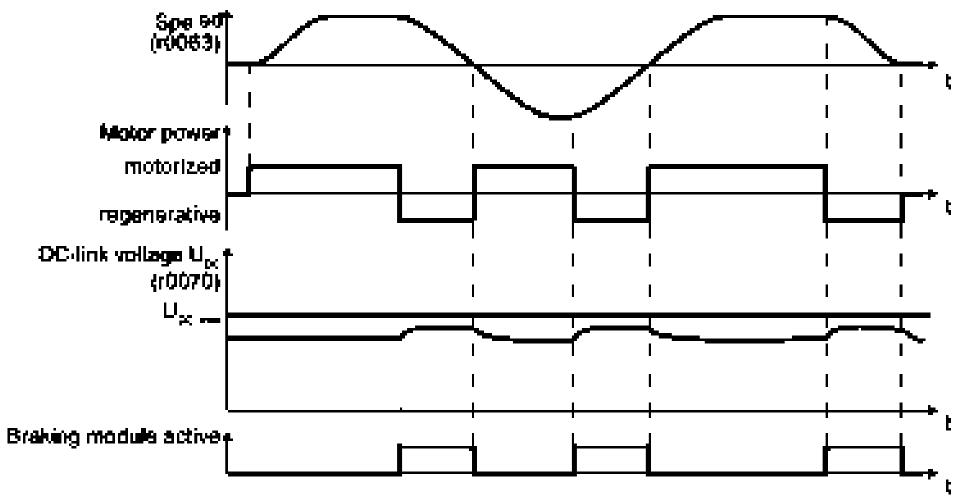


Figure 9-19 Simplified representation of dynamic braking with respect to time

Procedure: Set dynamic braking

In order to optimally utilize the connected braking resistor, you must know the braking power that occurs in your particular application.

Table 9- 23 Parameter

Parameter	Description	
p0219	**Braking power of the braking resistor** (factory setting: 0 kW) Set the maximum braking power that the braking resistor must handle in your particular application. Under certain circumstances, for low braking power ratings, the inverter extends the ramp-down time of the motor. **Example**: In your particular application, the motor brakes every 10 seconds. In so doing, the braking resistor must handle a braking power of 1 kW for 2 s. Use a braking resistor with a continuous power rating of 1 kW × 2 s / 10 s = 0.2 kW and set the maximum braking power to: p0219 = 1 (kW).	
p0844	**No coast down/coast down (OFF2) signal source 1**	
	p0844 = 722.x	Monitor the overtemperature of the braking resistor with digital input x of the inverter.

9.9.2.4 Motor holding brake

The motor holding brake prevents the motor turning when it is switched off. The inverter has internal logic to optimally control a motor holding brake.

The inverter-internal control of the motor holding brake is suitable typically for horizontal, inclined and vertical conveyors.

A motor holding brake can also be useful in several applications for pumps or fans to ensure that the powered-down motor does not rotate in the wrong direction through a liquid or air flow.

Connecting the motor holding brake

The Motor Holding Brake (MHB) function of the Control Units comprise dedicated hardware and software to control the actions of the MHB on the motor which is connected to the Inverter.

The MHB is connected to the Inverter using the EMB- and EMB+ terminals of the mains connectors in the Control Unit housing. The Power Module must be removed to access these terminals.

When the motor holding brake is connected to the Inverter , 180 V DC IS supplied to the motor holding brake and the software within the Inverter monitors the correct functioning of the brake.

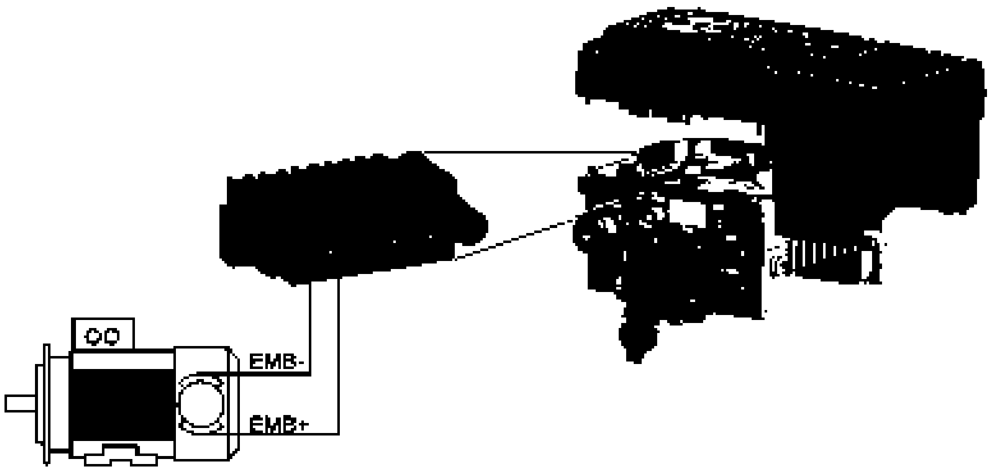


Figure 9-20 Simplied diagram of the motor holding brake connections

Function after OFF1 and OFF3 command

The inverter controls the motor holding brake in the following way:

- After the ON command (to switch on motor), the inverter magnetizes the motor.
- After the magnetizing time (p0346), the inverter issues the command to open the brake.
- The inverter keeps the motor at a standstill up until the end of the time in p1216. The motor holding brake must open within this time.
- At the end of the brake opening time the motor accelerates to the speed setpoint.
- After the OFF command (OFF1 or OFF3) the motor brakes to a standstill.
- When braking, the inverter compares the speed setpoint and the actual speed with the speed threshold p1226:

  If the speed setpoint falls below the threshold p1226, the inverter starts the time p1227.

  If the actual speed falls below the threshold p1226, the inverter starts the time p1228.

- As soon as the first of the two times (p1227 or p1228) has elapsed, the inverter issues the command to close the brake.

  The motor comes to a standstill but remains switched on.
- After the brake closing time p1217, the inverter switches off the motor.
  The motor holding brake must close within this time.

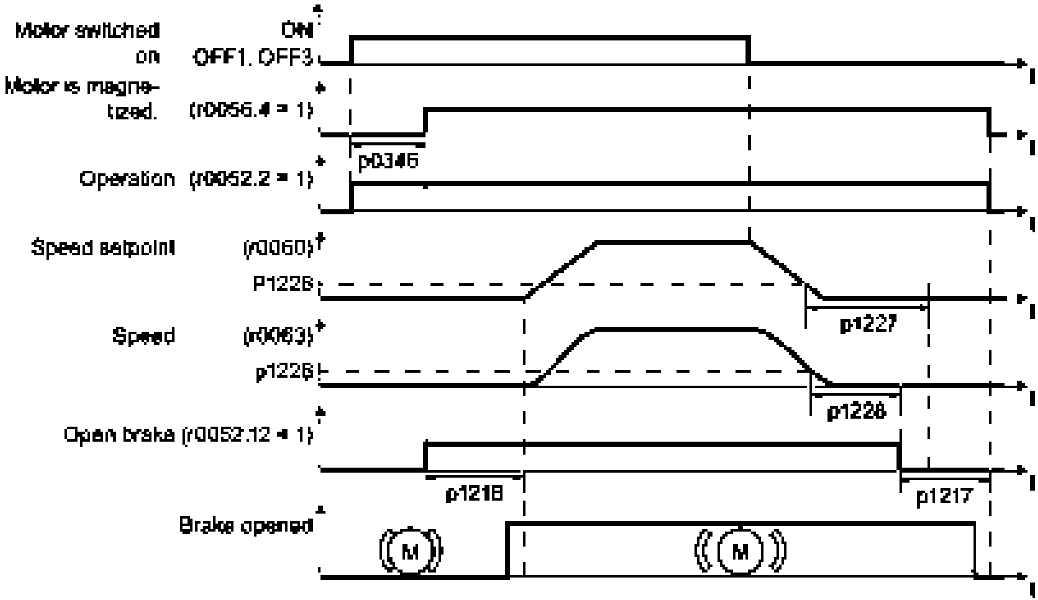


Figure 9-21 Controlling the motor holding brake when the motor is switched on and off

Function after OFF2

The brake closing time is not taken into account after an OFF2 command:

After an OFF2, the inverter issues the signal to immediately close the motor holding brake, independent of the motor speed.

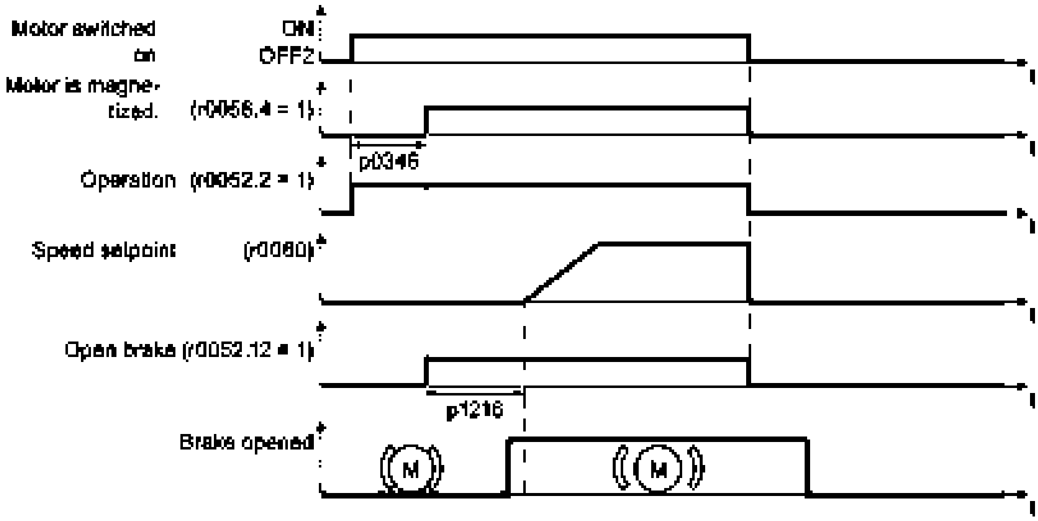


Figure 9-22 Controlling the motor holding brake after OFF2

Commissioning a motor holding brake

DANGER

Danger to life due to falling loads

For applications such as lifting equipment, cranes or elevators, there is a danger to life if the "Motor holding brake" function is incorrectly set.

- When commissioning the "Motor holding brake" function, secure any dangerous loads, e.g. by applying the following measures:
  - Lower the load down to the floor
  - Cordon off the hazardous area so that nobody can enter it

Precondition

The motor holding brake is connected to the inverter.

Procedure

Proceed as follows to commission the "Motor holding brake" function using an operator panel.

1. Set p1215 = 1.

   The "Motor holding brake" function" is enabled.
2. Check the magnetizing time p0346; the magnetizing time is pre-assigned during commissioning and must be greater than zero.
3. Take the opening and closing times of the connected brake from the technical data for the motor holding brake.
   - Depending on the brake size, brake opening times lie between 25 ms and 500 ms.
   - Depending on the brake size, brake closing times lie between 15 ms and 300 ms.

4. Set the following parameters in the inverter to match the opening and closing times of the brake:
   – Opening time ≤ p1216.
   – Closing time ≤ p1217.
5. Switch on the motor.
6. Check the acceleration behavior of the drive immediately after the motor has been switched on:
   – If the brake opens too late, the inverter accelerates the motor against the closed brake which results in a jerky motion.
     In this case, increase the opening time p1216.
   – After opening the brake, if the motor waits too long before it accelerates the motor, then reduce the opening time p1216.
7. If the load sags after switching on the motor, then you must increase the motor torque when opening the motor holding brake. Depending on the control mode, you must set different parameters:
   – U/f operation (p1300 = 0 to 3):
     Increase p1310 step-by-step.
     Increase p1351 step-by-step.
   – Vector control (p1300 ≥ 20):
     Increase p1475 in small steps.
8. Switch off the motor.
9. Check the braking behavior of the drive immediately after the motor has been switched off:
   – If the brake closes too late, the load briefly sags before the brake closes.
     In this case, increase the closing time p1217.
   – After closing the brake, if the motor waits too long before it switches off the motor, then reduce the closing time p1217.

You have commissioned the "Motor holding brake" function.

Table 9- 24 Setting the control logic of the motor holding brake

Parameter	Description
p1215 = 1	**Enable motor holding brake** 0 Motor holding brake locked (factory setting) 1 Motor holding brake just like the sequence control 2: Motor holding brake permanently open 3: Motor holding brake just like the sequential control, connected via BICO
p1216	**Motor holding brake opening time** (factory setting 0.1 s) p1216 > braking signal relay runtimes + brake release time
p1217	**Motor holding brake closing time** (factory setting 0.1 s) p1217 > braking signal relay runtimes + brake closing time
r0052.12	**"Open motor holding brake" command**

Table 9- 25 Advanced settings

Parameter	Description
p0346	**Magnetizing time** (factory setting 0 s) During this time the induction motor is magnetized. The inverter calculates this parameter using p0340 = 1 or 3.
p0855	**Open motor holding brake (imperative)** (factory setting 0)
p0858	**Close motor holding brake (imperative)** (factory setting 0)
p1226	**Stationary state detection speed threshold** (factory setting 20 rpm) When braking with OFF1 or OFF3, when the speed falls below this threshold, standstill is detected and the monitoring time p1227 or p1228 is started
p1227	**Stationary state detection monitoring time** (factory setting 300 s)
p1228	**Pulse deletion delay time** (factory setting 0.01 s)
p1351	**Starting frequency, motor holding brake** (factory setting 0%) Setting the frequency set value at the slip compensation output when starting with motor holding brake. When the parameter p1351 is set to > 0, slip compensation is automatically switched on.
p1352	**Starting frequency for motor holding brake** (factory setting 1351) Setting the signal source for the frequency set value at the slip compensation output when starting with motor holding brake.
p1475	**Speed controller torque set value for motor holding brake** (factory setting 0) Setting the signal source for the torque set value when starting with motor holding brake.

9.9.3 Quick Stop function

Overview

The Quick Stop function enables a load on a conveyor system to be detected and if Quick Stop is enabled, stop the load on the conveyor section.

The load on the conveyor section moves towards a dedicated sensor, as shown in the figure below.

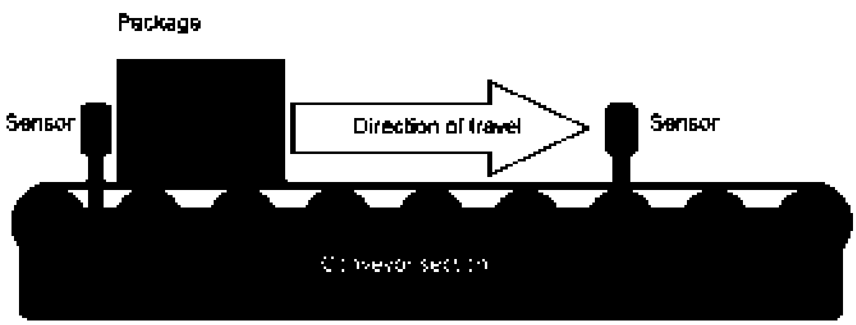


Figure 9-23 Conveyor example 1

The front edge of the load is detected by the sensor, which initiates the Quick Stop function.

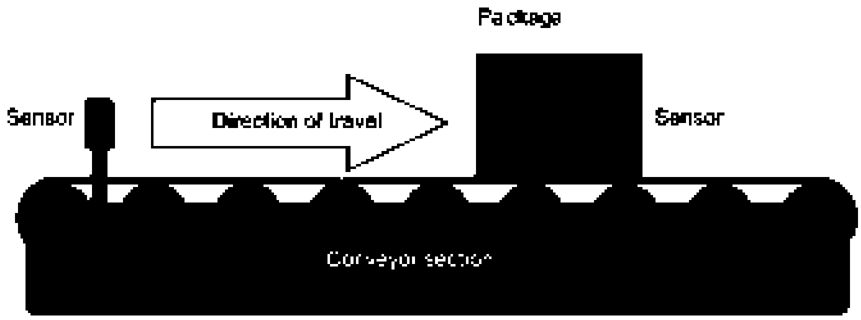


Figure 9-24 Conveyor example 2

The load is then slowed down and stopped.

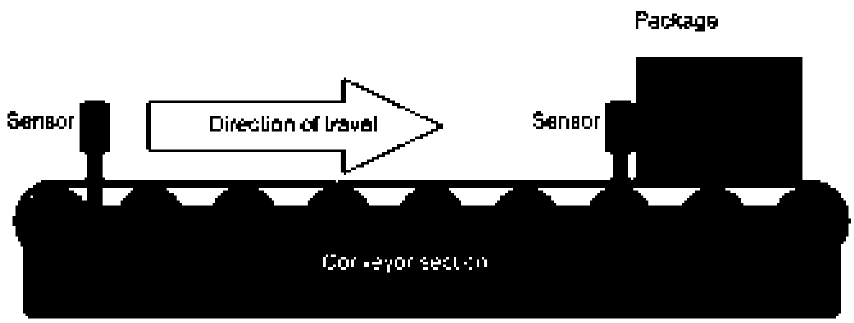


Figure 9-25 Conveyor example 3

There are two sensors on the conveyor section, so that the Quick Stop function can stop the conveyor section in either direction when a load is detected.

How does it work?

The Quick Stop function is configured using BICO parameters and they are explained in the table below.

Table 9- 26 Quick Stop parameters

Parameter	Description	Remarks
P0881	Quick Stop function Input 1 is ON	Allows Quick Stop source 1 command to be selected using BICO. The signal is expected to be active low (default setting P0886 = 2).
P0882	Quick Stop function Input 2 is ON	Allows Quick Stop source 2 command to be selected using BICO. The signal is expected to be active low (default setting (P0886 = 2).
P0883	Quick Stop override	Allows Quick Stop override command source to be selected using BICO. The signal is expected to be active high.

Parameter	Description	Remarks
r0885	Quick Stop status	Bit field describing status of quick stop **Bit /description 1 0** 00: Quick Stop is active Yes No 01: Quick Stop selected Yes No 02: Override selected Yes No 03: - 04: Quick Stop Enabled Yes No
P0886	Quick Stop input type	Control Word for selecting the Quick Stop input type. 0: Quick Stop not selected 1: Quick Stop input active high 2: Quick Stop input active low 3: Quick Stop input positive edge triggered 4: Quick Stop input negative edge triggered

When the Quick Stop function is activated, an OFF1 command is initiated. The motor will be slowed and brought to a standstill using the ramp-down times set in parameter P1121. The default setting for P1121 is 10 seconds and this value may need adjusted to ensure that the load on the conveyor section is brought to a halt at the correct position on the conveyor section

Setting the ramp-down time too short can cause the Inverter to trip with either and overcurrent or overvoltage fault.

The controlling system detects that the Quick Stop function has been activated and can, by use of the appropriate ON command or the 'Quick Stop override" signal restart the motor as required.

Using parameter P0886, it is possible to set the type of reaction required to stop the conveyor section. There are basically two trigger methods, edge triggered signals or level triggered signals. Each type of triggering method produces a different reaction to the OFF1 command and the restarting of the motor. These reactions are shown in the figures below:

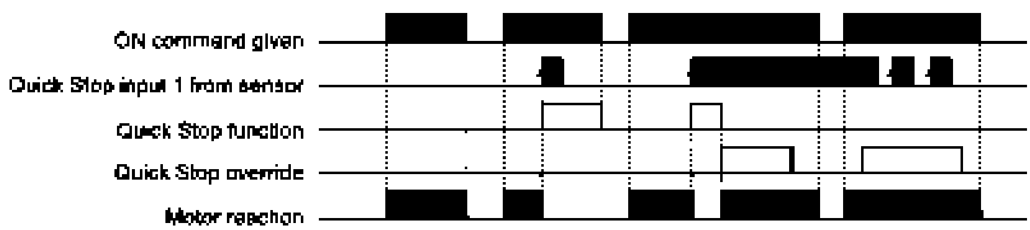


Figure 9-26 Positive edge triggered signals reactions

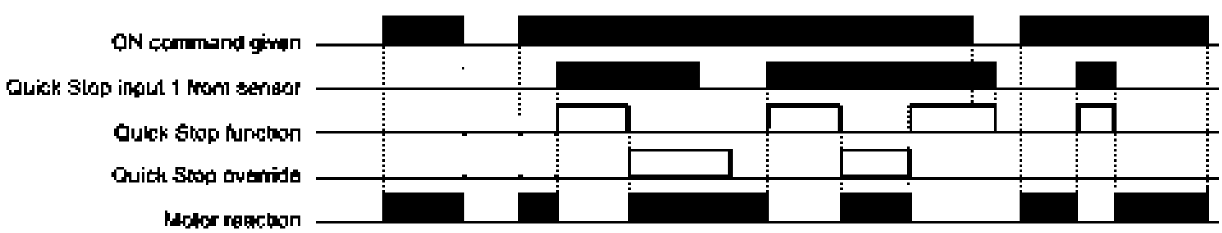
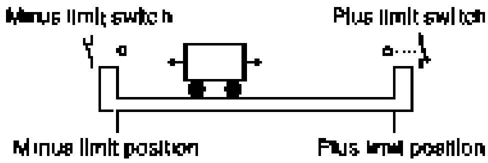


Figure 9-27 High level triggered signals reactions

9.9.4 Limit position control

Limit position and limit switch



A limit position is a position in the direction of motion of a machine component at which the motion stops due to the construction. A limit switch is a sensor that signals that the limit position has been reached.

Function

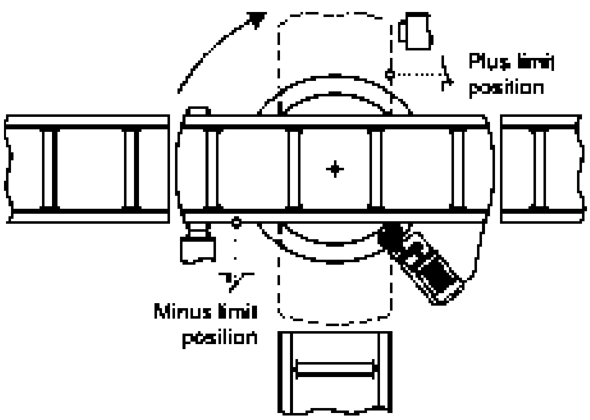
The limit position control moves the motor depending on the two limit switch signals:

- When a limit position is reached, the inverter stops the motor.
- At a limit position, the inverter starts the motor with a new motion command in the direction of the opposite limit position.
- If neither of the limit positions has been reached when the power is switched on, the polarity of the speed setpoint decides in which direction the motor is to start with the first motion command.

The function is described in the following example.

Roller conveyor with rotary table

Application

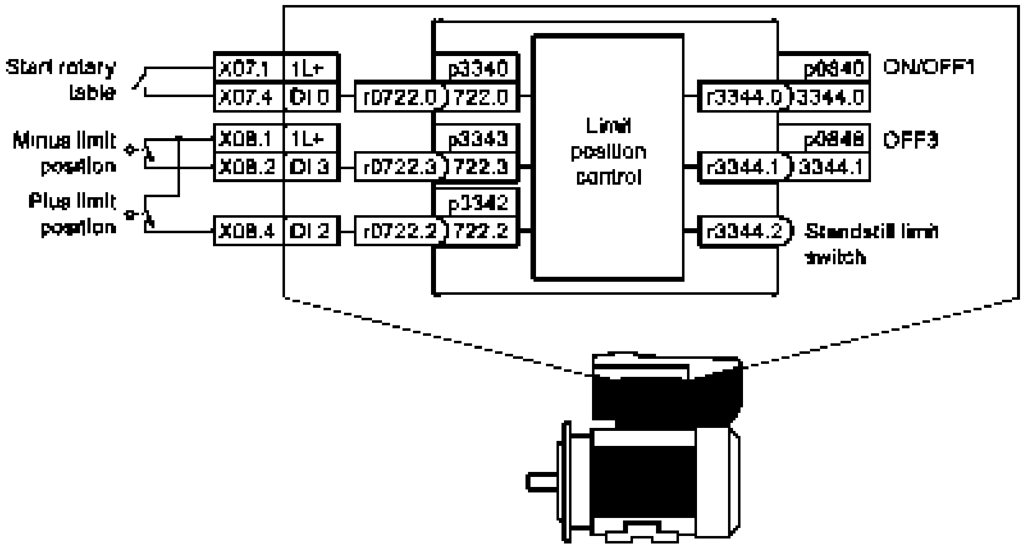


A rotary table in a roller conveyor directs the material at the crossing of two conveyor lines. The rotary table rotates through 90° from one limit position to the other. Two limit switches signal the respective limit position. The signal to start the rotary table comes from the higher-level controller.

Procedure

To adapt the limit position control of the inverter to the application, proceed as follows:

1. Connect the inverter to a commissioning tool, e.g. to an Operator Panel.
2. Interconnect the limit position control of the inverter to the signals of the limit switches and the higher-level controller.

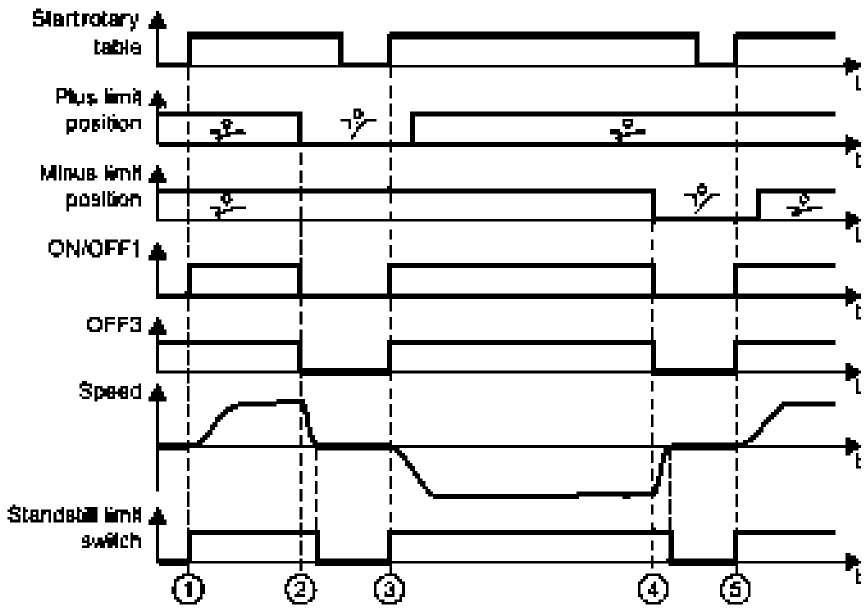


p3340 = 722.0 p3342 = 722.2 p3343 = 722.3	Interconnect inputs of the limit position control to digital inputs of your choice.
p0840 = r3344.0 p0848 = r3344.1	You must interconnect the ON/OFF1 command. If the motor is to stop with a shorter braking time than OFF1 when the limit position is reached, use the OFF3 command as well.
r3344.2	Interconnect this signal, e.g. to a digital output of the inverter, to signal the higher-level controller that the inverter is waiting for a 0 → 1 change of the "Start rotary table" signal.

3. Move the rotary table to one of the two end positions or open one of the limit switches manually.
4. Specify a speed setpoint. We recommended that you use a fixed setpoint for the limit position control. See also Fixed speed as setpoint source (Page 182).
5. Start the rotary table briefly.
6. If the rotary table has not traversed in the direction of the opposite limit position, invert the speed setpoint in the inverter.
7. Set the mechanical position of the limit switch and the OFF3 ramp-down time so that the rotary table stops in good time at each limit position.

You have adapted the limit position control to the application.

Signals of the limit position control



① The rotary table starts in the direction of positive limit position.

② The positive limit position has been reached. The rotary table stops with the minimum possible ramp-down time (OFF3).

③ The rotary table starts in the opposite direction at a 0 → 1 signal change.

④ The negative limit position has been reached. The rotary table stops with the minimum possible ramp-down time (OFF3).

⑤ The rotary table starts in the opposite direction at a 0 → 1 signal change.

Figure 9-28 Limit position control of the inverter

Parameter	Explanation	
p3340[0 … n]	Start limit switch	1 signal: Start is active 0 signal: Start is inactive
p3342[0 … n]	Minus limit switch	1 signal: Limit switch is inactive
p3343[0 … n]	Plus limit switch	0 signal: Limit switch is active
r3344	Limit switch ON/OFF	
	Bit 00	1 signal: Limit switch ON 0 signal: Limit switch OFF1
	Bit 01	1 signal: Limit switch no OFF3 0 signal: Limit switch OFF3
	Bit 02	1 signal: Motor turning 0 signal: Motor stopped

9.9.5 PID technology controller

9.9.5.1 Overview

The technology controller controls process variables, e.g. pressure, temperature, level or flow.

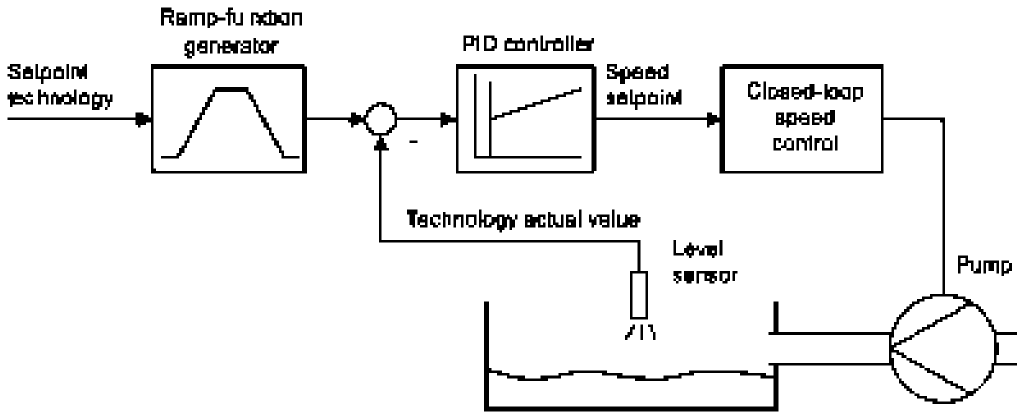


Figure 9-29 Example: Technology controller as a level controller

9.9.5.2 Setting the controller

Simplified representation of the technology controller

The technology controller is implemented as PID controller (controller with proportional, integral and differential component) and so can be adapted very flexibly.

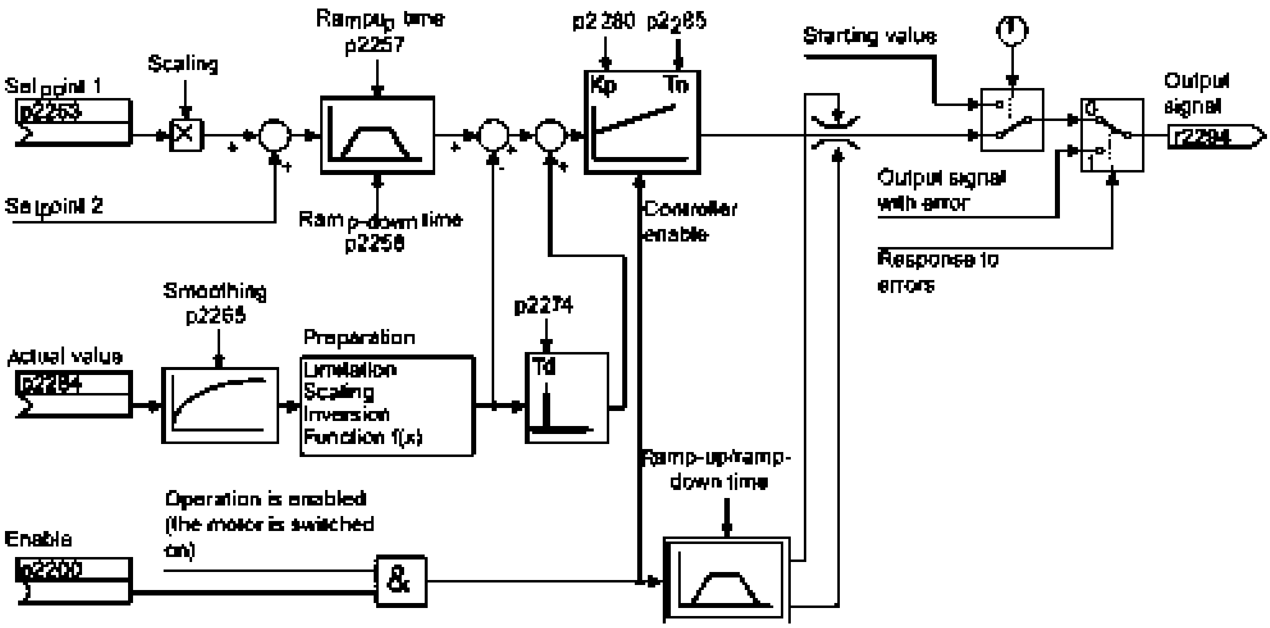


Figure 9-30 Simplified representation of the technology controller

① The inverter uses the start value if the following conditions are met simultaneously:

- The technology controller supplies the main setpoint (p2251 = 0).
- The ramp-function generator output of the technology controller has not yet reached the start value.

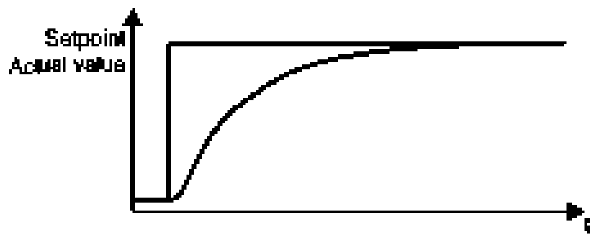
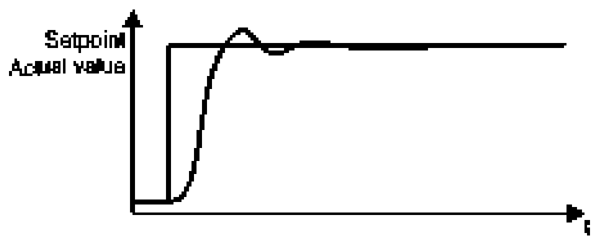
9.9.5.3 Optimizing the controller

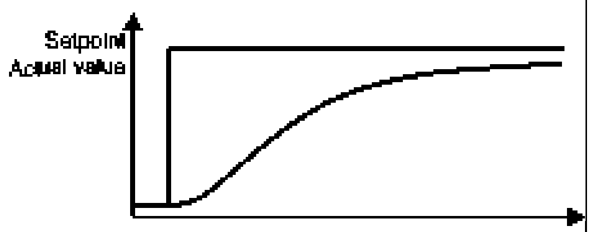
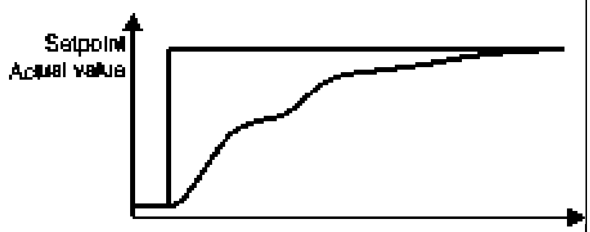
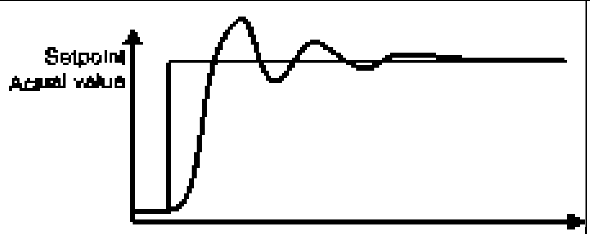
Setting the technology controller from a practical perspective

Procedure

Proceed as follows to set the technology controller:

1. Temporarily set the ramp-up and ramp-down times of the ramp-function generator (p2257 and p2258) to zero.
2. Enter a setpoint step and monitor the associated actual value, e.g. with the trace function of STARTER.
   The slower the response of the process to be controlled, the longer you must monitor the controller response. Under certain circumstances (e.g. for a temperature control), you need to wait several minutes until you can evaluate the controller response.

	**Optimum controller response for applications that do not permit any overshoot.** The actual value approaches the setpoint without any significant overshoot.
	**Optimum controller behavior for fast correction and quick compensation of noise components.** The actual value approaches the setpoint and slightly overshoots (maximum 10% of the setpoint step).

	**The actual value only slowly approaches the setpoint.** • Increase the proportional component K_P and reduce the integration time T_N.
	**Actual value only slowly approaches the setpoint with slight oscillation.** • Increase the proportional component K_P and reduce the rate time T_D (differentiating time).
	**The actual value quickly approaches the setpoint, but overshoots too much** • Decrease the proportional component K_P and increase the integration time T_N.

3. Set the ramp-up and ramp-down times of the ramp-function generator back to their original value.

You have now set the technology controller.

9.9.6 Monitor the load torque (system protection)

In many applications, it is advisable to monitor the motor torque:

- Applications where the load speed can be indirectly monitored by means of the load torque. For example, in fans and conveyor belts with too low a torque indicates that the drive belt is torn.
- Applications that are to be protected against overload or locking (e.g. extruders or mixers).
- Applications in which no-load operation of the motor represents an impermissible situation (e.g. pumps).

Load torque monitoring functions

The inverter monitors the motor torque in different ways:

- No-load monitoring
  The inverter generates a message if the motor torque is too low.
- Blocking protection
  The inverter generates a message if the motor speed cannot match the speed setpoint despite maximum torque.
- Stall protection:
  The inverter generates a message if the inverter control has lost the orientation of the motor.
- Speed-dependent torque monitoring
  The inverter measures the actual torque and compares it with a set speed/torque characteristic.

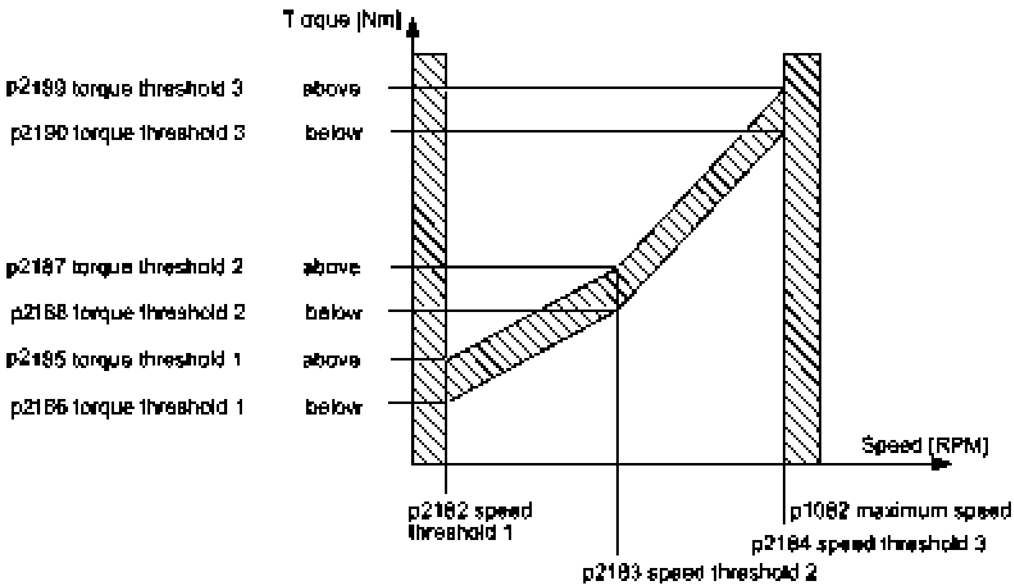


Figure 9-31 Parameters for the load torque monitoring

Table 9- 27 Parameterizing the monitoring functions

Parameter	Description
No-load monitoring	
p2179	**Current limit for no-load detection** If the inverter current is below this value, the message "no load" is output.
p2180	**Delay time for the "no load" message**
Blocking protection	
p2177	**Delay time for the "motor locked" message**
Stall protection	
p2178	**Delay time for the "motor stalled" message**
p1745	**Deviation of the setpoint from the actual value of the motor flux as of which the "motor stalled" message is generated** This parameter is only evaluated as part of encoderless vector control.
Speed-dependent torque monitoring	
p2181	**Load monitoring, response** Setting the response when evaluating the load monitoring. 0: Load monitoring disabled >0: Load monitoring enabled
p2182	**Load monitoring, speed threshold 1**
p2183	**Load monitoring, speed threshold 2**
p2184	**Load monitoring, speed threshold 3**
p2185	**Load monitoring, torque threshold 1, upper**
p2186	**Load monitoring, torque threshold 1, lower**
p2187	**Load monitoring, torque threshold 2, upper**
p2188	**Load monitoring, torque threshold 2, lower**
p2189	**Load monitoring, torque threshold 3, upper**
p2190	**Load monitoring torque threshold 3, lower**
p2192	**Load monitoring, delay time** Delay time for the message "Leave torque monitoring tolerance band"

Additional information about these functions is provided in the function diagrams 012 and 8013 as well as in the parameter list of the List Manual.

Runtime groups and time slices

The inverter computes runtime groups 1 … 6 in different time slices.

Table 9- 28 Runtime groups, time slices and assignment of the free function blocks

Free function blocks	Runtime groups 1 … 6 with associated time slices					
	1	2	3	4	5	6
	8 ms	16 ms	32 ms	64 ms	128 ms	256 ms
Logic AND, OR, XOR, NOT	✓	✓	✓	✓	✓	✓
Arithmetic ADD, SUB, MUL, DIV, AVA, NCM, PLI	-	-	-	-	✓	✓
Timers MFP, PCL, PDE, PDF, PST	-	-	-	-	✓	✓

Free function blocks	Runtime groups 1 … 6 with associated time slices					
	1	2	3	4	5	6
	8 ms	16 ms	32 ms	64 ms	128 ms	256 ms
Memories RSR, DSR	✓	✓	✓	✓	✓	✓
Switches NSW	-	-	-	-	✓	✓
Switches BSW	✓	✓	✓	✓	✓	✓
Controllers LIM, PT1, INT, DIF	-	-	-	-	✓	✓
Monitoring LVM	-	-	-	-	✓	✓

✓: The inverter can compute the free function block in this runtime group
-: A free function block is not possible in this runtime group

Scaling the analog signals

If you interconnect a physical quantity, e.g. speed or voltage to the input of a free function block, then the inverter automatically scales the signal to a value of 1. The analog output signals of the free function blocks are also scaled (0 ≙ 0%, 1≙ 100%).

As soon as you have interconnected the scaled output signal of a free function block to functions that require physical input quantities, then the inverter converts the signal into the physical quantity. An example of this is the signal source for the upper torque limit (p1522).

Scaling parameters of physical quantities:

Speed	p2000	Reference speed	(≙100 %)
Voltage	p2001	Reference voltage	(≙100 %)
Current	p2002	Reference current	(≙100 %)
Torque	p2003	Reference torque	(≙100 %)
Power	p2004	Reference power	(≙100 %)
Angle	p2005	Reference angle	(≙100 %)
Temperature	p2006	Reference temperature	(≙100 %)
Temperature	100° C ≙ 100%		

The assignments to the reference parameters are in the parameter description in the List Manual.

Examples

- Speed:
  Reference speed p2000 = 3000 rpm, actual speed 2100 rpm. As a consequence, the following applies to the scaled input quantity: 2100 / 3000 = 0,7.
- Temperature:
  Reference quantity is 100° C. For an actual temperature of 120° C, the input value is obtained from 120° C / 100° C = 1.2.

Limits

Enter limits within the function blocks as scaled values.

Scaled limit = physical limit value / value of the reference parameter.

Example: Or logic combination of two digital inputs

You want to switch on the motor via digital input 0 and also via digital input 1.

Procedure

Proceed as follows to logically interconnect digital inputs 0 and 1:

1. Activate a free OR block by assigning it to a runtime group, and define the run sequence.
2. Interconnect the status signals of the two digital inputs DI 0 and DI 1 with the two inputs of the OR block.
3. Finally, interconnect the OR block output with the internal ON command (p0840).

You have logically interconnected two digital inputs.

Parameter	Description
p20048 = 1	**Assignment of block OR 0 to runtime group 1** (factory setting: 9999) The block OR 0 is calculated in the time slice with 8 ms
p20049 = 60	Definition of run sequence within runtime group 1 (factory setting: 60) Within one runtime group, the block with the smallest value is calculated first.
p20046[0] = 722.0	**Interconnection of first OR 0 input (factory setting: 0)** The first OR 0 input is linked to digital input 0 (r0722.0)
p20046[1] = 722.1	**Interconnection of second OR 0 input (factory setting: 0)** The second OR 0 input is linked to digital input 1 (r0722.1)
p0840 = 20047	**Interconnection of OR 0 output (factory setting: 0)** The OR 0 output (r20047) is connected with the motor's ON command

Example: AND logic operation

An additional example of an AND logic operation, including the use of a timer block, is provided in Section Fundamentals (Page 286).

Additional information about free function blocks

See also: Example (Page 288).

9.10 Switchover between different settings

There are applications that require different inverter settings.

Example:

You connect different motors to one inverter. Depending on the particular motor, the inverter must operate with the associated motor data and the appropriate ramp-function generator.

Drive data sets (DDS)

Your can set several inverter functions differently and then switch over between the different settings.

The associated parameters are indexed (index 0, 1, 2 or 3). Using control commands select one of the four indexes and therefore one of the four saved settings.

The settings in the inverter with the same index are called the drive data set.

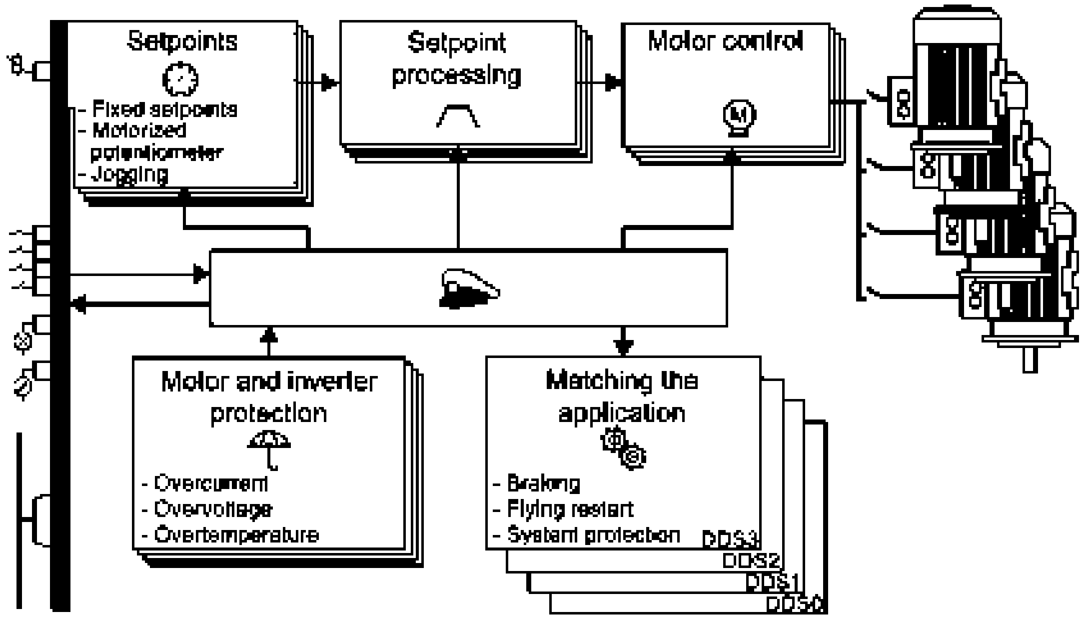


Figure 9-32 Switching over between different settings using drive data sets (DDS)

Using parameter p0180 you can define the number of drive data sets (1 ... 4).

Table 9- 29 Selecting the number of **drive data sets**

Parameter	Description
p0010 = 15	**Drive commissioning:** Data sets
p0180	**Drive data sets (DDS) number**(factory setting: 1)
p0010 = 0	**Drive commissioning:** Ready

Table 9- 30 Parameters for switching the drive data sets:

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>p0820[0…n]</td><td>Drive data set selection DDS bit 0</td><td rowspan="2">If you use several command data sets CDS, then you must set this parameter for each CDS. The parameters are assigned to a CDS through their index:
CDS0: p0820[0], p0821[0]
CDS1: p0820[1], p0821[1]
…</td></tr>
<tr><td>p0821[0…n]</td><td>Drive data set selection DDS bit 1</td></tr>
<tr><td>p0826</td><td colspan="2">Motor changeover, motor number
Each drive data set is assigned a motor number:
p0826[0] = motor number for drive data set 0.
…
p0826[3] = motor number for drive data set 3.
If you operate the same motor with different drive data sets, then you must enter the same motor number in every index of parameter p0826. In this particular case, you can also switch over between the different drive data sets in operation.
If you operate different motors on one inverter, then you must number the motors in parameter p0826. In this case, you may only switch over the drive data sets in the "ready for operation" state with the motor switched-off. The switchover time is approx. 50 ms.</td></tr>
<tr><td>r0051</td><td colspan="2">Displaying the number of the DDS that is currently effective</td></tr>
</table>

For an overview of all the parameters that belong to the drive data sets and can be switched, see the List Manual.

Table 9- 31 Parameters for copying the drive data sets

Parameter	Description
p0819[0]	**Source drive data set**
p0819[1]	**Target drive data set**
p0819[2] = 1	**Start copy operation**

For more information, see the List Manual (the parameter list and function diagram 8565).

10 Data backup and series commissioning

External data backup

After commissioning, your settings are saved in the inverter so that they are protected against power failure.

We recommend that you additionally back up the settings on a storage medium outside the inverter. Without backup, your settings could be lost if the inverter developed a defect.

The following storage media are available for your settings:

- Memory card
- PG/PC
- Operator panel

Note

Data backup using operator panels with USB connection with the PG/PC is not possible

If the inverter is connected to a PG/PC via a USB cable, you can save any data on the memory card using an operator panel.

- Before you save data to the memory card using an operator panel, disconnect the USB connection between the PG/PC and inverter.

Carrying out series commissioning

Series commissioning is the commissioning of several identical drives.

Precondition

The Control Unit to which the settings are transferred has the same order number and the same or a higher firmware version as the source Control Unit.

Overview

You must proceed as follows to carry out series commissioning:

1. Commission the first inverter.
2. Back up the settings of the first inverter to an external storage medium.
3. Transfer the settings of the first inverter to another inverter via the storage medium.

See also the following sections:

- Backing up and transferring settings using memory card (Page 236)
- Saving settings to the memory card (Page 236)
- Transferring the settings from the memory card (Page 238)

10.1 Backing up and transferring settings using memory card

What memory cards do we recommend?

You will find the recommended memory cards in Section: Commissioning tools (Page 31).

Using memory cards from other manufacturers

The inverter only supports memory cards up to 2 GB. SDHC cards (SD High Capacity) and SDXC cards (SD Extended Capacity) are not permitted.

If you use other SD or MMC memory cards, then you must format the memory card as follows:

- MMC: Format FAT 16
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat (x: Drive code of the memory card on your PC)
- SD: Format FAT 16 or FAT 32
  - Insert the card into your PC's card reader.
  - Command to format the card:
    format x: /fs:fat or format x: /fs:fat32 (x: Drive code of the memory card on your PC.)

Functional restrictions with memory cards from other manufacturers

The following functions are either not possible – or only with some restrictions – when using memory cards from other manufacturers:

- Licensing functions is only possible using a recommended memory card.
- Know-how protection is only possible using a recommended memory card.
- Under certain circumstances, memory cards from other manufacturers do not support writing or reading data from/to the inverter.

10.1.1 Saving settings to the memory card

We recommend that you insert the memory card before switching on the converter for the first time. The converter then automatically ensures that the actual parameter settings are saved both in the converter as well as on the card.

The memory card reader is located on the underside of the Power Module. It is necessary to insert the card before Power Module is fitted securely to the teminal housing. Once fitted, the memory card cannot be removed without removing the Power Module from the terminal housing.

The following describes how you can save the Inverter parameter settings on the memory card.

Automatic upload

The inverter power supply has been switched off.

1. Insert an empty memory card into the card reader of the Power Module.
2. Fit the Power Module to the Terminal Unit - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
3. Connect the external 24 V supply to the External Interface Module (EIM).

After the Control Unit has been powered-up, the Inverter copies all modified parameters to the memory card.

Note

If the memory card is not empty and already contains parameter settings, the Inverter will take the parameter settings from the memory card. The previous setting in the Inverter will be deleted.

Manual upload

To manually upload the parameter settings, you will need to transfer the data to the memory card as follows:

1. Disconnect the mains supply and the 24 V external supply.
2. Wait 5 minutes to ensure that any residual power in the system as dissipated.
3. Ensure the application under the control of the converter is in a safe state.
4. Remove the Power Module from the Terminal Unit.
5. Insert the memory card into the memory card reader.
6. Fit the Power Module to the Terminal Unit - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
7. Reconnect the mains supply and the external 24 V supply to the system.

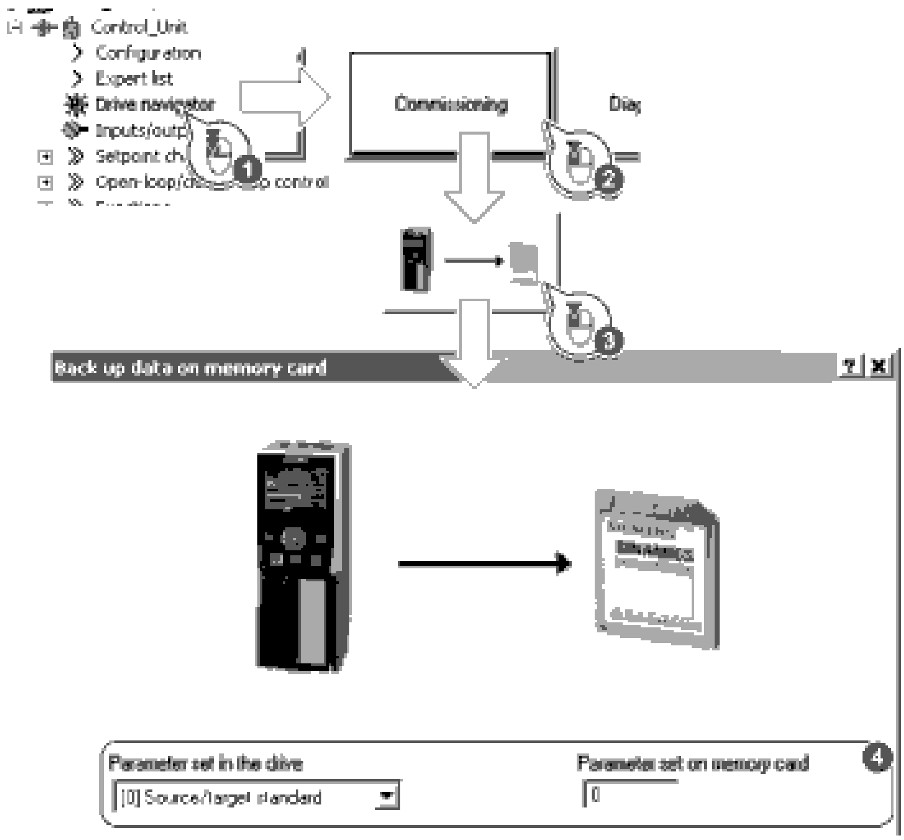
Procedure

Proceed as follows to back up your settings on a memory card:

1. Go online with STARTER, e.g. via a USB cable.

   In STARTER, press the "Copy RAM to ROM" button.

   In your drive, select "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the settings to the memory card.
4. Select the settings as shown in the diagram and start the data backup.
5. Close the screen forms.



You have backed up the settings of the inverter on the memory card.

10.1.2 Transferring the settings from the memory card

If you wish to transfer the parameter settings from a memory card into the inverter (download), you have two options:

Automatic download

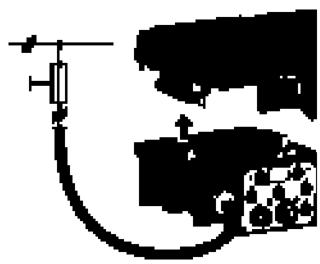
To automatically upload the parameter settings, you will need to transfer the data from the memory card as follows:

1. All mains supply and the 24 V external supply.
2. Wait 5 minutes to ensure that any residual power in the system as dissipated.
3. Ensure the application under the control of the converter is in a safe state.
4. Remove the Power Module from the Terminal Unit.
5. Insert the memory card, containing the parameter set data into the memory card reader.
6. Fit the Power Module to the Terminal Unit - making sure that the seals are fitted correctly and the correct tighten torque (2.0 Nm) is used to ensure the IP rating of the Inverter.
7. Reconnect the mains supply and the external 24 V supply to the system.
8. On power-up the converter will automatically read the default parameter set data into the converters memory.

10.1.3 Manually transferring the settings from the memory card

Procedure: Manual data transfer from a memory card

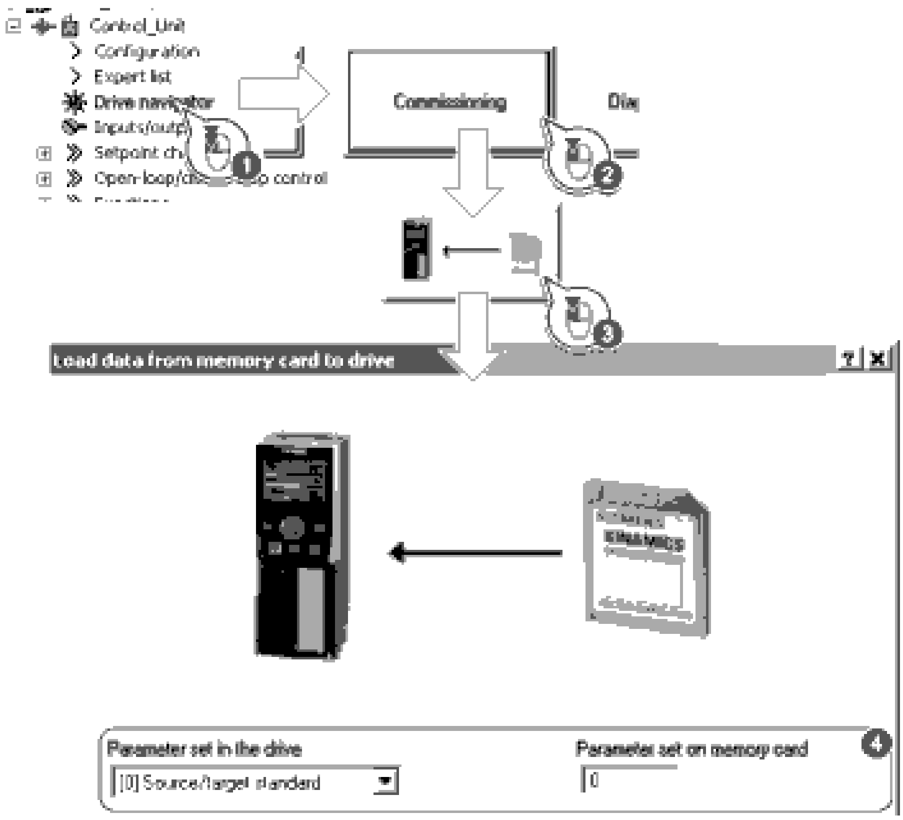
- The converter power supply has been switched on.
- Insert a memory card into the converter.



Procedure

Proceed as follows to transfer settings from a memory card to the inverter:

1. Go online with STARTER, and in your drive, select the "Drive Navigator".
2. Select the "Commissioning" button.
3. Select the button to transfer the data from the memory card to the inverter.
4. Select the settings as shown in the diagram and start the data backup.



5. Close the screen forms.
6. Go offline with STARTER.
7. Switch off the inverter power supply.
8. Wait until all LED on the inverter go dark.
9. Switch on the inverter power supply again.

   Your settings become effective after this power-on reset.

You have written the settings from the memory card to the inverter.

10.1.4 Safely remove the memory card

> ⚠ CAUTION
>
> **Possible corruption of memory card data**
>
> The files system on the memory card can be destroyed if the memory card is removed while the Inverter is powered-up without using the "safe removal" function.

To safely remove the memory card from the Power Module the following procedure should be performed, using either STARTER or the IOP:

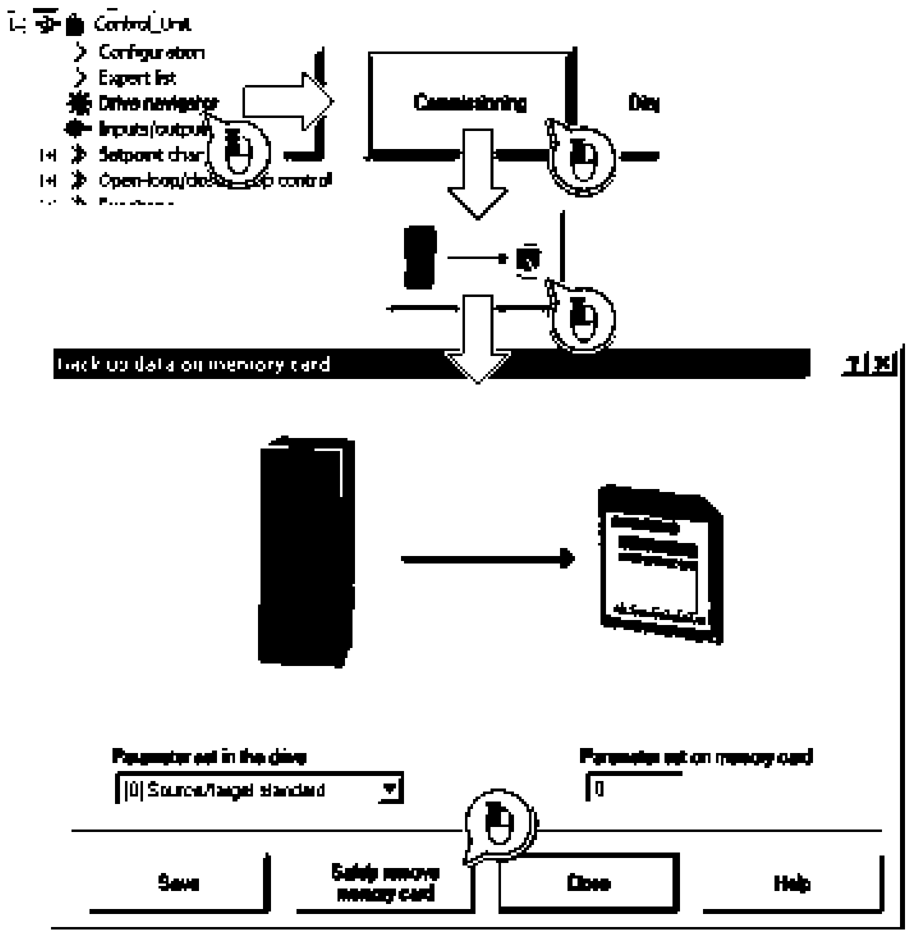
1. Set P9400 to 2.
2. Check the value of parameter P9400.
3. If P9400 = 3, it is safe to remove the memory card.
4. Disconnect the mains supply and the external 24 V supply from the system.
5. Wait 5 minutes to ensure that all residual voltages and currents have dissipated.
6. Remove the Power Module from the Terminal housing.
7. Remove the memory card.
8. Fit the Power Module back on the Terminal housing.

Safely removing memory card using STARTER

Procedure

To safely remove the memory card using STARTER, proceed as follows:

1. In the Drive Navigatorselect the following screen form:



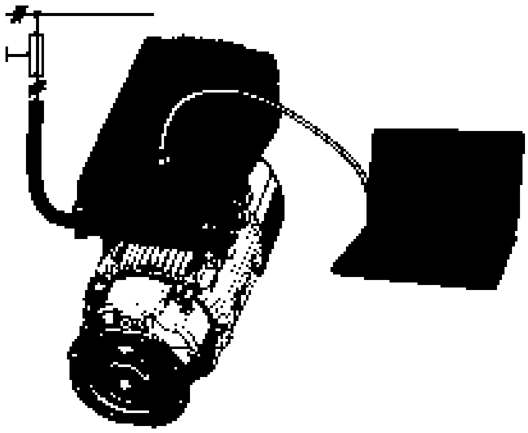
2. Click on the button to safely remove the memory card.
3. Remove the memory card from the inverter after the appropriate message has been output.

You have now safely removed the memory card from the inverter.

10.2 Backing up and transferring settings via STARTER

With the supply voltage switched on, you can transfer the converter settings from the converter to a PG/PC, or the data from a PG/PC to the converter.

This requires you to have installed the STARTER commissioning tool on your PG/PC.



You will find additional information about STARTER in Chapter: Basic commissioning with STARTER (Page 110).

Inverter → PC/PG

Procedure

To back up the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to PG": .
3. To save the data in the PG, select the button: .
4. Go offline with STARTER : .

You have backed up the settings.

PC/PG → inverter

Procedure

To transfer the settings, proceed as follows:

1. Go online with STARTER : .
2. Select the button "Download project to target system": .
3. To save the data in the inverter, select the "Copy RAM to ROM" button: .
4. Go offline with STARTER : .

You have transferred the settings.

10.3 Other ways to back up settings

In addition to the default setting, the inverter has an internal memory for backing up three other settings.

On the memory card, you can back up 99 other settings in addition to the default setting.

You will find additional information on the Internet at: Memory options (http://support.automation.siemens.com/WW/view/en/43512514).

10.4 Write and know how protection

The inverter offers the option to protect configured settings from being changed or copied.

Write protection and know-how protection are available for this purpose.

10.4.1 Write protection

Write protection prevents inverter settings from being inadvertently changed. No password is required for write protection, your settings remain unencrypted.

The following functions are excluded from the write protection:

- Activating/deactivating write protection (p7761)
- Changing the access level (p0003)
- Saving parameters (p0971)
- Safely removing the memory card (p9400)
- Access to service parameters (p3950) - only for service personnel, a password is required
- Restoring the factory setting
- Upload
- Acknowledging alarms and faults
- Switching over to the control panel
- Trace
- Function generator
- Measuring functions
- Reading out diagnostic buffer

The individual parameters that are excluded from the write protection, can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Activate and deactivate write protection

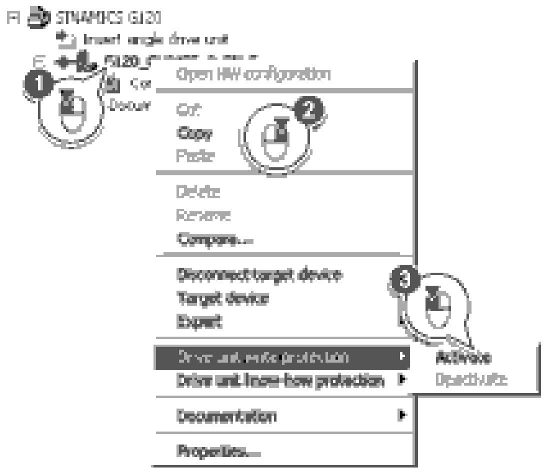
Precondition

You are online with STARTER.

Procedure

Proceed as follows to activate or deactivate the write protection:

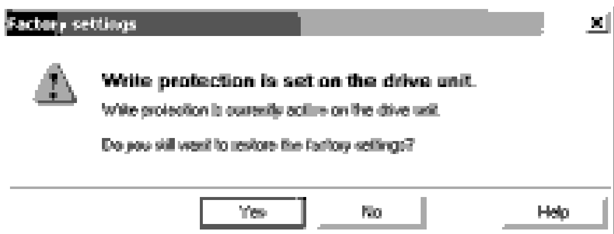
1. Select the inverter in your STARTER project with the left mouse button.
2. Open the shortcut menu with a right click.
3. Activate or deactivate write protection.
4. Press the "Copy RAM to ROM" button . Otherwise, your settings will be lost when the inverter is switched off.



You have activated or deactivated write protection.

Points to note about restoring the factory settings

If you select "Reset to factory settings" using the button when write protection is active, the following confirmation prompt opens.



The confirmation prompt is not issued, if you select another way to restore the factory setting, e.g. using the expert list.

Note

Points to note regarding CAN, BACnet and MODBUS

Using these bus systems, parameter factory settings can be changed despite active write protection. So that write protection is also active when accessing via these fieldbuses, you must additionally set p7762 to 1.

This setting is only possible via the expert list.

10.4.2 Know-how protection

The know-how protection is used to encrypt configuring/engineering know-how, and protect it against being changed or copied.

In the case of active know-how protection, support by technical support personnel is only possible with the consent of the machine manufacturer.

The know-how protection is available in the following versions:

- **Know-how protection without copy protection** (possible with or without memory card)
- **Know-how protection with copy protection** (possible only with recommended Siemens memory card, also see Section: Replacing devices with active know-how protection (Page 250))

A password is required for the know-how protection.

In case of active know-how protection, the STARTER dialog screens are locked. The expert list in STARTER shows only display parameters.

Actions that are also possible during active know-how protection

- Restoring factory settings
- Acknowledging messages
- Displaying messages
- Displaying the alarm history
- Reading out diagnostic buffer
- Switching to the control panel (complete control panel functionality: Fetch master control, all buttons and setting parameters)
- Upload (only parameters, which are accessible even though know-how protection is active)

Actions that are not possible during active know-how protection

- Download
- Export/import
- Trace
- Function generator
- Measuring functions
- Automatic controller setting
- Stationary/rotating measurement
- Deleting the alarm history

The individual parameters that are excluded from the know-how protection can be found in the List Manual in Chapter "Parameters for write protection and protection of know-how".

Commissioning the inverter with know-how protection

Procedure - overview

Proceed as follows to commission an inverter with know-how protection:

1. Commission the inverter.
2. Create the exception list (Page 249).
3. Activate the know-how protection (Page 248).
4. Save the settings in the inverter by copying RAM to ROM with or via p0971 = 1.
5. Save the project with on the PG/PC. Also back up any other project-related data (machine type, password, etc.) that may be required for the support of the end customer.

You have commissioned the inverter with know-how protection.

10.4.2.1 Settings for the know-how protection

Activating know-how protection

Preconditions

- You are online with STARTER.

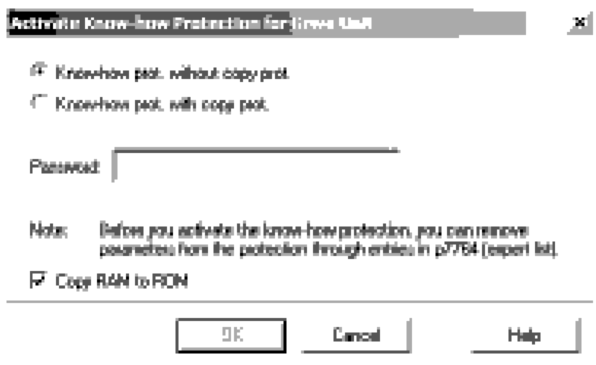
  If you have created a project offline on your computer, you must download it to the inverter and go online.
- You have inserted the recommended Siemens card. See also Section: Commissioning tools (Page 31).

Procedure

Proceed as follows to activate know-how protection:

1. Select the inverter in the STARTER project, and then select "Know-how protection drive unit/activate ..." in the shortcut menu (see also Write protection (Page 244)).
2. Enter your password. Length of the password: 1 … 30 characters.

   For the password, we recommend that you only use characters from the ASCII character set. If you use any character for the password, then if changes are made to the Windows language settings after activating know-how protection, errors can occur when subsequently checking the password.



3. In this screen form, press the "Copy RAM to ROM" button. This means that you save your settings so that they are protected against power failure.

You have activated know-how protection.

Backing up settings on the memory card

When the know-how protection is activated, you can save the settings via p0971 on the memory card.

To do this, set p0971 = 1. The data is encrypted before being written to the memory card. After saving, p0971 is reset to 0.

Deactivate know-how protection, delete password

Preconditions

- You are online with STARTER.
- You have inserted the recommended Siemens card. See also Section: Commissioning tools (Page 31).

Procedure

Proceed as follows to deactivate know-how protection:

1. Select the inverter in the STARTER project, and right-click to open the dialog box "Know-how protection drive unit/deactivate …".
2. There, select the desired option.
   - Temporary status: Know-how protection is active again after switching the power supply off and on.

   - Final status: If you select "Copy RAM to ROM", the inverter immediately deletes the password. If you do not select "Copy RAM to ROM", the inverter deletes the password the next time the supply voltage is switched off.
3. Enter the password and exit the screen form with OK.

You have deactivated know-how protection.

Changing the password

Select the inverter in the STARTER project and open the dialog box via the shortcut menu "know-how protection drive unit/change password … ".

10.4.2.2 Creating an exception list for the know-how protection

Using the exception list, you as a machine manufacturer may make individual adjustable parameters accessible to end customers although know-how protection is active. You may define the exception list via parameters p7763 and p7764 in the expert list. Specify the number of parameters for the selection list in p7763. Assign the individual indexes to the parameter numbers of the selection list in p7764.

Procedure

Proceed as follows to change the number of parameters for the selection list:

1. Save the inverter settings via an upload ( ) on the PC/PG and go offline ( )
2. In the project on the PC, set p7763 to the desired value.
3. Save the project.

4. Go online and load the project into the inverter ().
5. Now make the additional settings in p7764.

You have modified the number of parameters for the selection list.

Factory setting for the exception list:

- p7763 = 1 (selection list contains precisely one parameter)
- p7764[0] = 7766 (parameter number for entering the password)

Note

Block access to the inverter as a result of incomplete exception lists

If you remove p7766 from the exception list, you can no longer enter a password and therefore no longer de-activate know-how protection.

In this case to access the inverter again, you have to reset the inverter to the factory settings.

10.4.2.3 Replacing devices with active know-how protection

Replacing devices during know-how protection without copy protection

For know-how protection without copy protection, the converter settings can be transferred to another converter using a memory card.

See also:

- Commissioning tools (Page 31)
- Commissioning tools (Page 31)

See also

Write and know how protection (Page 244)

Replacing devices for know-how protection with copy protection

The know-how protection with copy protection prevents the inverter settings from being copied and passed on. This function is predominantly used by machine manufacturers.

If know-how protection with copy protection is active, the inverter cannot be replaced as described in "Service and maintenance".

However, to allow the inverter to be replaced, you must use a Siemens memory card, and the machine manufacturer must have an identical machine that he uses as sample.

There are two options for replacing the device:

Option 1: The machine manufacturer only knows the serial number of the new inverter

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 248)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the inserted memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 248)
  - writes the configuration with p0971 = 1 to the memory card
  - sends the memory card to the end customer
- The end customer inserts the memory card and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

Option 2: The machine manufacturer knows the serial number of the new inverter and the serial number of the memory card

- The end customer provides the machine manufacturer with the following information:
  - For which machine must the inverter be replaced?
  - What is the serial number (r7758) of the new inverter?
  - What is the serial number of the memory card?
- The machine manufacturer goes online on the sample machine.
  - deactivates the know-how protection, see Settings for the know-how protection (Page 248)
  - enters the serial number of the new inverter in p7759
  - enters the serial number of the customer's memory card as reference serial number in p7769
  - activates the know-how protection with copy protection ("Copy RAM to ROM" must be activated!), see Settings for the know-how protection (Page 248)
  - writes the configuration with p0971 = 1 to the memory card
  - copies the encrypted project from the card to his PC
  - for example, sends it by e-mail to the end customer
- The end customer copies the project to the Siemens memory card that belongs to the machine, inserts it in the inverter and switches on the inverter.

When powering up, the inverter checks the serial numbers of the card and when there is a match, the inverter goes into the "ready to start" state.

If the numbers do not match, then the inverter signals fault F13100 (no valid memory card).

11 Service and maintenance

11.1 Overview of replacing Inverter components

In the event of a permanent function fault, you can replace the Inverter's Power Module (PM) or Control Unit (CU) independently of one another. In the following cases, you may immediately switch on the motor again after the replacement.

WARNING

Recommissioning and removal of power before exchange of system components

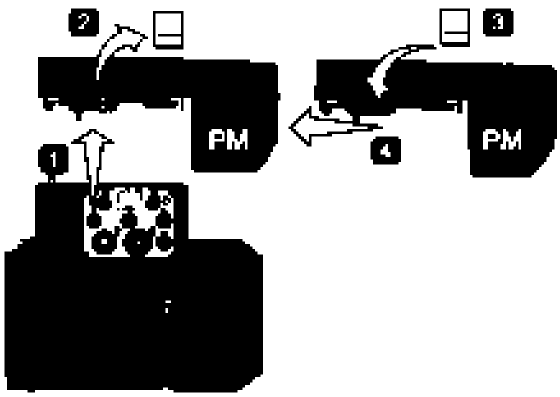
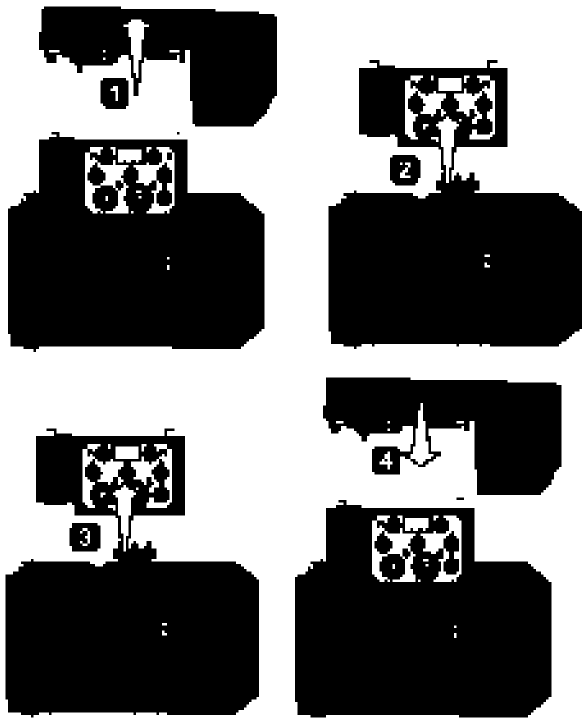
1. In all other cases, you must recommission the drive.
2. When exchanging the Terminal Unit (which contains the Control Unit Module) or the Power Module, the power supply and external 24 V supply MUST be removed from the system before attempting any replacement of components.

Note

Memory card reader

The memory card reader is located on the side of the PM and is not accessible when the PM is fitted to the CU.

Component replacement, general

Replacing the Power Module with external backup of the settings, e.g. on a memory card		Replacing the Control Unit	
Replacement: • Same type • Same power rating	Replacement: • Same type • *Higher* power rating	Replacement: • Same type • Same firmware version	Replacement: • Same type • *Higher* firmware version (e.g. replace FW V4.2 by FW V4.3)
			
	PM and motor must be adapted to one another (ratio of motor and Power Module rated power > 1/8)	The Inverter automatically loads the settings on the memory card into the new CU. If you have saved the settings of your inverter on another medium, e.g. on an operator panel or on a PC, then after the replacement, the settings must be loaded into the Inverter.	

Device replacement without removable storage medium - only for communication via PROFINET

If you have created a topology in your control, using the environment detection, you can replace a defective Inverter by a new device of the same type and with the identical software release without having to recommission the system.

You can either load the Inverter settings into the converter using the memory card, or – if you are using a SIMATIC S7 control with DriveES – using DriveES.

Details of the device replacement without removable storage medium can be found in the Profinet system description (http://support.automation.siemens.com/WW/view/en/19292127).

11.2 Replacing the Control Unit

After commissioning has been completed, we recommend that you back up your settings on an external storage medium, e.g.: on a memory card or the operator panel.

If you do not back up your data, you have to recommission the drive when you replace the Control Unit.

Procedure for replacing a Control Unit

DANGER

Dangerous voltages!

Hazardous voltages are still present for up to 5 minutes after the power supply has been switched off. Do not carry out any installation or replacement work before this time has expired.

No Hot-swap of components

The components of the SINAMICS G110M system cannot be swapped, installed or removed without securing any loads controlled by the application, removing the power supply from the system and waiting 5 minutes to allow the electrical components of the system to fully discharge.

CAUTION

Electrostatic discharge

Static discharges on surfaces or interfaces (e.g. terminal or connector pins) can cause malfunctions or defects. ESD protective measures should therefore be observed when working with Inverters or Inverter components.

Removing the Control Module

1. Disconnect all power supplies from the terminal housing.
2. Wait 5 minutes to allow all residual voltages and currents to dissipate.
3. Remove the Power Module (PM). SeeSystem Installation (Page 41).
4. Remove the Communications and Power Interface (CPI) ribbon cable from the Control Module (CM).
5. Remove the PROFIBUS/PROFINET communications cable from the CM.
6. Undo the four CM self-retaining screws.
7. Remove the CM.

Replacing the Control Unit

1. Fit the new CM.
2. Secure the CM in place using the four self-retaining screws.
3. Reconnect the PROFIBUS/PROFINET communications cable to the CM.

4. Reconnect CPI ribbon cable to the CM.
5. Replace the PM. See System Installation (Page 41).
6. Reconnect all the power supplies to the terminal housing.
7. The Inverter goes into the "ready-to-switch-on" state.
8. If you have backed up your settings:
   – Load the settings from the operator panel or via STARTER into the Inverter.
   – For Inverters of the same type and the same firmware version, you can now switch-on the motor. Check the function of the drive.
   – For a different type of Inverter, the Inverter outputs alarm A01028. The alarm indicates that the settings that have been loaded are not compatible with the Inverter. In this case, clear the alarm with p0971 = 1 and recommission the drive.
9. If you have not backed up your settings, then you must recommission the drive.

11.3 Replacing the Power Module

Procedure for replacing a Power Module

DANGER

Dangerous voltages!

Hazardous voltages are still present for up to 5 minutes after the power supply has been switched off. Do not carry out any installation or replacement work before this time has expired.

No Hot-swap of components

The components of the SINAMICS G110M system cannot be swapped, installed or removed without securing any loads controlled by the application, removing the power supply from the system and waiting 5 minutes to allow the electrical components of the system to fully discharge.

CAUTION

Electrostatic discharge

Static discharges on surfaces or interfaces (e.g. terminal or connector pins) can cause malfunctions or defects. ESD protective measures should therefore be observed when working with Inverters or Inverter components.

Removing the Power Module

1. Disconnect all external power to the system; this includes the line supply and the 24 Vdc supply to the Control Module (CM).
2. Wait 5 minutes to allow all residual voltages and currents to dissipate.

3. Undo the Power Module's (PM) four self-retaining screws.
4. Remove the PM from the terminal housing.
5. Remove the memory card from the memory card reader (if one is fitted).

Replacing the Power Module

1. Insert the memory card in the new PM.
2. Fit the PM onto the terminal housing.
3. Fasten the four self-retaining screws (ensuring the are tightened to the correct torque).
4. Reconnect the mains supply and the external 24 V supply to the system.
5. The CM will automatically read the default parameter set that is stored on the memory card.
6. The converter will then go into the "ready-to-switch-on" state.
7. If you have not backed up your settings, then you must recommission the drive.

Alarms, faults and system messages

12

12.1 Alarms

Alarms have the following properties:

- They do not have a direct effect in the converter and disappear once the cause has been removed
- They do not need have to be acknowledged
- They are signaled as follows
  - Status display via bit 7 in status word 1 (r0052)
  - At the Operator Panel with a Axxxxx
  - Via STARTER, if you click on TAB at the bottom left of the STARTER screen

In order to pinpoint the cause of an alarm, there is a unique alarm code and also a value for each alarm.

Alarm buffer

For each incoming alarm, the converter saves the alarm, alarm value and the time that the alarm was received.

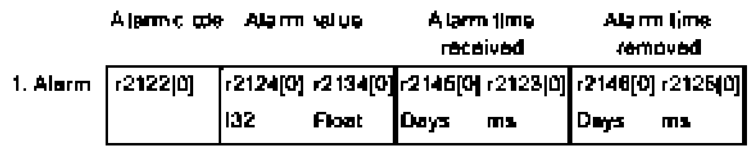


Figure 12-1 Saving the first alarm in the alarm buffer

r2124 and r2134 contain the alarm value - important for diagnostics - as "fixed point" or "floating point" number.

The alarm times are displayed in r2145 and r2146 (in complete days) as well as in r2123 and r2125 (in milliseconds referred to the day of the alarm).
The converter uses an internal time calculation to save the alarm times.

As soon as the alarm has been removed, the converter writes the associated instant in time into parameters r2125 and r2146. The alarm remains in the alarm buffer even if the alarm has been removed.

If an additional alarm is received, then this is also saved. The first alarm is still saved. The alarms that have occurred are counted in p2111.

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 12-2 Saving the second alarm in the alarm buffer

The alarm buffer can contain up to eight alarms. If an additional alarm is received after the eighth alarm - and none of the last eight alarms have been removed - then the next to last alarm is overwritten.

	Alarm code	Alarm value		Alarm time received		Alarm time, resolved	
1st alarm	r2122[0]	r2124[0]	r2134[0]	r2145[0]	r2123[0]	r2146[0]	r2125[0]
2nd alarm	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd alarm	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th alarm	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th alarm	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th alarm	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th alarm	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last alarm	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 12-3 Complete alarm buffer

Emptying the alarm buffer: Alarm history

The alarm history traces up to 56 alarms.

The alarm history only takes alarms that have been removed from the alarm buffer. If the alarm buffer is completely filled - and an additional alarm occurs - then the converter shifts all alarms that have been removed from the alarm buffer into the alarm history. In the alarm history, alarms are also sorted according to the "alarm time received", however, when compared to the alarm buffer, in the inverse sequence:

- The youngest alarm is in index 8
- The second youngest alarm is in index 9
- etc.

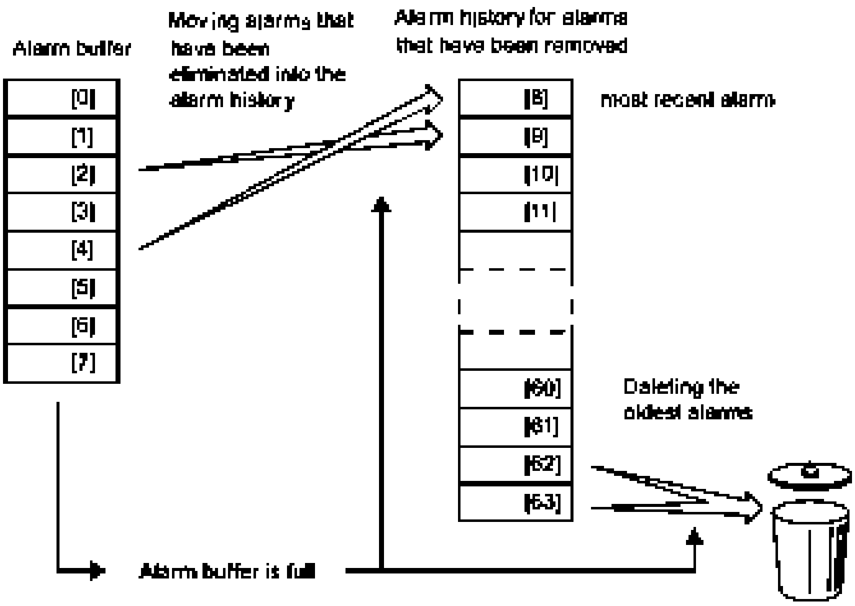


Figure 12-4 Shifting alarms that have been removed into the alarm history

Any alarms that have not been removed remain in the alarm buffer. The converter sorts the alarms and closes gaps between the alarms.

If the alarm history is filled up to index 63, each time a new alarm is accepted in the alarm history, the oldest alarm is deleted.

Parameters of the alarm buffer and the alarm history

Parameter	Description
r2122	**Alarm code** Displays the numbers of alarms that have occurred
r2123	**Alarm time received in milliseconds** Displays the time in milliseconds when the alarm occurred
r2124	**Alarm value** Displays additional information about the alarm
r2125	**Alarm time removed in milliseconds** Displays the time in milliseconds when the alarm was removed
p2111	**Alarm counter** Number of alarms that have occurred after the last reset When setting p2111 = 0, all of the alarms that have been removed from the alarm buffer [0...7] are transferred into the alarm history [8...63]
r2145	**Alarm time received in days** Displays the time in days when the alarm occurred

Parameter	Description
r2132	**Actual alarm code** Displays the code of the alarm that last occurred
r2134	**Alarm value for float values** Displays additional information about the alarm that occurred for float values
r2146	**Alarm time removed in days** Displays the time in days when the alarm was removed

Extended settings for alarms

Parameter	Description
You can change up to 20 different alarms into a fault or suppress alarms:	
p2118	**Setting the message number for the message type** Selection of the alarms for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected alarm 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

12.2 Faults

A fault indicates a severe fault during inverter operation.

The inverter signals a fault as follows:

- At the operator panel with Fxxxxx
- At the inverter using the red LED RDY
- In bit 3 of status word 1 (r0052)
- Via STARTER

To delete a message, you must remedy the cause of the fault and acknowledge the fault.

Every fault has a unique fault code and also a fault value. You need this information to determine the cause of the fault.

Fault buffer of actual values

The inverter saves the time, fault code and fault value for every fault it receives.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0] I32	r2133[0] Float	r2130[0] Days	r0948[0] ms	r2136[0] Days	r2109[0] ms

Figure 12-5 Saving the first fault in the fault buffer

r0949 and r2133 contain the fault value - important for diagnostics - as "fixed point" or "floating point" number.

The "fault time received" is in parameter r2130 (in complete days) as well as in parameter r0948 (in milliseconds referred to the day of the fault). The "fault time removed" is written to parameters r2109 and r2136 when the fault has been acknowledged.
The inverter uses its internal time calculation to save the fault times.

If an additional fault occurs before the first fault has been acknowledged, then this is also saved. The first alarm remains saved. The fault cases that have occurred are counted in p0952. A fault case can contain one or several faults.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]

Figure 12-6 Saving the second fault in the fault buffer

The fault buffer can accept up to eight actual faults. The next to last fault is overwritten if an additional fault occurs after the eighth fault.

	Fault code	Fault value		Fault time received		Fault time removed	
1st fault	r0945[0]	r0949[0]	r2133[0]	r2130[0]	r0948[0]	r2136[0]	r2109[0]
2nd fault	[1]	[1]	[1]	[1]	[1]	[1]	[1]
3rd fault	[2]	[2]	[2]	[2]	[2]	[2]	[2]
4th fault	[3]	[3]	[3]	[3]	[3]	[3]	[3]
5th fault	[4]	[4]	[4]	[4]	[4]	[4]	[4]
6th fault	[5]	[5]	[5]	[5]	[5]	[5]	[5]
7th fault	[6]	[6]	[6]	[6]	[6]	[6]	[6]
Last fault	[7]	[7]	[7]	[7]	[7]	[7]	[7]

Figure 12-7 Complete fault buffer

Acknowledgement

In most cases, you have the following options to acknowledge a fault:

- Switch-off the inverter power supply and switch-on again.
- Press the acknowledgement button on the operator panel

- Acknowledgement signal at digital input 2
- Acknowledgement signal in bit 7 of control word 1 (r0054) for Control Units with fieldbus interface

Faults detected during the inverter-internal monitoring of hardware and firmware can be acknowledged only by switching the supply voltage off and on again. The list of faults in the List Manual contains a note on this limited acknowledgement possibility.

Emptying the fault buffer: Fault history

The fault history can contain up to 56 faults.

The acknowledgement has no effect as long as none of the causes for the faults in the buffer have been removed. If at least one of the faults in the fault buffer has been removed (the cause of the fault has been removed) and you acknowledge the faults, then the following happens:

1. The inverter accepts all faults from the fault buffer in the first eight memory locations of the fault history (indexes 8 ... 15).
2. The inverter deletes the faults that have been removed from the fault buffer.
3. The inverter writes the time of acknowledgement of the faults that have been removed into parameters r2136 and r2109 (fault time removed).

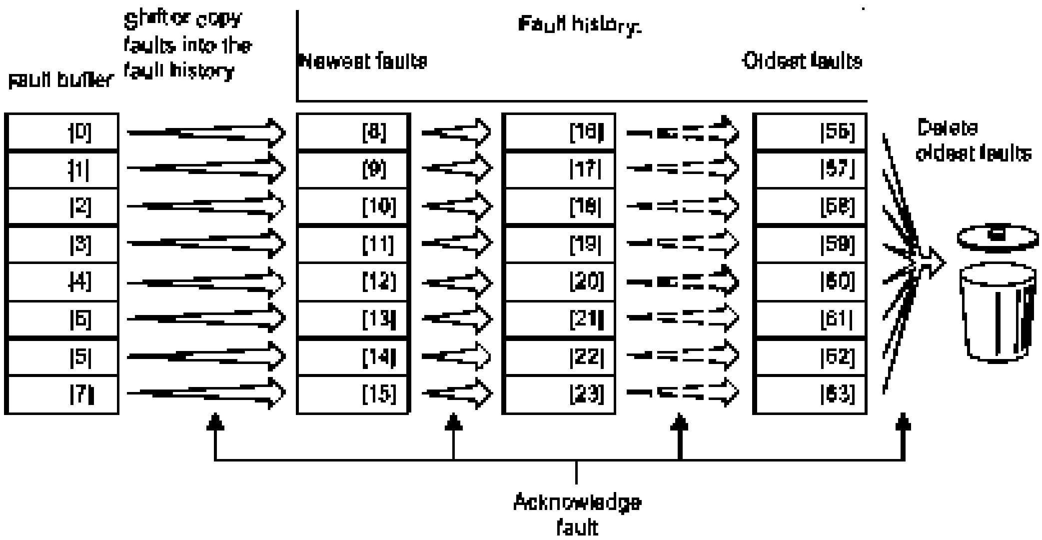


Figure 12-8 Fault history after acknowledging the faults

After acknowledgement, the faults that have not been removed are located in the fault buffer as well as in the fault history. For these faults, the "fault time coming" remains unchanged and the "fault time removed" remains empty.

If less than eight faults were shifted or copied into the fault history, the memory locations with the higher indexes remain empty.

The inverter shifts the values previously saved in the fault history by eight indexes. Faults, which were saved in indexes 56 … 63 before the acknowledgement, are deleted.

Deleting the fault history

If you wish to delete all faults from the fault history, set parameter p0952 to zero.

Parameters of the fault buffer and the fault history

Parameter	Description
r0945	**Fault code** Displays the numbers of faults that have occurred
r0948	**Fault time received in milliseconds** Displays the time in milliseconds when the fault occurred
r0949	**Fault value** Displays additional information about the fault
p0952	**Fault cases, counter** Number of fault cases that have occurred since the last acknowledgement. The fault buffer is deleted with p0952 = 0.
r2109	**Fault time removed in milliseconds** Displays the time in milliseconds when the fault occurred
r2130	**Fault time received in days** Displays the time in days when the fault occurred
r2131	**Actual fault code** Displays the code of the oldest fault that is still active
r2133	**Fault value for float values** Displays additional information about the fault that occurred for float values
r2136	**Fault time removed in days** Displays the time in days when the fault was removed

Extended settings for faults

Parameter	Description
You can change the fault response of the motor for up to 20 different fault codes:	
p2100	**Setting the fault number for fault response** Selection of the faults for which the fault response applies
p2101	**Setting, fault response** Setting the fault response for the selected fault
You can change the acknowledgement type for up to 20 different fault codes:	
p2126	**Setting the fault number for the acknowledgement mode** Selection of the faults for which the acknowledgement type should be changed
p2127	**Setting, acknowledgement mode** Setting the acknowledgement type for the selected fault 1: Can only be acknowledged using POWER ON 2: IMMEDIATE acknowledgement after removing the fault cause

Parameter	Description
You can change up to 20 different faults into an alarm or suppress faults:	
p2118	**Setting the message number for the message type** Selection of the message for which the message type should be changed
p2119	**Setting the message type** Setting the message type for the selected fault 1: Fault 2: Alarm 3: No message

You will find details in function diagram 8075 and in the parameter description of the List Manual.

12.3 Status LED overview

LED status indicators

The Power Module has number of dual-colour LEDs which are designed to indicate the operational state of the Inverter. The LEDs are used to indicate the status of the following states:

- General fault conditions
- Communication status

The location of the various LEDs on the Power Module and Communications and Power Interface (which is attached to the terminal housing) are shown in the figure below.

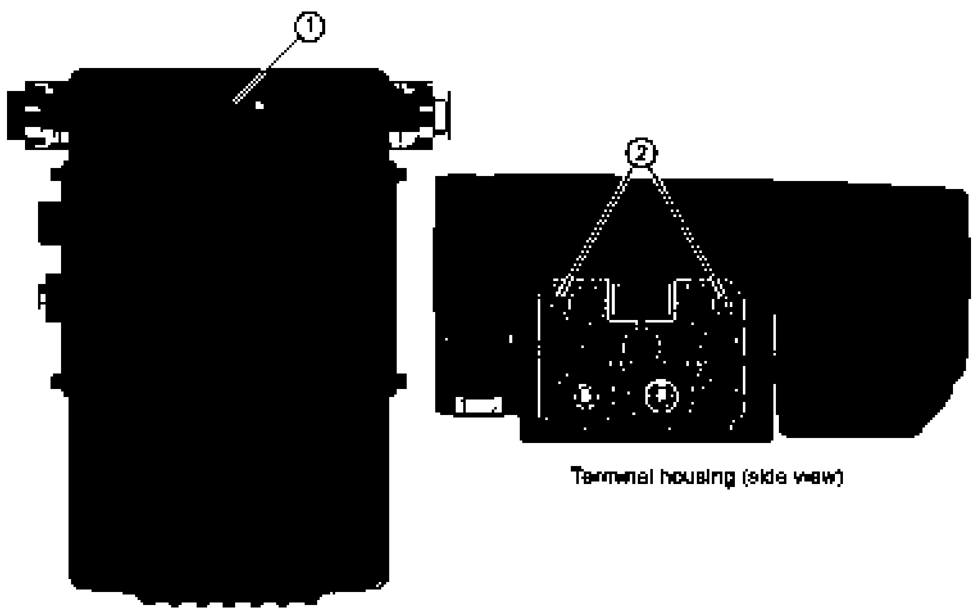


Figure 12-9 Status LED locations

Explanation of status LEDs

An explanation of the various states indicated by the LEDs are given in the tables below.

Table 12- 1 Description of general status LEDS

LED		Description of function
RDY	BF	
GREEN - On	-	Ready for operation (no active fault)
GREEN - flashing slowly	-	Commissioning or reset of factory settings
RED - on	ORANGE - flashing slowly	Firmware update in progress
RED - flashing slowly	RED - flashing slowly	Firmware updated is complete - power ON reset required
RED - flashing quickly	-	General fault condition
RED - flashing quickly	RED - On	Fault occurred during firmware update
RED - flashing quickly	RED - flashing quickly	Incompatible firmware or incorrect memory card

Table 12- 2 Description of PROFIBUS communications LED

BF LED	Description of function
Off	Cyclic data exchange (or PROFIBUS not in use - p2030 = 0)
RED - flashing slowly	Bus fault - configuration fault
RED - flashing quickly	Bus fault: - no data exchange - baud rate search - cannot detect the correct baud rate - no connection - the connection between the Inverter and PLC has been lost

Table 12- 3 Description of PROFINET communications LED

PROFINET LED	Description of function
LNK - On	Link is active
LNK - Off	Link inactive with no data being transferred

12.4 List of alarms and faults

Axxxxx Alarm

Fyyyyy: Fault

Table 12- 4 Faults, which can only be acknowledged by switching the converter off and on again (power on reset)

Number	Cause	Remedy
F01000	Software fault in CU	Replace CU.
F01001	Floating Point Exception	Switch CU off and on again.
F01015	Software fault in CU	Upgrade firmware or contact technical support.
F01018	Power-up aborted more than once	After this fault is output, the converter powers up with the factory settings. Remedy: Back up factory setting with p0971=1. Switch CU off and on again. Recommission the converter.
F01040	Parameters must be saved	Save parameters (p0971). Switch CU off and on again.
F01044	Loading of memory data card defective	Replace memory card or CU.
F01105	CU: Insufficient memory	Reduce number of data records.
F01205	CU: Time slice overflow	Contact technical support.
F01250	CU hardware fault	Replace CU.
F01512	An attempt has been made to establish an conversion factor for scaling which is not present	Create scaling or check transfer value.
F01662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30022	Power Module: Monitoring U_{CE}	Check or replace the Power Module.
F30052	Incorrect Power Module data	Replace Power Module or upgrade CU firmware.
F30053	Error in FPGA data	Replace the Power Module.
F30662	CU hardware fault	Switch CU off and on again, upgrade firmware, or contact technical support.
F30664	CU power up aborted	Switch CU off and on again, upgrade firmware, or contact technical support.
F30850	Software fault in Power Module	Replace Power Module or contact technical support.

Table 12- 5 The most important alarms and faults

Number	Cause	Remedy
F01018	Power-up aborted more than once	1. Switch the module off and on again. 2. After this fault has been output, the module is booted with the factory settings. 3. Recommission the converter.
A01028	Configuration error	Explanation: Parameterization on the memory card has been created with a different type of module (order number, MLFB) Check the module parameters and recommission if necessary.
F01033	Unit switchover: Reference parameter value invalid	Set the value of the reference parameter not equal to 0.0 (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).

Number	Cause	Remedy
F01034	Unit switchover: Calculation of the parameter values after reference value change unsuccessful	Select the value of the reference parameter so that the parameters involved can be calculated in the per unit notation (p0304, p0305, p0310, p0596, p2000, p2001, p2002, p2003, r2004).
F01122	Frequency at the probe input too high	Reduce the frequency of the pulses at the probe input.
A01590	Motor maintenance interval lapsed	Carry out maintenance and reset the maintenance interval (p0651).
A01900	PROFIBUS: Configuration telegram faulty	Explanation: A PROFIBUS master is attempting to establish a connection with a faulty configuration telegram. Check the bus configuration on the master and slave side.
A01910 F01910	Setpoint timeout	The alarm is generated when p2040 ≠ 0 ms and one of the following causes is present: • The bus connection is interrupted • The MODBUS master is switched off • Communications error (CRC, parity bit, logical error) • An excessively low value for the fieldbus monitoring time (p2040)
A01920	PROFIBUS: Cyclic connection interrupt	Explanation: The cyclic connection to PROFIBUS master is interrupted. Establish the PROFIBUS connection and activate the PROFIBUS master with cyclic operation.
F03505	Analog input, wire break	Check the connection to the signal source for interrupts. Check the level of the signal supplied. The input current measured by the analog input can be read out in r0752.
A03520	Temperature sensor fault	Check that the sensor is connected correctly.
A05000 A05001 A05002 A05004 A05006	Power Module overtemperature	Check the following: - Is the ambient temperature within the defined limit values? - Are the load conditions and duty cycle configured accordingly? - Has the cooling failed?
F06310	Supply voltage (p0210) incorrectly parameterized	Check the parameterized supply voltage and if required change (p0210). Check the line voltage.
F07011	Motor overtemperature	Reduce the motor load. Check ambient temperature. Check the wiring and connection of the sensor.
A07012	I2t Motor Module overtemperature	Check and if necessary reduce the motor load. Check the motor's ambient temperature. Check thermal time constant p0611. Check overtemperature fault threshold p0605.
A07015	Motor temperature sensor alarm	Check that the sensor is connected correctly. Check the parameter assignment (p0601).
F07016	Motor temperature sensor fault	Make sure that the sensor is connected correctly. Check the parameterization (p0601). Deactivate the temperature sensor fault (p0607 = 0).
F07086 F07088	Unit switchover: Parameter limit violation	Check the adapted parameter values and if required correct.

Number	Cause	Remedy
F07320	Automatic restart aborted	Increase the number of restart attempts (p1211). The actual number of start attempts is shown in r1214. Increase the wait time in p1212 and/or monitoring time in p1213. Connect an ON command (p0840). Increase the monitoring time of the power unit or switch off (p0857). Reduce the wait time for resetting the fault counter p1213[1] so that fewer faults are registered in the time interval.
A07321	Automatic restart active	Explanation: The automatic restart (AR) is active. During voltage recovery and/or when remedying the causes of pending faults, the drive is automatically switched back on.
F07330	Search current measured too low	Increase search current (p1202), check motor connection.
A07400	V_{DC_max} controller active	If it is not desirable that the controller intervenes: • Increase the ramp-down times. • Deactivate the V_{DC_max} controller (p1240 = 0 for vector control, p1280 = 0 for U/f control).
A07409	U/f control, current limiting controller active	The alarm automatically disappears after one of the following measures: • Increase the current limit (p0640). • Reduce the load. • Slow down the up ramp for the setpoint speed.
F07426	Technology controller actual value limited	• Adapt the limits to the signal level (p2267, p2268). • Check the actual value scaling (p2264).
F07801	Motor overcurrent	Check current limits (p0640). Vector control: Check current controller (p1715, p1717). U/f control: Check the current limiting controller (p1340 … p1346). Increase acceleration ramp (p1120) or reduce load. Check motor and motor cables for short circuit and ground fault. Check motor for star-delta connection and rating plate parameterization. Check power unit / motor combination. Select flying restart function (p1200) if switched to rotating motor.
A07805	Drive: Power unit overload I2t	• Reduce the continuous load. • Adapt the load cycle. • Check the assignment of rated currents of the motor and power unit.
F07806	Regenerative power limit exceeded	Increase deceleration ramp. Reduce driving load. Use power unit with higher energy recovery capability. For vector control, the regenerative power limit in p1531 can be reduced until the fault is no longer activated.
F07807	Short circuit detected	• Check the converter connection on the motor side for any phase-phase short-circuit. • Rule out that line and motor cables have been interchanged.

Number	Cause	Remedy
A07850 A07851 A07852	External alarm 1 … 3	The signal for "external alarm 1" has been triggered. Parameters p2112, p2116 and p2117 determine the signal sources for the external alarm 1… 3. Remedy: Remove the causes of these alarms.
F07860 F07861 F07862	External fault 1 … 3	Remove the external causes for this fault.
F07900	Motor blocked	Check that the motor can run freely. Check the torque limits (r1538 and r1539). Check the parameters of the "Motor blocked" message (p2175, p2177).
F07901	Motor overspeed	Activate precontrol of the speed limiting controller (p1401 bit 7 = 1). Increase hysteresis for overspeed signal p2162.
F07902	Motor stalled	Check whether the motor data has been parameterized correctly and perform motor identification. Check the current limits (p0640, r0067, r0289). If the current limits are too low, the drive cannot be magnetized. Check whether motor cables are disconnected during operation.
A07903	Motor speed deviation	Increase p2163 and/or p2166. Increase the torque, current and power limits.
A07910	Motor overtemperature	Check the motor load. Check the motor's ambient temperature. Check the KTY84 sensor. Check the overtemperatures of the thermal model (p0626 ... p0628).
A07920	Torque/speed too low	The torque deviates from the torque/speed envelope curve. • Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
A07921	Torque/speed too high	
A07922	Torque/speed out of tolerance	
F07923	Torque/speed too low	• Check the connection between the motor and the load. • Adapt the parameterization corresponding to the load.
F07924	Torque/speed too high	
A07927	DC braking active	Not required
A07980	Rotary measurement activated	Not required
A07981	No enabling for rotary measurement	Acknowledge pending faults. Establish missing enables (see r00002, r0046).
A07991	Motor data identification activated	Switch on the motor and identify the motor data.
F08501	Setpoint timeout	• Check the PROFINET connection. • Set the controller to RUN mode. • If the error occurs repeatedly, check the set monitoring time p2044.
F08502	Monitoring time sign-of-life expired	• Check the PROFINET connection.
F08510	Send configuration data not valid	• Check the PROFINET configuration
A08511	Receive configuration data not valid	

Number	Cause	Remedy
A08526	No cyclic connection	• Activate the controller with cyclic operation. • Check the parameters "Name of Station" and "IP of Station" (r61000, r61001).
A08565	Consistency error affecting adjustable parameters	Check the following: • IP address, subnet mask or default gateway is not correct. • IP address or station name used twice in the network. • Station name contains invalid characters.
F13100	Know-how protection: Copy protection error	The know-how protection and the copy protection for the memory card are active. An error occurred during checking of the memory card. • Insert a suitable memory card and switch the converter supply voltage temporarily off and then on again (POWER ON). • Deactivate the copy protection (p7765).
F13101	Know-how protection: Copy protection cannot be activated	Insert a valid memory card.
F30001	Overcurrent	Check the following: • Motor data, if required, carry out commissioning • Motor connection method (Y / Δ) • U/f operation: Assignment of rated currents of motor and Power Module • Line quality • Make sure that the line commutating reactor is connected properly • Power cable connections • Power cables for short-circuit or ground fault • Power cable length • Line phases If this doesn't help: • U/f operation: Increase the acceleration ramp • Reduce the load • Replace the power unit
F30002	DC-link voltage overvoltage	Increase the ramp-down time (p1121). Set the rounding times (p1130, p1136). Activate the DC link voltage controller (p1240, p1280). Check the line voltage (p0210). Check the line phases.
F30003	DC-link voltage undervoltage	Check the line voltage (p0210).
F30004	Converter overtemperature	Check whether the converter fan is running. Check whether the ambient temperature is in the permissible range. Check whether the motor is overloaded. Reduce the pulse frequency.
F30005	I2t converter overload	Check the rated currents of the motor and Power Module. Reduce current limit p0640. When operating with U/f characteristic: Reduce p1341.

Number	Cause	Remedy
F30011	Line phase failure	Check the converter's input fuses. Check the motor cables.
F30015	Motor cable phase failure	Check the motor cables. Increase the ramp-up or ramp-down time (p1120).
F30021	Ground fault	• Check the power cable connections. • Check the motor. • Check the current transformer. • Check the cables and contacts of the brake connection (a wire might be broken).
F30027	Time monitoring for DC link pre-charging	Check the supply voltage at the input terminals. Check the line voltage setting (p0210).
F30035	Overtemperature, intake air	• Check whether the fan is running. • Check the fan filter elements. • Check whether the ambient temperature is in the permissible range.
F30036	Overtemperature, inside area	
F30037	Rectifier overtemperature	See F30035 and, in addition: • Check the motor load. • Check the line phases
A30502	DC link overvoltage	• Check the unit supply voltage (p0210). • Check the dimensioning of the line reactor.
A30920	Temperature sensor fault	Check that the sensor is connected correctly.

For further information, please refer to the List Manual.

Technical data 13

13.1 Performance ratings Control Module

SINAMICS CU240M performance ratings

Table 13- 1 Control Unit performance ratings

Feature	Specification
Operating voltage	24 V DC External supply 24 V DC ± 15% Use a power supply with protective extra-low-voltage (PELV = Protective Extra Low Voltage acc. to EN 61800-5-1): 0 V of the power supply has to be connected with low resistance to the PE of the plant. Class 2 supply
Setpoint resolution	0.01 Hz digital; 0.01 Hz serial
Digital inputs	4 programmable digital inputs; PNP, SIMATIC-compatible, low < 5 V, high > 11 V, maximum input voltage 30 V
Digital outputs	2 programmable, 24 V DC / 0 A …0.5 A (resistive). The maximum current output is 0.5 A in total when using both or a single digital output. Update time of all DO: 2 ms
Analog inputs	2 inputs 0 V ... 10 V or 0 ... 20 mA with 12 bit resolution. Max. Can also be configured as digital inputs.
Temperature sensor	• PTC: Short-circuit monitoring 22 Ω, switching threshold 1650 Ω • KTY84 • Temperature sensor with dry contact
PFH	5 × 10E-8 Probability of failure of the fail-safe functions (Probability of Failure per Hour)
USB interface	Mini-B (situated on the cover of the Power Module)

Note

Short-term voltage dips in the external 24 V supply (≤ 3 ms and ≤ 95% of the rated voltage)

If the 400 V supply of the inverter is switched off, the inverter reacts to short-term voltage dips in the external 24 V supply with fault F30074. Communication via fieldbus, however, remains in effect in this case.

13.2 Performance ratings Power Module

SINAMICS PM240M performance ratings

Table 13- 2 Power Module performance ratings

Feature	Specification
Line operating voltage & power ranges	3 AC 380 V (- 10%) … 500 V (+ 6%)
	High Overload: 0.37 kW … 4.0 kW (0.5 hp … 5.0 hp)
Input frequency	47 Hz … 63 Hz
Output frequency	0 Hz … 650 Hz
cos φ	0.95
Inverter efficiency	95% … 97%
Overload capability (HO)	2 x Nominal output current for 3 seconds followed by 1.5 x Nominal output current for 57 seconds every 300 seconds (averages as 110%). For 4 kW variant: 1.6 x Nominal output current for 3 seconds followed by 1.5 x Nominal output current for 57 seconds every 300 seconds (averages as 110%).
Inrush current	Less than rated input current
Pulse frequency	4 kHz (standard); 4 kHz … 16 kHz (in 2 kHz steps)
Electromagnetic compatibility	Internal Class A filters according to EN 55011
Protection level	IP65 (when Power Module and Control Unit is fully assembled). The motor only has IP54 protection.
Temperature range	CU: -10 °C … +40 °C (14 °F … 104 °F) - High Overload (HO)
Storage temperature	-40 °C … +70 °C (-40 °F … 158 °F)
Humidity	< 95% RH - non-condensing
Operational altitude	Up to 1000 m (3280 ft) above sea level without derating
Protection features	Undervoltage, Overvoltage, Overload, Ground faults, Short circuit, Stall prevention, Motor blocking protection, Motor overtemperature, Power Module overtemperature, Parameter interlock
Standards	UL, cUL, CE, C-tick
CE mark	Conformity with EC Low Voltage Directive 73/23/EEC and filtered versions also Electromagnetic Compatibility Directive 89/336/EEC
EM Brake	180 V DC (400 V half-wave rectified) 1A maximum

13.3 SINAMICS G110M specifications

Power Module Specifications

Note

UL certified Fuses must be used

UL certified Fuses must be used" it should state "In order that the system is in compliance with UL requirements, UL listed class J fuses must be used. The fuse rating of these fuses must be equal to or less that the ratings given in Table 4-2 Rated Output, Input and Fuses (Page 59).

IP protection of the system

The Power Module and the Terminal Unit (which includes the Control Unit) when fully assembled and attach to the motor has an IP rating of IP65. The motor only has an IP rating of IP54.

Table 13- 3 PM240M, IP65, Frame Sizes A, Class A filter, 3 AC 380 V … 500 V

Order No.	6SL3517-…	…1BE11-3AM0	…1BE12-3AM0	...1BE13-3AM0
Rated / LO power Rated / LO input current Rated / LO Output current		0.37 kW 1.3 A 1.3 A	0.75 kW 2.0 A 2.2 A	1.1 kW 2.8 A 3.1 A
HO power HO input current HO output current		0.37 kW 1.3 A 1.3 A	0.75 kW 2.0 A 2.2 A	1,1 kW 2.8 A 3.1 A
Fuse		10 A, class J	10 A, class J	10 A, class J
Power losses		0.012 kW	0.014 kW	0.2 kW
Required cooling air flow		4.8 l/s	4.8 l/s	4.8 l/s
Cross section of line and motor cable		1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG	1 … 2.5 mm^2 18 … 14 AWG
Tightening torque for line and motor cable		0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight		2.1 kg	2.1 kg	2.1 kg

Table 13- 4 PM240M, IP65, Frame Sizes A, Class A filter, 3 AC 380 V … 500 V

Order No.	6SL3517-…	…1BE14-3AM0
Rated / LO power Rated / LO input current Rated / LO Output current		1.5 kW 3.6 A 4.1 A
HO power HO input current HO output current		1,5kW 3.6 A 4.1 A
Fuse		10 A, class J

Order No. 6SL3517-…	…1BE14-3AM0
Power losses	0.04 kW
Required cooling air flow	4.8 l/s
Cross section of line and motor cable	1 … 2.5 mm² 18 … 14 AWG
Tightening torque for line and motor cable	0.5 Nm / 4 lbf in
Weight	2.1 kg

Table 13- 5 PM240M, IP65, Frame Sizes B, Class A filter, 3 AC 380 V … 500 V

Order No. - Filtered 6SL3517-…	…1BE16-3AM0	…1BE17-7AM0	…1BE21-0AM0
Rated / LO power Rated / LO input current Rated / LO Output current	2.2 kW 5.3 A 5.9 A	3 kW 6.9 A 7.7 A	4 kW 8.0 A 10.2 A
HO power HO input current HO output current	2.2 kW 5.3 A 5.9 A	3 KW 6.9 A 7.7 A	4 kW 8.0 A 10.2 A
Fuse	20 A, Class J	20 A, Class J	20 A, Class J
Power losses	0.153 kW	0.073 kW	0.091 kW
Required cooling air flow	24 l/s	24 l/s	24 l/s
Cross section of line and motor cable	1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG	1 … 2.5 mm² 18 … 14 AWG
Tightening torque for line and motor cable	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in	0.5 Nm / 4 lbf in
Weight	3.4 kg	3.4 kg	3.4 kg

13.4 Ambient operating temperature

Temperature

The operating temperature range is shown diagramatically in the figure below:

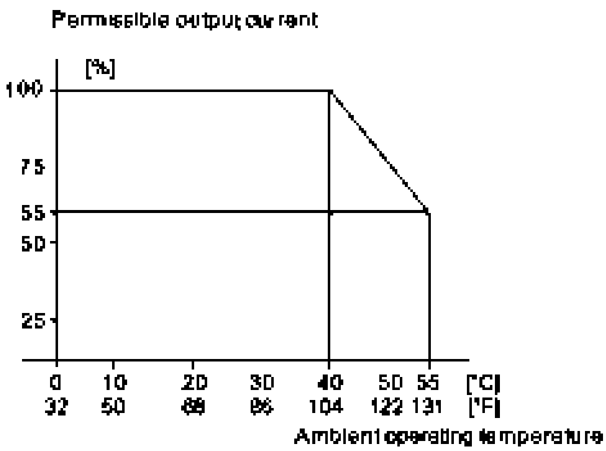


Figure 13-1 Power derating for temperature

Humidity range

Relative air humidity for the SINAMICS G110M is ≤ 95 % non-condensing.

Shock and vibration

Do not drop the SINAMICS G110M or expose to sudden shock. Do not install the SINAMICS G110M in an area where it is likely to be exposed to constant vibration.

Electromagnetic radiation

Do not install the SINAMICS G110M near sources of electromagnetic radiation.

Atmospheric pollution and water

When fully assembled the inverter has an IP65 rating. This means that the inverter is totally protected against dust and low pressure jets of water. Any unused connections should be covered with the correct sealing caps to ensure the IP65 rating.

Note

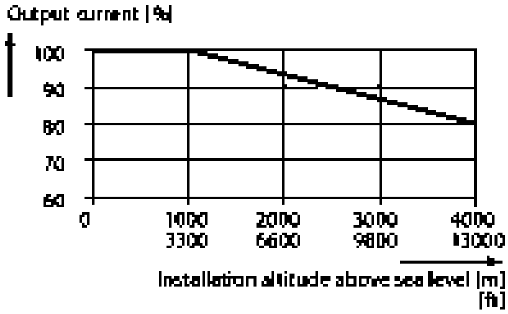
IP protection of the motor

The motors of the G110M system only have an IP protection rating of IP54. This means there is limited protection against dust ingress and splashes of water from any direction.

13.5 Current and voltage derating dependent on the installation altitude

Current derating depending on the installation altitude

Above 1000 m above sea level you must reduce the inverter output current corresponding to the adjacent curve as a result of the lower cooling power of the air.



Permissible line supplies depending on the installation altitude

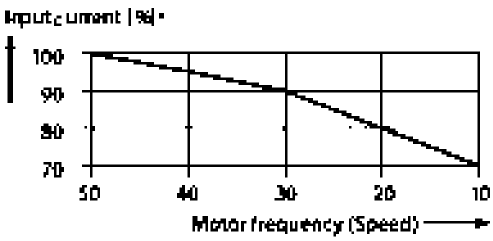
- Installation altitude up to 2000 m above sea level
  - Connection to every supply system permitted for the inverter.
- Installation altitudes between 2000 m and 4000 m above sea level
  - Connection to a TN system with grounded neutral point.
  - TN systems with grounded line conductor are not permitted.
  - The TN line system with grounded neutral point can also be supplied using an isolation transformer.
  - The phase-to-phase voltage does not have to be reduced.

Also observe restrictions related to the connection of components.

Motor speed

The speed at which the motor is running affects the temperature that is generated by the motor. At times it may be necessary to derate the speed of the motor by decrease the input current from the converter.

The derating curve in relationship to the input current from the converter is shown in the following diagram.



*
Up to the maximum capability of the converter output current.

13.6 Pulse frequency and current reduction

Relationship between pulse frequency and output base-load current reduction

Table 13- 6 Current reduction depending on pulse frequency [1]

Rated power based on LO	Rated output current at pulse frequency of						
	4 kHz	6 kHz	8 kHz	10 kHz	12 kHz	14 kHz	16 kHz
0.37 kW	--	1.30	1.11	0.91	0.78	0.65	0.59
0.75 kW	2.2 A	1.9 A	1.5 A	1.3 A	1.1 A	1.0 A	0.9 A
1.1 kW	3.1 A	2.6 A	2.2 A	1.9 A	1.6 A	1.4 A	1.2 A
1.5 kW	4.1 A	3.5 A	2.9 A	2.5 A	2.1 A	1.8 A	1.6 A
2.2 kW	5.6 A	4.8 A	3.9 A	3.4 A	2.8 A	2.5 A	2.2 A
3.0 kW	7.3 A	6.2 A	5.1 A	4.4 A	3.7 A	3.3 A	2.9 A
4.0 kW	8.8 A	7.5 A	6.2 A	5.3 A	4.4 A	4.0 A	3.5 A

[1] The permissible motor cable length depends on the cable type and the chosen pulse frequency.

Appendix

A

A.1 Star-delta motor connection and application examples

Depending on your application, you can operate the motor in the star or delta connection (Y/Δ).

Examples for operating the converter and motor on a 400 V line supply

Assumption: The motor rating plate states 230/400 V Δ/Y.

Case 1: A motor is normally operated between standstill and its rated speed (i.e. a speed corresponding to the line frequency). In this case, you need to connect the motor in Y.
Operating the motor above its rated speed is only possible in field weakening, i.e. the motor torque available is reduced above the rated speed.

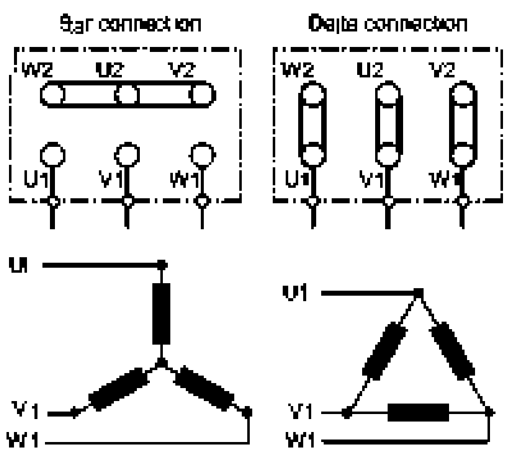
Case 2: If you want to operate the motor with the "87 Hz characteristic", you need to connect the motor in Δ.
With the 87 Hz characteristic, the motor's power output increases. The 87 Hz characteristic is mainly used with geared motors.

Before you connect the motor, ensure that the motor has the appropriate connection for your application:

Motor is connected in the star or delta configuration

With SIEMENS motors, you will see a diagram of both connection methods on the inside of the cover of the terminal box:

- Star connection (Y)
- Delta connection (Δ)



A.2 Adapting Inverter to the application

A.2.1 General basics

Inverters are used to improve and extend the starting and speed response of motors.

Adapting the inverter to the drive task

The inverter must match the motor that it is controlling and the drive task to be able to optimally operate and protect the motor.

Although the inverter can be parameterized for very specific applications, many standard applications function satisfactorily with just a few adaptations.

Use the factory settings (where possible)

In simple applications, the inverter already functions with its factory settings.

Only basic commissioning is required ... for simple, standard applications

Most standard applications function after just a few adaptations made during the basic commissioning.

A.2.2 Parameter

Parameters are the interface between the firmware of the converter and the commissioning tool, e.g. an Operator Panel.

Adjustable parameters

Adjustable parameters are the "adjusting screws" with which you adapt the converter to its particular application. If you change the value of an adjustable parameter, then the converter behavior also changes.

Adjustable parameters are shown with a "p" as prefix, e.g. p1082 is the parameter for the maximum motor speed.

Display parameters

Display parameters allow internal measured quantities of the converter and the motor to be read.

The Operator Panel and STARTER represent display parameters with an "r" prefix, for example, r0027 is the parameter for the converter output current.

A.3 Frequently required parameters

Parameters that are commonly required

Table A- 1 **How to switch to commissioning mode or restore the factory setting**

Parameter	Description
p0010	**Commissioning parameters** 0: Ready (factory setting) 1: Carry out basic commissioning 3: Perform motor commissioning 5: Technological applications and units 15: Define number of data records 30: Factory setting - initiate restore factory settings

Table A- 2 **How to determine the firmware version of the Control Unit**

Parameter	Description
R0018	**Firmware version is displayed**

Table A- 3 **How to select the command and setpoint sources for the converter**

Parameter	Description
p0015	Additional information is available in Section Terminal assignment dependent on interface configuration (Page 74).

Table A- 4 **How to set the ramp-up and ramp-down**

Parameter	Description
p1080	**Minimum speed** 0.00 [rpm] factory setting
p1082	**Maximum speed** 1500.000 [rpm] factory setting
p1120	**Ramp-up time** 10.00 [s]
p1121	**Ramp-down time** 10.00 [s]

Table A- 5 **This is how you set the closed-loop type**

Parameter	Description
P1300	0: V/f control with linear characteristic 1: V/f control with linear characteristic and FCC 2: V/f control with parabolic characteristic 3: V/f control with parameterizable characteristic 4: V/f control with linear characteristic and ECO 5: V/f control for drives requiring a precise frequency (textile area) 6: V/f control for drive requiring a precise frequency and FCC 7: V/f control with parabolic characteristic and ECO 19: V/f control with independent voltage setpoint

Table A- 6 **This is how you optimize the starting behavior of the V/f control for a high break loose torque and overload**

Parameter	Description
p1310	**Voltage boost to compensate ohmic losses** The voltage boost is active from standstill up to the rated speed. It is at its highest at speed 0 and continually decreases as the speed increases. Value of the voltage boost at speed 0 in V: 1.732 × rated motor current (p0305) × stator resistance (r0395) × p1310 / 100%
p1311	**Voltage boost when accelerating** The voltage boost is effective from standstill up to the rated speed. It is independent of the speed and has a value in V of: 1.732 × rated motor current (p0305) × stator resistance (p0350) × p1311 / 100%
p1312	**Voltage boost when starting** Setting to additionally boost the voltage when starting, however only when accelerating for the first time.

A.4 Interconnecting signals in the inverter

A.4.1 Fundamentals

The following functions are implemented in the converter:

- Open-loop and closed-loop control functions
- Communication functions
- Diagnosis and operating functions

Every function comprises one or several blocks that are interconnected with one another.

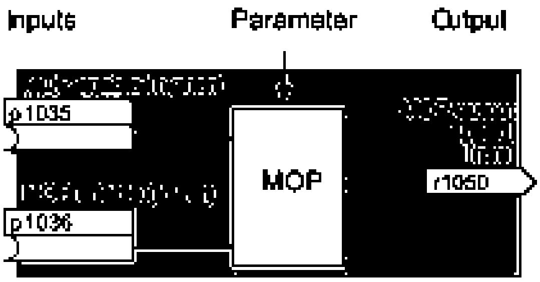


Figure A-1 Example of a block: Motorized potentiometer (MOP)

Most of the blocks can be adapted to specific applications using parameters.

You cannot change the signal interconnection within the block. However, the interconnection between blocks can be changed by interconnecting the inputs of a block with the appropriate outputs of another block.

The signal interconnection of the blocks is realized, contrary to electric circuitry, not using cables, but in the software.

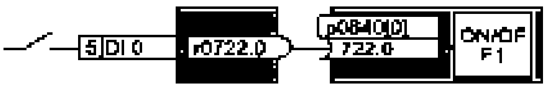


Figure A-2 Example: Signal interconnection of two blocks for digital input 0

Binectors and connectors

Connectors and binectors are used to exchange signals between the individual blocks:

- Connectors are used to interconnect "analog" signals. (e.g. MOP output speed)
- Binectors are used to interconnect "digital" signals. (e.g. 'Enable MOP up' command)

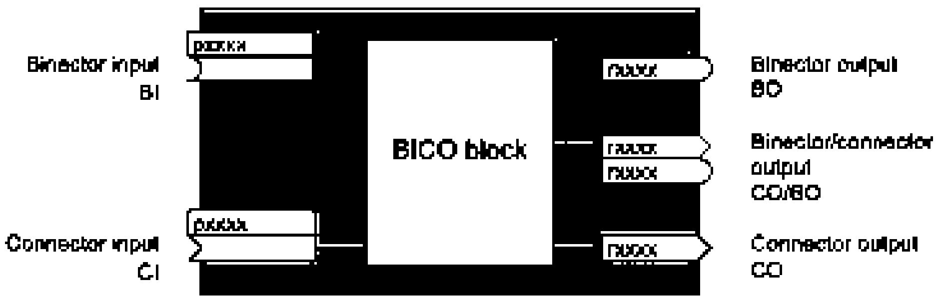


Figure A-3 Symbols for binector and connector inputs and outputs

Binector/connector outputs (CO/BO) are parameters that combine more than one binector output in a single word (e.g. r0052 CO/BO: status word 1). Each bit in the word represents a digital (binary) signal. This summary reduces the number of parameters and simplifies parameter assignment.

Binector or connector outputs (CO, BO or CO/BO) can be used more than once.

When must you interconnect signals in the converter?

If you change the signal interconnection in the converter, you can adapt the converter to a wide range of requirements. This does not necessarily have to involve highly complex functions.

Example 1: Assign a different function to a digital input.

Example 2: Switch the speed setpoint from the fixed speed to the analog input.

How much care is required when you change the signal interconnection?

Always take care when establishing internal signal interconnections. Note which changes you make as you go along since the process of analyzing them later can be quite difficult.

The STARTER commissioning tool offers signals in plain text and simplifies their interconnection.

Where can you find additional information?

- This manual is sufficient for simple signal interconnections (e.g. assigning a different function to digital inputs).
- The parameter list in the List Manual is sufficient for more complex signal interconnections.
- You can also refer to the function diagrams in the List Manual for complex signal interconnections.

A.4.2 Example

Moving a basic control logic into the inverter

A conveyor system is to be configured in such a way that it can only start when two signals are present simultaneously. These could be the following signals, for example:

- The oil pump is running (the required pressure level is not reached, however, until after 5 seconds)
- The protective door is closed

To implement this task, you must insert free function blocks between digital input 0 and the command to switch on the motor (ON/OFF1).

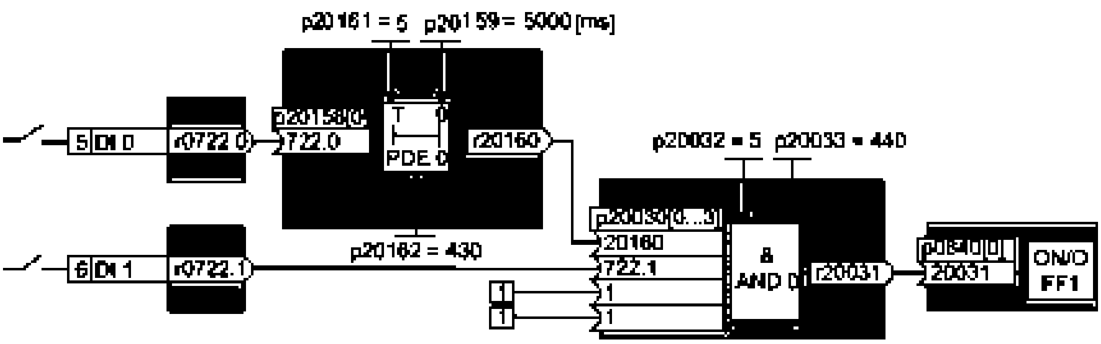


Figure A-4 Example: Signal interconnection for control logic

The signal of digital input 0 (DI 0) is fed through a time block (PDE 0) and is interconnected with the input of a logic block (AND 0). The signal of digital input 1 (DI 1) is interconnected to the second input of the logic block. The logic block output issues the ON/OFF1 command to switch-on the motor.

Setting the control logic

Parameter	Description
p20161 = 5	The time block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20162 = 430	Run sequence of the time block within runtime group 5 (processing before the AND logic block)
p20032 = 5	The AND logic block is enabled by assigning to runtime group 5 (time slice of 128 ms)
p20033 = 440	Run sequence of the AND logic block within runtime group 5 (processing after the time block)
p20159 = 5000.00	Setting the delay time [ms] of the time module: 5 seconds
p20158 = 722.0	Connect the status of DI 0 to the input of the time block r0722.0 = Parameter that displays the status of digital input 0.
p20030[0] = 20160	Interconnecting the time block to the 1st input of the AND
p20030[1] = 722.1	Interconnecting the status of DI 1 to the 2nd AND input r0722.1 = Parameter that displays the status of digital input 1.
p0840 = 20031	Interconnect the AND output to ON/OFF1

Explanation of the example using the ON/OFF1 command

Parameter p0840[0] is the input of the "ON/OFF1" block of the inverter. Parameter r20031 is the output of the AND block. To interconnect ON/OFF1 with the output of the AND block, set p0840 = 20031.

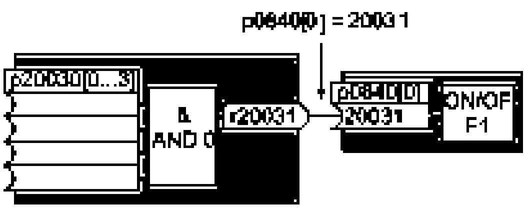


Figure A-5 Interconnecting blocks by setting p0840[0] = 20031

Principle for interconnecting blocks

Always interconnect the input (connector or binector input) with the signal source.

Note

For the basic commissioning, you determine the function of the interfaces for your converter via predefined settings (p0015).

If you subsequently select a different predefined setting for the function of the interfaces, then all interconnections that you changed will be lost.

A.5 Application examples

A.5.1 Configuring the PROFIBUS communication with STEP 7

Using a suitable example, the following section provides information on how you configure the communication of an inverter to a higher-level SIMATIC control system.

To configure the communication between an inverter and a SIMATIC control system, you require the SIMATIC STEP 7 software tool with HW Config.

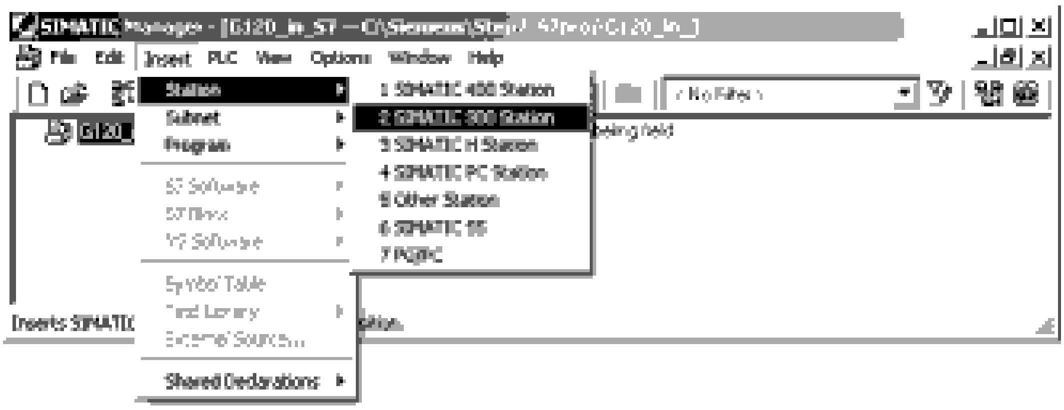
It is assumed that you are knowledgeable about working with SIMATIC control systems and that you have a sound understanding of the STEP 7 engineering tool.

A.5.1.1 Creating a STEP 7 project and network

Procedure

In order to create a STEP 7 project, proceed as follows:

1. Create a new STEP 7 project, e.g. "G120_in_S7".
2. Insert a SIMATIC control S7 300 CPU.

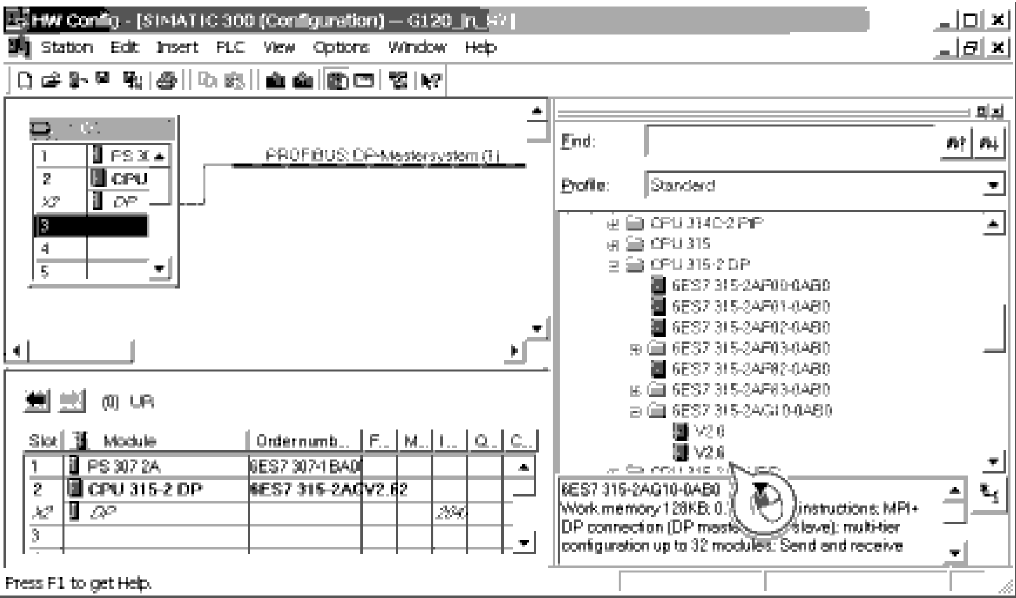


3. Select the SIMATIC 300 station in your project and open HW Config.
4. Insert an S7 300 mounting rail from the hardware catalog into your project with drag & drop.

5. Locate a power supply at slot 1 of the mounting rail and a CPU 315-2 DP control at slot 2.

   When inserting the control, HW Config opens the network setting.

6. Create a PROFIBUS DP network.



You have created a STEP 7 project with a SIMATIC control and a PROFIBUS network.

A.5.1.2 Integrating a converter into a project

The inverter can be connected to a SIMATIC control in two ways:

1. Using the inverter GSD
2. Using the STEP 7 object manager

   This somewhat more user-friendly method is only available for S7 controls and installed Drive ES Basic.

The following section describes how to configure the inverter using the GSD.

A.5.1.3 Inserting the converter into the STEP 7 project

- Install the GSD of the converter in STEP 7 via HW Config (Menu "Options - Install GSD files").
  Once the GSD has been installed, the converter appears under "PROFIBUS DP - Additional field devices" in the hardware catalog of HW Config.

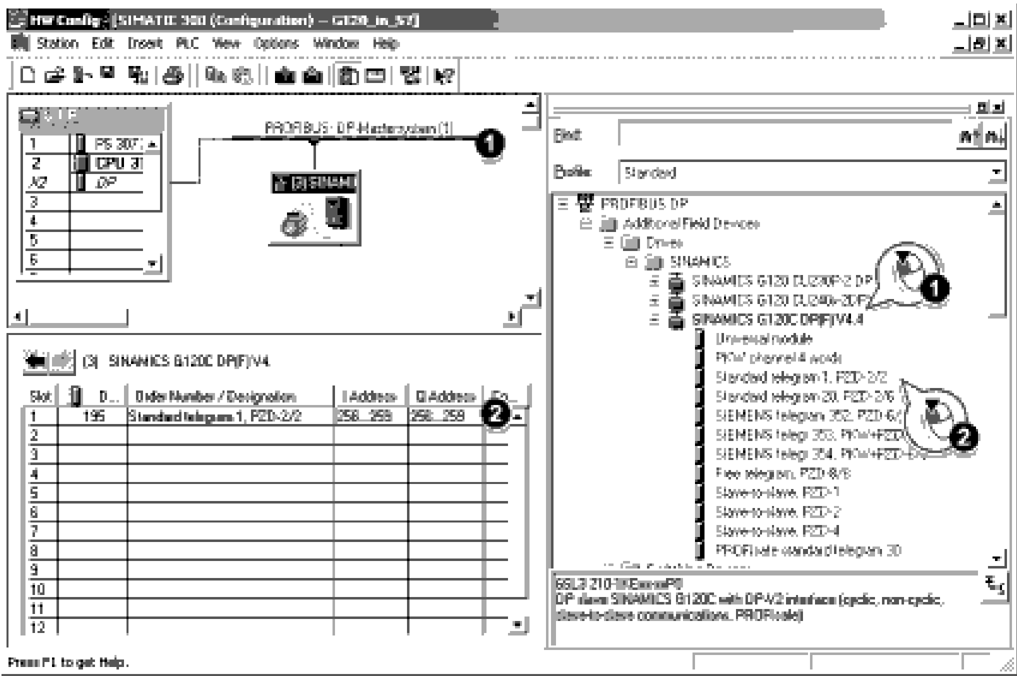


Figure A-6 Inserting a drive object

- Drag and drop the converter into the PROFIBUS network. Enter the PROFIBUS address set at the converter in HW Config.
- Insert the required telegram type from the HW Catalog to slot 1 of the converter by 'dragging and dropping'.

Sequence when assigning the slots

1. PROFIsafe module (if one is used)
   Information on connecting the converter via PROFIsafe can be found in the Safety Integrated Function Manual.
2. PKW channel (if one is used)
3. Standard, SIEMENS or free telegram (if one is used)
4. Slave-to-slave module

If you do not use one or several of the modules 1, 2 or 3, configure the remaining modules starting with the 1st slot.

Cyclic communication to the inverter when using the universal module

A universal module with the following properties is not permitted:

- PZD length 4/4 words
- Consistency over the complete length

With these properties, the universal module has the same DP identifier (4AX) as the "PKW channel 4 words". The higher-level control does not establish cyclic communication with the inverter.

Workaround when using the universal module above:

- In the properties of the DP slave, change the PZD length to 8/8 bytes
- Change the consistency to "Unit".

Final steps

- Save and compile the project in STEP 7.
- Establish an online connection between your PC and the S7 CPU and download the project data to the S7 CPU.
- In the converter, select the telegram type that you configured in STEP 7 using parameter P0922.

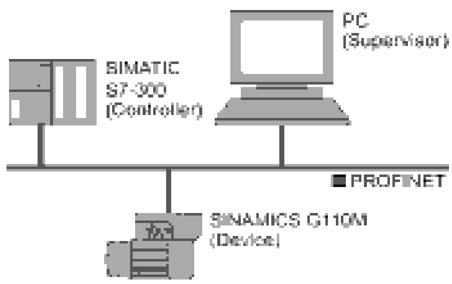
The converter is now connected to the S7 CPU. This therefore defines the communication interface between the CPU and the converter. An example of how you can supply this interface with data can be found in the next section.

A.5.2 Configuring the PROFINET communication with STEP 7

A.5.2.1 Communications via PROFINET - example

Profinet network in a line topology

The adjacent example shows the structure of a PROFINET network with one controller, one device, and one supervisor.



A.5.2.2 Configuring the controller and converter in HW Config

Using an example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2, the procedure shows how you insert the inverter into the project.

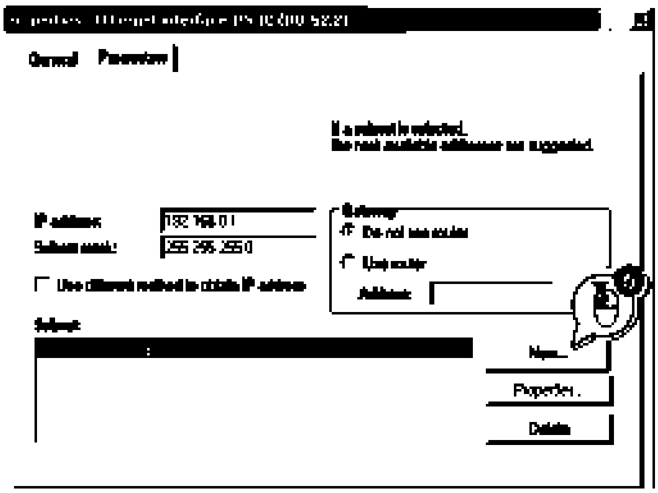
Procedure

Proceed as follows to configure communications between the inverter and the control system via PROFINET:

1. Open HW Config in STEP 7 via "Insert/[Station]", and create the components in accordance with your hardware structure. The following example is limited to the components that are absolutely required.
2. Build your station with a rack and power supply unit.
3. Insert the CPU.

   HW Config opens a screen form with suggestions for the next free IP address and a subnet screen form.
4. If you have configured a local area network, and are not working within a larger Ethernet network, use the proposed entries.

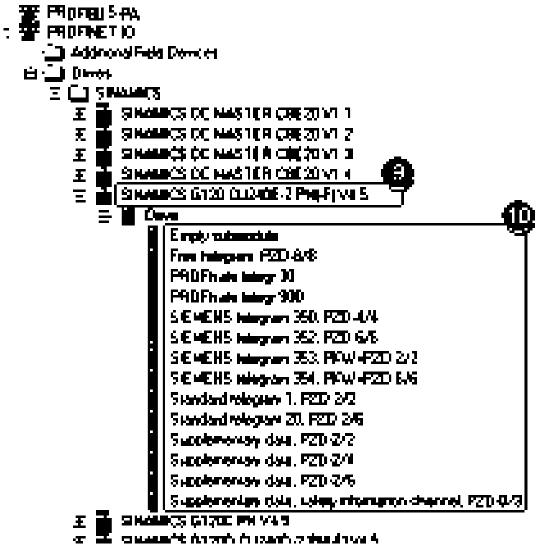
   Otherwise, ask your administrator about the IP addresses for the PROFINET participants and subnet mask. CPU and supervisor must have the same subnet screen form.

   
5. Use the "New" button to either create a new PROFINET subnet or select an existing one.
6. Assign a name for your PROFINET network.
7. Exit this screen form and the next one with OK.
8. Select your subnet.

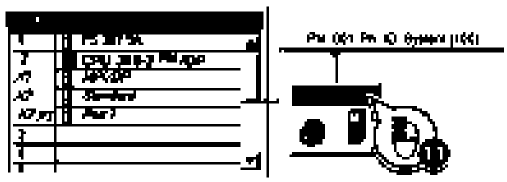
9. Using the hardware catalog, first insert the inverter using drag & drop.

10. Insert the communication telegram.



11. Open the properties window of the inverter and enter a unique and descriptive device name for the inverter.

    Using the device name, the PROFINET controller assigns the IP address when starting up.



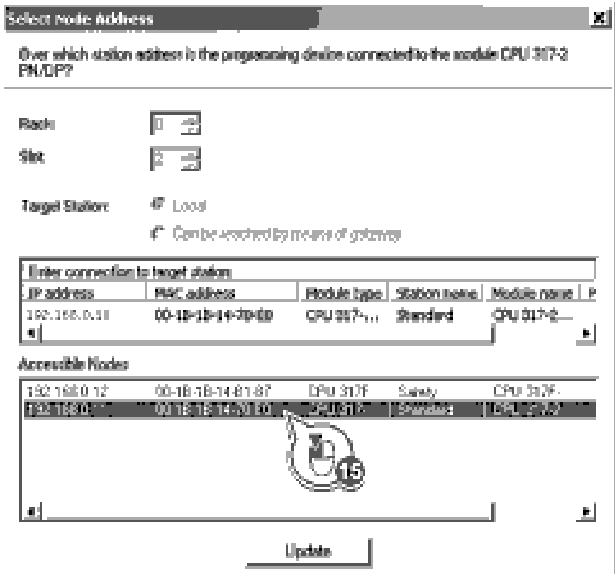
12. You will also find the proposed IP address in this screen form. If required, you can change the IP address via "Properties".

13. Save your hardware configuration with "Save and compile" ( ).

14. Load the configuration into the control unit via the button.

15. Enter the IP address of the controller.

    If you do not have the IP address readily available, you can display the participants that can be reached by clicking the "Display" button. Select the control from the list of accessible participants, and exit the screen form with OK.



16. If you have installed Drive ES Basic, open the STARTER by double-clicking the inverter symbol in the Hardware Manager and configure the inverter in the STARTER.

    In this case, STARTER automatically accepts the device name and IP address. The approach described in the following section is therefore superfluous.

17. If you are working with the GSDML, close HW Config now and create a reference for STARTER as described in the following section.

You have configured the communication between the inverter and the control unit using PROFINET .

See also

Create a reference for STARTERS (Page 296)

A.5.2.3 Create a reference for STARTERS

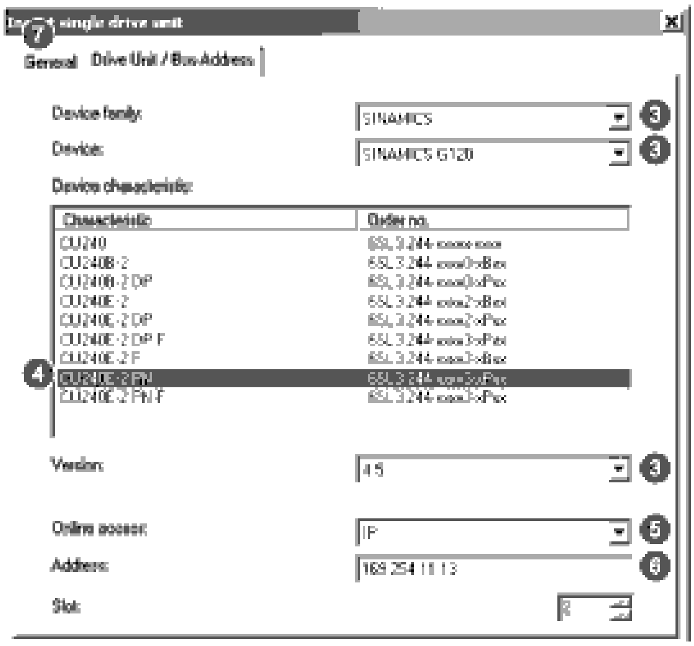
If you have configured the inverter via GSDML, in STEP 7, you must create a reference of the inverter for STARTER, so that you can call up STARTER from STEP 7.

This procedure is described using the example of a SINAMICS G120 with Control Unit CU240B-2 or CU240E-2.

Procedure

Proceed as follows to create a reference of the inverter for STARTER:

1. Highlight the project in the SIMATIC manager
2. Open the "Insert single drive unit" screen form by right clicking on "Insert New Object/SINAMICS".
3. Under the "Drive device/address" tab, set the device family, device and the firmware version.
4. In the device version, select your inverter.
5. Set the online access.
6. Set the address.
7. Enter the PROFINET device name in the "General" tab.



8. Exit the screen form with OK.
9. The inverter is visible in your project.

In your project, you have created an inverter reference for STARTER. You can now call STARTER from your STEP 7 project.

A.5.2.4 Activate diagnostic messages via STEP 7

Procedure

Proceed as follows to activate the diagnostic messages of the inverter:

1. In HW Config, select the inverter.

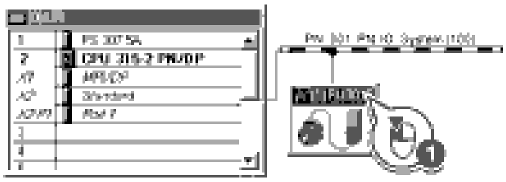
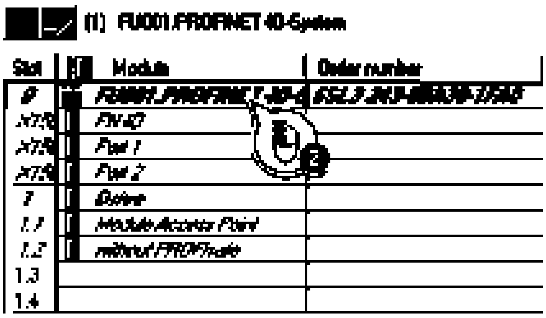
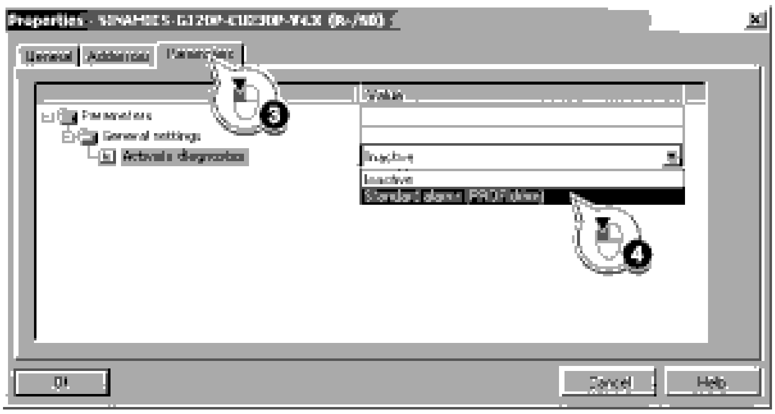


Figure A-7 Highlight inverter in HW Config

2. By double clicking on slot 0 in the station window, open the property window for the inverter's network settings.



3. Select the Parameters tab.
4. Activate the standard alarms.



You have activated the diagnosis messages.

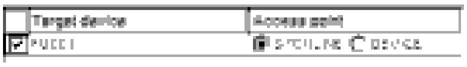
With the next ramp-up of the controller, the diagnostic messages of the inverter are then transferred to the controller.

A.5.2.5 Call the STARTER and go online

Procedure

To call STARTER from STEP 7 and establish an online connection to the inverter, proceed as follows:

1. Highlight the inverter in the SIMATIC manager with the right mouse button.
2. Open the STARTER via "Open object".
3. Configure the inverter in STARTER and click on the Online button ( ).
4. In the following window, select the inverter and then the S7ONLINE as access point.



5. Exit the screen form with OK.

You have called STARTER from STEP 7, and have established the online connection to the inverter.

A.5.3 STEP 7 program examples

Data exchange via the fieldbus

Analog signals

The inverter always scales signals that are transferred via the fieldbus to a value of 4000 hex.

Table A- 7 Signal category and the associated scaling parameters

Signal category	4000 hex ≙ …	Signal category	4000 hex ≙ …
Speeds, frequencies	p2000	Power	p2004
Voltage	p2001	Angle	p2005
Current	p2002	Temperature	p2006
Torque	p2003	Acceleration	p2007

Control and status words

Control and status words consist of a high byte and a low byte. A SIMATIC control interprets words differently than the inverter: The higher and lower-order bytes are interchanged when they are transferred. See also the following program example.

A.5.3.1 STEP 7 program example for cyclic communication

```
Network 1:  Control word 1 and setpoint

        L     W#16#47E
        T     MW     1
        L     W#16#2500
        T     MW     3

Network 2:  Acknowledge fault

        U     E      0.6
        =     M      2.7

Network 3:  Switch the motor on and off

        U     E      0.0
        =     M      2.0

Network 4:  Write process data

        L     MW     1
        T     PAW    256
        L     MW     3
        T     PAW    258

Network 4:  Read process data

        L     PEW    256
        T     MW     5
        L     PEW    258
        T     MW     7
```

The controller and inverter communicate via standard telegram 1. The control specifies control word 1 (STW1) and the speed setpoint, while the inverter responds with status word 1 (ZSW1) and its actual speed.

In this example, inputs E0.0 and E0.6 are linked to the ON/OFF1 bit or to the "acknowledge fault" bit of STW 1.

Control word 1 contains the numerical value 047E hex. The bits of control word 1 are listed in the following table.

The hexadecimal numeric value 2500 specifies the setpoint frequency of the inverter. The maximum frequency is the hexadecimal value 4000.

The controller cyclically writes the process data to logical address 256 of the inverter. The inverter also writes its process data to logical address 256. You define the address area in HW Config.

Table A- 8 Assignment of the control bits in the inverter to the SIMATIC flags and inputs

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
E	0	0	ON/OFF1	8		0	E0.0
	1	1	OFF2	9		1	
	1	2	OFF3	10		2	
	1	3	Operation enable	11		3	
7	1	4	Ramp-function generator enable	12		4	
	1	5	Start ramp-function generator	13		5	
	1	6	Setpoint enable	14		6	
	0	7	Acknowledge fault	15		7	E0.6

HEX	BIN	Bit in STW1	Significance	Bit in MW1	Bit in MB1	Bit in MB2	Inputs
4	0	8	Jog 1	0	0		
	0	9	Jog 2	1	1		
	1	10	PLC control	2	2		
	0	11	Setpoint inversion	3	3		
0	0	12	Irrelevant	4	4		
	0	13	Motorized potentiometer ↑	5	5		
	0	14	Motorized potentiometer ↓	6	6		
	0	15	Data set changeover	7	7		

A.5.3.2 STEP 7 program example for acyclic communication

```
OB1: cyclic control program
[redacted]

Network 1:   Reading and writing parameters
[redacted]

// read parameters
        O(
        U     M     9.2
        UN    M     9.1
        )
        O(
        U     M     9.0
        UN    M     9.1
        )
        R     M     9.3

        SPB   RD

// write parameters
        O(
        U     M     9.3
        UN    M     9.0
        )
        O(
        U     M     9.1
        UN    M     9.0
        )
        R     M     9.2

        SPB   WR
        BEA

RD:     NOP   0
        CALL  FC    1
        BEA
WR:     NOP   0     9.1
        CALL  FC    3
```

M9.0	Starts reading parameters
M9.1	Starts writing parameters
M9.2	Displays the read process
M9.3	Displays the write process

The number of simultaneous requests for acyclic communication is limited.

FC1: PA R_RD

[redacted]

Network 1: Parameters for reading

[redacted]

```
      L     MB      40
      T     DB1.DBB    0
      L     B#16#01
      T     DB1.DBB    1
      T     DB1.DBB    2
      L     MB      62
      T     DB1.DBB    3
//  ------------------------------------
      L     MW      50
      T     DB1.DBW    6
      L     MB      58
      T     DB1.DBB    5
      L     MW      63
      T     DB1.DBW    8
//  ------------------------------------
      L     MW      52
      T     DB1.DBW    12
      L     MB      59
      T     DB1.DBB    11
      L     MW      65
      T     DB1.DBW    14
//  ------------------------------------
      L     MW      54
      T     DB1.DBW    18
      L     MB      60
      T     DB1.DBB    17
      L     MW      67
      T     DB1.DBW    10
//  ------------------------------------
      L     MW      56
      T     DB1.DBW    24
      L     MB      61
      T     DB1.DBB    23
      L     MW      59
      T     DB1.DBW    26
```

Network 2: Read request, part 1

[redacted]

```
      CALL    SFC     58
        REQ       :=M9.0
        IOID      :=B#16#54
        LADDR     :=W#16#170
        RECNUM    :=B#16#2F
        RECORD    :=P#DB1.DBX0.0 BYTE 26
        RET_VAL   :=MW10
        BUSY      :=M8.1

      U     M     8.1
      R     M     9.0
      S     M     9.2
```

Network 3: Read delay after a read request

[redacted]

```
      U     M     8.1
      UN    M     9.1
      L     S5T#1s
      SS    T     1
      U     M     8.3
      R     T     1
      U     T     1
      =     M     9.2
```

Network 4: Read re uest, part 2ng

[redacted]

```
      CALL    SFC     59
        REQ       :=M9 2
        IOID      :=B#16#54
        LADDR     :=W#16#170
        RECNUM    :=B#16#2F
        RET_VAL   :=MW12
        BUSY      :=M8 3
        RECORD    :=P#DB2.DBX0.0 BYTE 36

      U     M     8.3
      R     M     9.2
```

Figure A-8 Reading parameters

Note

With PROFINET standard function blocks (SFB) instead of system functions (SFC)

With acyclic communication via PROFINET, you must replace the system functions with standard function blocks as follows:

- SFC 58 → SFB 53
- SFC 59 → SFB 52

Explanation of FC 1

Table A- 9 Request to read parameters

Data block DB 1	Byte n	Bytes n + 1	n
Header	Reference *MB 40*	01 hex: Read request	0
	01 hex	Number of parameters (m) *MB 62*	2
Address, parameter 1	Attribute *10 hex: Parameter value*	Number of indexes *MB 58*	4
	Parameter number *MW 50*		6
	Number of the 1st index *MW 63*		8
Address, parameter 2	Attribute *10 hex: Parameter value*	Number of indexes *MB 59*	10
	Parameter number *MW 52*		12
	Number of the 1st index *MW 65*		14
Address, parameter 3	Attribute *10 hex: Parameter value*	Number of indexes *MB 60*	16
	Parameter number *MW 54*		18
	Number of the 1st index *MW 67*		20
Address, parameter 4	Attribute *10 hex: Parameter value*	Number of indexes *MB 61*	22
	Parameter number *MW 56*		24
	Number of the 1st index *MW 69*		26

SFC 58 copies the specifications for the parameters to be read from DB 1 and sends them to the inverter as a read request. No other read requests are permitted while this one is being processed.

After the read request and a waiting time of one second, the controller takes the parameter values from the inverter via SFC 59 and saves them in DB 2.

```
FC 3:   PAR_WR
[redacted]

Network 1:   Parameters for writing
[redacted]

        L       MB          42
        T       DB3.DBB     0
        L       B#16#02
        T       DB3.DBB     1
        L       B#16#01
        T       DB3.DBB     2
        L       MB          44
        T       DB1.DBB     3
  //  ------------------------------------
        L       MW          21
        T       DB3.DBW     6
        L       MW          23
        T       DB3.DBW     8
        L       MW          35
        T       DB3.DBW     12
        L       MB          25
        T       DB3.DBB     10
        L       MB          27
        T       DB3.DBB     11
```

```
Network 2:   Write request
[redacted]

      CALL    SFC     58
        REQ           :=M9.1
        IOID          :=B#16#54
        LADDR         :=W#16#170
        RECNUM        :=B#16#2F
        RECORD        :=P#DB3.DBX0.0 BYTE 14
        RET_VAL       :=MW10
        BUSY          :=M8.1

      U       M       8.1
      R       M       9.1
      S       M       9.3
```

Figure A-9 Writing parameters

Explanation of FC 3

Table A- 10 Request to change parameters

Data block DB 3	Byte n	Bytes n + 1	n
Header	**Reference** *MB 42*	**02 hex**: Change request	0
	01 hex	**Number of parameters** *MB 44*	2
Address, parameter 1	**10 hex**: Parameter value	**Number of indexes** *00 hex*	4
	Parameter number *MW 21*		6
	Number of the 1st index *MW 23*		8
Values, parameter 1	**Format** *MB 25*	**Number of index values** *MB 27*	10
	Value of the 1st index *MW35*		12

SFC 58 copies the specifications for the parameters to be written from DB 3 and sends them to the inverter. The inverter blocks other write jobs while this write job is running.

A.5.4 Configuring slave-to-slave communication in STEP 7

Two drives communicate via standard telegram 1 with the higher-level controller. In addition, drive 2 receives its speed setpoint directly from drive 1 (actual speed).

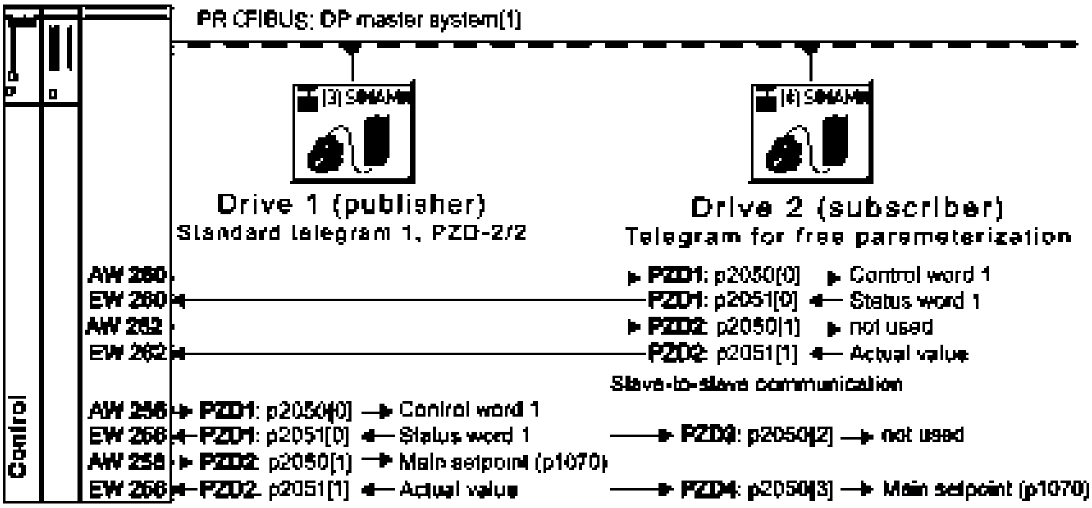


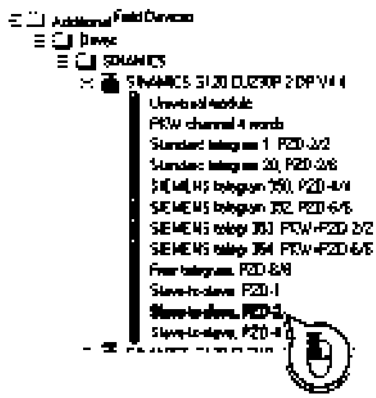
Figure A-10 Communication with the higher-level controller and between the drives with direct data exchange

Setting direct data exchange in the control

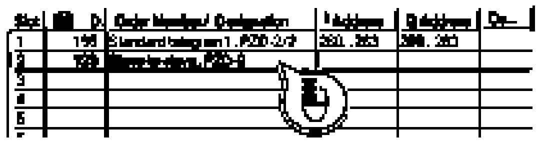
Procedure

Proceed as follows to set direct data exchange in the control:

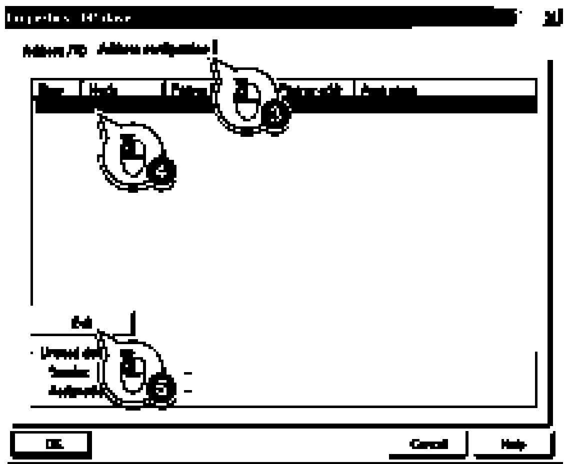
1. In HW Config in drive 2 (subscriber), insert a direct data exchange object, e.g. "Slave-to-slave, PZD2".



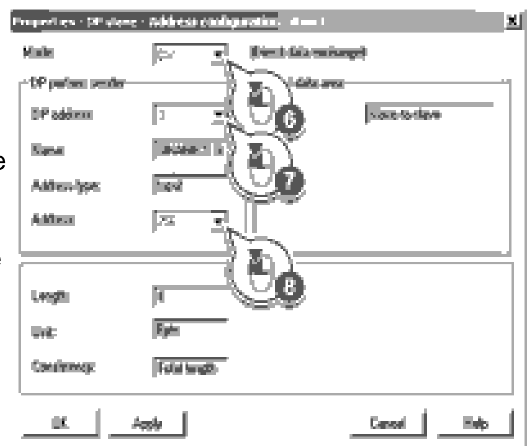
2. With a double-click, open the dialog box to make additional settings for the direct data exchange.



3. Activate the tab "Address configuration".
4. Select line 1.
5. Open the dialog box in which you define the Publisher and the address area to be transferred.



6. Select DX for direct data exchange
7. Select the address of drive 1 (publisher).
8. In the address field, select the start address specifying the data area to be received from drive 1. In the example, these are the status word 1 (PZD1) and the actual speed value with the start address 256.



9. Close both screen forms with OK.

You have now defined the value range for direct data exchange.

In the direct data exchange, drive 2 receives the sent data and writes this into the next available words, in this case, PZD3 and PZD4.

Settings in drive 2 (subscriber)

Drive 2 is preset in such a way that it receives its setpoint from the higher-level controller. In order that drive 2 accepts the actual value sent from drive 1 as setpoint, you must set the following:

- In drive 2, set the PROFIdrive telegram selection to "Free telegram configuration" (p0922 = 999).
- In drive 2, set the source of the main setpoint to p1070 = 2050.3.

The inverter indicates the inverter addresses that are configured for direct data exchange in parameter r2077.

A.6 Standards PM240M

European Low Voltage Directive

The SINAMICS G110M product range complies with the requirements of the Low Voltage Directive 2006/95/EC. The units are certified for complaince with the following standards:

EN 61800-5-1 — Semiconductor inverters –General requirements and line commutated inverters

EN 60204-1 — Safety of machinery –Electrical equipment of machines

European Machinery Directive

The SINAMICS G110M 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 SINAMICS G110M fulfils all requirements of the EMC Directive as defined by the EMC Product Standard for Power Drive Systems EN 61800-3

Underwriters Laboratories

UL and CUL LISTED POWER CONVERSION EQUIPMENT for use in a pollution degree 2 environment.

SEMI F47 **Specification for Semiconductor Process Equipment Voltage Sag Immunity**

SINAMICS G110M Inverters fulfill the requirements of the SEMI F47-0706 standard.

ISO 9001

Siemens plc operates a quality management system, which complies with the requirements of ISO 9001.

Certificates can be downloaded from the internet under the following link:

Standards (http://support.automation.siemens.com/WW/view/en/22339653/134200)

A.7 Electromagnetic Compatibility

The SINAMICS G110M drives have been tested in accordance with the EMC Product Standard EN 61800-3:2004.

Details see declaration of conformity

Note

Install all drives in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Table A- 11 Compliance Table

Category C2 - First Environment - Professional Use	
Order number	Remark
6SL3517-1BE11-*A*0 6SL3517-1BE12-*A*0 6SL3517-1BE13-*A*0 6SL3517-1BE14-*A*0 6SL3517-1BE16-*A*0 6SL3517-1BE17-*A*0 6SL351701BE21-*A*0	All inverters with integrated Class A filters. The inverter meets the requirements for category C2 for conducted emissions. In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.

EMC Emissions

Note

Install all drives in accordance with the manufacturer's guidelines and in accordance with good EMC practices.

Use screened cable type CY. The maximal cable length is 15 m.

Do not exceed the default switching frequency 4 kHz.

Table A- 12 Conducted disturbance voltage and radiated emissions

EMC Phenomenon	Converter type Remark	Level acc. to IEC 61800-3
Conducted emissions (disturbance voltage)	All converters with integrated class A filters. Order number: 6SL3517-1BE**-***A****	**Category C2** First Environment - Professional Use
Radiated emissions	Converter frame sizes A and B with integrated class A filter. Order number: 6SL3517-1BE11-***A***0 6SL3517-1BE12-***A***0 6SL3517-1BE13-***A***0 6SL3517-1BE14-***A***0 6SL3517-1BE16-***A***0 6SL3517-1BE17-***A***0 6SL3517-1BE21-***A***0 In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.	**Category C2** First Environment - Professional Use

Harmonic Currents

Table A- 13 Harmonic Currents

Typical Harmonic Current (% of rated input current) at U_K 1 %							
5th	**7th**	**11th**	**13th**	**17th**	**19th**	**23rd**	**25th**
24	11	9	7	6	5	4	4

Note

Units installed within the category C2 (domestic) environment require supply authority acceptance for connection to the public low-voltage power supply network. Please contact your local supply network provider.

Units installed within the category C3 (industrial) environment do not require connection approval.

EMC Immunity

The SINAMICS G110M drives have been tested in accordance with the immunity requirements of category C3 (industrial) environment:

Table A- 14 EMC Immunity

EMC Phenomenon	Standard	Level	Performance Criterion
Electrostatic Discharge (ESD)	EN 61000-4-2	4 kV Contact discharge	A
		8 kV Air discharge	
Radio-frequency Electromagnetic Field	EN 61000-4-3	80 MHz … 1000 MHz 10 V/m	A
Amplitude modulated		80 % AM at 1 kHz	
Fast Transient Bursts	EN 61000-4-4	2 kV @ 5 kHz	A
Surge Voltage	EN 61000-4-5	1 kV differential (L-L)	A
1.2/50 µs		2 kV common (L-E)	
Conducted	EN 61000-4-6	0.15 MHz … 80 MHz 10 V/rms	A
Radio-frequency Common Mode		80 % AM at 1 kHz	
Mains Interruptions & Voltage Dips	EN 61000-4-11	95 % dip for 3 ms	A
		30 % dip for 10 ms	C
		60 % dip for 100 ms	C
		95 % dip for 5000 ms	D
Voltage Distortion	EN 61000-2-4	10 % THD	A
Voltage Unbalance	EN 61000-2-4	3 % Negative Phase Sequence	A
Frequency Variation	EN 61000-2-4	Nominal 50 Hz or 60 Hz (± 4 %)	A
Commutation Notches	EN 60146-1-1	Depth = 40 %	A
		Area = 250 % x degrees	

A.8 Further information on your inverter

A.8.1 Further Information

Table A- 15 Technical Support

<table>
<tr><th>France</th><th>Germany</th><th>Italy</th><th>Spain</th><th>United Kingdom</th></tr>
<tr><td>+33 (0) 821 801 122</td><td>+49 (0)911 895 7222</td><td>+39 (02) 24362000</td><td>+34 902 237 238</td><td>+44 161 446 5545</td></tr>
<tr><td colspan="5">Further service contact information: Product support
(http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo2&aktprim=99&lang=en)</td></tr>
</table>

Table A- 16 Manuals with further information

<table>
<tr><th>Manual</th><th>Content</th><th>Available languages</th><th>Download or order number</th></tr>
<tr><td>Getting Started</td><td>Basic installation and commissioning.</td><td rowspan="2">English
German
Italian
French
Spanish
Chinese</td><td rowspan="4">Manuals
Manuals can be download using the following link:
SINAMICS G110M Documentation
(http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo&lang=en&siteid=csius&aktprim=0&extranet=standard&viewreg=WW&objid=36426537&treeLang=en)

SINAMICS Manual Collection (DVD)
The manual collection can be order using the following order number:
• 6SL3298-0CA00-0MG0</td></tr>
<tr><td>Operating instructions - inverter</td><td>Installing, commissioning and operating the inverter.
Description of inverter functions.
Technical data.</td></tr>
<tr><td>List manual</td><td>Complete list of parameters, alarms and faults.
Graphic function block diagrams.</td><td>English
German
Chinese</td></tr>
<tr><td>Operating instructions - IOP</td><td>Description of Intelligent Operator Panel</td><td>English,
German</td></tr>
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Industry Sector
Drive Technology
Motion Control Systems
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We reserve the right to make technical changes

Please scan the
QR code for more
information on
SINAMICS G110M

www.siemens.com/drives