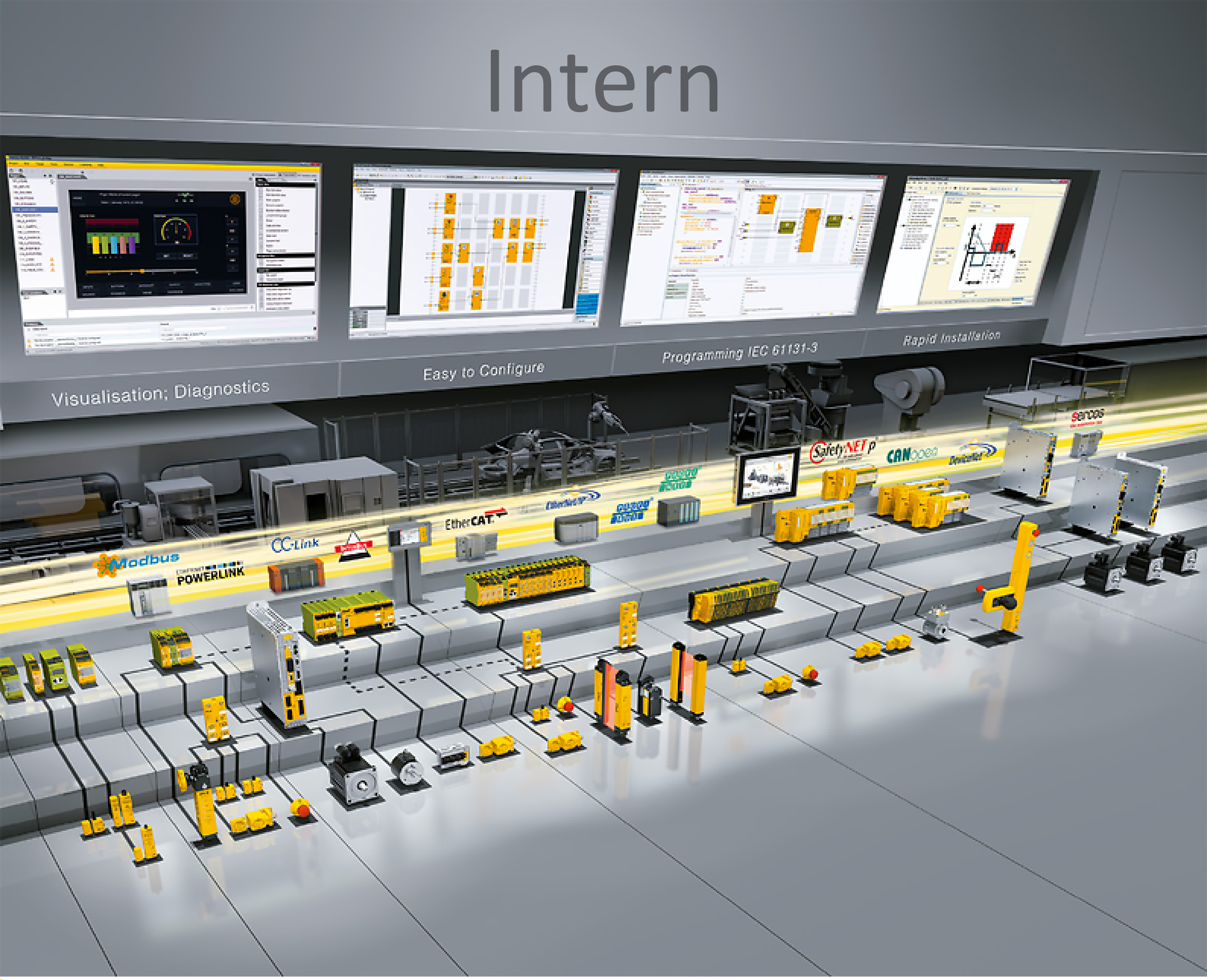


Multi-axis drive system with PMC SI6 and PMC PS6

Pilz

Manual-1005342-en-US-07

1 Foreword

The completely re-designed Pilz multi-axis drive system consists of the PMC SI6 drive controller and PMC PS6 supply module combination. Matching Quick DC-Link modules handle the energy supply for the networked drive controllers. The PMC SI6 drive controller is available in four sizes as a single or double-axis controller with a nominal output current of up to 50. The PMC PS6 supply module is available in two sizes with a nominal power of 10 kW or 20 kW. As an economically attractive system with a minimized device width, the PMC SI6 opens a new dimension in multi-axis applications.

Features

- Sensorless position control of Pilz Lean motors
- Control of rotary synchronous servo motors, asynchronous motors and torque motors
- HIPERFACE DSL One Cable Solution
- Electronic motor nameplate via HIPERFACE DSL and EnDat 2.2 digital encoder interfaces
- Integrated EtherCAT or PROFINET communication
- STO safety technology using terminals or STO and SS1 using FSoE (Fail Safe over EtherCAT): SIL 3, PL e (cat. 4)
- Integrated brake control
- Energy supply over DC link connection
- Single-ended nominal power consumption on double-axis controllers for operation of motors with different power
- Variable feed-in power using supply modules that can be connected in parallel

2 User information

This documentation covers multi-axis drive systems with PMC SI6 and PMC PS6. You will receive support for assembling the individual modules along with the associated components that you will need for operating the multi-axis drive controllers in the control cabinet.

You will also find information on wiring the modules correctly and checking their functionality in the group with an initial test.

Combinations with other 6th generation Pilz drive controllers are possible under certain boundary conditions.

More detailed information on project configuration, diagnostics and service are additional topics covered in this manual.

2.1 Storage and transfer

As this documentation contains important information for handling the product safely and efficiently, it must be stored in the immediate vicinity of the product until product disposal and be accessible to qualified personnel at all times.

Also pass on this documentation if the product is transferred or sold to a third party.

2.2 Described product

This documentation is binding for:

PMC SI6 series drive controllers in conjunction with the
DriveControlSuite software (DS6) in V 6.4-E or higher and associated firmware in V 6.4-E or higher.

Type			ID No.
Drive controller	PMC SI6A061	EtherCAT (EC)	8C000011
		PROFINET (PN)	8C000012
	PMC SI6A062	EC	8C000019
		PN	8C000020
	PMC SI6A161	EC	8C000027
		PN	8C000028
	PMC SI6A162	EC	8C000035
		PN	8C000036
	PMC SI6A261	EC	8C000043
		PN	8C000044
	PMC SI6A262	EC	8C000051
		PN	8C000052
	PMC SI6A361	EC	8C000059
		PN	8C000060
DC link connection	PMC DL6B10	—	8C000086
	PMC DL6B11	—	8C000087
	PMC DL6B12	—	8C000088

Described product types, PMC SI6 drive controllers and associated Quick DC-Link rear section modules

Type		ID No.
Supply module	PMC PS6A24	8C000001
	PMC PS6A34	8C000003
DC link connection	PMC DL6B20	8C000089
	PMC DL6B21	8C000090

Described product types, PMC PS6 supply modules and associated Quick DC-Link rear section modules

2.3 UL file number

cULus-certified devices with corresponding test symbols meet the requirements of the standards UL 61800-5-1 and CSA C22.2 No. 274.

Under the file number specified in the following table, you can find the product in the online database of Underwriter Laboratories (UL):
https://iq2.ulprospector.com

Type		File number	UL Category Control Number		Certification
			America	Canada	cULus/ cURus
Drive controller	PMC SI6A061	E189114	NMMS	NMMS7	cULus
	PMC SI6A062				
	PMC SI6A161				
	PMC SI6A162				
	PMC SI6A261				
	PMC SI6A262				
	PMC SI6A361				
Supply module	PMC PS6A24				
	PMC PS6A34				
DC link connection	PMC DL6B10				
	PMC DL6B11				
	PMC DL6B12				
	PMC DL6B20				
	PMC DL6B21				
Braking resistors	PMC KWADQU	E212934	NMTR2	NMTR8	cURus
	PMC FZZMQU				
	PMC FGFKQU				
Power chokes	PMC TEP4010-2US00	E103902	XQNX2	XQNX8	cURus
Output chokes	PMC TEP3720-0ES41	E333628	NMMS2	NMMS8	cURus
	PMC TEP3820-0CS41				
	PMC TEP4020-0RS41				

Type		File number	UL Category Control Number		Certification
			America	Canada	cULus/ cURus
Motors	PMC EZ or PMC LM series synchronous servo motors	E488992	PRHZ2	PRHZ8	cURus
	Asynchronous motors	E216143	PRGY2	PRGY8	cURus
Encoder and power cables	All types	E172204	AVLV2	AVLV28	cURus
One Cable Solution	All types	On request	On request	On request	cURus

File number-certified products

2.4 Timeliness

Check whether this document is the most up-to-date version of the documentation. We make the latest document versions for our products available for download on our website: https://www.pilz.com/en-INT.

2.5 Original language

The original language of this documentation is German; all other language versions are derived from the original language.

2.6 Limitation of liability

This documentation was created taking into account the applicable standards and regulations as well as the current state of technology.

No warranty or liability claims for damage shall result from failure to comply with the documentation or from use that deviates from the intended use of the product. This is especially true for damage caused by individual technical modifications to the product or the project configuration and operation of the product by unqualified personnel.

2.7 Formatting conventions

Orientation guides in the form of signal words, symbols and special text markups are used to emphasize specific information so that you are able identify it in this documentation quickly.

2.7.1 Use of symbols

Safety instructions are identified with the following symbols. They indicate special risks when handling the product and are accompanied by relevant signal words that express the extent of the risk. Furthermore, useful tips and recommendations for efficient, error-free operation are specially highlighted.

ATTENTION!

Attention indicates that damage to property may occur

- if the stated precautionary measures are not taken.

CAUTION!

Caution with a warning triangle indicates that minor personal injury may occur

- if the stated precautionary measures are not taken.

WARNING!

Warning with a warning triangle means there may be a considerable risk of fatal injury

- if the stated precautionary measures are not taken.

DANGER!

Danger with a warning triangle indicates that there is a considerable risk of fatal injury

- if the stated precautionary measures are not taken.

Information

Information indicates important information about the product or serves to emphasize a section in the documentation that deserves special attention from the reader.

WARNINGS!

Warnings with the UL symbol mark text passages quoted from the original.

2.7.2 Markup of text elements

Certain elements of the continuous text are distinguished as follows.

Important information	Words or expressions with a special meaning
Interpolated position mode	Optional: File or product name or other name
Detailed information	Internal cross-reference
http://www.samplelink.com	External cross-reference

Software and other displays

The following formatting is used to identify the various information content of elements referenced by the software interface or a drive controller display, as well as any user entries.

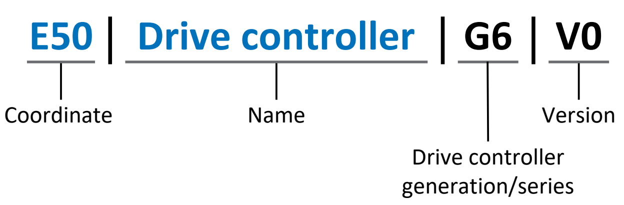
Main menu Settings	Window names, dialog box names, page names or buttons, combined proper nouns, functions referenced by the interface
Select `Referencing method A`	Predefined entry
Save your `<own IP address>`	User-defined entry
EVENT 52: COMMUNICATION	Displays (status, messages, warnings, faults) for status information referenced by the interface

Keyboard shortcuts and command sequences or paths are represented as follows.

[CTRL], [CTRL] + [S]	Key, shortcut
Table > Insert table	Navigation to menus/submenus (path specification)

Interpretation of parameter identification

Parameter identification consists of the following elements, where short forms are also possible, i.e. only specifying a coordinate or the combination of coordinate and name.



2.7.3 Mathematics and formulas

The following signs are used to represent mathematical relationships and formulas.

-	Subtraction
+	Addition
×	Multiplication
÷	Division
| |	Amount

2.7.4 Conventions for cables

In the cable connection descriptions, core colors are shortened and used as follows.

Cable colors

BK:	BLACK	PK:	PINK
BN:	BROWN	RD:	RED
BU:	BLUE	VT:	VIOLET
GN:	GREEN	WH:	WHITE
GY:	GRAY	YE:	YELLOW
OG:	ORANGE		

Formatting conventions

Two-colored core:	WHYE	WHITEYELLOW (white and yellow)
Single-colored core:	BK/BN	BLACK/BROWN (black or brown)

2.8 Symbols, marks and test symbols

The following symbols, marks and test symbols are used in this document.

Grounding symbol
Grounding symbol in accordance with IEC 60417, symbol 5019.

RoHS lead-free mark
Marking in accordance with RoHS directive 2011-65-EU.

CE mark
Manufacturer's self declaration: The product meets the requirements of EU directives.

UL test symbol
This product is listed by UL for the United States and Canada. Representative samples of this product have been evaluated by UL and meet the requirements of applicable standards.

UL recognized component mark
This component or material is recognized by UL. Representative samples of this product have been evaluated by UL and meet applicable requirements.

2.9 Trademarks

The following names used in connection with the device, its optional equipment and its accessories are trademarks or registered trademarks of other companies:

CANopen®, CiA®	CANopen® and CiA® are registered European Union trademarks of CAN in AUTOMATION e.V., Nuremberg, Germany.
EnDat®	EnDat® and the EnDat® logo are registered trademarks of Dr. Johannes Heidenhain GmbH, Traunreut, Germany.
EtherCAT®, Safety over EtherCAT®, TwinCAT®	EtherCAT®, Safety over EtherCAT® and TwinCAT® are registered trademarks of patented technologies licensed by Beckhoff Automation GmbH, Verl, Germany.
HIPERFACE®	HIPERFACE® and the HIPERFACE DSL® logo are registered trademarks of SICK STEGMANN GmbH, Donaueschingen, Germany.
Hyper-V®	Hyper-V® is a registered trademark of the Microsoft Corporation in the United States and/or other countries.
PLCopen®	PLCopen® is a registered trademark of the PLCopen Organisation, Gorinchem, Netherlands.
PROFIBUS®, PROFINET®	The PROFIBUS and the PROFINET logo are registered trademarks of PROFIBUS Nutzerorganisation e.V., Karlsruhe, Germany.
speedtec®	speedtec® is a registered trademark of TE Connectivity Industrial GmbH, Niederwinkling, Germany.
VirtualBox®	VirtualBox® is a registered trademark of Oracle America, Inc., Redwood Shores, USA.
VMware®	VMware® is a registered trademark of VMware, Inc., Palo Alto, USA.
Windows®, Windows® 7, Windows® 10	Windows®, das Windows®-Logo, Windows® XP, Windows® 7 und Windows® 10 are registered trademarks of Microsoft Corporation in the United States and/or other countries.

All other trademarks not listed here are the property of their respective owners.

Products that are registered as trademarks are not specially indicated in this documentation. Existing property rights (patents, trademarks, protection of utility models) are to be observed.

3 General safety instructions

There are risks associated with the product described in this documentation that can be prevented by complying with the described warning and safety instructions as well as the included technical rules and regulations.

3.1 Directives and standards

The following European directives and standards are relevant to the drive controllers:

- Machinery Directive 2006/42/EC
- Low Voltage Directive 2014/35/EU
- EMC Directive 2014/30/EU
- EN 61326-3-1:2008
- EN 61800-3:2004 and A1:2012
- EN 61800-5-1:2007
- EN 61800-5-2:2007
- EN 50178:1997
- IEC 61784-3:2010

Subsequent references to the standards do not specify the respective year in order to improve readability.

3.2 Qualified personnel

In order to be able to perform the tasks described in this documentation, the persons instructed to perform them must have the appropriate professional qualification and be able to assess the risks and residual hazards when handling the products. For this reason, all work on the products as well as their operation and disposal may be performed only by professionally qualified personnel.

Qualified personnel are persons who have acquired the authorization to perform these activities either through training to become a specialist and/or instruction by specialists.

Furthermore, valid regulations, legal requirements, applicable basic rules, this documentation and the safety instructions included in it must be carefully read, understood and observed.

3.3 Intended use

As defined by DIN EN 50178, PMC SI6 drive controllers and PMC PS6 supply modules are electrical devices operating as power electronics to control the flow of energy in high-voltage systems.

PMC SI6 drive controllers are intended solely for the operation of motors that meet the requirements of DIN EN 60034-1:

- Lean motors of the PMC LM series
- Synchronous servo motors (e.g. of the PMC EZ series)
- Asynchronous motors
- Torque motors

The PMC PS6 supply module is intended solely for the supply of one or more drive controllers. Only Pilz drive controllers of the 6th generation may be connected to PMC PS6.

The connection of other electronic loads or operation outside applicable technical specifications constitutes improper use.

When installing drive controllers in machines, commissioning (i.e. commencing intended operation) may not be performed until it has been determined that the machine is in compliance with local laws and directives. For example, in the European region, the following applies:

- Machinery Directive 2006/42/EC
- Low Voltage Directive 2014/35/EU
- EMC Directive 2014/30/EU

EMC-compliant installation

The PMC SI6 drive controller and accessories must be installed and wired compliant for EMC

Modification

As the user, you may not make any physical, technical or electrical modifications to the PMC SI6 drive controller and the accessories.

Maintenance

The PMC SI6 drive controller and accessories are maintenance-free. However, take appropriate measures to detect or prevent possible errors in the connecting wiring.

Product life span

A drive controller with integrated safety module must be taken out of operation 20 years after the production date. The production date of the drive controller is found on the accompanying nameplate.

3.4 Transport and storage

Inspect the delivery for any transport damage immediately after you receive it. Notify the transport company of any damage immediately. Do not put a damaged product into operation.

To ensure the faultless and safe operation of the products, they must be professionally configured, installed, operated and maintained.

Store the products in a dry and dust-free room if you do not install them immediately.

Transport and store the products in the original packaging and protect the products from mechanical impacts and vibrations. Observe the transport and storage conditions recommended in the technical data.

Initiate reforming on the drive controllers in storage every year or before commissioning; see the chapter Storage [85].

3.5 Operational environment and operation

The products are subject to sales restrictions in accordance with IEC 61800-3.

The products are not designed for use in a public low-voltage network that supplies residential areas. Radio-frequency interference can be expected if the products are used in this type of network.

The products are intended exclusively for installation in control cabinets with at least protection class IP54.

Always operate the products within the limits specified by the technical data.

The following applications are prohibited:

- Use in potentially explosive atmospheres
- Use in environments with harmful substances as specified by EN 60721, such as oils, acids, gases, vapors, dust and radiation

Implementation of the following applications is permitted only after approval from Pilz:

- Use in non-stationary applications
- The use of active components (drive controllers, supply modules, energy recovery units or discharge units) from third-party manufacturers

The PMC PS6 supply module is intended only for operation on TN networks or wye sources that deliver, at most, a differential short-circuit current at a nominal voltage between 200 and 480 V_{AC} in accordance with the following table:

Size	Max. differential short-circuit current
Size 2 and size 3	5000 A

Maximum differential short-circuit current

The drive controller has a configurable restart. If the drive controller is designed for an automatic restart after energy shutdown, this must be clearly specified on the system in accordance with DIN EN 61800-5-1.

3.6 Working on the machine

Before all work on machines and systems, apply the 5 safety rules in accordance with DIN VDE 0105-100 (Operation of electrical installations – Part 100: General requirements) in the order listed:

- Disconnect (also ensure that the auxiliary circuits are disconnected).
- Ensure power cannot be switched on again.
- Ensure that everything is de-energized.
- Ground and short circuit.
- Cover adjacent live parts.

Information

Note that you can only determine that voltage is no longer present once the discharge time has elapsed. The discharge time depends on the self-discharge of the drive controller and, if applicable, the fast discharge. You can find the discharge time in the general technical data.

3.7 Decommissioning

In safety-oriented applications, note the mission time T_M = 20 years in the safety-relevant key performance indicators.

Detailed information about using the safety technology can be found in the corresponding manual; see the chapter Detailed information [300].

3.8 Disposal

Observe the current national and regional regulations when disposing of the packaging and product! Dispose of the packaging and individual product parts depending on their properties, e.g. as:

- Cardboard
- Electronic waste (circuit boards)
- Plastic
- Sheet metal
- Copper
- Aluminum
- Battery

3.9 Firefighting

DANGER!

Electrical voltage! Risk of fatal injury due to electric shock!

There is a risk of fatal injury due to electric shock when using conductive firefighting equipment.

- Use ABC powder or carbon dioxide (CO_2) for firefighting.

4 UL-compliant use

This chapter contains relevant information for use under UL conditions (UL – Underwriters Laboratories).

Surrounding air temperature and pollution degree

The maximum surrounding air temperature for UL-compliant operation is 45 °C. Use in an environment with pollution degree 2 is permitted.

Network layout

All device types supplied with 480 V_{AC} are intended solely for operation with grounded wye sources at 480/277 V_{AC}.

Project configuration

The maximum number of devices in the device group is limited by certain variables. The nominal output current $I_{2N,PU}$ of the supply module, the charging capacity C_{PU} of the supply module and the maximum copper rail length of 1500 mm must not be exceeded.

For this purpose, observe the information in the chapter Example design for UL-compliant operation [271].

You can find an order overview of the required hardware components in the attachment.

Line fuse

Mark each device group and observe the specifications in the chapter UL-compliant line fuses [110] to ensure that the line fuses of the supply modules with power are UL-compliant.

Branch circuit protection

Integral solid state short circuit protection does not provide branch circuit protection (line fuse) upstream of the drive controller. Branch circuit protection must be provided in accordance with the manufacturer instructions, the National Electrical Code, the Canadian Electrical Code, part I, and any additional local codes.

Protective grounding

The protective grounding of motors connected to the drive controller must not be connected using terminals X20A and X20B. The grounding conductor connection of the motor must be ensured for the respective application in accordance with the valid electrical standards.

The grounding at terminal X10 of the PMC PS6 supply module must not be used for the protective grounding of the PMC PS6 drive system in combination with PMC SI6. The housing for the PMC PS6 supply modules must be connected to the protective grounding using the M6 ground bolt (4.0 Nm, 35 Lb.inch).

The drive controller housing must be connected to the PMC DL6B modules of the DC link connection through proper installation of the drive controllers using the two M5 fastening nuts. The specified tightening torque for these fastening screws at the PMC DL6B modules is 3.5 Nm (31 Lb.inch).

Original text:

WARNINGS!

Safety grounding

The external motors which are connected to the inverter units SI6 units shall not be grounded over the modular drive system. The bonding/grounding of the motor(s) shall occur in the end use application in accordance with the requirements of applicable electrical codes/standards.

The grounding provisions present on the terminals X20A/X20B of the SI6 unit are not intended for safety grounding of the motors. The grounding provision present on terminal X10 of the inverter unit is not to be used for the grounding of the drive system.

The chassis of the PS6A/SI6A units is to be bonded through the M6 grounding studs on the PS6A units (4.0 Nm, 35 Lb.inch).

The chassis of the SI6A units are to be bonded by means of proper mounting of the SI6A unit(s) by means of two mounting screws on top of the DL6B unit(s). The specified tightening torque for these mounting screws on the DL6B units is: 3.5 Nm (31 Lb.inch).

The connection for the protective grounding on the housing is identified by the grounding symbol in accordance with IEC 60417 (symbol 5019).

Observe the notes in the chapter UL-compliant connection of the grounding conductor [114] for correct installation.

Functional grounding

In addition to the protective grounding, a functional grounding is required for proper operation of the PMC PS6 drive system in combination with PMC SI6 and of the motor. The functional grounding of the PMC PS6 drive system in combination with PMC SI6 is connected using the X10 terminal. The functional grounding of the motor is connected using terminals X20A and X20B. The connections for the functional grounding to terminals X10, X20A and X20B are marked with **PE**. For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

Terminals

Note that the basic device is delivered without terminals. Suitable terminal sets are available separately for each size. An order overview of the available terminal sets can be found in the appendix.

Motor overload protection/motor temperature protection

Use motor overload protection/motor temperature protection. The PMC SI6 drive controller features connections for PTC thermistors (NAT 145 °C, sensor voltage = 3.3 V_{DC}, sensor current = 0.6 mA) at X2A/X2B, pins 7 and 8. The devices are only intended for use with motors with integrated temperature protection. In accordance with UL certification, operation without motor overload protection/motor temperature protection in or on the motor (X2 jumpers) is not permitted!

For a proper connection, observe the terminal description for X2A in the chapter X2A: Motor temperature sensor A [124].

Braking resistor

Use braking resistors with thermal monitoring and a resistor with at least 22 Ω.

The temperature switch of the braking resistor must be connected to terminal X23 of the PMC PS6 supply module.

If the temperature switch reports a braking resistor overload, the PMC PS6 supply module must be disconnected from the power supply using the WARNING1 relay at terminal X100.

Observe the wiring example in the chapter UL-compliant connection of the supply module [📖 270].

Brake

Observe the technical data for the brake in the chapter Controllable brakes [📖 65].

Digital inputs

Observe the technical data for the digital inputs at X101 and X103 in the chapter Digital inputs [📖 48].

Power terminals

Use only copper conductors for a surrounding temperature of 60/75 °C.

Fuses

Fuses must be approved for DC voltage in accordance with UL 248.

Low-voltage circuits must be supplied by an isolated source with a maximum output voltage that does not exceed 30 V_{DC}.

- Provide the 24 V_{DC} supply for the brake using a 10 A fuse (time delay). Observe the terminal description for X11 in the chapter X11: 24 V supply [📖 118].
- Provide the supply for the brake using a 10 A fuse (time delay). Observe the terminal description for X300 in the chapter X300: Brake 24 V supply [📖 140].
- For the STO safety function via terminal X12: Use a 3.15 A fuse (time delay) to protect the supply voltage of the status signal. Observe the terminal description for X12 in the chapter X12: Safety technology (option PMC SR6) [📖 132].

UL test

Only the risks of electric shock and the risk of fire have been examined during UL acceptance. Functional safety aspects have not been assessed during the UL approval process. These are assessed for Pilz by bodies such as the TÜV SÜD certification service.

Intern

5 System design

The multi-axis drive system consists of at least one PMC PS6 supply module and one PMC SI6 drive controller. To supply energy to the drive controllers in the device group, you need suitable Quick DC-Link modules for the DC link connection for each supply module and drive controller.

For connecting the drive controller to a higher-level controller, we recommend the EtherCAT fieldbus as well as an application with a CiA 402 interface. You commission the drive controllers using the DriveControlSuite software.

The drive controllers offer the STO safety function in accordance with EN 61800-5-2 as an option. For connection to a higher-level safety circuit, different interfaces are available.

The following graphic explains the principle system design.

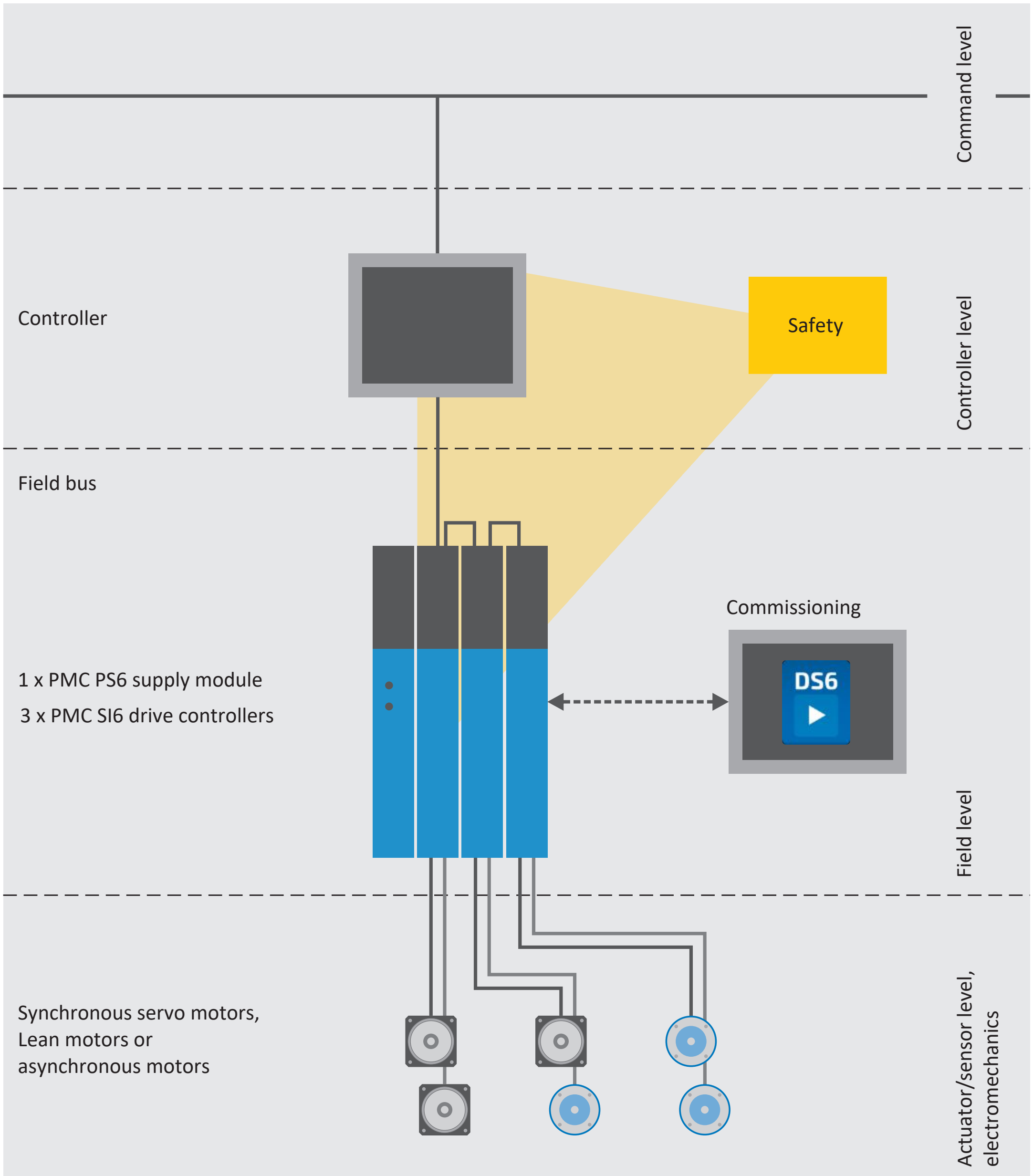


Fig. 1: System overview for the multi-axis drive system with PMC SI6 and PMC PS6

5.1 Hardware components

Below you will find an overview of the available hardware components.

5.1.1 Supply module

The PMC PS6 supply module is available in two sizes.

5.1.1.1 Nameplate

The nameplate is placed on the side of the supply module.

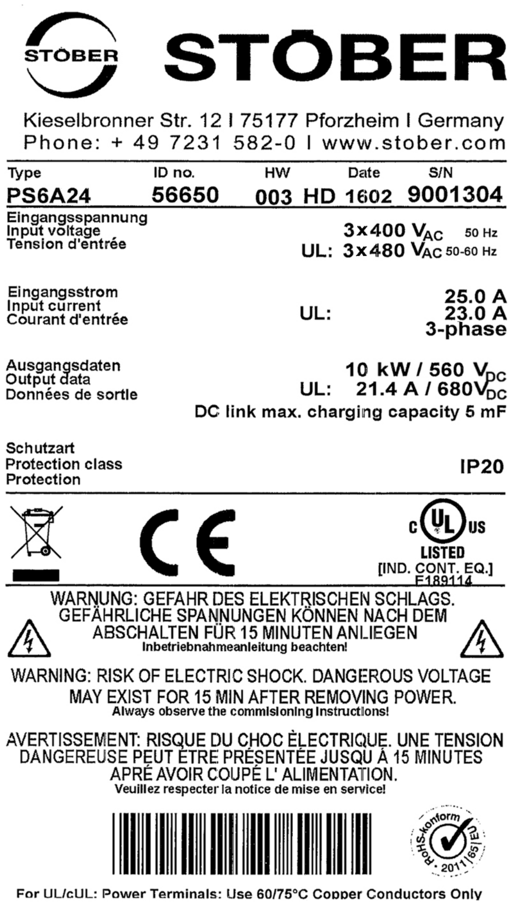


Fig. 2: PS6A24 nameplate

Designation	Value in example	Meaning
Type	PS6A24	Production information
ID No.	56650	
HW	003 HD	
Date	1602	
S/N	9001304	
Input voltage	3 × 400 V_{AC} UL: 3 × 480 V_{AC}	Input voltage
Input current	25.0 A UL: 23.0 A 3-phase	Input current Number of phases
Output data	10 kW / 560 V_{DC} UL: 21.4 A / 680 V_{DC} DC link max. charging capacity 5 mF	Output voltage and nominal power or nominal current Maximum charging capacity
Protection class	IP20	Protection class

Meaning of the specifications on the supply module nameplate

Information

UL and cUL-certified devices with corresponding test symbols meet the requirements of the standards UL 61800-5-1 and CSA C22.2 No. 274.

5.1.1.2 Type designation

PS	6	A	2	4

Example code for supply module type designation

Code	Designation	Design
PS	Series	PowerSupply
6	Generation	Generation 6
A	Version	
2 – 3	Size	
4	Power output stage	

Meaning of the example code

5.1.1.3 Material variant

On the side of the supply module above the nameplate, there is another sticker with the material variant (MV) and serial number (SN).

Fig. 3: Sticker with MV and serial number

Value in example	Meaning
PMC PS6A24	Pilz type designation
ID No. 8C123456	Identification number
MV0000012345	MV number
SN 60011192064	Serial number
1000914812 / 001100	Order number/order item

Meaning of the specifications on the sticker

5.1.1.4 Sizes

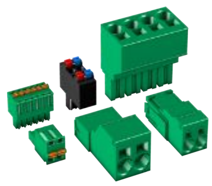
Type	ID No.	Size
PMC PS6A24	8C000001	Size 2
PMC PS6A34	8C000003	Size 3

Available PMC PS6 types and sizes

PMC PS6 in sizes 2 and 3

Note that the basic device is delivered without terminals. Suitable terminal sets are available separately for each size.

Terminal set for supply module



The following designs are available:

ID No. 8C000002
Terminal set for PMC PS6A24.

ID No. 8C000004
Terminal set for PMC PS6A34.

5.1.2 Drive controllers

The PMC SI6 drive controller is available in several sizes as a single or double-axis controller. Various safety options are also available.

5.1.2.1 Nameplate

The nameplate is placed on the side of the drive controller.

Fig. 4: SI6A061 nameplate

Designation	Value in example	Meaning
Type	SI6A061	Production information
ID No.	56646	
HW	027 HD	
Date	1602	
S/N	9001302	
Input voltage	560 V_{DC} UL: 680 V_{DC}	Input voltage
Input current	UL: 4.2 A	Input current
Output data	0 to 460 V_{AC} 0 to 700 Hz @4 kHz: 5.0 A @8 kHz: 4.5 A 3-phase	Output voltage Output frequency Output current for 4 kHz clock frequency Output current for 8 kHz clock frequency Number of phases
Protection class	IP20	Protection class

Meaning of the specifications on the drive controller nameplate

Information

UL and cUL-certified devices with corresponding test symbols meet the requirements of the standards UL 61800-5-1 and CSA C22.2 No. 274.

5.1.2.2 Type designation

SI	6	A	0	6	1	Z

Example code for drive controller type designation

Code	Designation	Design
SI	Series	ServoInverter
6	Generation	Generation 6
A	Version	
0 – 3	Size	
6	Power output stage	Power output stage within the size
1 2	Axis controller	Single-axis controller Double-axis controller
Z R Y	Safety technology	PMC SZ6: Without safety technology PMC SR6: STO using terminals PMC SY6: STO and SS1 using FSoE

Meaning of the example code

5.1.2.3 Material variant

On the side of the drive controller above the nameplate, there is another sticker with the material variant (MV) and serial number (SN).

Fig. 5: Sticker with MV and serial number

Value in example	Meaning
PMC SI6A061Y/EC 2x 5A	Pilz type designation
ID No. 8C123456	Identification number
MV0000012345	MV number
SN 60011192064	Serial number
1000914812 / 001100	Order number/order item

Meaning of the specifications on the sticker

5.1.2.4 Sizes

Type		ID No.[a]	Size	Axis controller
PMC SI6A061	EC	8C000011	Size 0	Single-axis controller
	PN	8C000012		
PMC SI6A062	EC	8C000019	Size 0	Double-axis controller
	PN	8C000020		
PMC SI6A161	EC	8C000027	Size 1	Single-axis controller
	PN	8C000028		
PMC SI6A162	EC	8C000035	Size 1	Double-axis controller
	PN	8C000036		
PMC SI6A261	EC	8C000043	Size 2	Single-axis controller
	PN	8C000044		
PMC SI6A262	EC	8C000051	Size 2	Double-axis controller
	PN	8C000052		
PMC SI6A361	EC	8C000059	Size 3	Single-axis controller
	PN	8C000060		

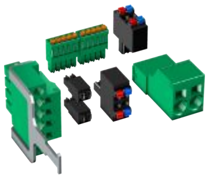
Available PMC SI6 types and sizes

a) With PMC SZ6 option: Without safety technology

PMC SI6 in sizes 0 to 3

Note that the basic device is delivered without terminals. Suitable terminal sets are available separately for each size.

Terminal set for drive controller – PMC SZ6 option (without safety technology) or PMC SY6 option (STO and SS1 using FSoE)



The following designs are available:

ID No. 8C000006
Terminal set for PMC SI6A061Z/Y.

ID No. 8C000014
Terminal set for PMC SI6A062Z/Y.

ID No. 8C000022
Terminal set for PMC SI6A161Z/Y.

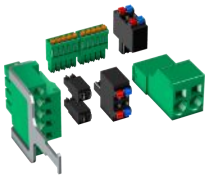
ID No. 8C000030
Terminal set for PMC SI6A162Z/Y.

ID No. 8C000038
Terminal set for PMC SI6A261Z/Y.

ID No. 8C000046
Terminal set for PMC SI6A262Z/Y.

ID No. 8C000054
Terminal set for PMC SI6A361Z/Y.

Terminal set for drive controller – PMC SR6 option (STO via terminals)



The following designs are available:

ID No. 8C000005
Terminal set for PMC SI6A061R.

ID No. 8C000013
Terminal set for PMC SI6A062R.

ID No. 8C000021
Terminal set for PMC SI6A161R.

ID No. 8C000029
Terminal set for PMC SI6A162R.

ID No. 8C000037
Terminal set for PMC SI6A261R.

ID No. 8C000045
Terminal set for PMC SI6A262R.

ID No. 8C000053
Terminal set for PMC SI6A361R.

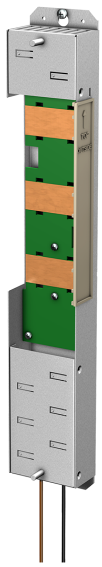
5.1.3 DC link connection

For the energy supply of the existing networked drive controllers, you need suitable Quick DC-Link modules of type PMC DL6B for each PMC PS6 supply module and each PMC SI6 drive controller.

For the horizontal connection, you receive PMC DL6B rear section modules in various designs, matched to the size of the drive controller or supply module.

The quick fastening clamps for attaching the copper rails and an insulation connection piece are contained in the scope of delivery. The copper rails are not included in the scope of delivery. These must have a cross-section of 5 x 12 mm. Insulation end sections are available separately.

Quick DC-Link PMC DL6B for drive controller



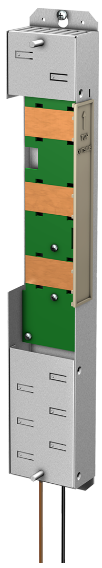
The following designs are available:

PMC DL6B10
ID No. 8C000086
Rear section module for size 0 drive controller:
PMC SI6A061 and PMC SI6A062

PMC DL6B11
ID No. 8C000087
Rear section module for size 1 or 2 (single-axis controller) drive controller:
PMC SI6A161, PMC SI6A162 and PMC SI6A261

PMC DL6B12
ID No. 8C000088
Rear section module for size 2 (double-axis controller) or 3 drive controller:
PMC SI6A262 and PMC SI6A361

Quick DC-Link PMC DL6B for supply module



The following designs are available:

PMC DL6B20
ID No. 8C000089
Rear section module for size 2 supply module:
PMC PS6A24

PMC DL6B21
ID No. 8C000090
Rear section module for size 3 supply module:
PMC PS6A34

Quick DC-Link PMC DL6B insulation end section

ID No. 8C000085
Insulation end sections for the left and right termination of the group, 2 pcs.

5.1.4 Operating motors, encoders and brakes

You can use the PMC SI6 drive controller to operate Pilz Lean motors of the PMC LM series, synchronous servo motors (such as those of the PMC EZ series), asynchronous motors or torque motors.

Evaluation options for feedback are available on the X4 connection for the following encoders:

- EnDat 2.2 digital encoders
- SSI encoders
- Differential TTL and differential HTL incremental encoders (HTL via PMC HT6 adapter)
- Resolver
- HIPERFACE DSL encoders

In addition, evaluation options for the following encoders are available on the X101 and X103 connection:

- Single-ended HTL incremental encoders
- Single-ended HTL pulse train

All device types of the PMC SI6 drive controller have connections for PTC thermistors and can control a 24 V_{DC} brake as standard.

5.1.5 Accessories

You can find information about the available accessories in the following chapters.

5.1.5.1 Safety technology

The safety modules are used to realize the STO safety function. They prevent the generation of a rotating magnetic field in the power unit of the drive controller. For an external requirement or in the event of error, the safety module switches the drive controller to the STO state. Different human-machine interfaces and additional safety functions are available depending on the selected design of the accessories.

For double-axis controllers, the STO safety function has a two-channel structure that acts upon both axes.

> **Information**
>
> Note that the drive controller is delivered as a standard version without safety technology (PMC SZ6 option). If you want a drive controller with integrated safety technology, you must order it together with the drive controller. The safety modules are an integrated part of the drive controllers and must not be modified.

PMC SZ6 option – Without safety technology

ID No. —
Standard version.

PMC SR6 safety module – STO using terminals

ID No. —
Optional accessory for the use of the Safe Torque Off safety function (STO) in safety-relevant applications (PL e, SIL 3) in accordance with DIN EN ISO 13849-1 and DIN EN 61800-5-2. Connection to a higher-level safety circuit via terminal X12.

PMC SY6 safety module – STO and SS1 using FSoE

Safety over EtherCAT

ID No. —
Optional accessory for the use of the Safe Torque Off (STO) and Safe Stop 1 (SS1) safety functions in safety-relevant applications (PL e, SIL 3) in accordance with DIN EN ISO 13849-1 and DIN EN 61800-5-2. Connection to the higher-level safety circuit using Fail Safe over EtherCAT (FSoE).

Detailed information about using the safety technology can be found in the corresponding manual; see the chapter Detailed information [300].

5.1.5.2 Communication

The drive controller has two interfaces for the fieldbus connection on the top of the device as well as an Ethernet service interface on the front of the device. Cables for the connection are available separately.

EtherCAT or PROFINET fieldbus system

Please specify the desired fieldbus system when placing your purchase order for the base device.

EtherCAT cables

Ethernet patch cable, CAT5e, yellow.

The following designs are available:

ID No. on request: Length approx. 0.2 m.
ID No. on request: Length approx. 0.35 m.

PC connecting cables

ID No. on request
Cable for connecting the X9 service interface to the PC, CAT5e, blue, 5 m.

USB 2.0 Ethernet adapter

ID No. on request
Adapter for connecting Ethernet to a USB port.

Detailed information about the fieldbus connection can be found in the corresponding manual, see the chapter Detailed information [📖300].

5.1.5.3 Braking resistor

Pilz offers braking resistors in different sizes and performance classes.

More detailed information can be found in the chapter Braking resistor [📖66].

5.1.5.4 Choke

Pilz offers different chokes corresponding to your application.

More detailed information can be found in the technical data in the chapter Choke [📖72].

5.1.5.5 Encoder battery module

Absolute Encoder Support PMC AES

ID No. on request
Battery module for buffering the supply voltage when using the EnDat 2.2 digital inductive encoder with battery-buffered multi-turn stage, for example EBI1135 or EBI135.
A battery is included.

Information

Note that a 15-pin extension cable between the socket and the PMC AES may be necessary for the connection to the drive controller due to limited space.

- A commercially available shielded extension cable with a 15-pin D-sub connector and a length of ≤ 1 m can be used between the socket and the PMC AES.

PMC AES replacement battery

ID No. on request
Replacement battery for PMC AES battery module.

5.1.5.6 HTL-to-TTL adapter

PMC HT6 HTL-to-TTL adapter

ID No. on request
Adapters for PMC SC6 and PMC SI6 series drive controllers for level conversion from HTL signals to TTL signals.
It is used to connect an HTL differential incremental encoder to terminal X4 of the drive controller.

5.1.5.7 Interface adapters

PMC AP6A00 interface adapters

ID No. on request
Adapter (9/15-pin) for connecting resolver cables with a 9-pin D-sub connector to the X4 encoder interface of the drive controller.

5.2 Software components

The available software components help you implement your drive system.

5.2.1 Project configuration and parameterization

For project configuration and parameterization, the drive controller can be addressed using the DriveControlSuite commissioning software. The program guides you step by step through the complete project configuration and parameterization process using wizards.

5.2.2 Applications

Controller-based motion control is recommended for the central motion control of complex machines.

Using the controller-based operating modes of the CiA 402 application, you can implement applications with synchronized, cyclic set value specification (csp, csv, cst, ip) by a motion controller. In addition, the drive controllers can also independently handle motion tasks, such as referencing and jogging during commissioning.

Drive-based Drive Based and Drive Based Synchronous applications and drive-based operating modes (pp, pv, pt) of the CiA 402 application are also available for torque/force mode, velocity mode or positioning mode.

Detailed information about the available applications can be found in the corresponding manual; see the chapter Detailed information [300].

6 Technical data

Technical data for the drive controllers, supply modules and accessories can be found in the following chapters.

6.1 General technical data

The following specifications apply equally to the PMC SI6 drive controller and the PMC PS6 supply module.

Device features	
Protection class of the device	IP20
Protection class of the installation space	At least IP54
Protection class	Protection class I in accordance with DIN EN 61140
Radio interference suppression	Integrated line filter in accordance with DIN EN 61800-3, interference emission class C3
Overvoltage category	III in accordance with DIN EN 61800-5-1
Test symbols	

Device features

Transport and storage conditions	
Storage/ transport temperature	−20 °C to +70 °C Maximum change: 20 K/h
Relative humidity	Maximum relative humidity 85%, non-condensing
Vibration (transport) in accordance with DIN EN 60068-2-6	5 Hz ≤ f ≤ 9 Hz: 3.5 mm 9 Hz ≤ f ≤ 200 Hz: 10 m/s² 200 Hz ≤ f ≤ 500 Hz: 15 m/s²
Fall height for freefall[1] Weight < 100 kg in accordance with DIN EN 61800-2 (or DIN EN 60721-3-2:1997, class 2M1)	0.25 m

Transport and storage conditions

Operating conditions	
Surrounding temperature during operation	0 °C to 45 °C with nominal data 45 °C to 55 °C with derating −2.5% / K
Relative humidity	Maximum relative humidity 85%, non-condensing
Installation altitude	0 m to 1000 m above sea level without restrictions 1000 m to 2000 m above sea level with −1.5%/100 m derating
Pollution degree	Pollution degree 2 in accordance with EN 50178
Ventilation	Installed fan
Vibration (operation) in accordance with DIN EN 60068-2-6	5 Hz ≤ f ≤ 9 Hz: 0.35 mm 9 Hz ≤ f ≤ 200 Hz: 1 m/s²

Operating conditions

[1] Only valid for components in original packaging

Discharge times	
Self-discharge of DC link	15 min
DC link circuit fast discharge	Thanks to PMC PS6 supply module in combination with a braking resistor: < 1 min

Discharge times of the DC link circuit

6.2 Supply module

The following section contains specifications for the electrical data, dimensions and weight of the PS6 supply module.

6.2.1 Electrical data

The electrical data of the available PMC PS6 sizes as well as the properties of the brake chopper can be found in the following sections.

Information

For cyclic power-on/power-off operation, the following is to be observed to prevent the charging capacities of the supply modules from being exceeded:

- PMC PS6 without braking resistor: Direct, repeat activation of the supply voltage possible.
- PMC PS6 with braking resistor and an interval < 30 s after power-off: Direct, repeat activation of the supply voltage possible.
- PMC PS6 with braking resistor and an interval > 30 s after power-off: Reactivation of the supply voltage only possible 2 min after previous activation!

Information

The STO safety function is available for safe stopping as an alternative to continuous, cyclical power-on/power-off operation.

An explanation of the symbols used for formulas can be found in Chapter Symbols in formulas [301].

6.2.1.1 Control unit

Electrical data	All types
U_{1CU}	24 V_{DC}, +20%/−15%
I_{1maxCU}	0.5 A

Control unit electrical data

6.2.1.2 Power unit: Size 2

Electrical data	PMC PS6A24
U_{1PU}	3 × 400 V_{AC}, +32%/−50%, 50/60 Hz; 3 × 480 V_{AC}, +10%/−58%, 50/60 Hz
U_{2PU}	√2 × U_{1PU}
$P_{N,PU}$	10 kW
$I_{1N,PU}$	25 A
I_{1maxPU}	$I_{1N,PU}$ × 180% for 5 s; $I_{1N,PU}$ × 150% for 30 s
C_{maxPU}	5000 µF

PMC PS6 electrical data, size 2

6.2.1.3 Power unit: Size 3

Electrical data	PMC PS6A34
U_{1PU}	3 × 400 V_{AC}, +32%/−50%, 50/60 Hz; 3 × 480 V_{AC}, +10%/−58%, 50/60 Hz
U_{2PU}	√2 × U_{1PU}
$P_{N,PU}$	20 kW
$I_{1N,PU}$	50 A
I_{1maxPU}	$I_{1N,PU}$ × 180% for 5 s; $I_{1N,PU}$ × 150% for 30 s
C_{maxPU}	10000 µF

PMC PS6 electrical data, size 3

6.2.1.4 Parallel connection

The power and current increase if supply modules are connected in parallel. Take into account that the total is derated by a factor of 0.8 in doing so.

The charging capacity of the supply modules can be increased by a parallel connection only if the power grid supply is connected to all supply modules simultaneously. Increasing the charging capacity also requires derating the total by a factor of 0.8.

The following table shows example combinations for parallel connection.

Electrical data	2 x PMC PS6A24	3 x PMC PS6A24	2 x PMC PS6A34	3 x PMC PS6A34
$P_{N,PU}$	16 kW	24 kW	32 kW	48 kW
$I_{1N,PU}$	40 A	60 A	80 A	120 A
C_{maxPU}	8000 µF	12000 µF	16000 µF	24000 µF

Electrical data for parallel connection: Example combinations

Note the general conditions for parallel connection of supply modules in the chapter Parallel connection of supply modules [📖 77].

6.2.1.5 Brake chopper

Electrical data	All types
U_{onCH}	780 – 800 V_{DC}
U_{offCH}	740 – 760 V_{DC}
R_{2minRB}	22 Ω
P_{maxRB}	29.1 kW
P_{effRB}	13.2 kW

Brake chopper electrical data

Information

Use braking resistors with thermal monitoring (see the chapter Braking resistor [66]).

6.2.1.6 Fast discharge

Fast discharge is activated when no power supply is present for 20 s and the DC link voltage has reduced over this time. For active fast discharge, the DC link is discharged via the brake chopper and the braking resistor. Fast discharge does not take place for constant or increasing DC link voltage as this behavior indicates a second supply module in the DC link group. If the temperature sensor of the braking resistor is active, the fast discharge also remains off.

6.2.1.7 Status output

The relay status output of terminal X100 in conjunction with the 3 diagnostic LEDs on the front of the device provides information about the status of the supply module.

Electrical data	Relay
U_{2max}	30 V_{DC}
I_{2max}	2.0 A
Expected service life	Mechanical min. 100 000 000 switch.; at 30 V_{DC}/2 A (ohm. load): 100 000 switch.

Electrical data

6.2.2 Dimensions

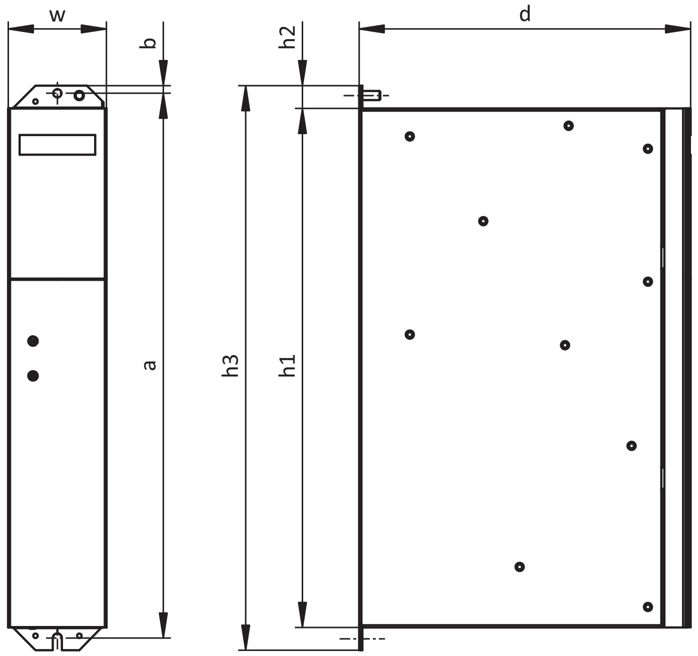


Fig. 6: PMC PS6 dimensional drawing

Dimension			Size 2	Size 3
Supply module	Width	w	45	65
	Depth	d	204	219
	Body height	h1	343	
	Fastening clip height	h2	15	
	Height incl. fastening clips	h3	373	
Fastening holes (M5)	Vertical distance	a	360+2	
	Vertical distance to the upper edge	b	5	

PMC PS6 dimensions [mm]

6.2.3 Weight

Type	Weight without packaging [g]	Weight with packaging [g]
PMC PS6A24	2680	4180
PMC PS6A34	3820	4920

PMC PS6 weight [g]

6.3 Drive controllers

The following chapters contain specifications for the electrical data, dimensions and weight of the drive controller.

6.3.1 Electrical data

The electrical data of the available PMC SI6 sizes can be found in the following sections.

An explanation of the symbols used for formulas can be found in Chapter Symbols in formulas [301].

6.3.1.1 Control unit

Electrical data	All types
U_{1CU}	24 V_{DC}, +20%/−15%
I_{1maxCU}	0.5 A

Control unit electrical data

6.3.1.2 Power unit: Size 0

Electrical data	PMC SI6A061	PMC SI6A062
U_{1PU}	280 – 800 V_{DC}	
f_{2PU}	0 – 700 Hz	
U_{2PU}	0 – max.	
C_{PU}	180 µF	270 µF

PMC SI6 electrical data, size 0

Nominal currents up to +45 °C (in the control cabinet)

Electrical data	PMC SI6A061	PMC SI6A062
$f_{PWM,PU}$	4 kHz	
$I_{2N,PU}$	5 A	2 × 5 A
I_{2maxPU}	210% for 2 s	

PMC SI6 electrical data, size 0, for 4 kHz clock frequency

Electrical data	PMC SI6A061	PMC SI6A062
$f_{PWM,PU}$	8 kHz	
$I_{2N,PU}$	4.5 A	2 × 4.5 A
I_{2maxPU}	250% for 2 s	

PMC SI6 electrical data, size 0, for 8 kHz clock frequency

6.3.1.3 Power unit: Size 1

Electrical data	PMC SI6A161	PMC SI6A162
U_{1PU}	280 – 800 V_{DC}	
f_{2PU}	0 – 700 Hz	
U_{2PU}	0 – max.	
C_{PU}	470 µF	940 µF

PMC SI6 electrical data, size 1

Nominal currents up to +45 °C (in the control cabinet)

Electrical data	PMC SI6A161	PMC SI6A162
$f_{PWM,PU}$	4 kHz	
$I_{2N,PU}$	12 A	2 × 12 A
I_{2maxPU}	210% for 2 s	

PMC SI6 electrical data, size 1, for 4 kHz clock frequency

Electrical data	PMC SI6A161	PMC SI6A162
$f_{PWM,PU}$	8 kHz	
$I_{2N,PU}$	10 A	2 × 10 A
I_{2maxPU}	250% for 2 s	

PMC SI6 electrical data, size 1, for 8 kHz clock frequency

6.3.1.4 Power unit: Size 2

Electrical data	PMC SI6A261	PMC SI6A262
U_{1PU}	280 – 800 V_{DC}	
f_{2PU}	0 – 700 Hz	
U_{2PU}	0 – max.	
C_{PU}	940 µF	2250 µF

PMC SI6 electrical data, size 2

Nominal currents up to +45 °C (in the control cabinet)

Electrical data	PMC SI6A261	PMC SI6A262
$f_{PWM,PU}$	4 kHz	
$I_{2N,PU}$	22 A	2 × 25 A
I_{2maxPU}	210% for 2 s	

PMC SI6 electrical data, size 2, for 4 kHz clock frequency

Electrical data	PMC SI6A261	PMC SI6A262
$f_{PWM,PU}$	8 kHz	
$I_{2N,PU}$	20 A	2 × 20 A
I_{2maxPU}	250% for 2 s	

PMC SI6 electrical data, size 2, for 8 kHz clock frequency

6.3.1.5 Power unit: Size 3

Electrical data	PMC SI6A361
U_{1PU}	280 – 800 V_{DC}
f_{2PU}	0 – 700 Hz
U_{2PU}	0 – max.
C_{PU}	2250 µF

PMC SI6 electrical data, size 3

Nominal currents up to +45 °C (in the control cabinet)

Electrical data	PMC SI6A361
$f_{PWM,PU}$	4 kHz
$I_{2N,PU}$	50 A
I_{2maxPU}	210% for 2 s

PMC SI6 electrical data, size 3, for 4 kHz clock frequency

Electrical data	PMC SI6A361
$f_{PWM,PU}$	8 kHz
$I_{2N,PU}$	40 A
I_{2maxPU}	250% for 2 s

PMC SI6 electrical data, size 3, for 8 kHz clock frequency

6.3.1.6 Digital inputs

X101 specification for digital signals

The inputs are suitable for the connection of PELV voltage in accordance with EN 60204-1.

Electrical data	Digital input	Value
Low level	DI1 – DI4	0 – 8 V_{DC}
High level		12 – 30 V_{DC}
U_{1max}		30 V_{DC}
I_{1max}		16 mA
f_{1max}	DI1 – DI2	10 kHz
	DI3 – DI4	250 kHz
Internal device update rate	DI1 – DI4	Cycle time for the application parameterized in A150; t_{min} = 1 ms; Also applicable for digital inputs DI3 and DI4: with timestamp correction in an accuracy range of 1 µs
Max. cable length		30 m

X101 electrical data

X103 specification for digital signals

The inputs are suitable for the connection of PELV voltage in accordance with EN 60204-1.

Electrical data	Digital input	Value
Low level	DI6 – DI9	0 – 8 V_{DC}
High level		12 – 30 V_{DC}
U_{1max}		30 V_{DC}
I_{1max}		16 mA
f_{1max}	DI6 – DI7	10 kHz
	DI8 – DI9	250 kHz
Internal device update rate	DI6 – DI9	Cycle time for the application parameterized in A150; t_{min} = 1 ms; also applicable for digital inputs DI8 and DI9: with timestamp correction in an accuracy range of 1 µs
Max. cable length		30 m

X103 electrical data

6.3.1.7 Single-ended nominal power consumption on double-axis controllers

Operating two motors on one double-axis controller makes it possible to operate one of the motors with a continuous current above the nominal current of the drive controller if the continuous current of the second connected motor is lower than the nominal current of the drive controller. This enables economical combinations of double-axis controllers and motors.

The nominal output current for axis B can be determined using the following formula if the output current for axis A is known:

Example 1

$$I_{2PU(B)} = I_{2N,PU} - \left(I_{2PU(A)} - I_{2N,PU} \right) \times \frac{3}{5} \quad \text{where} \quad 0 \leq I_{2PU(A)} \leq I_{2N,PU}$$

Example 2

$$I_{2PU(B)} = I_{2N,PU} - \left(I_{2PU(A)} - I_{2N,PU} \right) \times \frac{5}{3} \quad \text{where} \quad I_{2N,PU} \leq I_{2PU(A)} \leq 1{,}6 \times I_{2N,PU}$$

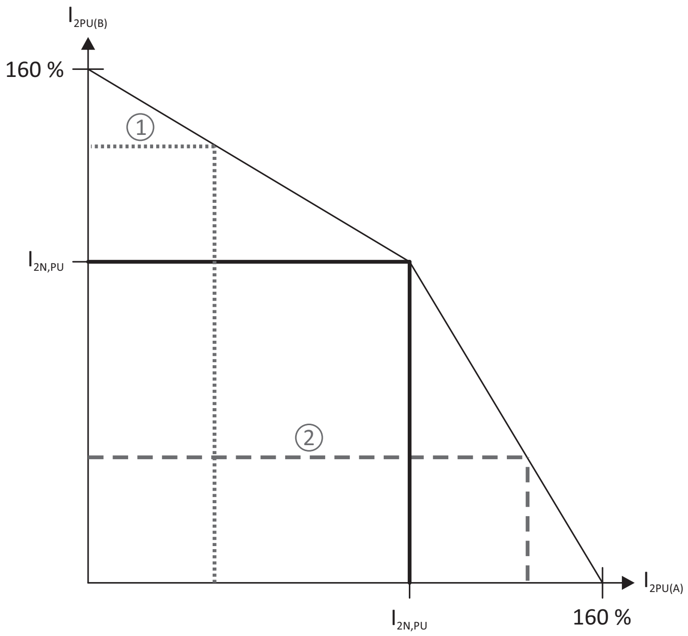


Fig. 7: Asymmetric load on double-axis controllers

Information

Note that the available maximum currents I_{2maxPU} of the axis controllers are also relative to the nominal output current $I_{2N,PU}$ for single-ended nominal power consumption.

6.3.1.8 Power loss data in accordance with EN 61800-9-2

Type	Nominal current $I_{2N,PU}$	Apparent power	Absolute losses $P_{V,CU}$ [2]	Operating points[3]								IE class[4]	Comparison[5]
				(0/25)	(0/50)	(0/100)	(50/25)	(50/50)	(50/100)	(90/50)	(90/100)		
				Relative losses									
	[A]	[kVA]	[W]	[%]									
PMC SI6A06x	5	3.5	Max. 10	0.71	0.86	1.33	0.76	0.97	1.61	1.13	2.13	IE2	
PMC SI6A16x	12	8.3	Max. 10	0.55	0.71	1.19	0.59	0.80	1.44	0.94	1.87	IE2	
PMC SI6A261	22	16.6	Max. 10	0.55	0.71	1.19	0.59	0.80	1.44	0.94	1.87	IE2	
PMC SI6A262	25	17.3	Max. 10	0.45	0.62	1.12	0.50	0.74	1.47	0.95	2.12	IE2	
PMC SI6A361	50	34.6	Max. 10	0.45	0.62	1.12	0.50	0.74	1.47	0.95	2.12	IE2	
				Absolute losses P_V									
	[A]	[kVA]	[W]	[W]									[%]
PMC SI6A06x	5	3.5	Max. 10	25	30.2	46.5	26.5	33.8	56.5	39.5	74.4	IE2	24.9
PMC SI6A16x	12	8.3	Max. 10	45.7	58.7	98.7	49.1	66.3	119.6	78.1	155.4	IE2	26.7
PMC SI6A261	22	16.6	Max. 10	91.5	117.4	197.3	98.2	132.6	239.2	156.2	310.8	IE2	30.8
PMC SI6A262	25	17.3	Max. 10	77.9	106.5	193.0	87.1	127.9	254.3	163.8	367.6	IE2	36.4
PMC SI6A361	50	34.6	Max. 10	155.8	213.1	386.0	174.3	255.8	508.6	327.6	735.2	IE2	39.5

Power loss data in accordance with EN 61800-9-2 for one axis of a PMC SI6 drive controller

General conditions

The specified losses apply to an axis of a drive controller and take into account the proportionate losses of the PMC PS6 supply module for that axis.

For a group with a total of x axes, the values are to be multiplied by the number of axis controllers (x), e.g. x = 4 for 1 × PMC PS6 and 2 × PMC SI6A062.

2 Absolute losses for a power unit that is switched off
3 Operating points for relative motor stator frequency in % and relative torque current in %
4 IE class in accordance with EN 61800-9-2
5 Comparison of the losses for the reference related to IE2 in the nominal point (90, 100)

The loss data applies to drive controllers without any accessories.

The power loss calculation is based on a three-phase supply voltage with 400 V_{AC}/50 Hz.

The calculated data includes a supplement of 10% in accordance with EN 61800-9-2.

The power loss specifications refer to a clock frequency of 4 kHz.

The absolute losses for a power unit that is switched off refer to the 24 V_{DC} power supply of the control electronics.

6.3.1.9 Power loss data of accessories

The power loss data of the PMC PS6 supply module is partially included in the power loss specifications in accordance with EN 61800-9-2.

If you intend to order the drive controller with accessory parts, however, losses increase as follows.

Type	Absolute losses P_V [W]
PMC SR6 safety module	1
PMC SY6 safety module	2

Absolute losses of the accessories

Information

Note the absolute power loss of the encoder (usually < 3 W) and of the brake when designing as well.

Loss specifications for other optional accessories can be found in the technical data of the respective accessory part.

6.3.2 Derating

When dimensioning the drive controller, observe the derating of the nominal output current as a function of the clock frequency, surrounding temperature and installation altitude. There is no restriction for a surrounding temperature from 0 °C to 45 °C and an installation altitude of 0 m to 1000 m. The details given below apply to values outside these ranges.

6.3.2.1 Effect of the clock frequency

Changing the clock frequency f_{PWM} affects the amount of noise produced by the drive, among other things. However, increasing the clock frequency results in increased losses. During project configuration, define the highest clock frequency and use it to determine the nominal output current $I_{2N,PU}$ for dimensioning the drive controller.

Type	$I_{2N,PU}$ 4 kHz [A]	$I_{2N,PU}$ 8 kHz [A]	$I_{2N,PU}$ 16 kHz [A]
PMC SI6A061	5	4.5	3.5
PMC SI6A062	2 × 5	2 × 4.5	2 × 3.5
PMC SI6A161	12	10	6
PMC SI6A162	2 × 12	2 × 10	2 × 6
PMC SI6A261	22	20	10
PMC SI6A262	2 × 25	2 × 20	2 × 10
PMC SI6A361	50	40	—

Nominal output current $I_{2N,PU}$ dependent on the clock frequency

Information

Select the defined clock frequency using parameter B24. The clock frequency for double-axis controllers always applies to both axis controllers.

6.3.2.2 Effect of the surrounding temperature

Derating as a function of the surrounding temperature is determined as follows:

- 0 °C to 45 °C: No restrictions (D_T = 100%)
- 45 °C to 55 °C: Derating −2.5%/K

Example

The drive controller needs to be operated at 50 °C.

The derating factor D_T is calculated as follows
D_T= 100% − 5 × 2.5% = 87.5%

6.3.2.3 Effect of the installation altitude

Derating as a function of the installation altitude is determined as follows:

- 0 m to 1000 m: No restriction (D_{IA} = 100%)
- 1000 m to 2000 m: Derating −1.5%/100 m

Example

The drive controller needs to be installed at an altitude of 1500 m above sea level.

The derating factor D_{IA} is calculated as follows:
D_{IA} = 100% − 5 × 1.5% = 92.5%

6.3.2.4 Calculating the derating

Follow these steps for the calculation:

1. Determine the highest clock frequency (f_{PWM}) that will be used during operation and use it to determine the nominal current $I_{2N,PU}$.
2. Determine the derating factors for installation altitude and surrounding temperature.
3. Calculate the reduced nominal current $I_{2N,PU(red)}$ in accordance with the following formula:
   $I_{2N,PU(red)} = I_{2N,PU} \times D_T \times D_{IA}$

Example

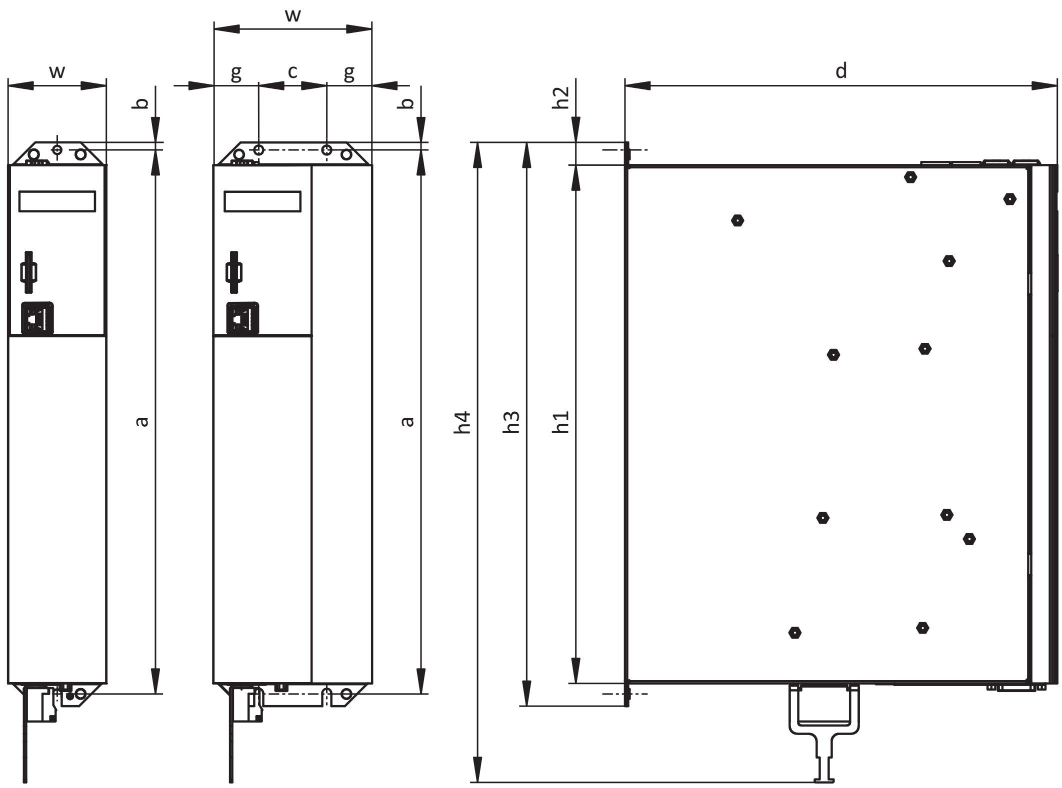
A drive controller of type PMC SI6A061 needs to be operated at a clock frequency of 8 kHz at an altitude of 1500 m above sea level and a surrounding temperature of 50 °C.

The nominal current of the PMC SI6A061 at 8 kHz is 4.5 A. The derating factor D_T is calculated as follows:
D_T = 100% − 5 × 2.5% = 87.5%

The derating factor D_{IA} is calculated as follows:
D_{IA} = 100% − 5 × 1.5% = 92.5%

The output current of importance for the project configuration is:
$I_{2N,PU(red)}$ = 4.5 A × 0.875 × 0.925 = 3.64 A

6.3.3 Dimensions



0 – 2 3

Fig. 8: PMC SI6 dimensional drawing

Dimension			Size 0	Size 1	Size 2[6]	Size 2[7]	Size 3
Drive controller	Width	w	45	65		105	
	Depth	d	265	286			
	Body height	h1	343				
	Fastening clip height	h2	15				
	Height incl. fastening clips	h3	373				
	Total height incl. shield connection	h4	423				
Fastening holes (M5)	Vertical distance	a	360+2				
	Vertical distance to the upper edge	b	5				
	Horizontal spacing of the fastening holes	c	45				
	Horizontal distance to the side edge	g	30				

PMC SI6 dimensions [mm]

[6] Single-axis controller
[7] Double-axis controller

6.3.4 Weight

Type	Weight without packaging [g]	Weight with packaging [g]
PMC SI6A061	2980	4600
PMC SI6A062	3460	5060
PMC SI6A161	3880	5260
PMC SI6A162	4820	6240
PMC SI6A261	4760	6200
PMC SI6A262	6240	7420
PMC SI6A361	6180	7360

PMC SI6 weight [g]

6.4 DC link connection

The following section contains specifications for the electrical data, dimensions and weight of the PMC DL6B modules Quick DC-Link.

6.4.1 General technical data

The following information applies to all Quick DC-Link modules and corresponds to the general technical data for the base device.

Device features	
Protection class of the device	IP20 (if built over with drive controller or supply module)
Protection class	Protection class I in accordance with DIN EN 61140 (if built over with drive controller or supply module)
Protection class of the installation space	At least IP54

Device features

Transport and storage conditions	
Storage/ transport temperature	−20 °C to +70 °C Maximum change: 20 K/h
Relative humidity	Maximum relative humidity 85%, non-condensing
Vibration (transport) in accordance with DIN EN 60068-2-6	5 Hz ≤ f ≤ 9 Hz: 3.5 mm 9 Hz ≤ f ≤ 200 Hz: 10 m/s² 200 Hz ≤ f ≤ 500 Hz: 15 m/s²
Fall height for freefall[8] Weight < 100 kg in accordance with DIN EN 61800-2 (or DIN EN 60721-3-2:1997, class 2M1)	0.25 m

Transport and storage conditions

Operating conditions	
Surrounding temperature during operation	0 °C to 45 °C with nominal data 45 °C to 55 °C with derating −2.5% / K
Relative humidity	Maximum relative humidity 85%, non-condensing
Installation altitude	0 m to 1000 m above sea level without restrictions 1000 m to 2000 m above sea level with −1.5%/100 m derating
Pollution degree	Pollution degree 2 in accordance with EN 50178
Vibration (operation) in accordance with DIN EN 60068-2-6	5 Hz ≤ f ≤ 9 Hz: 0.35 mm 9 Hz ≤ f ≤ 200 Hz: 1 m/s²

Operating conditions

[8] Only valid for components in original packaging

6.4.2 assignment to PMC DL6B – PMC SI6 and PMC PS6

PMC DL6B is available in the following designs suitable for the individual drive controller types and supply module types:

Type	PMC DL6B10	PMC DL6B11	PMC DL6B12	PMC DL6B20	PMC DL6B21
ID No.	8C000086	8C000087	8C000088	8C000089	8C000090
PMC SI6A061	X	–	–	–	–
PMC SI6A062	X	–	–	–	–
PMC SI6A161	–	X	–	–	–
PMC SI6A162	–	X	–	–	–
PMC SI6A261	–	X	–	–	–
PMC SI6A262	–	–	X	–	–
PMC SI6A361	–	–	X	–	–
PMC PS6A24	–	–	–	X	–
PMC PS6A34	–	–	–	–	X

PMC DL6B assignment to PMC SI6 and PMC PS6

6.4.3 Dimensions

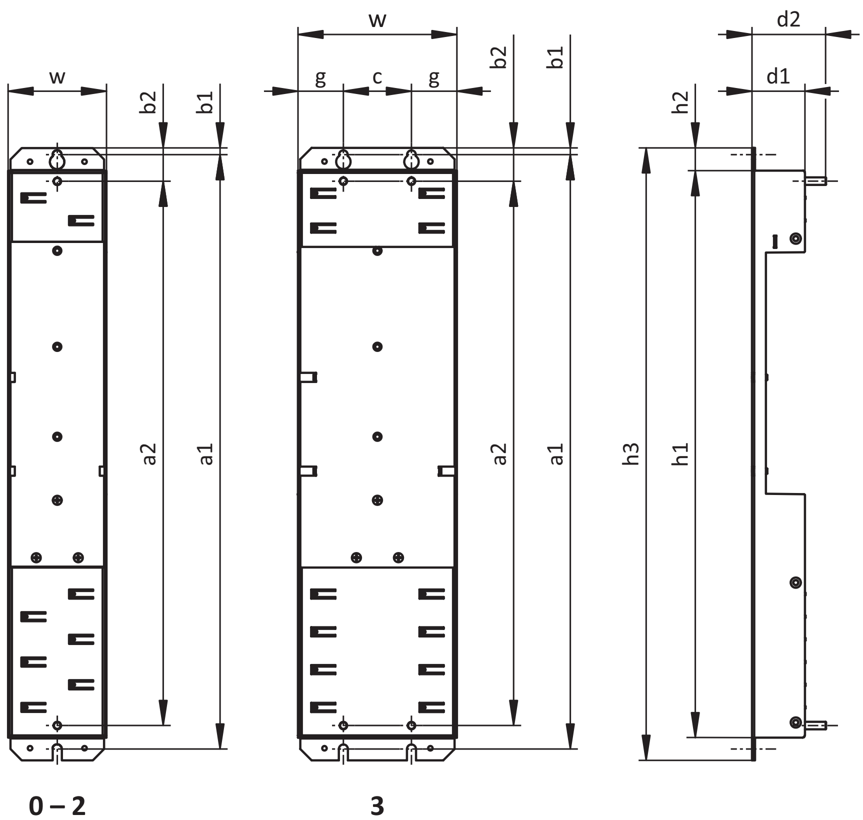


Fig. 9: PMC DL6B dimensional drawing

<table>
<tr><th colspan="3">Dimension</th><th>PMC DL6B10
PMC DL6B20</th><th>PMC DL6B11
PMC DL6B21</th><th>PMC DL6B12</th></tr>
<tr><td rowspan="6">Quick DC-Link</td><td>Width</td><td>w</td><td>45</td><td>65</td><td>105</td></tr>
<tr><td>Depth</td><td>d1</td><td colspan="3">35</td></tr>
<tr><td>Depth incl. attachment bolts</td><td>d2</td><td colspan="3">49</td></tr>
<tr><td>Height</td><td>h1</td><td colspan="3">375</td></tr>
<tr><td>Fastening clip height</td><td>h2</td><td colspan="3">15</td></tr>
<tr><td>Height incl. fastening clips</td><td>h3</td><td colspan="3">405</td></tr>
<tr><td rowspan="6">Fastening holes</td><td>Vertical distance (wall mounting)</td><td>a1</td><td colspan="3">393+2</td></tr>
<tr><td>Vertical distance (module mounting)</td><td>a2</td><td colspan="3">360</td></tr>
<tr><td>Vertical distance to the upper edge</td><td>b1</td><td colspan="3">4.5</td></tr>
<tr><td>Vertical distance to the upper edge</td><td>b2</td><td colspan="3">22</td></tr>
<tr><td>Horizontal spacing of the fastening holes</td><td>c</td><td colspan="2">—</td><td>45</td></tr>
<tr><td>Horizontal distance to the side edge</td><td>g</td><td colspan="2">—</td><td>30</td></tr>
</table>

PMC DL6B dimensions [mm]

6.4.4 Weight

Type	Weight without packaging [g]	Weight with packaging [g]
PMC DL6B10	440	480
PMC DL6B11	560	600
PMC DL6B12	880	920
PMC DL6B20	480	520
PMC DL6B21	740	780

PMC DL6B weight [g]

6.5 Safety technology

The PMC SR6 option adds the STO safety function to the PMC SI6 drive controller via terminal X12.

For double-axis controllers, the STO safety function has a two-channel structure that acts upon both axes.

Information

If you would like to use the STO safety function via terminals, be sure to read the manual for the PMC SR6 safety module.

<table>
<tr><th>Specification</th><th>Electrical data</th></tr>
<tr><td>STO_a</td><td rowspan="2">U_{1max} = 30 V_{DC} (PELV)
high level = 15 – 30 V_{DC}
low level = 0 – 8 V_{DC}
I_{1max} = 100 mA (typically < 30 mA for 24 V_{DC})
I_{max} = 4 A
C_{1max} = 10 nF</td></tr>
<tr><td>STO_b</td></tr>
<tr><td>STO_{status}</td><td>$U_2 = U_1 - (1.5\ \Omega * I_1)$</td></tr>
<tr><td>STO_{status} supply</td><td>U_1 = +24 V_{DC}, +20%/25%
I_{1max} = 100 mA</td></tr>
<tr><td>GND</td><td>—</td></tr>
</table>

X12 electrical data

6.6 Operating motors

The drive controller supports rotational motors with a number of motor poles from 2 to 120 poles (1 through 60 pole pairs). You can operate the following motors with the specified control modes.

<table>
<tr><th>Motor type</th><th>B20 Control mode</th><th>Encoders</th><th>Other settings</th><th>Characteristics</th></tr>
<tr><td>Lean motor</td><td>32: LM - sensorless vector control</td><td>No encoder required</td><td>—</td><td>Dynamics, high speed accuracy, constant speed, overcurrent protection</td></tr>
<tr><td rowspan="2">Synchronous servo motor, torque motor</td><td rowspan="2">64: SSM - vector control</td><td rowspan="2">Absolute encoder required: EnDat 2.2 digital, SSI, resolver or HIPERFACE DSL encoders</td><td>Without field weakening (B91 Field weakening = 0: Inactive)</td><td>High dynamics, high speed accuracy, very constant speed, high overcurrent protection</td></tr>
<tr><td>With field weakening (B91 Field weakening = 1: Active)</td><td>High dynamics, high speed accuracy, very constant speed, high overcurrent protection, greater speed range, but also higher current requirement</td></tr>
</table>

Motor type	B20 Control mode	Encoders	Other settings	Characteristics
Asynchronous motor	2: ASM - vector control	Encoder required	—	High dynamics, high speed accuracy, very constant speed, high overcurrent protection
	3: ASM - sensorless vector control	No encoder required	—	Dynamics, speed accuracy, constant speed, overcurrent protection
	1: ASM - V/f-slip compensated		Linear characteristic curve (B21 V/f-characteristic = 0: Linear)	Very constant speed
			Quadratic characteristic curve (B21 V/f-characteristic = 1: Square)	Very constant speed, especially suitable for fan applications
	0: ASM - V/f-control		Linear characteristic curve (B21 V/f-characteristic = 0: Linear)	Very constant speed
			Quadratic characteristic curve (B21 V/f-characteristic = 1: Square)	Very constant speed, especially suitable for fan applications

Motor types and control modes

Unsuitable drive controller/motor combinations

Lean motors of type LM704 and LM706 cannot be operated on drive controller types PMC SI6A061 or PMC SI6A062.

6.7 Evaluable encoders

The technical data of the evaluable encoder can be found in the following chapters.

You can use all of the encoder connections as position encoders or motor encoders. The use as a motor encoder depends on which encoder version is required by your motor and supported by the encoder connection. Master encoders may be connected only to connection X4A or X101.

6.7.1 Overview

The following table explains which connections are available for the various encoders.

Encoders	Connection	Note
EnDat 2.1 digital	X4	Only encoders with 12 V_{DC} power supply
EnDat 2.2 digital	X4	—
SSI	X4	—
Incremental TTL	X4	TTL signals, differential
Incremental HTL	X4	With PMC HT6 adapter for level conversion: HTL signals, differential
	X101	HTL signals, single-ended
	X103	HTL signals, single-ended
HTL pulse and direction	X101	HTL signals, single-ended
	X103	HTL signals, single-ended
Resolver	X4	—

Encoder connections

6.7.2 Signal transmission

You can find the signal levels valid for the signal transmission in the following chapters.

6.7.2.1 Encoder inputs

The following signal levels apply to the encoder inputs for single-ended signal transmission:

Signal level	HTL, single-ended
Low level	0 to 8 V_{DC}
High level	15 to 30 V_{DC}

Signal level encoder inputs, single-ended

The following signal levels apply to the encoder inputs for differential signal transmission:

Signal level	HTL, differential[9]	TTL, differential (RS422 standard)
Low level	−30 to −4.2 V_{DC}	−6 to −0.2 V_{DC}
High level	4.2 to 30 V_{DC}	0.2 to 6 V_{DC}

Signal level encoder outputs, differential

[9] Encoder-side level at HTL to TTL adapter HT6

6.7.3 X4

EnDat 2.1 digital encoders

Specification	EnDat 2.1 digital
U_2	12 V_{DC} (unregulated)
I_{2max}	250 mA
I_{2min}	—
Encoder type	Single-turn and multi-turn
Clock frequency	2 MHz
Max. cable length	100 m, shielded

EnDat 2.1 digital specification

ATTENTION!

Risk of encoder destruction!

The drive controller provides 12 V_{DC} for the encoder supply. Take this into account when selecting the encoder. Only connect an encoder that is made for operation with a supply voltage of 12 V_{DC}.

EnDat 2.2 digital encoders

Specification	EnDat 2.2 digital
U_2	12 V_{DC} (unregulated)
I_{2max}	250 mA
Encoder type	Single-turn and multi-turn
Clock frequency	4 MHz
Max. cable length	100 m, shielded

EnDat 2.2 digital specification

SSI encoders

Specification	SSI signals
U_2	12 V_{DC} (unregulated)
I_{2max}	250 mA
Encoder type	Single-turn and multi-turn
Clock frequency	250 kHz and 600 kHz
Sampling rate	250 µs
Monoflop time	≤ 30 µs
Code	Binary or gray
Format	13, 24 or 25 bits
Transfer	Double or single
Max. cable length	100 m, shielded

SSI specification

Incremental encoders

Specification	Incremental signals
U_2	12 V_{DC} (unregulated)
I_{2max}	250 mA
f_{max}	1 MHz
Signal level	TTL, differential
Max. cable length	100 m, shielded

Specification for TTL differential incremental signals

Information

Calculation example – Maximum frequency f_{max}
for an encoder with 2,048 pulses per revolution: 3,000 revolutions per minute (equivalent to 50 revolutions per second) * 2,048 pulses per revolution = 102,400 pulses per second = 102.4 kHz << 1 MHz

Information

Using an PMC HT6 adapter for level conversion from HTL signals to TTL signals, it is also possible to connect a differential HTL incremental encoder to terminal X4. Note that, with an external power supply, the maximum level of 20 V_{DC} for the HTL signals may not be exceeded.

Resolver

Specification	Resolver signals
Measuring range	± 2.5 V
Resolution	12 bits
U_2	± 10 V
I_{2max}	80 mA
f_2	7 – 9 kHz
P_{max}	0.8 W
Transfer ratio	0.5 ± 5%
Number of poles	2, 4, 6 and 8
Signal shape	Sine
Max. cable length	100 m, shielded

Specification for resolver signals

HIPERFACE DSL encoders

Specification	HIPERFACE DSL
U_2	12 V_{DC}
I_{2max}	250 mA
Encoder type	Single-turn and multi-turn
Max. cable length	100 m, shielded

Specification for HIPERFACE DSL

6.7.4 X101 for encoders

Electrical data	Digital input	Incremental signals, pulse/direction signals
Low level	DI1 – DI4	0 – 8 V_{DC}
High level		15 – 30 V_{DC}
U_{1max}		30 V_{DC}
I_{1max}		16 mA
f_{1max}	DI1 – DI2	10 kHz
	DI3 – DI4	250 kHz
Max. cable length	DI1 – DI4	30 m

Specification for single-ended HTL incremental signals and single-ended HTL pulse/direction signals

Information

Calculation example – Maximum frequency f_{max}
for an encoder with 2,048 pulses per revolution: 3,000 revolutions per minute (equivalent to 50 revolutions per second) * 2,048 pulses per revolution = 102,400 pulses per second = 102.4 kHz < 250 kHz

6.7.5 X103 for encoders

Electrical data	Digital input	Incremental signals, pulse/direction signals
Low level	DI6 – DI9	0 – 8 V_{DC}
High level		15 – 30 V_{DC}
U_{1max}		30 V_{DC}
I_{1max}		16 mA
f_{1max}	DI6 – DI7	10 kHz
	DI8 – DI9	250 kHz
Max. cable length	DI6 – DI9	30 m

Specification for single-ended HTL incremental signals and single-ended HTL pulse/direction signals

Information

Calculation example – Maximum frequency f_{max}
for an encoder with 2,048 pulses per revolution: 3,000 revolutions per minute (equivalent to 50 revolutions per second) * 2,048 pulses per revolution = 102,400 pulses per second = 102.4 kHz < 250 kHz

6.8 Controllable brakes

The brake of axis A is connected to X2A. Connect the brake of axis B to X2B for double-axis controllers.

You can control the following brakes:

- Directly connected 24 V_{DC} brakes
- Indirectly connected brakes (e.g. over coupling contactor)

The brake is supplied over X300.

Electrical data	Brake output
U_2	24 V_{DC}, +20 %
I_{2max}	2.5 A
f_{2max}	1 Hz at $I_N \leq 2.1$ A; 0.25 Hz at $I_N > 2.1$ A
E_{2max}	1.83 J

Electrical data of the brake output

Information

In the case of a nominal brake current > 2.1 A, the system controller must ensure compliance with the maximum switching frequency of 0.25 Hz.

6.9 Evaluable motor temperature sensors

You can connect a maximum of 2 PTC triplets in series to the PMC SI6 drive controller.

Information

Note that temperature sensor evaluation is always active. If operation without a temperature sensor is permitted, the connections must be bridged on X2. Otherwise a fault is triggered when switching on the device.

6.10 Braking resistor

In addition to the supply modules, Pilz offers braking resistors in the various sizes and performance classes described below. For the selection, note the minimum permitted braking resistors specified in the technical data of the supply modules. In the event of a fault, such as a defective brake chopper, the supply module must be disconnected from the power supply.

6.10.1 Braking resistor assignment – PMC PS6

Type	PMC KWADQU	PMC FZZMQU	PMC FGFKQU
ID No.	8C000091	8C000092	8C000093
PMC PS6A24	(—)	(X)	X
PMC PS6A34	(—)	(X)	X

Braking resistor assignment to PMC PS6 supply module

X	Recommended
(X)	Possible
(—)	Useful under certain conditions

6.10.2 PMC KWADQU flat resistor

Properties

Specification	PMC KWADQU 420×91
ID No.	8C000091
Type	Flat resistor with temperature switch (incl. mounting bracket)
Resistance [Ω]	100
Power [W]	600
Thermal time constant τ_{th} [s]	60
Pulse power for < 1 s [kW]	13
U_{max} [V]	848
Cable design	FEP
Cable length [mm]	500
Conductor cross-section [AWG]	14/19 (1.9 mm²)
Weight without packaging [g]	2600
Protection class	IP54
Test symbols	cULus CE

PMC KWADQU specification

Specification	Temperature switch
Switching capacity	2 A / 24 V_{DC} (DC11)
Nominal response temperature ϑ_{NAT}	180 °C ± 5 K
Type	NC
Cable design	FEP
Cable length [mm]	500
Conductor cross-section [AWG]	22

Temperature switch specification

Dimensions

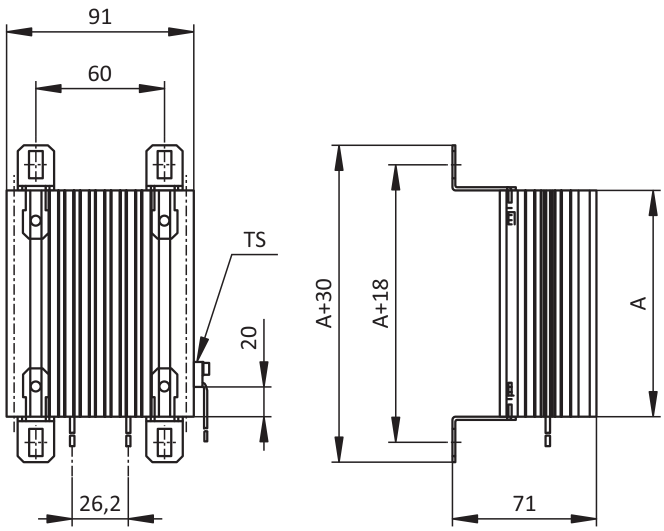


Fig. 10: PMC KWADQU dimensional drawing

Dimension	PMC KWADQU 420×91
A	420

PMC KWADQU dimensions [mm]

6.10.3 PMC FZZMQU tubular fixed resistor

Properties

Specification	PMC FZZMQU 400×65
ID No.	8C000092
Type	Tubular fixed resistor with temperature switch
Resistance [Ω]	47
Power [W]	1200
Thermal time constant τ_{th} [s]	40
Pulse power for < 1 s [kW]	36
U_{max} [V]	848
Weight without packaging [g]	4200
Protection class	IP20
Test symbols	cULus CE

PMC FZZMQU specification

Specification	Temperature switch
Switching capacity	2 A / 24 V_{DC} (DC11)
Nominal response temperature ϑ_{NAT}	180 °C ± 5 K
Type	NC
Cable design	FEP
Cable length [mm]	500
Conductor cross-section [AWG]	22

Temperature switch specification

Dimensions

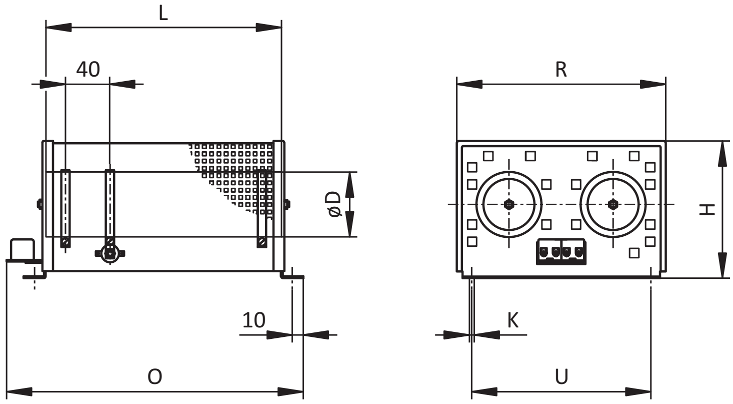


Fig. 11: PMC FZZMQU dimensional drawing

Dimension	PMC FZZMQU 400×65
L × D	400 × 65
H	120
K	6.5 × 12
O	485
R	185
U	150

PMC FZZMQU dimensions [mm]

6.10.4 PMC FGFKQU steel-grid fixed resistor

Properties

Specification	PMC FGFKQU 31005
ID No.	8C000093
Type	Steel-grid fixed resistor with temperature switch
Resistance [Ω]	22
Power [W]	2500
Thermal time constant τ_{th} [s]	30
Pulse power for < 1 s [kW]	50
U_{max} [V]	848
Weight without packaging [g]	7500
Protection class	IP20
Test symbols	cULus CE

PMC FGFKQU specification

Specification	Temperature switch
Switching capacity	2 A / 24 V_{DC} (DC11)
Nominal response temperature ϑ_{NAT}	180 °C ± 5 K
Type	NC
Cable design	FEP
Cable length [mm]	500
Conductor cross-section [AWG]	22

Temperature switch specification

Dimensions

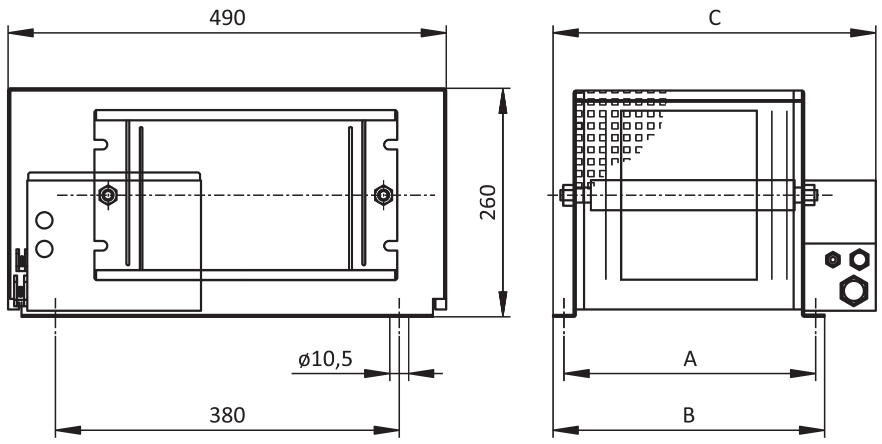


Fig. 12: PMC FGFKQU dimensional drawing

Dimension	PMC FGFKQU 31005
A	270
B	295
C	355

PMC FGFKQU dimensions [mm]

6.11 Choke

Technical specifications for suitable chokes can be found in the following chapters.

6.11.1 PMC TEP power choke

Power chokes are used to dampen voltage and current peaks and reduce the load of the power feed-in of the supply modules.

Properties

Specification	PMC TEP4010-2US00
ID No.	8C000102
Phases	3
Thermally allowed continuous current	100 A
Nominal current $I_{N,MF}$	90 A
Absolute loss P_V	103 W
Inductance	0.14 mH
Voltage range	3 × 400 V_{AC}, +32%/−50% 3 × 480 V_{AC}, +10%/−58%
Voltage drop U_k	2%
Frequency range	50/60 Hz
Protection class	IP00
Max. surrounding temperature $\vartheta_{amb,max}$	40 °C
Insulation class	B
Connection	Screw terminal
Connection type	Flexible with and without end sleeve
Max. conductor cross-section	6 – 35 mm²
Tightening torque	2.5 Nm
Insulation stripping length	17 mm
Installation	Screws
Directive	EN 61558-2-20
UL Recognized Component (CAN; USA)	Yes
Test symbol, symbol	

PMC TEP specification

Dimensions

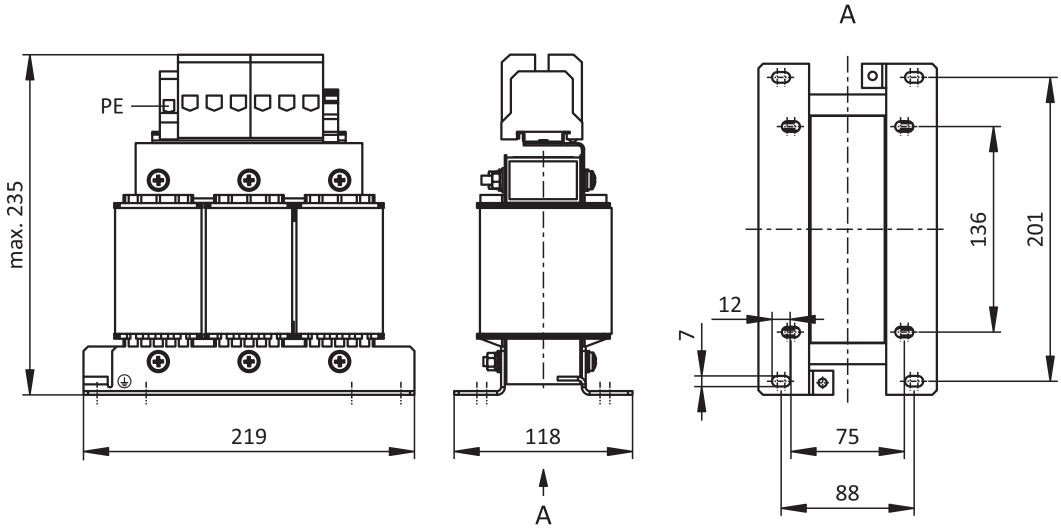


Fig. 13: Power choke dimensional drawing

Dimensions	PMC TEP4010-2US00
Height [mm]	235
Width [mm]	219
Depth [mm]	118
Vertical distance 1 – fastening holes [mm]	201
Vertical distance 2 – Fastening holes [mm]	136
Horizontal distance 1 – fastening holes [mm]	88
Horizontal distance 2 – Fastening holes [mm]	75
Drill holes – Depth [mm]	7
Drill holes – Width [mm]	12
Screw connection – M	M6
Weight without packaging [g]	9900

PMC TEP dimensions and weight

6.11.2 PMC TEP output choke

Output chokes are required for connecting size 0 to 2 drive controllers to synchronous servo motors or asynchronous motors from a cable length > 50 m in order to reduce interference pulses and protect the drive system. If Lean motors are connected, output chokes must not be used.

Information

The following technical data only applies to a rotating magnetic field frequency of 200 Hz. For example, this rotating magnetic field frequency is achieved with a motor with 4 pole pairs and a nominal speed of 3000 rpm. Always observe the specified derating for higher rotating magnetic field frequencies. Also observe the relationship with the clock frequency.

Properties

Specification	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
ID No.	8C000099	8C000100	8C000101
Voltage range	3 × 0 to 480 V_{AC}		
Frequency range	0 – 200 Hz		
Nominal current $I_{N,MF}$ at 4 kHz	4 A	17.5 A	38 A
Nominal current $I_{N,MF}$ at 8 kHz	3.3 A	15.2 A	30.4 A
Max. permitted motor cable length with output choke	100 m		
Max. surrounding temperature $\vartheta_{amb,max}$	40 °C		
Protection class	IP00		
Winding losses	11 W	29 W	61 W
Iron losses	25 W	16 W	33 W
Connection	Screw terminal		
Max. conductor cross-section	10 mm²		
UL Recognized Component (CAN; USA)	Yes		
Test symbols			

PMC TEP specification

Dimensions

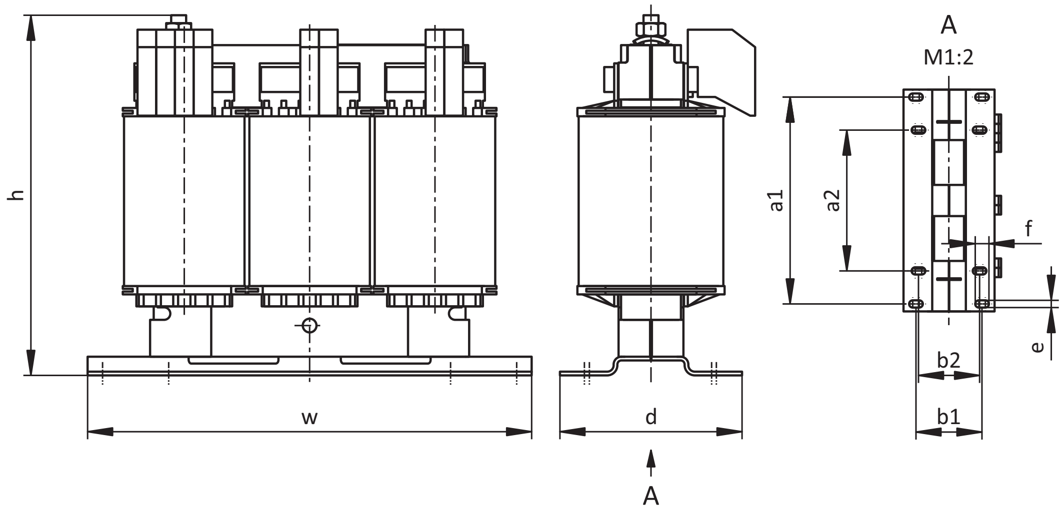


Fig. 14: PMC TEP dimensional drawing

Dimension	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
Height h [mm]	Max. 153	Max. 153	Max. 180
Width w [mm]	178	178	219
Depth d [mm]	73	88	119
Vertical distance – Fastening holes a1 [mm]	166	166	201
Vertical distance – Fastening holes a2 [mm]	113	113	136
Horizontal distance – Fastening holes b1 [mm]	53	68	89
Horizontal distance – Fastening holes b2 [mm]	49	64	76
Drill holes – Depth e [mm]	5.8	5.8	7
Drill holes – Width f [mm]	11	11	13
Screw connection – M	M5	M5	M6
Weight without packaging [g]	2900	5900	8800

PMC TEP dimensions and weight

7 Project configuration

Relevant information on the project configuration and design of your drive system can be found in the following chapters.

7.1 Supply module

For project configuration of supply modules, note the framework conditions described below.

7.1.1 Information on design and operation

Information

For the design of the supply module, note that the summed self-capacitance of all PMC SI6 drive controllers may not exceed the maximum charging capacity of the supply module.

Minimum time between energizing two devices

The supply modules have temperature-dependent resistors in the charging circuit that prevent devices from being damaged when being connected to the grid after a fault, such as a short-circuited DC link, incorrect wiring, etc. These resistors are heated when charging the DC link.

Information

For cyclic power-on/power-off operation, the following is to be observed to prevent the charging capacities of the supply modules from being exceeded:

- PMC PS6 without braking resistor: Direct, repeat activation of the supply voltage possible.
- PMC PS6 with braking resistor and an interval < 30 s after power-off: Direct, repeat activation of the supply voltage possible.
- PMC PS6 with braking resistor and an interval > 30 s after power-off: Reactivation of the supply voltage only possible 2 min after previous activation!

Information

The STO safety function is available for safe stopping as an alternative to continuous, cyclical power-on/power-off operation.

7.1.2 Parallel connection of supply modules

The following general conditions apply to the parallel connection of several PMC PS6 supply modules:

- Only the same sizes may be connected in parallel.
- You can connect a maximum of 3 PMC PS6A34 in parallel.
- For UL-compliant operation:
  A single PMC PS6A24 or PMC PS6A34 supply module converts the 3-phase AC input voltage into a common DC bus output voltage, which can be used to feed one or more PMC SI6 drive controllers.
- You can connect one braking resistor for each supply module. The braking power for each braking resistor has to be overdimensioned:
  - By 15% for parallel connection of 2 supply modules
  - By 30% for parallel connection of 3 supply modules
- Observe a derating factor of 0.8 each for the sum in parallel connection for nominal power, current and charging capacity.
- The resistance values of the braking resistors must be the same. Note that the power is output to all braking resistors in equal parts.
- Take into account the specifications for the fuse design for each supply module within the device group; see the chapter Line fuse [109].
- All supply modules must be connected to the same three-phase supply grid.
- The grid must be switched on at all supply modules simultaneously; see the chapter Grid connection [110].
- Each supply module must additionally be grounded at the grounding bolt of the Quick DC-Link module; see the chapter Protective grounding [112].
- There are no restrictions for the position of a supply module within the group.
- Mixed feed-in operation in which additional components (e.g. drive controllers or energy recovery units) contribute to the DC link supply in addition to the supply modules is not permitted.

Example combinations for parallel connection

The following table shows example combinations for parallel connection. A derating factor of 0.8 is taken into account for the values.

Electrical data	2 x PMC PS6A24	3 x PMC PS6A24	2 x PMC PS6A34	3 x PMC PS6A34
$P_{N,PU}$	16 kW	24 kW	32 kW	48 kW
$I_{1N,PU}$	40 A	60 A	80 A	120 A
C_{maxPU}	8000 µF	12000 µF	16000 µF	24000 µF

Electrical data for parallel connection: Example combinations

Dimensioning the braking resistors

Proceed as follows to dimension the braking resistors:

1. Determine the required braking power P_{effRB}
2. Divide this by the number of braking resistors
3. Multiply the result by the factor for overdimensioning
4. Take the resulting value into account for selecting the right braking resistor: $P_{N,RB}$ must be greater than the determined value

Sample calculation

The required braking power P_{effRB} is 800 W. Two supply modules of type PMC PS6A34 are connected in parallel.

A braking resistor is connected to every supply module. The required braking power for each braking resistor is calculated as follows:
2400 W ÷ 2 = 400 W

For 2 supply modules connected in parallel, increase the required braking power of the braking resistors by 15%:
400 W × 1.15 = 460 W

A braking resistor of type PMC KWADQU with a nominal power of 600 W should be connected to each supply module:
460 W < 600 W

The nominal power of the braking resistor is then sufficient.

Wiring example

The examples in the chapter Wiring examples [267] illustrate the basic connection based on a DC link connection with PMC DL6B Quick DC-Link.

7.2 DC link connection

Braked motors work like generators: Operating with an active drive controller, they convert kinetic energy from movement into electrical energy. This electrical energy is stored in the DC link capacitors of the drive controller. It is supplied to powered motors with connected DC links and thus used efficiently.

The DC link voltage increases when a motor decelerates. However, capacitors in the DC link can only accept a limited amount of energy. If the DC link voltage rises above a defined limit, a chopper circuit is activated that converts the excess energy into heat by means of a connected braking resistor. If the permitted maximum voltage is reached, any possible damage must be prevented. The drive controller switches to the fault state and shuts down. In a DC link connection, the DC link capacitors of the drive controllers involved are connected in parallel. As a result, the maximum acceptable amount of energy increases in the DC link.

7.2.1 Information on design and operation

In order to connect the capacitors of multiple drive controllers, you need a separate PMC DL6B type Quick DC-Link module for each drive controller and each supply module in the group.

Information

Note that Quick DC-Link can be subject to system or country-specific standards.

Electrical data of the drive controllers

For the design and the operation of the Quick DC-Link, the electrical data of the individual drive controller and supply module types must be observed, particularly the following:

- Self-capacitance C_{PU} of the drive controllers
- Charging capacity C_{maxPU} of the supply modules
- Nominal input current $I_{1N,PU}$ of the supply modules
- Derating of the nominal input current

The values can be taken from the technical data of the drive controllers and supply modules.

Maximum voltage and maximum current

The maximum DC link voltage is 750 V_{DC} and the maximum permitted overall current is 200 A.

7.3 Motor

During the project configuration for motors, note the framework conditions described below.

Rotational motors (Lean motors, synchronous servo motors, asynchronous motors, torque motors)

The maximum possible motor speed is limited to 20000 rpm.

The following relationship applies:
Rotating magnetic field frequency = Motor speed × Number of pole pairs ÷ 60

Since the output frequency f_{2PU} can be a maximum of 700 Hz, the motor speed can only be reached if the calculated rotating magnetic field frequency is less than f_{2PU}.

The specified torque/speed curve or the nominal points can only be reached in vector control if field weakening operation is not in effect. Theoretical field weakening operation begins when a voltage is required for the speed (speed × KE constant) that is greater than the available DC link voltage. In practice, however, field weakening must begin before reaching this voltage limit (control reserve).

You define the voltage limit in B92. The default value is 80%.

Note that the field weakening is always active for Lean motors (B91 Field weakening = 1: Active). The voltage limit preset in B92 is 95% for Lean motors.

7.4 Choke

For project configuration of the chokes, note the general conditions described below.

7.4.1 PMC TEP power choke

Derating – Effect of surrounding temperature

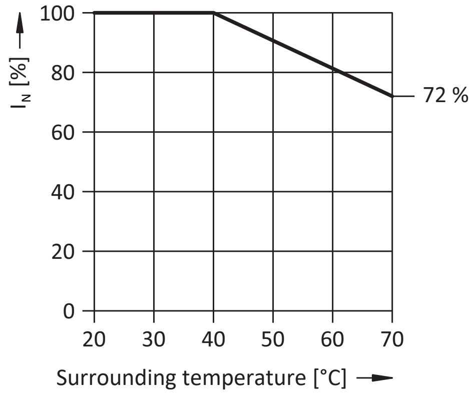


Fig. 15: Derating the nominal current based on surrounding temperature

Derating – Effect of the installation elevation

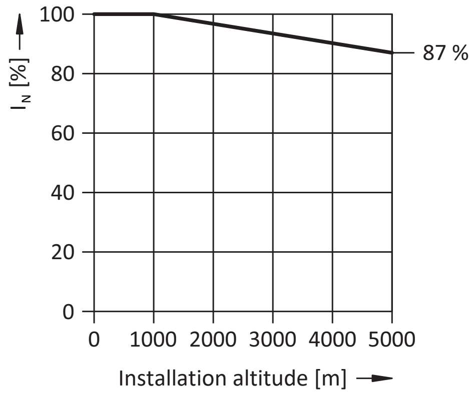


Fig. 16: Derating the nominal current depending on installation elevation

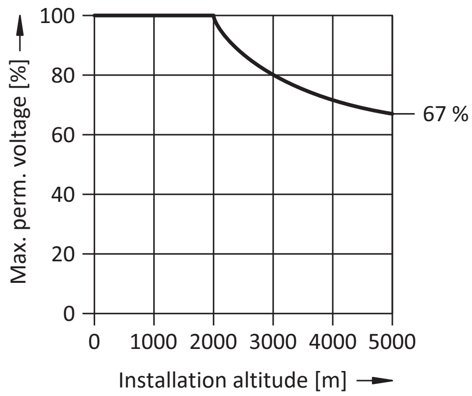


Fig. 17: Derating the voltage depending on installation elevation

7.4.2 PMC TEP output choke

Select the output chokes in accordance with the nominal currents of the output chokes, motor and drive controller. In particular, observe the derating of the output choke for rotating magnetic field frequencies higher than 200 Hz. You can calculate the rotating magnetic field frequency for your drive with the following formula:

$$f_N = n_N \times \frac{p}{60}$$

Derating – Effect of the clock frequency

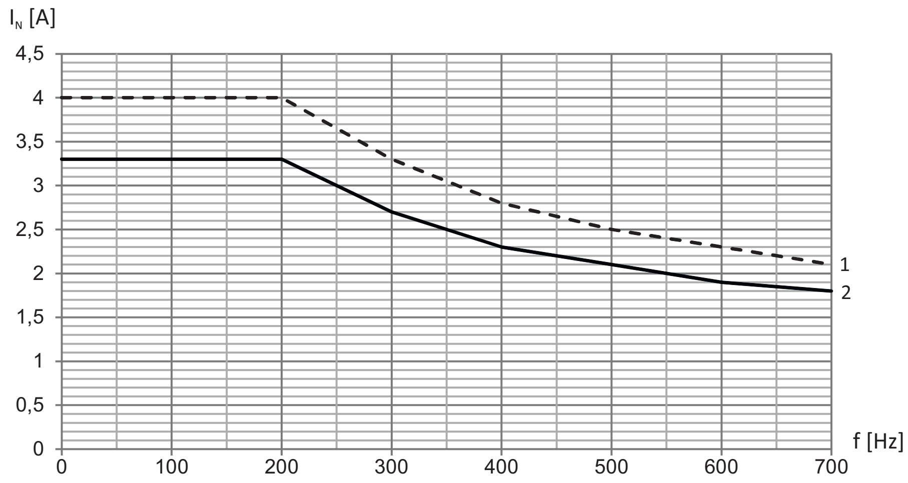


Fig. 18: Derating the nominal current depending on the clock frequency, PMC TEP3720-0ES41

1 4 kHz clock frequency
2 8 kHz clock frequency

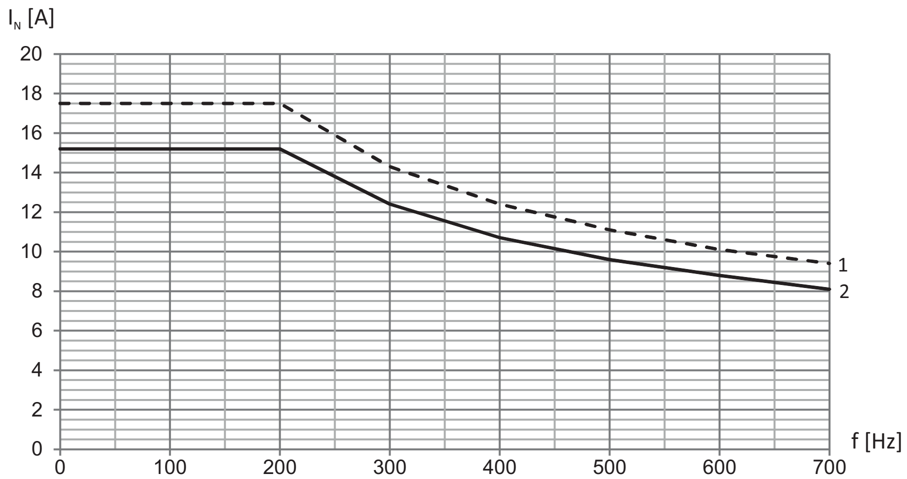


Fig. 19: Derating the nominal current depending on the clock frequency, PMC TEP3820-0CS41

1 4 kHz clock frequency
2 8 kHz clock frequency

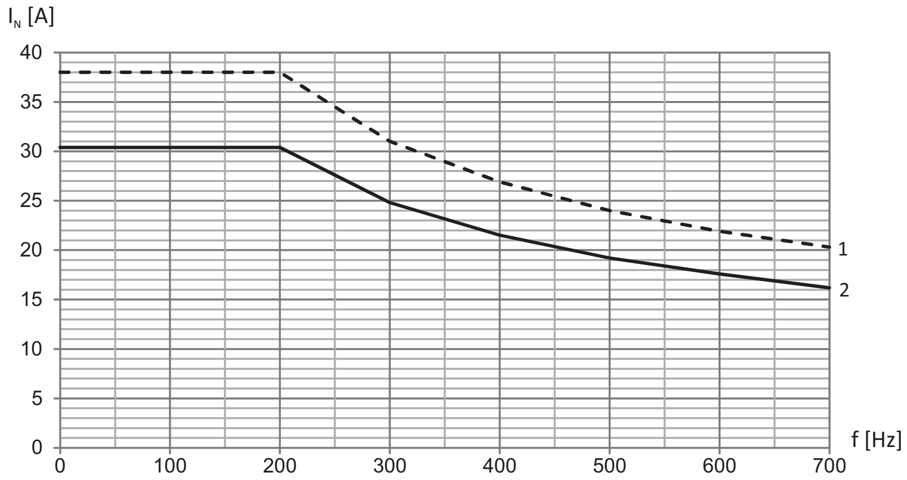


Fig. 20: Derating the nominal current depending on the clock frequency, PMC TEP4020-0RS41

1 4 kHz clock frequency
2 8 kHz clock frequency

Derating – Effect of surrounding temperature

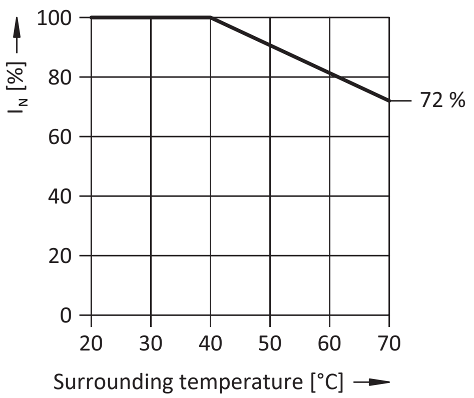


Fig. 21: Derating the nominal current based on surrounding temperature

Derating – Effect of the installation elevation

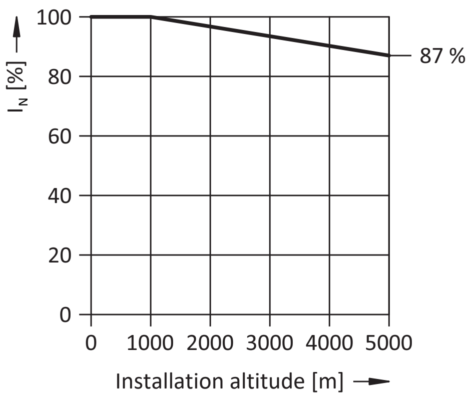


Fig. 22: Derating the nominal current depending on installation elevation

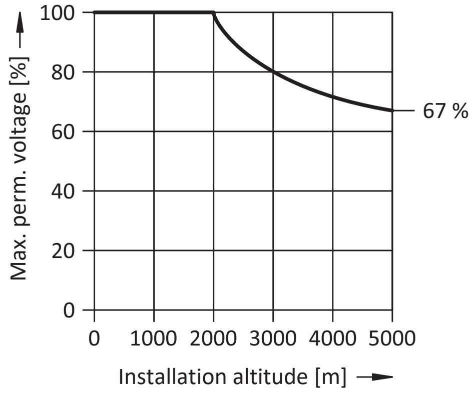


Fig. 23: Derating the voltage depending on installation elevation

7.5 Mixed operation

You can combine the PMC PS6 supply module and the PMC SI6 drive controller with other 6th generation Pilz drive controllers.

For UL-compliant operation, note that mixed operation is not currently possible.

In mixed operation, only device types of the same series and size may be supplied with power. The general conditions for the supplying device apply.

The graphic below shows an example of the grounding concept in mixed operation with feed-in by a PMC PS6 supply module. The protective connection between the supply module or drive controller and the associated Quick DC-Link rear section module (type PMC DL6B or PMC DL6A) is made using the metallic connection of the housings. The protective connection between the rear section modules of the PMC DL6B type is made using a copper rail. You can find the requirements for the connection of a 2nd grounding conductor for a supply module in the chapter Connection of the grounding conductor [113]. The same requirements also apply to drive controllers with PMC DL6A rear section modules.

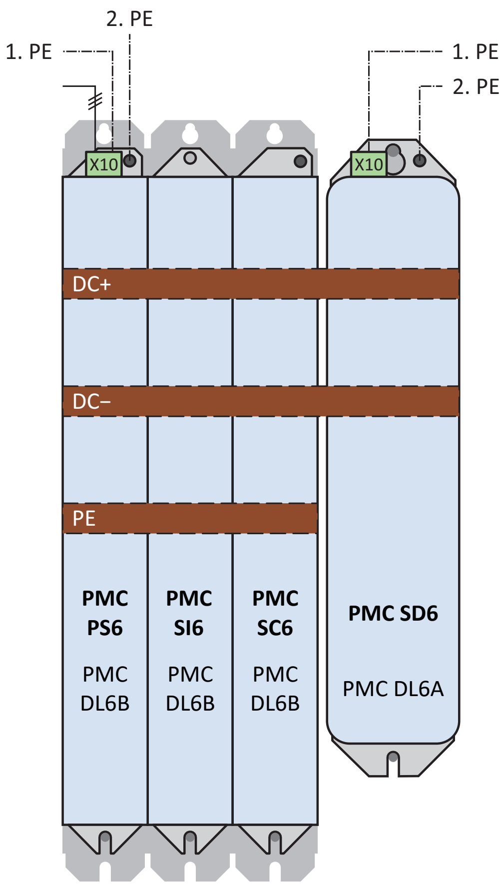


Fig. 24: Grounding concept in mixed operation with powered PMC PS6 supply module

8 Storage

Store the products in a dry and dust-free room if you do not install them immediately.

Observe the Transport and storage conditions [40] specified in the technical data.

8.1 Supply module

No reforming is required for the PMC PS6 supply module, even after long storage times.

8.2 Drive controllers

The DC link capacitors can lose their electrical strength due to long storage times and must be reformed before commissioning.

This property does not apply to size 3 DC link capacitors. Therefore, size 3 drive controllers do not require reforming even after prolonged storage periods.

ATTENTION!

Material damage due to reduced electrical strength!

Reduced electrical strength can cause considerable material damage when switching on the drive controller.

- Reform drive controllers in storage annually or before commissioning.

8.2.1 Annual reforming

To prevent damage to stored drive controllers, Pilz recommends connecting stored devices to the supply voltage once per year for one hour.

The following graphic shows the predominant supply connection.

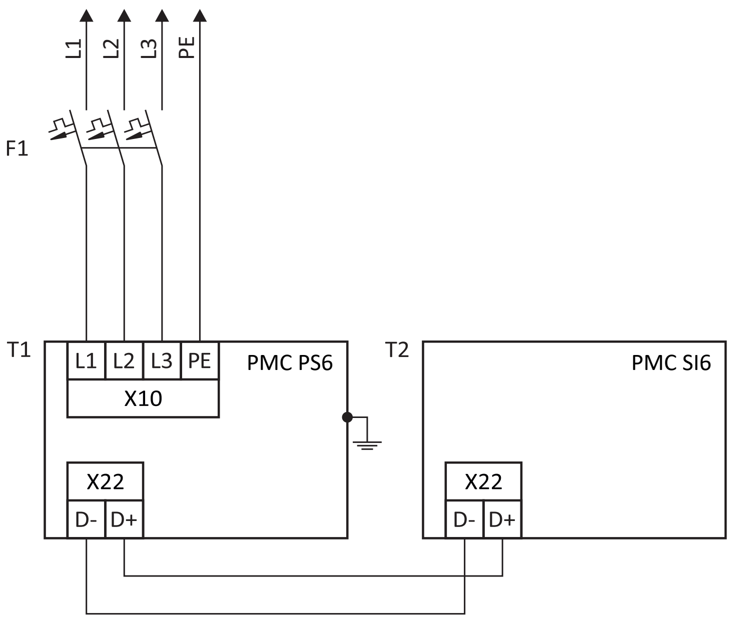


Fig. 25: Annual reforming

L1 – L3	Lines 1 to 3
N	Neutral conductor
PE	Grounding conductor
F1	Fuse
T1	Supply module
T2	Drive controller

Information

For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

8.2.2 Reforming before commissioning

If annual reforming is not possible, implement reforming on stored devices before commissioning. Note that the voltage levels depend on the storage time.

The following graphic shows the predominant supply connection.

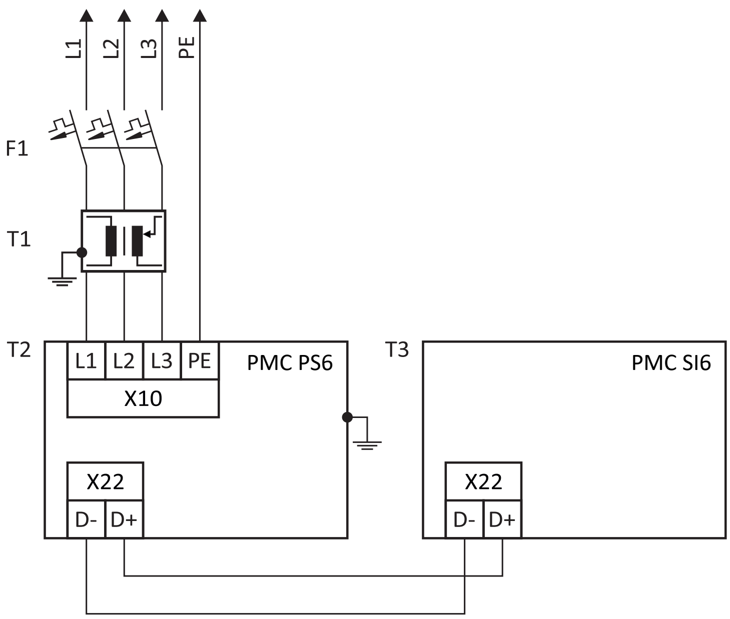


Fig. 26: Reforming before commissioning

L1 – L3	Lines 1 to 3
N	Neutral conductor
PE	Grounding conductor
F1	Fuse
T1	Variable transformer
T2	Supply module
T3	Drive controller

Information

For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

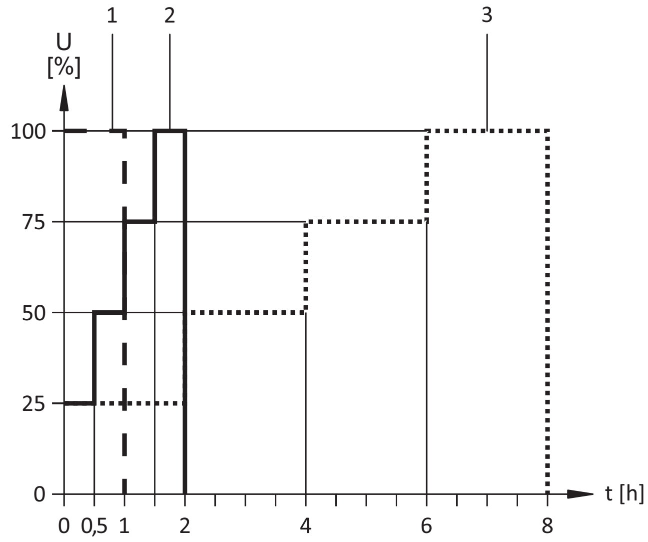


Fig. 27: Voltage levels dependent on storage time

1	Storage time of 1 – 2 years:	Apply voltage for 1 hour before switching on.
2	Storage time of 2 – 3 years:	Implement reforming according to the graph before switching on.
3	Storage time ≥ 3 years:	Implement reforming according to the graph before switching on.
	Storage time < 1 year:	No actions required.

9 Installation

The following chapters describe the installation of the Quick DC-Link rear section modules for the DC link connection as well as the subsequent installation of the drive controllers and supply modules.

Information on replacing a drive controller or supply module can be taken from the chapter Replacement [📖 249].

9.1 Safety instructions for installation

Installation work is permitted only when no voltage is present. Observe the 5 safety rules; see the chapter Working on the machine [📖 21].

To protect the devices from overheating, observe the operating conditions described in the technical data and comply with the required minimum clearances for installation.

Protect the devices against falling parts (wire scraps, cores, pieces of metal, etc.) during installation or other work in the control cabinet. Parts with conductive properties may result in a short circuit inside the devices and device failure as a result.

9.2 Basic assembly instructions

Note the points described below for installation.

9.2.1 Drive controllers and supply modules

Note the following points for installation:

- Prevent condensation, e.g. with anti-condensation heating elements.
- For reasons related to EMC, use installation plates with a conductive surface (unpainted, etc.).
- Avoid installation above or in the immediate vicinity of heat-generating devices, e.g. output chokes or braking resistors.
- To ensure there is sufficient air circulation in the control cabinet, observe the minimum clearances.
- Install the devices vertically.

Reference identification

Attach a sticker to the provided field on the front on the device with the unique reference identification of the respective device to prevent mix-ups during installation or replacement.

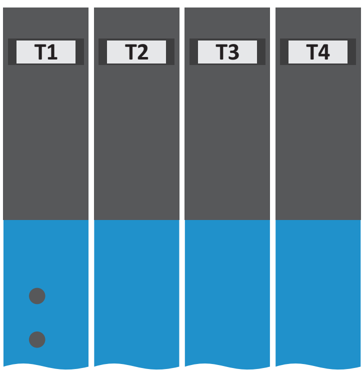
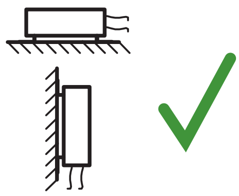


Fig. 28: Fields for equipment identification on the front of the device

9.2.2 Braking resistor

Note the permitted mounting positions for the braking resistor.

PMC KWADQU flat resistor



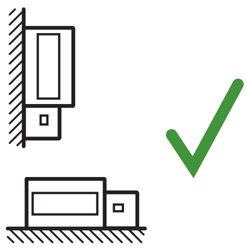
Permitted installation:

- On vertical surfaces with cables downwards
- On horizontal surfaces
- Installation outside of the control cabinet possible for mechanical protection of the conductors

Impermissible installation:

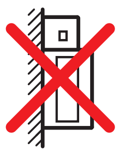
- On vertical surfaces with cables upwards

PMC FZZMQU tubular fixed resistor



Permitted installation:

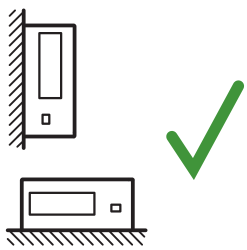
- On vertical surfaces with terminals downwards
- On horizontal surfaces
- In control cabinets



Impermissible installation:

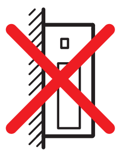
- On vertical surfaces with terminals upwards, left or right
- Outside of control cabinets

PMC FGFKQU steel-grid fixed resistor



Permitted installation:

- On vertical surfaces with terminals downwards
- Top and bottom perforated sheets
- On horizontal surfaces
- Installation on, next to or in the control cabinet possible

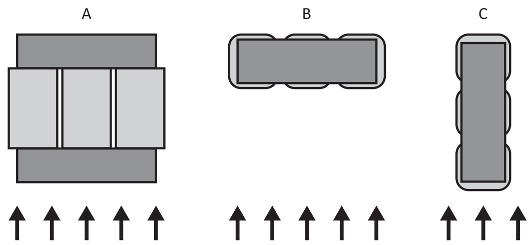


Impermissible installation:

- On vertical surfaces with terminals upwards, left or right

9.2.3 Choke

In relation to the flow of cooling air, the following mounting positions are permitted for the PMC TEP output choke:



9.3 Minimum clearances

Note the minimum clearances for installation below.

Drive controllers and supply modules

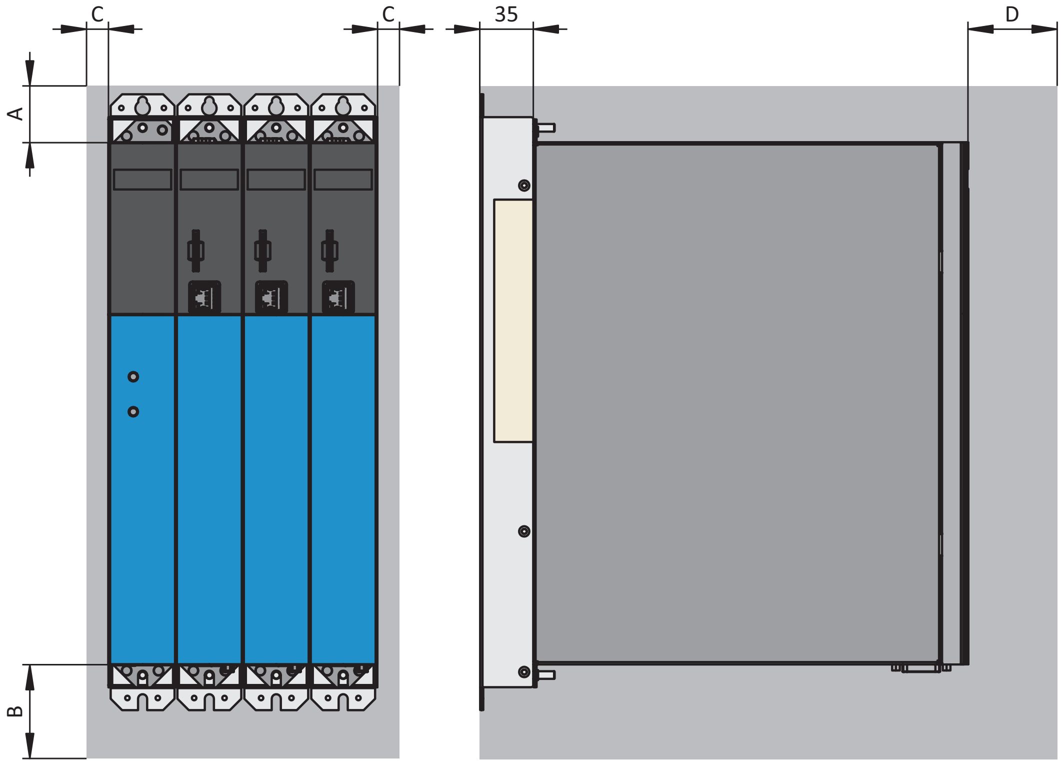


Fig. 29: Minimum clearances

The specified dimensions refer to the outside edges of the drive controller or supply module including the Quick DC-Link rear section module.

Minimum clearance	A (above)	B (below)	C (on the side)	D (in front)
All sizes	100	200	5	50[10]

Minimum clearances [mm]

[10] Minimum clearance to be taken into account for permanent connection of the X9 service interface

Chokes and filters

Avoid installation below drive controllers or supply modules. For installation in a control cabinet, a distance of approximately 100 mm to other neighboring components is recommended. This distance ensures proper heat dissipation for chokes and filters.

Braking resistors

Avoid installation below drive controllers or supply modules. In order for heated air to flow out unimpeded, a minimum clearance of approximately 200 mm must be maintained in relation to neighboring components or walls and approximately 300 mm must be maintained to components above or ceilings.

9.4 Drilling diagrams and dimensions

You can find drilling diagrams and dimensions for a multi-axis drive system with PMC SI6 and PMC PS6 and for accessories in the following chapters.

9.4.1 Multi-axis drive system

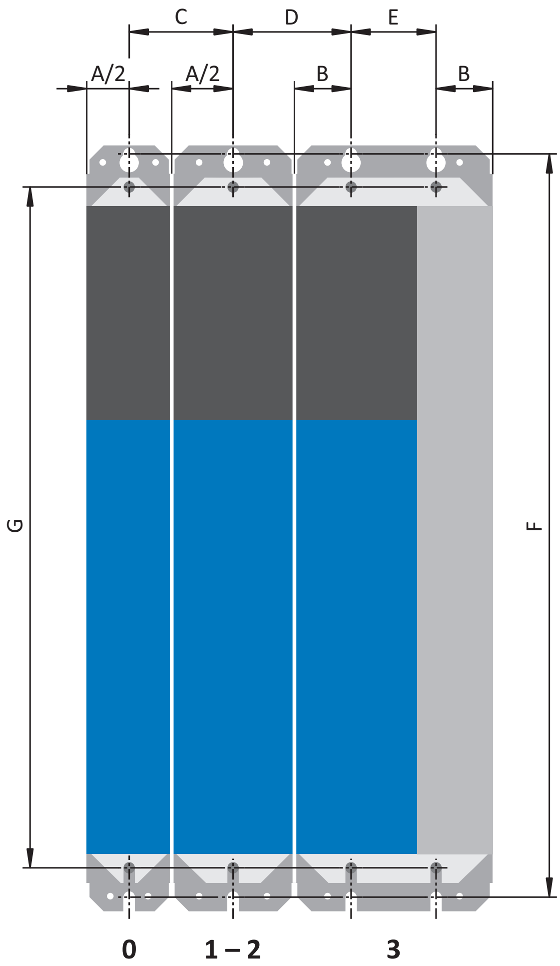


Fig. 30: Drilling diagram for multi-axis drive system

DL6B dimensions			Size 0	Size 1, size 2	Size 3
Horizontal fastening holes ∅ 4.2 (M5)	A		45	65	–
	B		–	–	30
	E		–	–	45+0.2/−0.2
	C	Size 0	46±1	56±1	–
	C	Size 1, size 2	56±1	66±1	–
	D	Size 0	–	–	53.5±1
	D	Size 1, size 2	–	–	63.5±1
	D	Size 3	–	–	61±1
Vertical fastening holes ∅ 4.2 (M5)	F		393+2		
Vertical distance for drive controllers and supply modules	G		360		

Drilling dimensions for the multi-axis drive system [mm]

9.4.2 Braking resistor

9.4.2.1 PMC KWADQU flat resistor

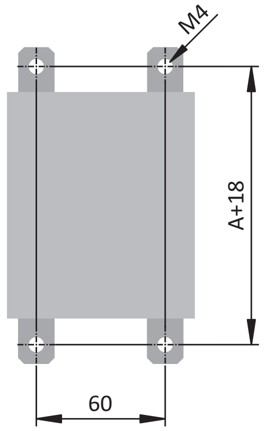


Fig. 31: PMC KWADQU drilling diagram

Dimension	PMC KWADQU 420×91
A	420

PMC KWADQU dimensions [mm]

9.4.2.2 PMC FZZMQU tubular fixed resistor

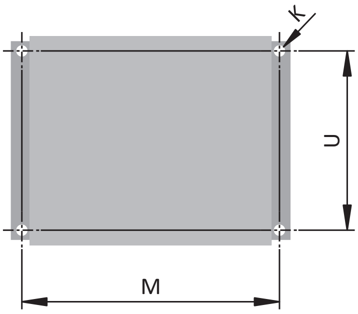


Fig. 32: PMC FZZMQU drilling diagram

Dimension	PMC FZZMQU 400×65
K	6.5 × 12
M	426
U	150

PMC FZZMQU dimensions [mm]

9.4.2.3 PMC FGFKQU steel-grid fixed resistor

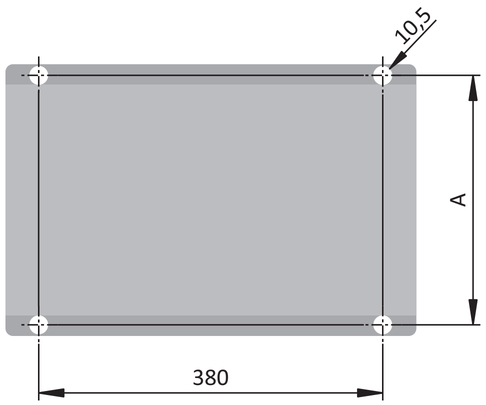


Fig. 33: PMC FGFKQU drilling diagram

Dimension	PMC FGFKQU 31005
A	270

PMC FGFKQU dimensions [mm]

9.4.3 Choke

9.4.3.1 PMC TEP power choke

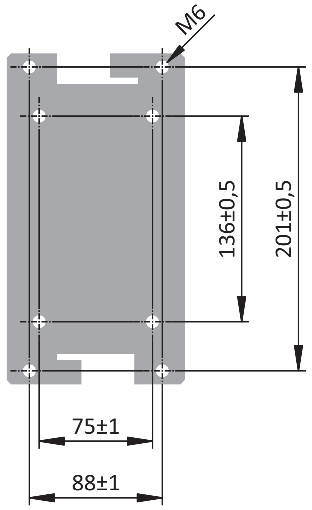


Fig. 34: Power choke drilling diagram

9.4.3.2 PMC TEP output choke

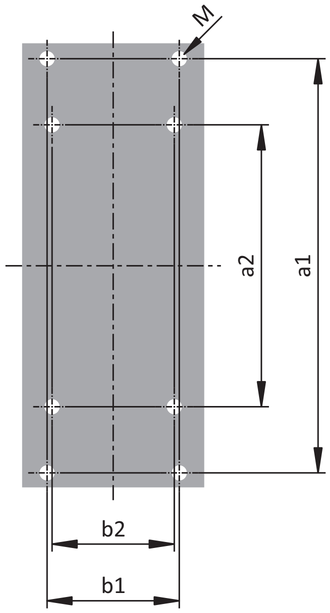


Fig. 35: PMC TEP drilling diagram

Dimension	PMC TEP3720-0ES41	PMC TEP3820-0CS41	PMC TEP4020-0RS41
Vertical distance – Fastening holes a1 [mm]	166	166	201
Vertical distance – Fastening holes a2 [mm]	113	113	136
Horizontal distance – Fastening holes b1 [mm]	53	68	89
Horizontal distance – Fastening holes b2 [mm]	49	64	76
Drill holes – Depth e [mm]	5.8	5.8	7
Drill holes – Width f [mm]	11	11	13
Screw connection – M	M5	M5	M6

PMC TEP dimensions

9.5 Length of copper rails

For the installation of the Quick DC-Link modules, you require three prepared copper rails with a cross-section of 5 × 12 mm.

The length of the copper rails is 5 mm shorter than the total width of the group, i.e. the total width of all PMC DL6B Quick DC-Link modules present in the group:
B = A − 5 mm

Note that the correct length of the copper rails can be determined only after installation of all modules:

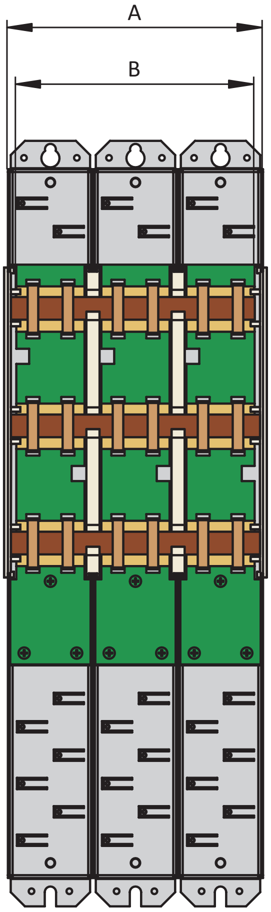


Fig. 36: Determination of the correct length of the copper rails

A	Total width of the group after installation
B	Length of the copper rails = A − 5 mm

9.6 DC link connection

Observe the installation notes when installing the DC link connection and associated hardware components.

9.6.1 Components for the DC link connection

Device			Safety technology	Terminal set	Quick DC-Link		
Type	**Option**	**ID No.**	**Option**	**ID No.**	**Type**	**ID No.**	**Width [mm]**
PMC PS6A24	—	8C000001	—	8C000002	PMC DL6B20	8C000089	45
PMC PS6A34	—	8C000003	—	8C000004	PMC DL6B21	8C000090	65
PMC SI6A061	EtherCAT (EC)	8C000011	PMC SZ6[a]	8C000006	PMC DL6B10	8C000086	45
		8C000009	PMC SY6[b]				
		8C000007	PMC SR6[c]	8C000005			
	PROFINET (PN)	8C000012	PMC SZ6	8C000006	PMC DL6B10	8C000086	45
		8C000010	PMC SY6				
		8C000008	PMC SR6	8C000005			
PMC SI6A062	EC	8C000019	PMC SZ6	8C000014	PMC DL6B10	8C000086	45
		8C000017	PMC SY6				
		8C000015	PMC SR6	8C000013			
	PN	8C000020	PMC SZ6	8C000014	PMC DL6B10	8C000086	45
		8C000018	PMC SY6				
		8C000016	PMC SR6	8C000013			
PMC SI6A161	EC	8C000027	PMC SZ6	8C000022	PMC DL6B11	8C000087	65
		8C000025	PMC SY6				
		8C000023	PMC SR6	8C000021			
	PN	8C000028	PMC SZ6	8C000022	PMC DL6B11	8C000087	65
		8C000026	PMC SY6				
		8C000024	PMC SR6	8C000021			
PMC SI6A162	EC	8C000035	PMC SZ6	8C000030	PMC DL6B11	8C000087	65
		8C000033	PMC SY6				
		8C000031	PMC SR6	8C000029			
	PN	8C000036	PMC SZ6	8C000030	PMC DL6B11	8C000087	65
		8C000034	PMC SY6				
		8C000032	PMC SR6	8C000029			

Device			Safety technology	Terminal set	Quick DC-Link		
Type	**Option**	**ID No.**	**Option**	**ID No.**	**Type**	**ID No.**	**Width [mm]**
PMC SI6A261	EC	8C000043	PMC SZ6	8C000038	PMC DL6B11	8C000087	65
		8C000041	PMC SY6				
		8C000039	PMC SR6	8C000037			
	PN	8C000044	PMC SZ6	8C000038	PMC DL6B11	8C000087	65
		8C000042	PMC SY6				
		8C000040	PMC SR6	8C000037			
PMC SI6A262	EC	8C000051	PMC SZ6	8C000046	PMC DL6B12	8C000088	105
		8C000049	PMC SY6				
		8C000047	PMC SR6	8C000045			
	PN	8C000052	PMC SZ6	8C000046	PMC DL6B12	8C000088	105
		8C000050	PMC SY6				
		8C000048	PMC SR6	8C000045			
PMC SI6A361	EC	8C000059	PMC SZ6	8C000054	PMC DL6B12	8C000088	105
		8C000057	PMC SY6				
		8C000055	PMC SR6	8C000053			
	PN	8C000060	PMC SZ6	8C000054	PMC DL6B12	8C000088	105
		8C000058	PMC SY6				
		8C000056	PMC SR6	8C000053			

Overview of hardware components with ID No.

a) PMC SZ6 option: Without safety technology

b) PMC SY6 safety module: STO and SS1 using FSoE

c) PMC SR6 safety module: STO using terminals

9.6.2 Installing the DC link connection

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

Tools and material

You will need:

- 3 copper rails with sufficient length and a cross-section of 5 x 12 mm, see the chapter Length of copper rails [98]
- The nut and washer assemblies (M5), insulation connection pieces and quick fastening clamps included with the PMC DL6B Quick DC-Link modules
- The insulation end sections for the left and right termination of the group that are available separately
- Fastening screws and tool for tightening the fastening screws

Requirements and installation

Observe the basic installation instructions in the chapter Drive controllers and supply modules [89].

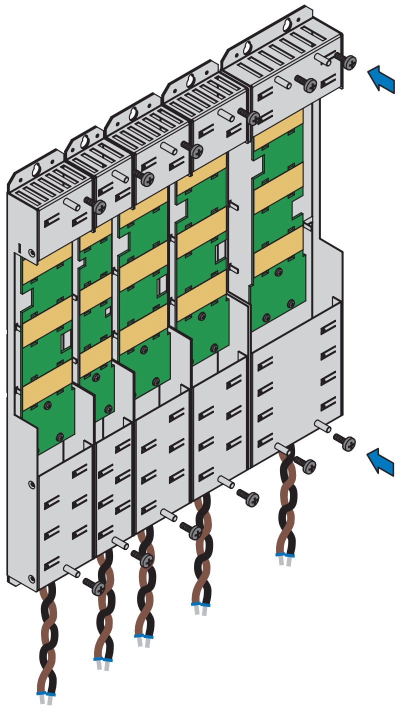
Perform the following steps in the specified order.

✓ You have tapped holes for fastening screws on the mounting plate at the installation location in accordance with the drilling diagram and taking into consideration the different device dimensions.

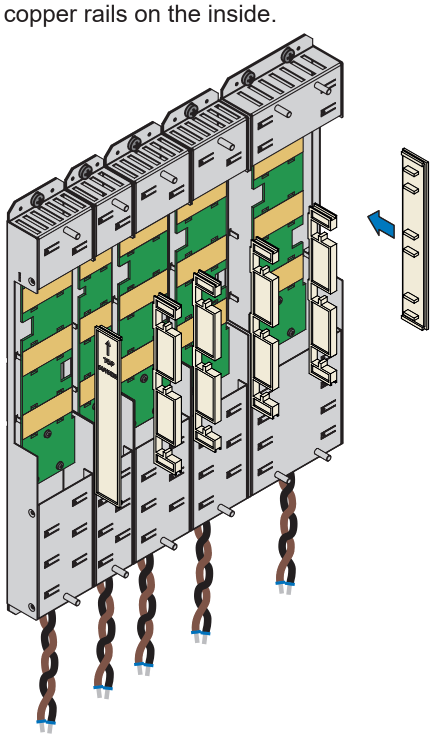
✓ The mounting plate has been cleaned (free of oil, grease and swarf).

✓ The copper rails must be straight, smooth, free of burrs and cleaned (free of oil and grease).

1. Fasten the Quick DC-Link modules onto the mounting plate with the fastening screws.

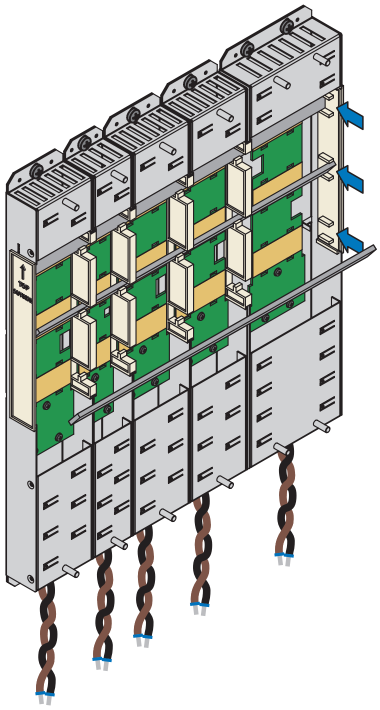


2. Insert the insulation connection pieces between the modules and insulation end section each at the left edge of the first module and at the right edge of the last module. Ensure correct alignment of the end section using the marking on the outside and the insertion aids for the copper rails on the inside.

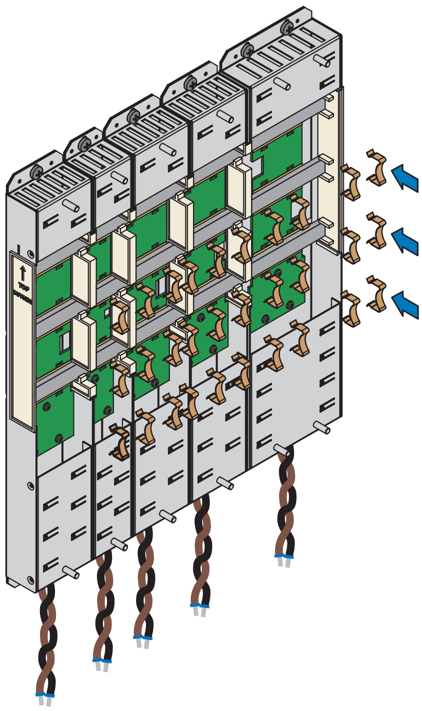


3. Shorten the copper rails to the correct length.
4. Clean the copper rails, especially at the contact points.

5. Insert the three copper rails one after the other.



6. Fasten each of the copper rails with two quick fastening clamps per rail and Quick DC-Link module. Make certain the contact points of the copper rails do not become contaminated.



⇨ You have installed the Quick DC-Link. In the next step, build over the Quick DC-Link modules with suitable drive controllers and supply modules.

9.7 Installing the drive controller and supply module

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

Information

Note that drive controllers in storage require reforming each year or before commissioning at the latest.

Tools and material

You will need:

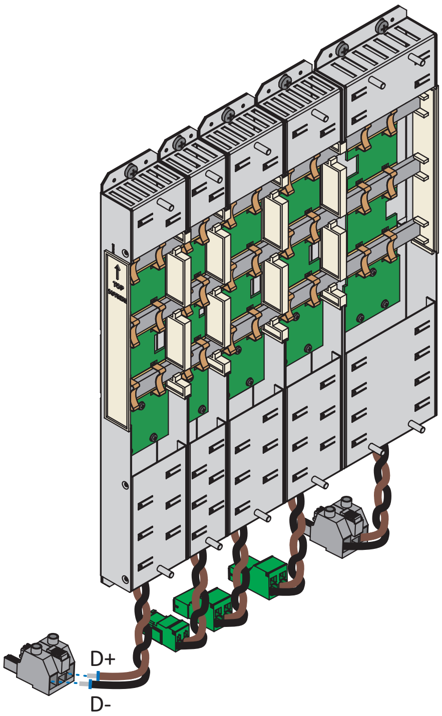
- A suitable terminal set for each drive controller and for each supply module
- An 8 mm hexagonal socket wrench to tighten the nuts

Requirements and installation

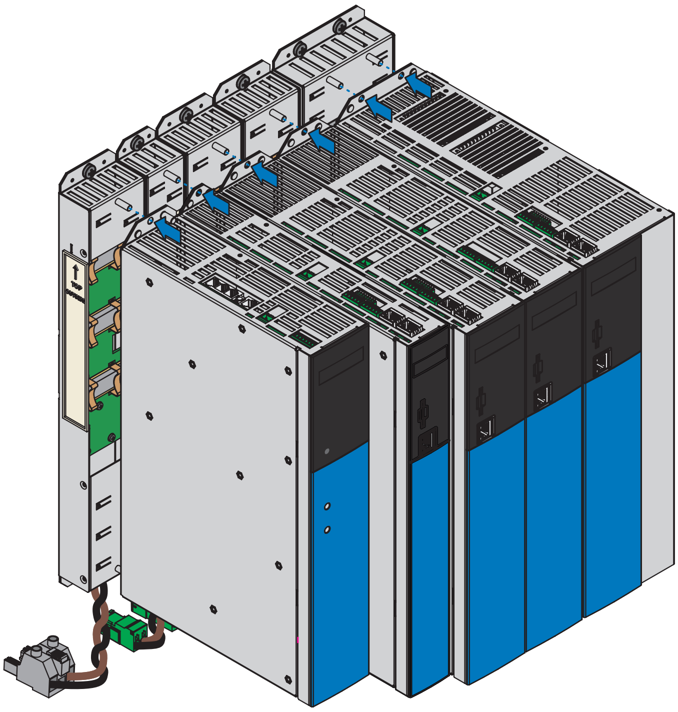
Perform the following steps for each drive controller and for each supply module within the group.

- ✓ A circuit diagram of the system is available containing a description of connecting the drive controllers and supply modules.
- ✓ Suitable PMC DL6B Quick DC-Link rear section modules for the DC link connection are already installed at the installation location for each drive controller and each supply module.

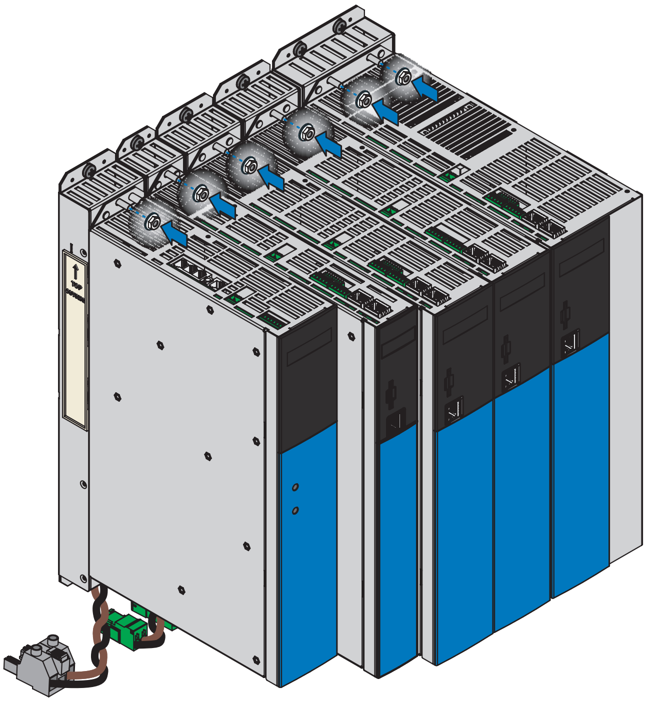
1. Remove terminal X22 from the appropriate terminal set. Connect the brown cable D+ on the bottom of the Quick DC-Link module to D+ of terminal X22, and the black cable D- of the Quick DC-Link module to D- of terminal X22. Make sure that the conductors of the Quick DC-Link module are twisted pairs.



2. Place the drive controller or supply module on the bottom threaded bolt of the Quick DC-Link module and properly align the device vertically with the bottom and top threaded bolt.

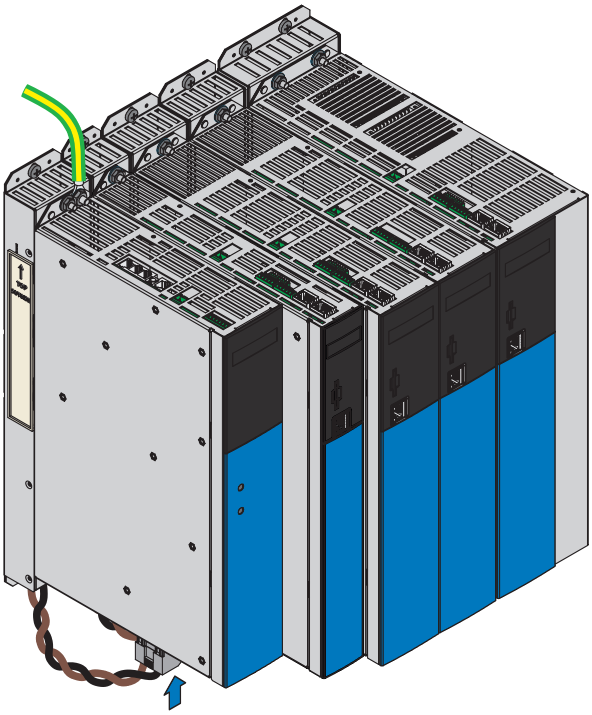


3. Fasten the drive controller or the supply module with the nut and washer assemblies (M5, 3.5 Nm) to both threaded bolts of the Quick DC-Link module. The nut and washer assemblies are included with the Quick DC-Link module.



4. Connect the grounding conductor to the ground bolt of the supply module. Note the instructions and requirements in the chapter Protective grounding [112].

5. Attach the X22 terminal of the Quick DC-Link module.



⇨ The installation is completed. In the next step, connect the drive controllers and supply modules.

10 Connection

The following chapters describe the connection of the supply modules and drive controllers as well as the available accessories.

10.1 Safety instructions for connection

Connection work is permitted only when no voltage is present. Observe the 5 safety rules; see the chapter Working on the machine [21].

Make sure that all Quick DC-Link modules are covered, i.e. built over with a PMC PS6 supply module or PMC SI6 drive controller.

The device housing must be closed before you turn on the supply voltage.

When the power supply voltage is turned on, hazardous voltages may be present on the connection terminals and the cables connected to them.

The device is not reliably de-energized simply because the voltage supply is switched off and all displays are blank!

Information

Note that you can only determine that voltage is no longer present once the discharge time has elapsed. The discharge time depends on the self-discharge of the drive controller and, if applicable, the fast discharge. You can find the discharge time in the general technical data.

Information

You can check the output voltage at the marked measuring points at the front of the housing of the PMC PS6 supply module that are used for the DC link connection of the drive controllers.

ATTENTION!

Material damage due to overload!

Insufficient electrical strength of the voltage measuring device can cause damage to or failure of the measuring device.

- Make sure that the measuring device has an electrical strength of at least 1000 V_{DC}.

Opening the housing, plugging in or unplugging connection terminals, connecting or removing a connecting wiring, and installing or removing accessories are prohibited while the voltage supply is switched on.

Protect the devices against falling parts (bits or strands of wire, pieces of metal, etc.) during installation or other work in the control cabinet. Parts with conductive properties may result in a short circuit inside the devices and device failure as a result.

Use only copper conductors. For the corresponding conductor cross-sections, consult the standards DIN VDE 0298-4 or DIN EN 60204-1 (Annexes D, G) as well as the relevant terminal specifications in this documentation.

The protection class of the devices is protective grounding (protection class I in accordance with DIN EN 61440). This means operation is permitted only if the grounding conductor is connected according to requirements.

All protective ground connections are identified by "PE" or the international grounding symbol (IEC 60417, symbol 5019).

The products are not designed for use in a public low-voltage network that supplies residential areas. Radio-frequency interference can be expected if the products are used in this type of network.

10.2 Line routing

Observe the valid provisions for your machine or system, e.g. DIN IEC 60364 or DIN EN 50110, during the installation of electrical equipment.

10.3 Protective measures

Take the following protective measures into account.

10.3.1 Power grid supply

All supply modules must be connected to the same supply grid.

ATTENTION!

Damage to device due to the emission of electromagnetic interference!

If the EMC threshold limits are exceeded during the operation of a DC link connection, devices in the immediate area can be interrupted or damaged.

- Take suitable measures to comply with the electromagnetic compatibility.
- Always route the shortest possible connections for DC links. If they are longer than 30 cm, they must be shielded.

ATTENTION!

Damage to device in case of supply module failure!

The failure of a supply module in the DC link group can result in damage to additional devices.

- A failure must trigger the isolation of the entire DC link group from the grid.

Wiring example

The examples in the chapter Wiring examples [267] illustrate the basic connection based on a DC link connection with PMC DL6B Quick DC-Link.

10.3.2 Line fuse

The PMC PS6 supply module is intended only for operation on TN networks or wye sources that deliver, at most, a differential short-circuit current at a nominal voltage between 200 and 480 V_{AC} in accordance with the following table:

Size	Max. differential short-circuit current
Size 2 and size 3	5000 A

Maximum differential short-circuit current

The line fuse ensures the line and overload protection in the supply module. To that end, observe the requirements described below, which vary based on the configuration.

10.3.2.1 Line fuses

Every supply module in the group supplied with power must be protected against overload and short circuit at the line input. To do this, a safety combination consisting of overload protection and solid state short-circuit protection is connected in series.

Information

The installation of short-circuit fuses is not necessary under ideal prerequisites and ambient conditions. However, if the application conditions pose the risk of contaminating the drive-controllers and supply modules, short-circuit fuses can protect against damage to or failure of other devices within the DC link group.

You can use the following fuse combinations:

Size	Type	$I_{1N,PU}$ [A]	I_{1maxPU} [A]	Overload protection	Solid state short-circuit protection
Size 2	PMC PS6A24	25	$I_{1N,PU}$ × 180% for 5 s; $I_{1N,PU}$ × 150% for 30 s	EATON Type FAZ-Z25/3 Order number 278929 Z 25 A	SIBA Type URZ Art. No. 50 124 06.40 gR 40 A
Size 3	PMC PS6A34	50	$I_{1N,PU}$ × 180% for 5 s; $I_{1N,PU}$ × 150% for 30 s	EATON Type FAZ-Z50/3 Order number 278932 Z 50 A	SIBA Type URZ Order number 50 140 06.80 gR 80 A

Line fuses

Information

To ensure problem-free operation, always comply with the recommended trigger limits and trigger characteristics of the fuse elements.

10.3.2.2 UL-compliant line fuses

For UL compliance, use one of the following protection measures:

- Class CC, CF, J, T, G or RK1 safety fuses
- Circuit breakers

More detailed specifications about the appropriate fuses can be found in the following table:

Size	Type	Safety fuse		Circuit breakers
		I_N [A]	U_N [V_{AC}]	
2	PMC PS6A24	30	600	EATON NZMB1-AF30-NA Manufacturer No. 281556
3	PMC PS6A34	60	600	EATON NZMB1-AF60-NA Manufacturer No. 272208

UL-compliant line fuses

Information

To ensure problem-free operation, always comply with the recommended trigger limits and trigger characteristics of the fuse elements.

10.3.3 Grid connection

The grid must be switched on at all supply modules simultaneously. Simultaneously in this case means that the time difference may be a maximum of 20 ms. This condition is generally met if you use contactors of identical design from one manufacturer.

Provided that the grid connection is made simultaneously, a design with a contactor for each supply module is permitted.

ATTENTION!

Damage due to overload!

If the grid does not connect to all modules simultaneously in a design with a contactor for each supply module, their charging resistors can be damaged.

10.3.4 Residual current protective device

Pilz devices can be protected with a residual current protective device (RCD) to detect residual currents. Residual current protective devices prevent electrical accidents, especially ground fault through the body. They are generally classified by their triggering limit and suitability for detecting different types of residual currents.

Depending on the function, leakage currents may occur when operating drive controllers. Leakage currents are interpreted as residual currents by residual current protective devices and may therefore lead to false triggering. Depending on the relevant power supply connections, residual currents may occur with or without a DC current component. Because of this, you should take into consideration both the magnitude as well as the profile of the possible leakage or residual current when selecting a suitable RCD.

DANGER!

Electrical voltage! Risk of fatal injury due to electric shock!

This product can cause a direct current in the protective grounding conductor.

- If a residual current protective device (RCD) or residual current monitoring device (RCM) is used for protection in case of direct or indirect contact, only one RCD or RCM of type B is permitted on the power supply side of this product.

DANGER!

Electrical voltage! Risk of fatal injury due to electric shock!

Leakage currents with a DC current component may occur in 3-phase installations.

- Always protect 3-phase installations with type B residual current protective devices, sensitive to all currents.

False triggering – Causes

Depending on stray capacitances and imbalances, leakage currents above 30 mA may occur during operation. Undesirable false triggering occurs under the following conditions:

- When connecting installations to the supply voltage. This false triggering can be rectified by using short-time delayed (super-resistant), selective (delayed switch-off) RCDs or RCDs with increased trigger current (e.g. 300 or 500 mA).
- Due to higher frequency leakage currents for long power cables under normal operating conditions. This false triggering can be rectified using low-capacitance cables or an output choke, for example.
- Due to imbalances in the supply grid. This false triggering can be rectified, e.g. using an isolating transformer.

Information

Check whether the use of residual current protective devices with increased trigger current as well as with short-time delayed or delayed switch-off trigger characteristics are permitted in your application.

DANGER!

Electrical voltage! Risk of fatal injury due to electric shock!

Leakage and residual currents with a DC current component can restrict the functionality of type A and AC residual current protective devices.

- Always follow the installation instructions for the protective devices you are using.

10.3.5 Protective grounding

Observe the requirements described below for the correct connection of the protective grounding.

10.3.5.1 Minimum cross-section of the grounding conductor

Leakage currents > 10 mA can arise in normal operation. To fulfill local safety regulations such as DIN EN 60204-1, connect the grounding bolt with a copper conductor according to the following table:

Cross-section A Power grid line	Minimum cross-section A_{min} Grounding conductor at grounding bolt
A ≤ 2.5 mm²	2.5 mm²
2.5 < A ≤ 16 mm²	A
16 – 35 mm²	≥ 16 mm²
> 35 mm²	A/2

Minimum cross-section of the grounding conductor

10.3.5.2 Connection of the grounding conductor

Connect the grounding conductor to the supply module over terminal X10.

Additional requirements for protective equipotential bonding apply in the event of ground leakage currents > 10 mA. At least one of the following conditions must be fulfilled:

- The grounding conductor must have a minimum cross-section of 10 mm² Cu over its overall length
- If the grounding conductor has a cross-section of less than 10 mm², a 2nd grounding conductor must be provided with a cross-section of at least the same size up to the point at which the grounding conductor exhibits the minimum cross-section of 10 mm²

A grounding bolt is mounted to the devices for connecting the 2nd grounding conductor.

For correct housing ground, connect the 2nd grounding conductor to the grounding bolt of the PMC DL6B Quick DC-Link module of the supply module. Housing grounds for the PMC SI6 drive controllers in the group are connected via the PE rail of the Quick DC-Link modules to the grounding conductor circuit.

You will need an open-ended wrench or external hex key with a width across flats of 10 mm.

Note the tightening torque of 4.0 Nm, 35 Lb.inch.

Observe the order for assembly:

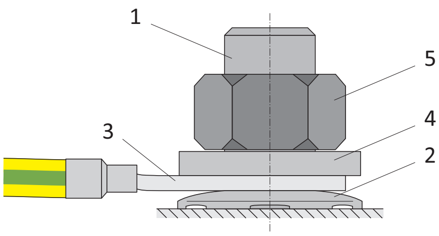


Fig. 37: Connection of the grounding conductor

1	M6 ground bolt
2	Contact disk
3	Cable lug
4	Washer
5	Nut

The contact disk, washer and nut are supplied with the supply module.

10.3.5.3 UL-compliant connection of the grounding conductor

Note that UL-compliant operation requires just a single grounding conductor.

The grounding at terminal X10 of the PMC PS6 supply module must not be used for the protective grounding of the PMC PS6 drive system in combination with PMC SI6. The housing for the PMC PS6 supply modules must be connected to the protective grounding using the M6 ground bolt (4.0 Nm, 35 Lb.inch).

The drive controller housing must be connected to the PMC DL6B modules of the DC link connection through proper installation of the drive controllers using the two M5 fastening nuts. The specified tightening torque for these fastening screws at the PMC DL6B modules is 3.5 Nm (31 Lb.inch).

You will need an open-ended wrench or external hex key with a width across flats of 10 mm.

Observe the order for assembly:

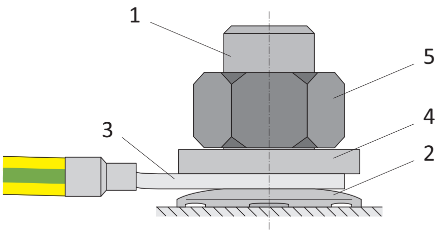


Fig. 38: Connection of the grounding conductor

1 M6 ground bolt
2 Contact disk
3 Cable lug
4 Washer
5 Nut

The contact disk, washer and nut are supplied with the supply module.

In order to dimension the grounding, it must be ensured that the upstream fuse is triggered in the event of a short circuit.

Observe the wiring example in the chapter UL-compliant connection of the supply module [270] to ensure correct connection of the supply module.

10.3.6 EMC recommendations

Information

This chapter provides general information on EMC-compliant installation. These are recommendations. Depending on the application, the ambient conditions as well as the legal requirements, measures beyond these recommendations may be required.

Lay the power line, power cable and signal lines separately from each other, e.g. in separate cable ducts.

Only use shielded, low-capacitance cables as power cables.

If the brake line is carried in the power cable, it must be shielded separately. Also close the brake lines on the drive controller if you are using a motor without a brake.

Connect the shield of the power cable over a wide area and in the immediate vicinity of the drive controller. To do this, use the shield clamp and shield contact at terminal X20.

The connection lines for braking resistors as well as the conductors of the Quick DC-Link modules have to be implemented as twisted pairs. At line lengths of 30 cm or more, the lines also have to be implemented with shielding and the shield must be applied over a wide area in the immediate vicinity of the drive controller.

For motors with terminal boxes, connect the shield to the terminal box over large contact areas. For example, use EMC cable screw connections.

Connect the shield of the control lines on one side to the reference ground of the source, e.g. the PLC or CNC.

You may use chokes to improve the EMC and protect the drive system. Power chokes are used to dampen voltage and current peaks and reduce the load of the power feed-in of the drive controllers or supply modules. Output chokes reduce current peaks caused by line capacity at the power output of the drive controller.

ATTENTION!

Material damage due to incorrect or uncontrolled movement!

When connecting Lean motors in combination with an output choke, a successful position and speed determination is not ensured. This can lead to an incorrect or uncontrolled movement right from the start.

- If Lean motors are connected, output chokes must not be used.

10.4 Supply module

For detailed information about the terminals and correct connection of the supply module, refer to the following chapters.

Information

For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

10.4.1 Overview

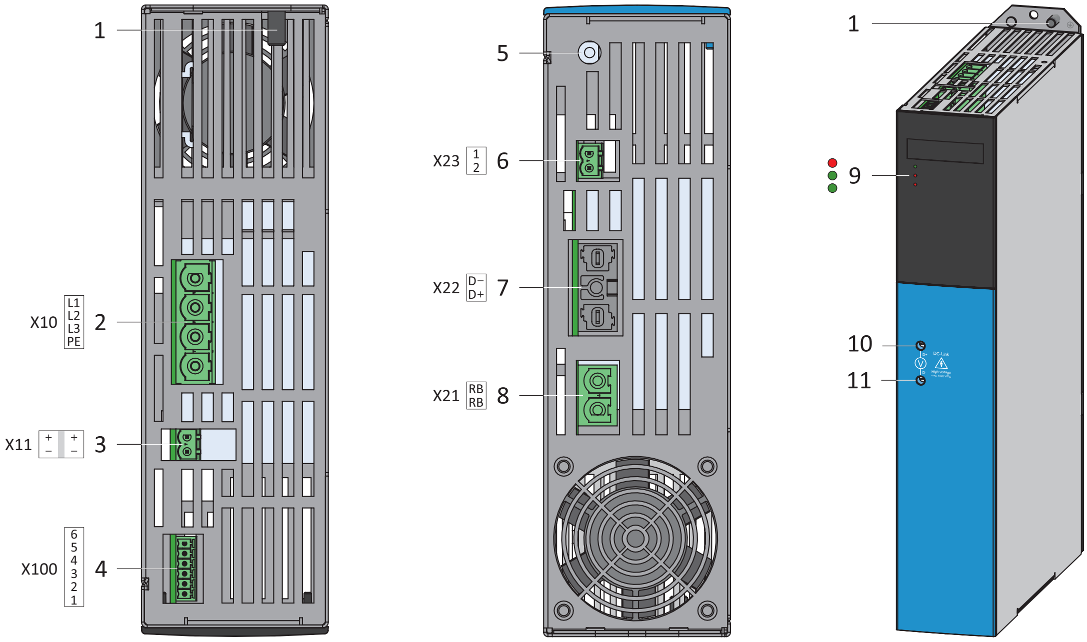


Fig. 39: Connection overview using the example of the PMC PS6A34

	Top of the device		Bottom of the device		Front of the device
1	Ground bolt	5	Fan on/off switch	9	3 diagnostic LEDs
2	X10: 400 V_{AC} supply	6	X23: Braking resistor temperature monitoring	10	D+ DC link potential measuring point
3	X11: 24 V_{DC} supply	7	X22: DC link connection	11	D− DC link potential measuring point
4	X100: Status output	8	X21: Braking resistor		

10.4.2 X10: 400 V supply

Terminal X10 is used to connect the supply module to the supply grid.

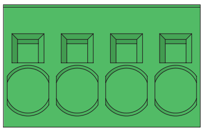
Conductor cross-sections for the power connection

When selecting the conductor cross-section, note the line fuse, the maximum permitted conductor cross-section of terminal X10, the routing method and the surrounding temperature.

UL-compliant operation

The grounding at terminal X10 of the PMC PS6 supply module must not be used for the protective grounding of the PMC PS6 drive system in combination with PMC SI6. The housing for the PMC PS6 supply modules must be connected to the protective grounding using the M6 ground bolt (4.0 Nm, 35 Lb.inch).

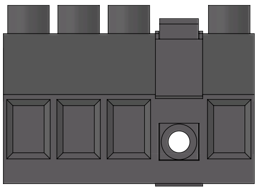
Size 2

<table>
<tr><th>Terminal</th><th>Pin</th><th>Designation</th><th>Function</th></tr>
<tr><td rowspan="4">
1 | 2 | 3 | 4</td><td>1</td><td>L1</td><td rowspan="3">Power supply</td></tr>
<tr><td>2</td><td>L2</td></tr>
<tr><td>3</td><td>L3</td></tr>
<tr><td>4</td><td>PE</td><td>Grounding conductor</td></tr>
</table>

X10 connection description, size 2

For connecting wiring, observe the terminal specifications in the chapter SPC 16 -ST-10,16 [266].

Size 3

<table>
<tr><th>Terminal</th><th>Pin</th><th>Designation</th><th>Function</th></tr>
<tr><td rowspan="4">
1 | 2 | 3 | 4</td><td>1</td><td>L1</td><td rowspan="3">Power supply</td></tr>
<tr><td>2</td><td>L2</td></tr>
<tr><td>3</td><td>L3</td></tr>
<tr><td>4</td><td>PE</td><td>Grounding conductor</td></tr>
</table>

X10 connection description, size 3

For connecting wiring, observe the terminal specifications in the chapter BUZ 10.16IT 180 MF [267].

10.4.3 X11: 24 V supply

The connection of 24 V_{DC} to X11 is required for the power supply of the control unit.

ATTENTION!

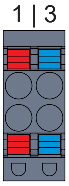
Device damage due to overload!

If the 24 V_{DC} power supply is looped to multiple devices over the terminal, the terminal may be damaged by a current that is too high.

- Make sure that the current over the terminal does not exceed the value 15 A (UL: 10 A).

Electrical data	All types
U_{1CU}	24 V_{DC}, +20%/−15%
I_{1maxCU}	0.5 A

Control unit electrical data

	Pin	Designation	Function
1 | 3  2 | 4	1	+	24 V_{DC} supply for the control unit; bridged in the terminal; design in accordance with EN 60204: PELV, secondary grounded, recommended fuse protection: max. 15 AT[11]
	2		
	3	–	Reference potential for +24 V_{DC}, bridged in the terminal
	4		

X11 connection description

Information

The device may not be connected to a DC supply grid. Instead, supply it over a local 24 V_{DC} power supply unit.

For connecting wiring, observe the terminal specifications in the chapter BLDF 5.08 180 SN [263].

Cable requirements

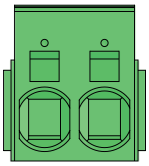
Feature	All sizes
Max. cable length	30 m

Cable length [m]

[11] For UL-compliance, use of a 10 A fuse (time delay) is required. Be sure that the fuse meets certification requirements for DC voltage in accordance with UL 248.

10.4.4 X21: Braking resistor

Terminal X21 is available for the connection of a braking resistor.

Terminal	Pin	Designation	Function
 1 | 2	1	RB	Braking resistor connection
	2	RB	

X21 connection description

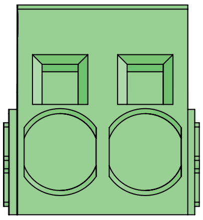
For connecting wiring, observe the terminal specifications in the chapter ISPC 5 -STGCL-7,62 [265].

10.4.5 X22: DC link connection

Terminal X22 is available for the DC link connection of the supply module.

For setting up the Quick DC-Link, note the information on project configuration in the chapter DC link connection [78].

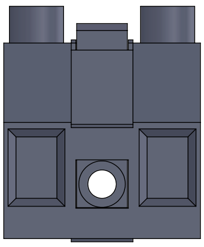
Size 2

Terminal	Pin	Designation	Function
 1 | 2	1	D−	DC link connection
	2	D+	

X22 connection description, size 2

For connecting wiring, observe the terminal specifications in the chapter ISPC 16 -ST-10,16 [266].

Size 3

Terminal	Pin	Designation	Function
 1 | 2	1	D−	DC link connection
	2	D+	

X22 connection description, size 3

For connecting wiring, observe the terminal specifications in the chapter BUZ 10.16IT 180 MF [267].

Wiring example

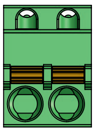
The examples in the chapter Wiring examples [📖 267] illustrate the basic connection based on a DC link connection with PMC DL6B Quick DC-Link.

10.4.6 X23: Temperature monitoring of braking resistor

Connect the temperature monitoring of the braking resistor to terminal X23.

UL-compliant operation

For project configuration of the braking resistor, observe the notes in the chapter UL-compliant use [📖 22].

	Pin	Designation	Function
 1 | 2	1	1TP1	Temperature monitoring connection
	2	1TP2	

X23 connection description

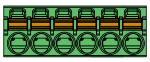
For connecting wiring, observe the terminal specifications in the chapter FKC 2,5 -ST-5,08 [📖 263].

10.4.7 X100: Status output

The relay status output of terminal X100 in conjunction with the 3 diagnostic LEDs on the front of the device provides information about the status of the supply module.

Technical data

Observe the technical data for X100; see the chapter Status output [📖 43].

Terminal	Pin	Designation	Function
 6|5|4|3|2|1	1	READY	NO contact; Operational readiness status; recommended fuse protection: max. 2 AT
	2		
	3	WARNING1	NO contact; Warning 1 status; Overload; recommended fuse protection: max. 2 AT
	4		
	5	WARNING2	NO contact; Warning 2 status; grid phase failure; recommended fuse protection: max. 2 AT
	6		

X100 connection description

Use a 2 A fuse (time delay) upstream of the 3 relays for fuse protection.

For UL-compliant use, be sure that the fuse meets certification requirements for DC voltage in accordance with UL 248.

During UL-compliant operation, the PMC PS6 supply module must be removed from the power supply using the WARNING1 relay. An associated application is a notification from the temperature switch when the braking resistor is overloaded.

For notes about diagnostics, refer to the chapter Supply module [📖 194].

For connecting wiring, observe the terminal specifications in the chapter FMC 1,5 -ST-3,5 [📖 261].

Cable requirements

Feature	All sizes
Max. cable length	30 m

Cable length [m]

10.4.8 Connecting the supply module

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

Tools and material

You will need:

- A suitable terminal set for the supply module
- Tool for tightening the fastening screws

Requirements and connection

Bottom of the device:

✓ You have a system circuit diagram describing the connection of the supply module.

1. Connect the braking resistor to terminal X21 and attach the terminal. Make sure that the conductors are twisted pairs.
2. Connect the temperature monitoring of the braking resistor to terminal X23 and attach the terminal.

Top of the device:

✓ You have a system circuit diagram describing the connection of the supply module.

1. Connect the power supply to terminal X10 and attach the terminal.
2. Connect the 24 V_{DC} power supply for the control electronics to terminal X11 and attach the terminal.
3. Connect the status output to terminal X100 and attach the terminal.

10.5 Drive controllers

The following section contains detailed information about the terminals and the correct connection of the drive controller.

Information

For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

10.5.1 Overview

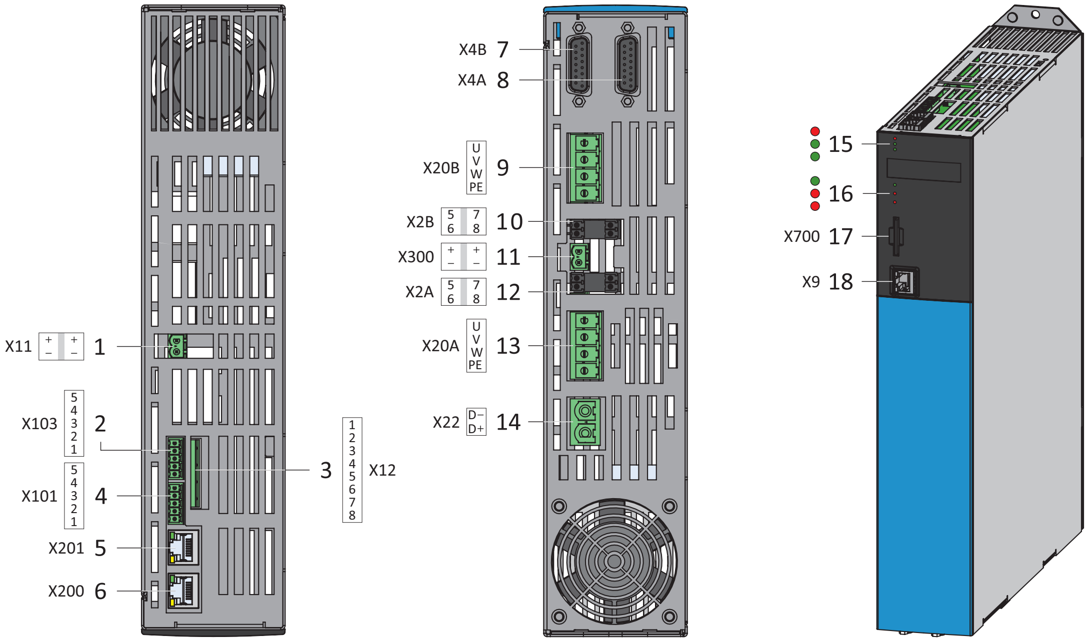


Fig. 40: Connection overview using the example of the PMC SI6A162

	Top of the device		Bottom of the device		Front of the device
1	X11: 24 V_{DC} supply	7	X4B: Encoder B (only for double-axis controllers)	15	3 diagnostic LEDs for communication and safety technology
2	X103: DI6 – DI9	8	X4A: Encoder A	16	3 diagnostic LEDs for drive controller
3	X12: STO via terminals (only for PMC SR6 option)	9	X20B: Motor B (only for double-axis controllers)	17	X700: SD slot
4	X101: DI1 – DI4	10	X2B: Brake B (pin 5/6) and temperature sensor B (pin 7/8); (only for double-axis controllers)	18	X9: Ethernet service interface
5	X201: EtherCAT Out / PROFINET	11	X300: Brake 24 V_{DC} supply		
6	X200: EtherCAT In / PROFINET	12	X2A: Brake A (pin 5/6) and temperature sensor A (pin 7/8)		
		13	X20A: Motor A		
		14	X22: DC link connection		

10.5.2 X2A: Brake A

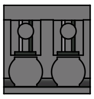
The brake of axis A is connected to X2A. All device types of the PMC SI6 drive controller can control a 24 V_{DC} brake as standard.

> **Information**
>
> Note that brakes from other manufacturers may be connected only after consultation with Pilz.

Controllable brakes

Note the technical data of the brakes controllable at X2A; see the chapter Controllable brakes [65].

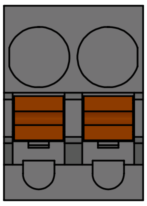
Sizes 0 to 2 (single-axis controllers)

	Pin	Designation	Function
 5 | 6	5	1BD1	Brake actuation
	6	1BD2	Reference potential

X2A connection description, brake A, sizes 0 to 2 (single-axis controllers)

For connecting wiring, observe the terminal specifications in the chapter BCF 3,81 180 SN [262].

Sizes 2 (double-axis controllers) and 3

	Pin	Designation	Function
 5 | 6	5	1BD1	Brake actuation
	6	1BD2	Reference potential

X2A connection description, brake A, sizes 2 (double-axis controllers) and 3

For connecting wiring, observe the terminal specifications in the chapter BFL 5.08HC 180 SN [262].

Cable requirements

Motor type	Connection	Size 0 to 2	Size 3
Synchronous servo motor, asynchronous motor	Without output choke	50 m, shielded	100 m, shielded
Synchronous servo motor, asynchronous motor	With output choke	100 m, shielded	—
Lean motor	Without output choke	50 m, shielded	50 m, shielded

Maximum cable length of the power cable [m]

10.5.3 X2A: Motor temperature sensor A

The motor temperature sensor of axis A is connected to terminal X2A. All device types of the PMC SI6 drive controller have connections for PTC thermistors.

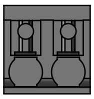
Information

Note that the evaluation of the temperature sensor is always active. If operation without a temperature sensor is permitted, the connections must be bridged on X2. Otherwise a fault is triggered when switching on the device.

Information

Note that a temperature sensor does not have to be connected to terminal X2 for a HIPERFACE DSL encoder. In this case, the temperature sensor signal is transferred together with the encoder signal over connector X4.

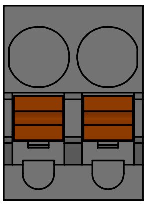
Sizes 0 to 2 (single-axis controllers)

	Pin	Designation	Function
 7 | 8	7	1TP1+	PTC connection
	8	1TP2−	

X2A connection description, motor temperature sensor A, sizes 0 to 2 (single-axis controller)

For connecting wiring, observe the terminal specifications in the chapter BCF 3,81 180 SN [262].

Sizes 2 (double-axis controllers) and 3

	Pin	Designation	Function
 7 | 8	7	1TP1+	PTC connection
	8	1TP2−	

X2A connection description, motor temperature sensor A, sizes 2 (double-axis controller) and 3

For connecting wiring, observe the terminal specifications in the chapter BFL 5.08HC 180 SN [262].

Cable requirements

Motor type	Connection	Size 0 to 2	Size 3
Synchronous servo motor, asynchronous motor	Without output choke	50 m, shielded	100 m, shielded
Synchronous servo motor, asynchronous motor	With output choke	100 m, shielded	–
Lean motor	Without output choke	50 m, shielded	50 m, shielded

Maximum cable length of the power cable [m]

10.5.4 X2B: Brake B

The brake of axis B is connected to X2B for double-axis controllers. Only X2A is available for single-axis controllers. The connection description of X2B matches the X2A description.

10.5.5 X2B: Motor temperature sensor B

The motor temperature sensor of axis B is connected to X2B for double-axis controllers. Only X2A is available for single-axis controllers. The connection description of X2B matches the X2A description.

10.5.6 X4A: Encoder A

The encoder of axis A is connected to terminal X4A.

ATTENTION!

Risk of encoder destruction!

X4 may not be plugged in or unplugged when the device is switched on!

ATTENTION!

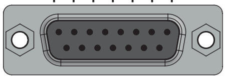
Risk of encoder destruction!

Only encoders with a suitable input voltage range (minimum 12 V_{DC}) may be connected to X4.

Evaluable encoders

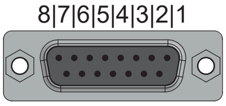
Note the technical data of the evaluable encoders at X4; see the chapter Evaluable encoders [61].

EnDat 2.2 digital encoders and SSI encoders

Socket	Pin	Designation	Function
8|7|6|5|4|3|2|1  15|14|13|12|11|10|9	1	—	—
	2	GND	Reference potential for encoder supply to pin 4
	3	—	—
	4	U_2	Encoder supply
	5	Data+	Differential input for DATA
	6	—	—
	7	—	—
	8	Clock+	Differential input for CLOCK
	9	—	—
	10	—	—
	11	—	—
	12	—	—
	13	Data−	Inverse differential input for DATA
	14	—	—
	15	Clock−	Inverse differential input for CLOCK

X4A connection description for EnDat 2.2 digital encoders and SSI encoders

Differential TTL and differential HTL incremental encoders (HTL via PMC HT6 adapter)

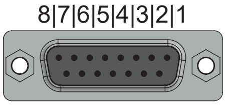
Socket	Pin	Designation	Function
8|7|6|5|4|3|2|1  15|14|13|12|11|10|9	1	—	—
	2	GND	Reference potential for encoder supply to pin 4
	3	—	—
	4	U_2	Encoder supply
	5	B+	Differential input for B channel
	6	—	—
	7	N+	Differential input for N channel
	8	A+	Differential input for A channel
	9	—	—
	10	—	—
	11	—	—
	12	—	—
	13	B−	Inverse differential input for B channel
	14	N−	Inverse differential input for N channel
	15	A−	Inverse differential input for A channel

X4A connection description for differential TTL and differential HTL incremental encoders (HTL via PMC HT6 adapter)

Information

Using an PMC HT6 adapter for level conversion from HTL signals to TTL signals, it is also possible to connect a differential HTL incremental encoder to terminal X4. Note that, with an external power supply, the maximum level of 20 V_{DC} for the HTL signals may not be exceeded.

Resolver

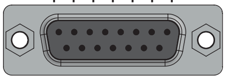
<table>
<tr><th>Socket</th><th>Pin</th><th>Designation</th><th>Function</th></tr>
<tr><td rowspan="15">8|7|6|5|4|3|2|1

15|14|13|12|11|10|9</td><td>1</td><td>S4 Sin+</td><td>Sin input</td></tr>
<tr><td>2</td><td>R1 Ref−</td><td>Reference potential for pin 6</td></tr>
<tr><td>3</td><td>S3 Cos+</td><td>Cos input</td></tr>
<tr><td>4</td><td>—</td><td>—</td></tr>
<tr><td>5</td><td>—</td><td>—</td></tr>
<tr><td>6</td><td>R2 Ref+</td><td>Resolver excitation signal</td></tr>
<tr><td>7</td><td>1TP1</td><td>Reserve</td></tr>
<tr><td>8</td><td>—</td><td>—</td></tr>
<tr><td>9</td><td>S2 Sin−</td><td>Reference potential for pin 1</td></tr>
<tr><td>10</td><td>—</td><td>—</td></tr>
<tr><td>11</td><td>S1 Cos−</td><td>Reference potential for pin 3</td></tr>
<tr><td>12</td><td>—</td><td>—</td></tr>
<tr><td>13</td><td>—</td><td>—</td></tr>
<tr><td>14</td><td>1TP2</td><td>Reserve</td></tr>
<tr><td>15</td><td>—</td><td>—</td></tr>
</table>

X4A connection description for resolvers

Information

For connecting Pilz resolver cables with a 9-pin D-sub connector, use the PMC AP6A00 interface adapter (ID No. on request, 9-pin to 15-pin D-sub), available separately.

HIPERFACE DSL encoders

Socket	Pin	Designation	Function
8|7|6|5|4|3|2|1  15|14|13|12|11|10|9	1	—	—
	2	DSL−	Inverse HIPERFACE DSL signal (motor temperature sensor evaluation over DSL communication)
	3	—	—
	4	DSL+	HIPERFACE DSL signal (motor temperature sensor evaluation over DSL communication)
	5	—	—
	6	—	—
	7	—	—
	8	—	—
	9	—	—
	10	—	—
	11	—	—
	12	—	—
	13	—	—
	14	—	—
	15	—	—

X4A connection description for HIPERFACE DSL encoders

Cable requirements

Feature	All sizes
Max. cable length	100 m, shielded

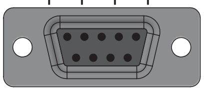
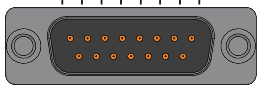
Cable length [m]

Information

To ensure proper functionality, we recommend using cables from Pilz that are matched to the complete system. If unsuitable connection cables are used, we reserve the right to reject claims under the warranty.

10.5.6.1 PMC AP6 interface adapter (resolver)

PMC AP6A00 – resolver (9-pin to 15-pin)

Socket[12]	Pin	Designation	Function	Pin	Connector[13]
1 | 2 | 3 | 4 | 5  6 | 7 | 8 | 9	1	—	—	—	1|2|3|4|5|6|7|8|9  10|11|12|13|14|15
	2	1TP1	—	—	
	3	S2 Sin−	Sin input reference potential	9	
	4	S1 Cos−	Cos input reference potential	11	
	5	R1 Ref−	Resolver excitation signal reference potential	2	
	6	1TP2	—	—	
	7	S4 Sin+	Sin input	1	
	8	S3 Cos+	Cos input	3	
	9	R2 Ref+	Resolver excitation signal	6	

PMC AP6A00 connection description for resolver (9-pin to 15-pin)

10.5.7 X4B: Encoder B

The encoder of axis B is connected to X4B for double-axis controllers. Only X4A is available for single-axis controllers. The connection description of X4B matches the X4A description.

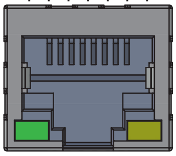
Information

Note that a master encoder must be connected to axis A during synchronous operation.

[12] View of 9-pin D-sub for connecting the SDS 4000-compatible resolver cable
[13] View of 15-pin D-sub for connecting to terminal X4

10.5.8 X9: Ethernet service interface

X9 is used to connect the drive controller to a PC with DriveControlSuite commissioning software installed.

Socket	Pin	Designation	Function
1|2|3|4|5|6|7|8 	1	TxData+	Ethernet communication
	2	TxData–	
	3	RecvData+	
	4	—	—
	5	—	—
	6	RecvData–	Ethernet communication
	7	—	—
	8	—	—

X9 connection description

Cable requirements

Feature	All sizes
Max. cable length	100 m, shielded

Cable length [m]

> **Information**
>
> To ensure proper functionality, we recommend using cables from Pilz that are matched to the complete system. If unsuitable connection cables are used, we reserve the right to reject claims under the warranty.

It is also possible to use cables with the following specification:

Feature	Design
Connector wiring	Patch or crossover
Quality	CAT 5e
Shielding	SF/FTP, S/FTP or SF/UTP

Cable requirements

Device addressing

Information for device addressing can be found in the chapter Device addressing [277].

10.5.9 X11: 24 V supply

The connection of 24 V_{DC} to X11 is required for the power supply of the control unit.

ATTENTION!

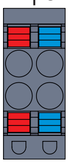
Device damage due to overload!

If the 24 V_{DC} power supply is looped to multiple devices over the terminal, the terminal may be damaged by a current that is too high.

- Make sure that the current over the terminal does not exceed the value 15 A (UL: 10 A).

Electrical data	All types
U_{1CU}	24 V_{DC}, +20%/−15%
I_{1maxCU}	0.5 A

Control unit electrical data

<table>
<tr><th></th><th>Pin</th><th>Designation</th><th>Function</th></tr>
<tr><td rowspan="4">1 | 3

2 | 4</td><td>1</td><td rowspan="2">+</td><td rowspan="2">24 V_{DC} supply for the control unit; bridged in the terminal; design in accordance with EN 60204: PELV, secondary grounded, recommended fuse protection: max. 15 AT[14]</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="2">–</td><td rowspan="2">Reference potential for +24 V_{DC}, bridged in the terminal</td></tr>
<tr><td>4</td></tr>
</table>

X11 connection description

Information

The device may not be connected to a DC supply grid. Instead, supply it over a local 24 V_{DC} power supply unit.

For connecting wiring, observe the terminal specifications in the chapter BLDF 5.08 180 SN [263].

Cable requirements

Feature	All sizes
Max. cable length	30 m

Cable length [m]

[14] For UL-compliance, use of a 10 A fuse (time delay) is required. Be sure that the fuse meets certification requirements for DC voltage in accordance with UL 248.

10.5.10 X12: Safety technology (option PMC SR6)

The PMC SR6 option adds the STO safety function to the PMC SI6 drive controller via terminal X12.

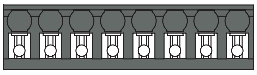
For double-axis controllers, the STO safety function has a two-channel structure that acts upon both axes.

Information

If you would like to use the STO safety function via terminals, be sure to read the manual for the PMC SR6 safety module.

Technical data

Observe the technical data of the safety options for X12; see the chapter Safety technology [59].

Terminal	Pin	Designation	Function
 1|2|3|4|5|6|7|8	1	STO_a	Input of safety channel 1
	2		
	3	STO_b	Input of safety channel 2
	4		
	5	GND	Reference potential for STO_a and STO_b, internally bridged with terminal 7
	6	STO_{status}	Feedback signal of safety channels 1 and 2 for diagnostic purposes
	7	GND	Reference potential for STO_a and STO_b, internally bridged with terminal 5
	8	$U_{1status}$	STO supply $_{status}$; recommended fuse protection: max. 3.15 AT[15]

X12 connection description

Connecting wiring

For connecting wiring, observe the terminal specifications in the chapter BCF 3,81 180 SN [262].

Cable requirements

Feature	All sizes
Max. cable length	30 m

Cable length [m]

[15] For UL-compliance, use of a 3.15 A fuse (time delay) is required. The fuse must be certified for DC voltage in accordance with UL 248.

10.5.11 X20A: Motor A

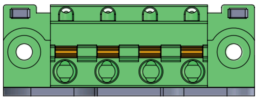
The motor of axis A is connected to X20A.

UL-compliant operation

The protective grounding of motors connected to the drive controller must not be connected using terminals X20A and X20B. The grounding conductor connection of the motor must be ensured for the respective application in accordance with the valid electrical standards.

For the protective grounding of the motor, use the grounding conductor connection available on the motor.

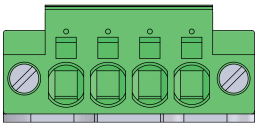
Size 0

Terminal	Pin	Designation	Function
 1 | 2 | 3 | 4	1	U	Motor phase U connection
	2	V	Motor phase V connection
	3	W	Motor phase W connection
	4	PE	Grounding conductor

X20A connection description, size 0

For connecting wiring, observe the terminal specifications in the chapter GFKC 2,5 -ST-7,62 [264].

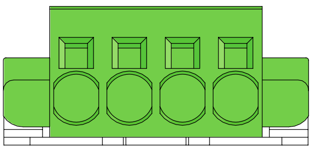
Sizes 1 and 2 (single-axis controllers)

Terminal	Pin	Designation	Function
 1 | 2 | 3 | 4	1	U	Motor phase U connection
	2	V	Motor phase V connection
	3	W	Motor phase W connection
	4	PE	Grounding conductor

X20A connection description, sizes 1 and 2 (single-axis controllers)

For connecting wiring, observe the terminal specifications in the chapter SPC 5 -ST-7,62 [265].

Sizes 2 (double-axis controllers) and 3

Terminal	Pin	Designation	Function
 1 | 2 | 3 | 4	1	U	Motor phase U connection
	2	V	Motor phase V connection
	3	W	Motor phase W connection
	4	PE	Grounding conductor

X20A connection description, sizes 2 (double-axis controllers) and 3

For connecting wiring, observe the terminal specifications in the chapter SPC 16 -ST-10,16 [266].

Cable requirements

Motor type	Connection	Size 0 to 2	Size 3
Synchronous servo motor, asynchronous motor	Without output choke	50 m, shielded	100 m, shielded
Synchronous servo motor, asynchronous motor	With output choke	100 m, shielded	–
Lean motor	Without output choke	50 m, shielded	50 m, shielded

Maximum cable length of the power cable [m]

Information

To ensure proper functionality, we recommend using cables from Pilz that are matched to the complete system. If unsuitable connection cables are used, we reserve the right to reject claims under the warranty.

Shielded connection of the power cable

Note the following points for the connection of the power cable:

- Ground the shield of the power cable on the shield contact on the drive controller intended for this.
- Keep the exposed conductors as short as possible. All devices and circuits that are sensitive to EMC must be kept at a distance of at least 0.3 m.

10.5.12 X20B: Motor B

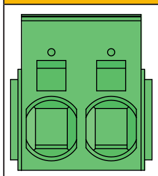
The motor of axis B is connected to X20B for double-axis controllers. Only X20A is available for single-axis controllers. The connection description of X20B matches the X20A description.

10.5.13 X22: DC link connection

Terminal X22 is available for the DC link connection of the drive controller.

For setting up the Quick DC-Link, note the information on project configuration in the chapter DC link connection [78].

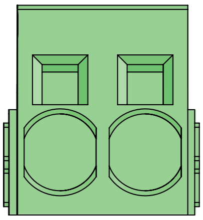
Size 0

Terminal	Pin	Designation	Function
 1 | 2	1	D−	DC link connection
	2	D+	

X22 connection description, size 0

For connecting wiring, observe the terminal specifications in the chapter ISPC 5 -STGCL-7,62 [265].

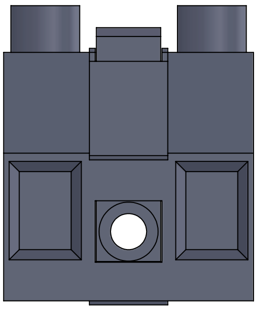
Sizes 1 and 2 (single-axis controllers)

Terminal	Pin	Designation	Function
 1 | 2	1	D−	DC link connection
	2	D+	

X22 connection description, sizes 1 and 2 (single-axis controllers)

For connecting wiring, observe the terminal specifications in the chapter ISPC 16 -ST-10,16 [📖 266].

Sizes 2 (double-axis controllers) and 3

Terminal	Pin	Designation	Function
 1 | 2	1	D−	DC link connection
	2	D+	

X22 connection description, sizes 2 (double-axis controllers) and 3

For connecting wiring, observe the terminal specifications in the chapter BUZ 10.16IT 180 MF [📖 267].

Wiring example

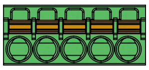
The examples in the chapter Wiring examples [📖 267] illustrate the basic connection based on a DC link connection with PMC DL6B Quick DC-Link.

10.5.14 X101: DI1 – DI4

Digital inputs 1 to 4 are available at terminal X101.

X101 for digital signals

For evaluating digital signals at X101, note the specification for the digital inputs in the technical data of the drive controller; see the chapter Digital inputs [48].

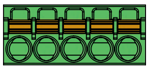
Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI1	Digital inputs
	2	DI2	
	3	DI3	
	4	DI4	
	5	DGND	Reference ground; not bridged with X103, pin 5

X101 connection description for digital signals

X101 for encoders

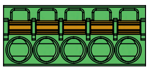
If you would like to use X101 as an encoder connection, note the technical data of the evaluable encoders at X101; see the chapter X101 for encoders [64].

Single-ended HTL incremental encoders

Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI1	–
	2	DI2	N channel
	3	DI3	A channel
	4	DI4	B channel
	5	DGND	Reference ground; not bridged with X103, pin 5

X101 connection description for single-ended HTL incremental signals, axis A

Single-ended HTL pulse/direction interface

Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI1	–
	2	DI2	–
	3	DI3	Frequency
	4	DI4	Direction
	5	DGND	Reference ground; not bridged with X103, pin 5

X101 connection description for single-ended HTL pulse/direction signals, axis A

Connecting wiring

For connecting wiring, observe the terminal specifications in the chapter FMC 1,5 -ST-3,5 [261].

Cable requirements

Feature	All sizes
Max. cable length	30 m

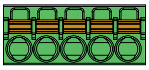
Cable length [m]

10.5.15 X103: DI6 – DI9

Digital inputs 6 to 9 are available at terminal X103.

X103 for digital signals

For the evaluation of digital signals at X103, observe the technical data of the drive controller; see the chapter Digital inputs [48].

Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI6	Digital inputs
	2	DI7	
	3	DI8	
	4	DI9	
	5	DGND	Reference ground; not bridged with X101, pin 5

X103 connection description for digital signals

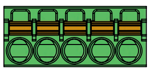
X103 for encoders

If you would like to use X103 as an encoder connection, note the technical data of the evaluable encoders at X103; see the chapter X103 for encoders [65].

Information

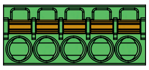
Note that a master encoder must be connected to X101 during synchronous operation.

Single-ended HTL incremental encoders

Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI6	–
	2	DI7	N channel
	3	DI8	A channel
	4	DI9	B channel
	5	DGND	Reference ground; not bridged with X101, pin 5

X103 connection description for single-ended HTL incremental signals, axis B

Single-ended HTL pulse/direction interface

Terminal	Pin	Designation	Function
 5|4|3|2|1	1	DI6	–
	2	DI7	–
	3	DI8	Frequency
	4	DI9	Direction
	5	DGND	Reference ground; not bridged with X101, pin 5

X103 connection description for single-ended HTL pulse/direction signals, axis B

Connecting wiring

For connecting wiring, observe the terminal specifications in the chapter FMC 1,5 -ST-3,5 [📖 261].

Cable requirements

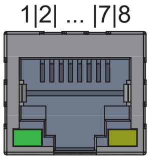
Feature	All sizes
Max. cable length	30 m

Cable length [m]

10.5.16 X200, X201: EtherCAT

The drive controllers have both RJ-45 sockets X200 and X201. The sockets are located on top of the device. The associated pin assignment and color coding correspond to the EIA/TIA-T568B standard.

X200 is to be connected as an input with the cable coming from the EtherCAT master. X201 is to be connected as an output with any subsequent EtherCAT nodes.

Socket	Pin	Designation	Function
1|2| ... |7|8 	1	Tx+	Communication
	2	Tx−	
	3	Rx+	
	4	—	—
	5	—	—
	6	Rx−	Communication
	7	—	—
	8	—	—

X200 and X201 connection description

Cable requirements

Information

To ensure proper functionality, we recommend using cables from Pilz that are matched to the complete system. If unsuitable connection cables are used, we reserve the right to reject claims under the warranty.

Pilz provides ready-made cables for the EtherCAT connection. It is also possible to use cables with the following specification:

Ethernet patch cables or crossover cables meeting the CAT 5e quality level are the ideal cables. The Fast Ethernet technology allows a maximum cable length of 100 m between two nodes.

Information

Ensure that you only use shielded cables with an SF/FTP, S/FTP or SF/UTP design.

Device addressing and fieldbus connection

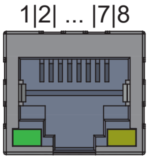
Information for device addressing can be found in the chapter Device addressing [277].

Detailed information about the fieldbus connection can be found in the corresponding manual for communication with EtherCAT.

10.5.17 X200, X201: PROFINET

In order to be able to connect the drive controllers to other PROFINET nodes, an integrated switch with both X200 and X201 RJ-45 sockets is provided. The sockets are located on top of the device. The associated pin assignment and color coding correspond to the EIA/TIA-T568B standard.

Connect X200 or X201 with the IO controller and the remaining connection with the next drive controller.

Socket	Pin	Designation	Function
1|2| ... |7|8 	1	Tx+	Communication
	2	Tx−	
	3	Rx+	
	4	—	—
	5	—	—
	6	Rx−	Communication
	7	—	—
	8	—	—

X200 and X201 connection description

Cable requirements

A PROFINET network generally consists of symmetrical, shielded copper cables twisted in pairs (shielded twisted pair, CAT 5e quality level).

Signals are transmitted according to the 100BASE TX method, i.e. with a transfer rate of 100 Mbps at a frequency of 125 MHz.
A maximum of 1440 bytes can be transferred per frame. The maximum cable length is 100 m.

PROFINET cables exist in different versions that are tailored to different application scenarios and ambient conditions.

We recommend using the cables specified in the PROFINET installation guidelines. They are adjusted for use in automation technology with regard to usage, resistance, EMC properties and color coding.

There are type A, B and C cables, differentiated by installation type:

- Type A
  4-wire shielded copper cable for fixed installation
- Type B
  4-wire shielded copper cable for flexible installation
- Type C
  4-wire shielded copper cable for constant movements

Device addressing and fieldbus connection

Information for device addressing can be found in the chapter Device addressing [277].

Detailed information about the fieldbus connection can be found in the corresponding manual for communication with PROFINET.

10.5.18 X300: Brake 24 V supply

X300 is used to supply the brake.

ATTENTION!

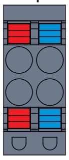
Device damage due to overload!

If the 24 V_{DC} power supply is looped to multiple devices over the terminal, the terminal may be damaged by a current that is too high.

- Make sure that the current over the terminal does not exceed the value 15 A (UL: 10 A).

Electrical data	Single-axis controller	Double-axis controller
U_1	+24 V_{DC}, +25%/−0%	
I_{1max}	2.5 A	2 × 2.5 A

Electrical data of the control unit brake control

<table>
<tr><th></th><th>Pin</th><th>Designation</th><th>Function</th></tr>
<tr><td rowspan="4">1 | 3

2 | 4</td><td>1</td><td rowspan="2">+</td><td rowspan="2">24 V_{DC} supply for the brake; bridged in the terminal; design in accordance with EN 60204-1: PELV, secondary grounded, recommended fuse protection: max. 15 AT[16]</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="2">–</td><td rowspan="2">Reference potential for supply voltage of the brake</td></tr>
<tr><td>4</td></tr>
</table>

X300 connecection description

For connecting wiring, observe the terminal specifications in the chapter BLDF 5.08 180 SN [263].

Cable requirements

Feature	All sizes
Max. cable length	30 m

Cable length [m]

10.5.19 X700: SD slot

The SD slot is used for data backup in the case of service. SD and SDHC cards with storage capacity from 128 MB to 32 GB are supported. SDHC cards with a storage capacity of 64 GB can be used only if they have been first reformatted to max. 32 GB. Since higher capacities increase the controller starting time, Pilz recommends the use of cards with a storage capacity from 2 to 4 GB, such as industrial SD cards from ATP Electronics.

Information

The drive controller has internal configuration memory and can therefore be operated without an inserted SD card. In the DriveControlSuite commissioning software, the action Save values always saves to both the internal configuration memory and the inserted SD card. Back up your configuration to an SD card after completing commissioning in order to allow transfer of the configuration to the replacement controller in the case of service. When the replacement controller is switched on, the data is loaded with priority given to the inserted SD card. To make a non-volatile back-up in the internal configuration memory, you must run the action Save values in parameter A00.

[16] For UL-compliance, use of a 10 A fuse (time delay) is required. Be sure that the fuse meets certification requirements for DC voltage in accordance with UL 248.

10.5.20 Connecting a drive controller

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

Tools and material

You will need:

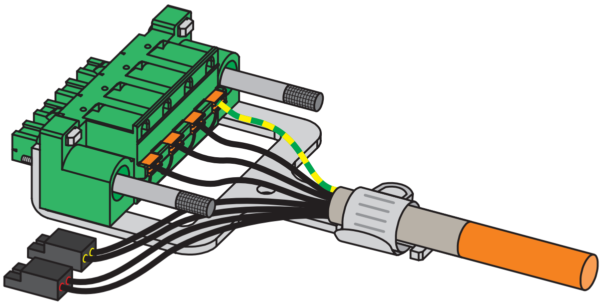
- A suitable terminal set for the drive controller
- Tool for tightening the fastening screws

Requirements and connection

Bottom of the device:

✓ You have a system circuit diagram describing the connection of the drive controller.

1. In order to connect the motor temperature sensor, the control of the brake and the motor itself to the drive controller, wire the cores of the power cables with terminals X2A and X20A.
2. Attach the power cable with the shield clamp to the shield contact of terminal X20A.



3. Attach terminals X20A and X2A and tighten the screws of X20A.
4. Optional: Connect the supply voltage for the brakes to terminal X300 and attach it.
5. For double-axis controllers: Repeat steps 2 to 4 for the terminals X2B and X20B.
6. Optional: Connect an encoder to terminal X4A.
7. Optional for double-axis controllers: Connect an encoder to terminal X4B.

Top of the device:

✓ There is a circuit diagram of the system that describes the connection of the drive controller.

1. Connect the 24 V_{DC} power supply for the control electronics to terminal X11 and attach the terminal.
2. If you use the STO safety function, connect it as follows:
   2.1. PMC SR6 option: Connect terminal X12 according to your safety configuration.
   2.2. PMC SY6 option: In order to be able to identify the safety module in the FSoE network, you must transfer its unique address in the FSoE network to the drive controller using the DIP switches.
3. Optional: Connect the digital inputs to terminals X101 and X103 and attach the terminals.
4. Connect the fieldbus to the sockets X200 and X201.

You can find examples in the chapter Wiring examples [267].

10.6 Braking resistor with temperature monitoring

WARNING!

Risk of burns! Fire hazard! Material damage!

Chokes and braking resistors can heat up to over 100 °C under permitted operating conditions.

- Take protective measures against accidental and intentional contact with the choke or braking resistor.
- Make sure that no flammable material is in the vicinity of the choke or braking resistor.
- Note the specified minimum clearances for installation.

WARNING!

Fire hazard due to overheating!

Using chokes or braking resistors outside of the nominal data (cable length, current, frequency, etc.) can cause them to overheat.

- Always comply with the maximum nominal data when operating the chokes and braking resistors.

Information

The temperature switch reports a resistor overload. The evaluation in the form of a warning or line-side shutdown of the energy supply must take place separately, e.g. using the PMC PS6 supply module. Observe the wiring example for the supply module in the chapter UL-compliant connection of the supply module [270] to ensure UL-compliant operation.

Housing grounding of the braking resistor

Note the information on connecting the grounding conductor in the chapter Connection of the grounding conductor [113] for the braking resistor housing ground.

10.6.1 PMC KWADQU connection description

The flat resistor has a gray and white core for connecting the braking resistor to the supply module as well as two blue cores for connecting the temperature switch.

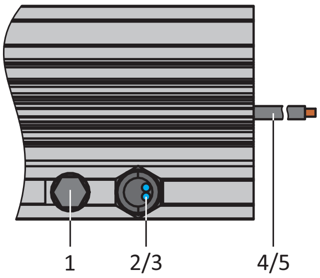


Fig. 41: PMC KWADQU connection overview

No.	Core color	Function
1	—	Grounding conductor
2	BU	1TP1 temperature monitoring supply module connection: X23, pin 1
3	BU	1TP2 temperature monitoring supply module connection: X23, pin 2
4	GY	RB braking resistor supply module connection: X21, pin 1
5	WH	RB braking resistor supply module connection: X21, pin 2

PMC KWADQU connection description

10.6.2 PMC FZZMQU connection description

The internal connections of the tubular fixed resistor are wired to terminals with heat-resistant, silicone-insulated strands of wire. Also ensure a heat-resistant and sufficiently surge-proof design for the connection!

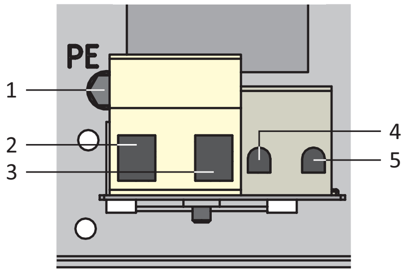


Fig. 42: PMC FZZMQU connection overview

No.	Function
1	Grounding conductor
2	RB braking resistor supply module connection: X21, pin 1
3	RB braking resistor supply module connection: X21, pin 2
4	1TP1 temperature monitoring supply module connection: X23, pin 1
5	1TP2 temperature monitoring supply module connection: X23, pin 2

PMC FZZMQU connection description

Connection type	Conductor cross-section [mm²]
Rigid	0.5 – 4.0
Flexible with end sleeve	0.5 – 2.5

PMC FZMU, PMC FZZMU, PMC FZZMQU conductor cross-section

10.6.3 PMC FGFKQU connection description

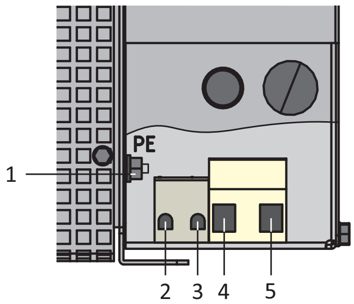


Fig. 43: PMC FGFKQU connection overview

No.	Function
1	Grounding conductor
2	1TP1 temperature monitoring supply module connection: X23, pin 1
3	1TP2 temperature monitoring supply module connection: X23, pin 2
4	RB braking resistor supply module connection: X21, pin 1
5	RB braking resistor supply module connection: X21, pin 2

PMC FGFKQU connection description

10.7 Power choke

WARNING!

Risk of burns! Fire hazard! Material damage!

Chokes and braking resistors can heat up to over 100 °C under permitted operating conditions.

- Take protective measures against accidental and intentional contact with the choke or braking resistor.
- Make sure that no flammable material is in the vicinity of the choke or braking resistor.
- Note the specified minimum clearances for installation.

WARNING!

Fire hazard due to overheating!

Using chokes or braking resistors outside of the nominal data (cable length, current, frequency, etc.) can cause them to overheat.

- Always comply with the maximum nominal data when operating the chokes and braking resistors.

10.7.1 Connection description

Designation	Function
1U1	Phase L1 supply module connection: X10, pin 1
1U2	Phase L1 network connection
1V1	Phase L2 supply module connection: X10, pin 2
1V2	Phase L2 network connection
1W1	Phase L3 supply module connection: X10, pin 3
1W2	Phase L3 network connection
PE	Grounding conductor

TEP power choke connection description

Choke housing ground

Note the information on connecting the grounding conductor in the chapter Connection of the grounding conductor [113] for the choke housing ground.

10.8 Output choke

WARNING!

Risk of burns! Fire hazard! Material damage!

Chokes and braking resistors can heat up to over 100 °C under permitted operating conditions.

- Take protective measures against accidental and intentional contact with the choke or braking resistor.
- Make sure that no flammable material is in the vicinity of the choke or braking resistor.
- Note the specified minimum clearances for installation.

WARNING!

Fire hazard due to overheating!

Using chokes or braking resistors outside of the nominal data (cable length, current, frequency, etc.) can cause them to overheat.

- Always comply with the maximum nominal data when operating the chokes and braking resistors.

10.8.1 Connection description

Designation	Function
1U1	Phase U drive controller connection: X20, pin 1
1U2	Motor phase U connection
1V1	Phase V drive controller connection: X20, pin 2
1V2	Motor phase V connection
1W1	Phase W drive controller connection: X20, pin 3
1W2	Motor phase W connection
7	Drive controller grounding conductor: X20, Pin 4
8	Power cable grounding conductor

PMC TEP output choke connection description

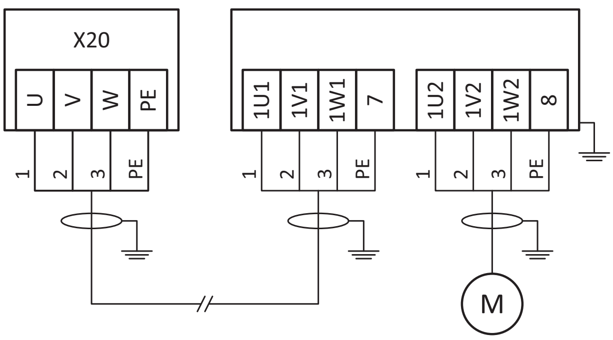


Fig. 44: PMC TEP output choke connection example

Shielded connection of the power cable

Note the following points for the connection of the power cable for a motor with output choke:

- Ground the shield of the power cable over large contact areas in the immediate vicinity of the output choke, for example with electrically conductive metal cable clips on a grounded connection rail.
- Keep the exposed conductors as short as possible. All devices and circuits that are sensitive to EMC must be kept at a distance of at least 0.3 m.

The following graphic shows an example of the shielded connection of the power cable.

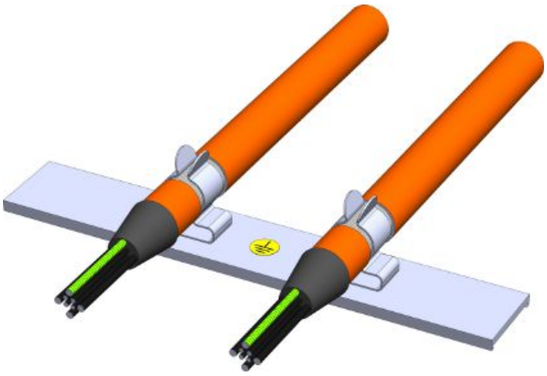


Fig. 45: Shielded connection of the power cable (graphics: icotek GmbH)

Choke housing grounding

Observe the requirements in the chapter Connection of the grounding conductor [113] to ensure correct connection of the grounding conductor.

10.9 Cables

Note that the motor, cables and drive controller each have electrical properties which influence one another. Unfavorable combinations could possibly result in impermissible voltage peaks on the motor and drive controller and increased wear as a result.

Take into consideration the following instructions when selecting suitable cables:

- Cable cross-sections for connection to the motor:
  Note the permitted stall current I_0 for the motor when making your selection.
- Conductor cross-sections for the power connection:
  Note the line fuse, the maximum permitted conductor cross-section for terminal X10, the routing method and the surrounding temperature when making your selection.
- Also pay attention to the trailing and torsional strength of the lines.
- When using a motor brake, pay attention to the voltage drop in the supply voltage on the line.

Information

To ensure proper functionality, we recommend using cables from Pilz that are matched to the complete system. If unsuitable connection cables are used, we reserve the right to reject claims under the warranty.

Information

Please observe the motor connection diagram that is delivered with every Pilz motor.

10.9.1 Power cables

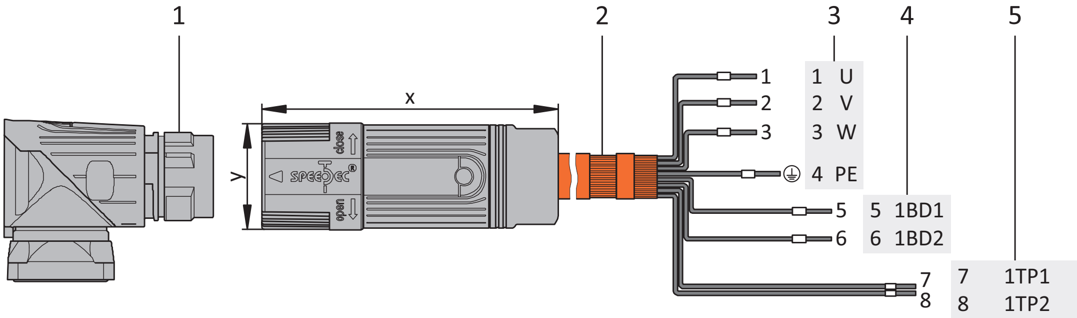
Synchronous servo motors and Lean motors from Pilz are equipped with plug connectors as standard, while asynchronous motors are equipped with terminal boxes.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

10.9.1.1 Connection description

Depending on the size of the motor plug connector, power cables are available in the following designs:

- Quick lock for con.15
- speedtec quick lock for con.23 and con.40

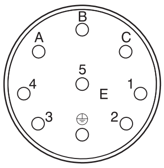


1: Plug connector
2: Pilz power cable, cable shield
3: Connection to terminal X20, motor
4: Connection of terminal X2, brake
5: Connection to terminal X2, temperature sensor

Motor type	Connection	Size 0 to 2	Size 3
Synchronous servo motor, asynchronous motor	Without output choke	50 m, shielded	100 m, shielded
Synchronous servo motor, asynchronous motor	With output choke	100 m, shielded	—
Lean motor	Without output choke	50 m, shielded	50 m, shielded

Maximum cable length of the power cable [m]

Power cables – con.15 plug connector

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	**Pin**	**Designation**	**Int. motor Core color**	**Core No./ Core color**	**Pin X20**	**Pin X2**	**Pin X2**
	A	1U1	BK	1	1	–	–
	B	1V1	BU	2	2	–	–
	C	1W1	RD	3	3	–	–
	1	1TP1[a]	BK	7	–	–	7
	2	1TP2[a]	WH	8	–	–	8
	3	1BD1	RD	5	–	5	–
	4	1BD2	BK	6	–	6	–
	5	–	–	–	–	–	–
	⏚	PE	GNYE	GNYE	4	–	–
	Housing	Shield	–	–	Shield contact	–	–

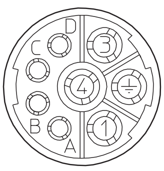
con.15 power cable pin assignment

a) PTC

Length x [mm]	Diameter y [mm]
42	18.7

con.15 connector dimensions

Power cables – con.23 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	**Pin**	**Designation**	**Int. motor Core color**	**Core No./ Core color**	**Pin X20**	**Pin X2**	**Pin X2**
	1	1U1	BK	1	1	–	–
	3	1V1	BU	2	2	–	–
	4	1W1	RD	3	3	–	–
	A	1BD1	RD	5	–	5	–
	B	1BD2	BK	6	–	6	–
	C	1TP1[a]	BK	7	–	–	7
	D	1TP2[a]	WH	8	–	–	8
	⏚	PE	GNYE	GNYE	4	–	–
	Housing	Shield	–	–	Shield contact	–	–

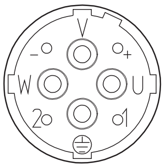
con.23 power cable pin assignment

a) PTC

Length x [mm]	Diameter y [mm]
78	26

con.23 connector dimensions

Power cables – con.40 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Motor connection diagram	**Pin**	**Designation**	**Int. motor Core color**	**Core No./ Core color**	**Pin X20**	**Pin X2**	**Pin X2**
	U	1U1	BK	1	1	—	—
	V	1V1	BU	2	2	—	—
	W	1W1	RD	3	3	—	—
	+	1BD1	RD	5	—	5	—
	–	1BD2	BK	6	—	6	—
	1	1TP1[a)]	BK	7	—	—	7
	2	1TP2[a)]	WH	8	—	—	8
	⏚	PE	GNYE	GNYE	4	—	—
	Housing	Shield	—	—	Shield contact	—	—

con.40 power cable pin assignment

a) PTC

Length x [mm]	Diameter y [mm]
99	46

con.40 connector dimensions

10.9.2 Encoder cables

Pilz motors are equipped with encoder systems and plug connectors as standard.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

Depending on the respective motor types, different encoder systems can be used.

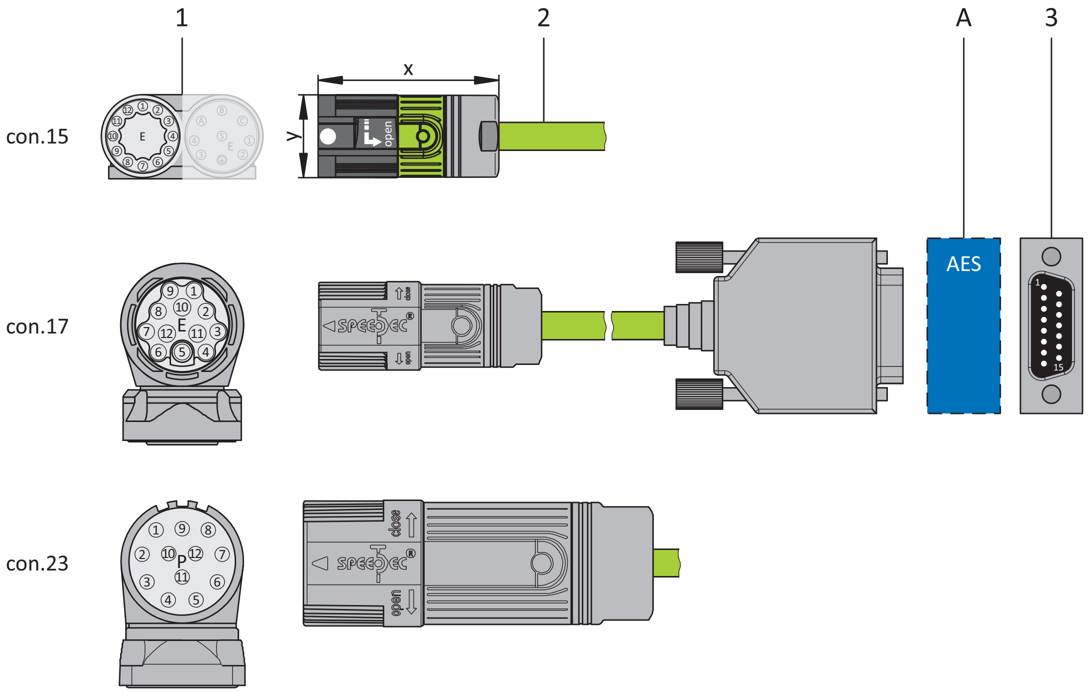
10.9.2.1 EnDat 2.1/2.2 digital encoders

Suitable encoder cables are described below.

10.9.2.1.1 Connection description

Depending on the size of the motor plug connector, encoder cables are available in the following designs:

- Quick lock for con.15
- speedtec quick lock for con.17 and con.23



1: Plug connector

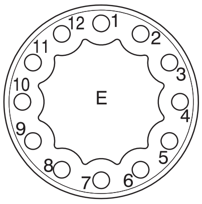
2: Pilz encoder cable

A: Only con.15 and con.17: Optional Absolute Encoder Support (PMC AES) battery module

3: D-sub X4

Encoder cables – con.15 plug connector

The power supply is buffered for EnDat 2.2 digital "EBI 1135" and "EBI 135" inductive encoders with a multi-turn function. In this case, pin 2 and pin 3 of the motor are assigned to the U_{2BAT} buffer battery. Note that the encoder cable must not be connected to the encoder interface of the drive controller, but rather to the PMC AES battery module for these encoders.

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
 	1	Clock+	VT	YE	8
	2	Sense U_2 U_{2BAT+}[17]	BU	PK	12
	3	– U_{2BAT-}[18]	WH	GY	3
	4	–	–	–	–
	5	Data−	PK	BN	13
	6	Data+	GY	WH	5
	7	–	–	–	–
	8	Clock−	YE	GN	15
	9	–	–	–	–
	10	GND	WHGN	BU	2
	11	–	–	–	–
	12	U_2	BNGN	RD	4
	Housing	Shield	–	–	–

con.15 encoder cable pin assignment, EnDat 2.1/2.2 digital

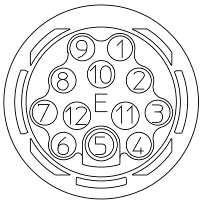
Length x [mm]	Diameter y [mm]
42	18.7

con.15 connector dimensions

[17] Only relevant for EBI encoders
[18] Only relevant for EBI encoders

Encoder cables – con.17 plug connectors

The power supply is buffered for EnDat 2.2 digital "EBI 1135" and "EBI 135" inductive encoders with a multi-turn function. In this case, pin 2 and pin 3 of the motor are assigned to the U_{2BAT} buffer battery. Note that the encoder cable must not be connected to the encoder interface of the drive controller, but rather to the PMC AES battery module for these encoders.

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	Pin	Designation	Core color	Core color	Pin X4
	1	Clock+	VT	YE	8
	2	Sense U_2	BU	PK	12
		U_{2BAT+}[19]			
	3	–	WH	GY	3
		U_{2BAT-}[20]			
	4	–	–	–	–
	5	Data−	PK	BN	13
	6	Data+	GY	WH	5
	7	–	–	–	–
	8	Clock−	YE	GN	15
	9	–	–	–	–
	10	GND	WHGN	BU	2
	11	–	–	–	–
	12	U_2	BNGN	RD	4
	Housing	Shield	–	–	–

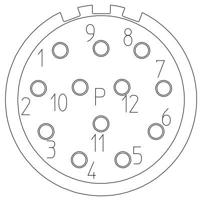
con.17 encoder cable pin assignment, EnDat 2.1/2.2 digital

Length x [mm]	Diameter y [mm]
56	22

con.17 connector dimensions

[19] Only relevant for EBI encoders
[20] Only relevant for EBI encoders

Encoder cables – con.23 plug connector

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
	1	Clock+	VT	YE	8
	2	Sense U_2	BU	PK	12
	3	–	–	–	–
	4	–	–	–	–
	5	Data−	PK	BN	13
	6	Data+	GY	WH	5
	7	–	–	–	–
	8	Clock−	YE	GN	15
	9	–	–	–	–
	10	GND	WHGN	BU	2
	11	–	–	–	–
	12	U_2	BNGN	RD	4
	Housing	Shield	–	–	–

con.23 encoder cable pin assignment, EnDat 2.1/2.2 digital

Length x [mm]	Diameter y [mm]
58	26

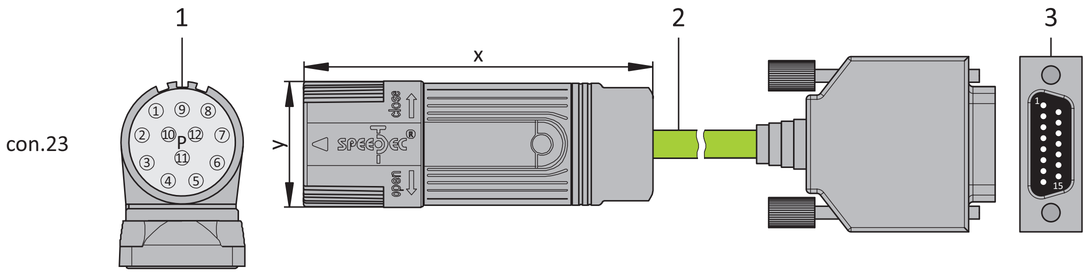
con.23 dimensions

10.9.2.2 SSI encoders

Suitable encoder cables are described below.

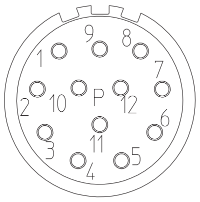
10.9.2.2.1 Connection description

The encoder cable is available in plug connector size con.23 with a speedtec quick lock.



1: Plug connectors
2: Pilz encoder cable
3: D-sub X4

Encoder cables – con.23 plug connectors

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
	1	Clock+	VT	YE	8
	2	Sense U_2	BNGN	PK	12
	3	–	–	–	–
	4	–	–	–	–
	5	Data−	PK	BN	13
	6	Data+	GY	WH	5
	7	–	–	–	–
	8	Clock−	YE	GN	15
	9	–	–	–	–
	10	GND	WHGN	BU	2
	11	–	–	–	–
	12	U_2	BNGN	RD	4
	Housing	Shield	–	–	–

con.23 encoder cable pin assignment, SSI

Length x [mm]	Diameter y [mm]
58	26

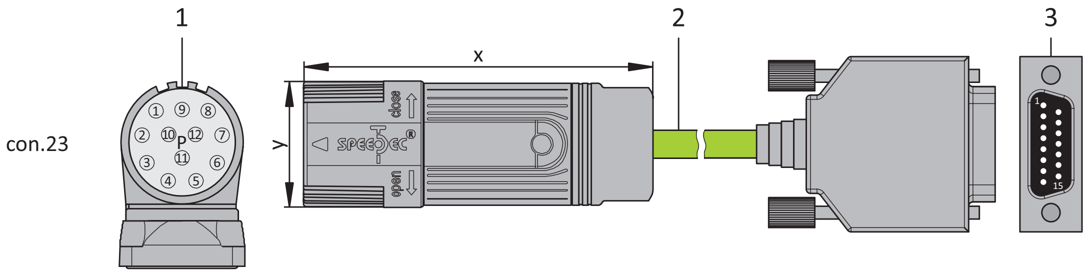
con.23 dimensions

10.9.2.3 Differential HTL incremental encoders

Suitable encoder cables are described below.

10.9.2.3.1 Connection description

The encoder cable is available in plug connector size con.23 with a speedtec quick lock.



1: Plug connectors

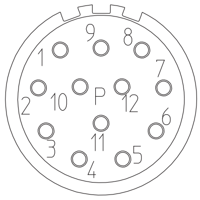
2: Pilz encoder cable

3: D-sub X4

Information

For the connection of an HTL incremental encoder to terminal X4 of the PMC SC6 or PMC SI6 drive controller, you need the PMC HT6 adapter (ID No. on request). PMC HT6 takes over level conversion from HTL signals to TTL signals.

Encoder cables – con.23 plug connectors

Motor (1)					Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color up to size 80**	**Core color size 90 or larger**	**Core color**	**Pin X4**
	1	B−	PK	BK	YE	9
	2	–	–	YE	–	–
	3	N+	BU	PK	PK	3
	4	N−	RD	WH	GY	10
	5	A+	GN	GN	BN	6
	6	A−	YE	BN	WH	11
	7	–	–	–	–	–
	8	B+	GY	GY	GN	1
	9	–	–	–	–	–
	10	GND	WH	BU	BU	2[21]
	11	–	–	VT	–	–
	12	U_2	BN	RD	RD	4
	Housing	Shield	–	–	–	–

con.23 encoder cable pin assignment, incremental HTL

Length x [mm]	Diameter y [mm]
58	26

con.23 dimensions

[21] Pin 12 (Sense) with pin 2 (GND) bridged: The bridge is constructed in the cable connector that is connected to X4.

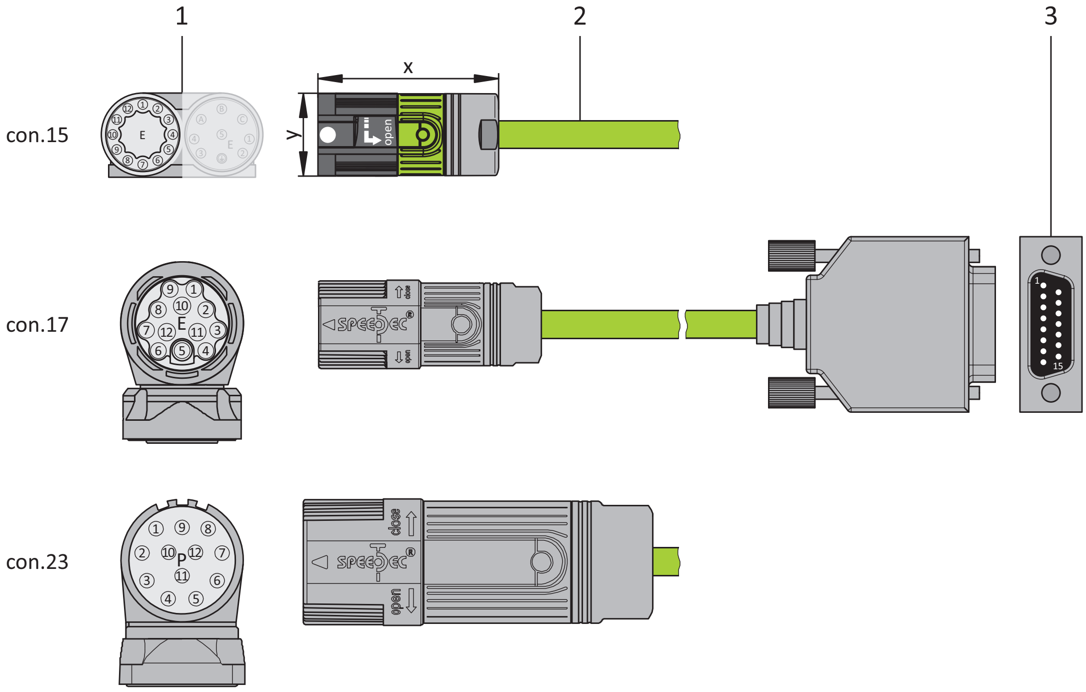
10.9.2.4 Resolver

Suitable encoder cables are described below.

10.9.2.4.1 Connection description

Depending on the size of the motor plug connector, encoder cables are available in the following designs:

- Quick lock for con.15
- speedtec quick lock for con.17 and con.23

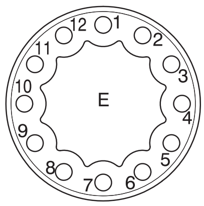


1: Plug connector
2: Pilz encoder cable
3: D-sub X4

> **Information**
>
> Note that the cores for the temperature sensor in Pilz are routed in the power cable as standard. For motors that provide the temperature sensor at the encoder connection, you need an interface adapter to lead out the temperature sensor cores for connecting the cable to the drive controller.

> **Information**
>
> For connecting Pilz resolver cables with a 9-pin D-sub connector, use the PMC AP6A00 interface adapter (ID No. on request, 9-pin to 15-pin D-sub), available separately.

Encoder cables – con.15 plug connector

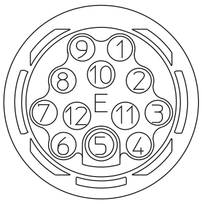
Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
	1	S3 Cos+	BK	YE	3
	2	S1 Cos−	RD	GN	11
	3	S4 Sin +	BU	WH	1
	4	S2 Sin−	YE	BN	9
	5	1TP1	BK	RD	7
	6	1TP2	WH	BU	14
	7	R2 Ref+	YEWH/ BKWH	GY	6
	8	R1 Ref−	RDWH	PK	2
	9	—	—	—	—
	10	—	—	—	—
	11	—	—	—	—
	12	—	—	—	—
	Housing	Shield	—	—	—

con.15 encoder cable pin assignment, resolver

Length x [mm]	Diameter y [mm]
42	18.7

con.15 connector dimensions

Encoder cables – con.17 plug connector

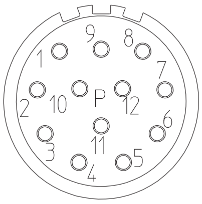
Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
	1	S3 Cos+	BK	YE	3
	2	S1 Cos−	RD	GN	11
	3	S4 Sin +	BU	WH	1
	4	S2 Sin−	YE	BN	9
	5	1TP1	BK	RD	7
	6	1TP2	WH	BU	14
	7	R2 Ref+	YEWH/ BKWH	GY	6
	8	R1 Ref−	RDWH	PK	2
	9	—	—	—	—
	10	—	—	—	—
	11	—	—	—	—
	12	—	—	—	—
	Housing	Shield	—	—	—

con.17 encoder cable pin assignment, resolver

Length x [mm]	Diameter y [mm]
56	22

con.17 connector dimensions

Encoder cables – con.23 plug connector

Motor (1)				Cable (2)	Drive controller (3)
Connection diagram	**Pin**	**Designation**	**Core color**	**Core color**	**Pin X4**
	1	S3 Cos+	BK	YE	3
	2	S1 Cos−	RD	GN	11
	3	S4 Sin +	BU	WH	1
	4	S2 Sin−	YE	BN	9
	5	1TP1	BK	RD	–
	6	1TP2	WH	BU	–
	7	R2 Ref+	YEWH/ BKWH	GY	6
	8	R1 Ref−	RDWH	PK	2
	9	–	–	–	–
	10	–	–	–	–
	11	–	–	–	–
	12	–	–	–	–
	Housing	Shield	–	–	–

con.23 encoder cable pin assignment, resolver

Length x [mm]	Diameter y [mm]
58	26

con.23 dimensions

10.9.3 One Cable Solution

Pilz synchronous servo motors are equipped with plug connectors as standard.

Pilz provides suitable cables in various lengths, conductor cross-sections and connector sizes.

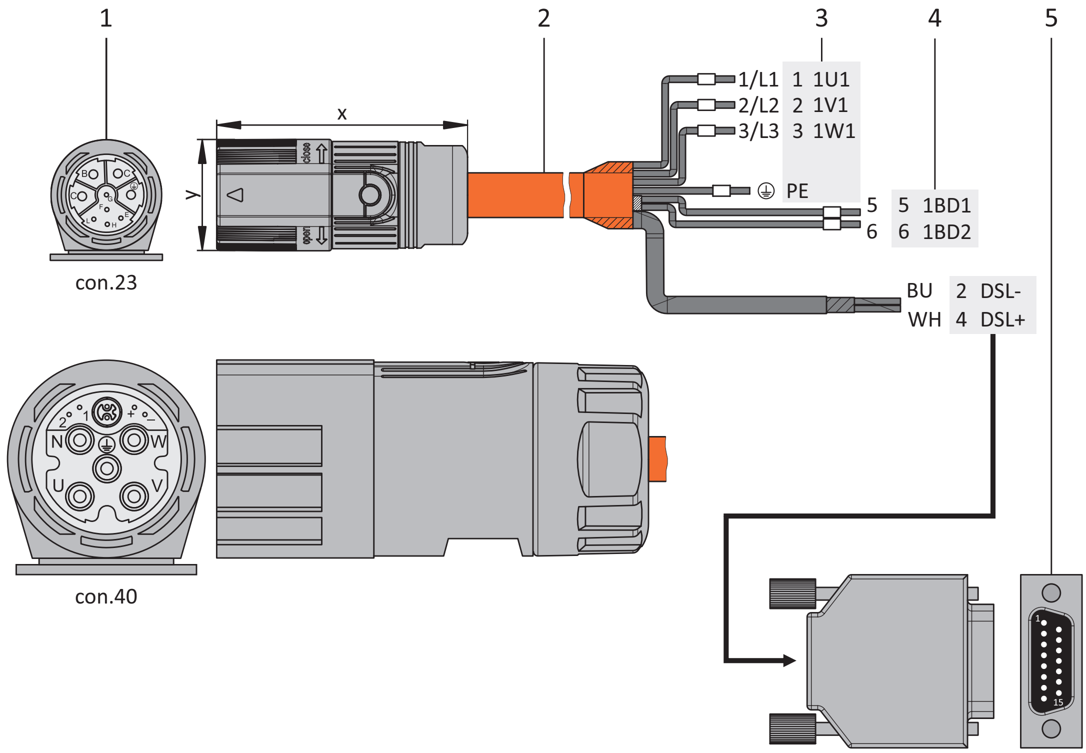
A motor connection as a One Cable Solution (OCS) combined with a HIPERFACE DSL encoder requires hybrid cables which feature encoder communication and power transmission in a shared cable.

Information

For connecting as a One Cable Solution, use exclusively hybrid cables from Pilz. The use of unsuitable cables or poorly made connections can cause subsequent damage. For this reason, we reserve the right to reject claims under the warranty in this case.

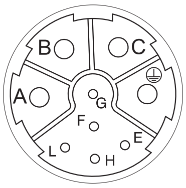
10.9.3.1 Connection description

The hybrid cables are available in plug connector sizes con.23 and con.40 with a speedtec quick lock.



1: Plug connectors
2: Pilz hybrid cable
3: Connection to terminal X20, motor
4: Connection of terminal X2, brake
5: D-sub X4

Hybrid cables – con.23 plug connectors

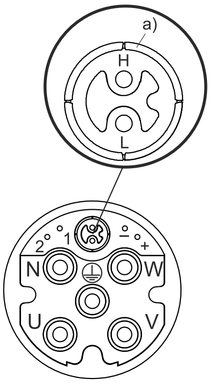
Motor (1)				**Cable (2)**	**Drive controller (3) – (5)**		
Connection diagram	**Pin**	**Designa-tion**	**Core color**	**Core No./ Core color**	**Pin X20**	**Pin X2**	**Pin X4**
	A	1U1	BK	1/L1	1	—	—
	B	1V1	BU	2/L2	2	—	—
	C	1W1	RD	3/L3	3	—	—
	E	DSL−	GN	BU	—	—	2
	F	DSL shield	—	—	—	—	Connector
	G	1BD1	RD	5	—	5	—
	H	DSL+	GY	WH	—	—	4
	L	1BD2	BK	6	—	6	—
	⏚	PE	GNYE	GNYE	4	—	
	Hous-ing	Shield	—	—	Shield contact	—	—

con.23 hybrid cable pin assignment

Length x [mm]	**Diameter y [mm]**
78	26

con.23 connector dimensions

Hybrid cables – con.40 plug connectors

Motor (1)				Cable (2)	Drive controller (3) – (5)		
Connection diagram	**Pin**	**Designation**	**Core color**	**Core No./ core color**	**Pin X20**	**Pin X2**	**Pin X4**
	U	1U1	BK	1/L1	1	—	—
	V	1V1	BU	2/L2	2	—	—
	W	1W1	RD	3/L3	3	—	—
	N	—	—	—	—	—	—
	+	1BD1	RD	5	—	5	—
	−	1BD2	BK	6	—	6	—
	1	—	—	—	—	—	—
	2	—	—	—	—	—	—
	H	DSL+	GY	WH	—	—	4
	L	DSL−	GN	BU	—	—	2
	⏚	PE	GNYE	GNYE	4	—	—
	Housing	Shield	—	—	Shield contact	—	—

con.40 hybrid cable pin assignment

a) Coaxial shield to which the DSL shield is connected.

Length x [mm]	Diameter y [mm]
99	46

con.40 connector dimensions

11 Commissioning

The following chapters describe how to commission your drive system using the DriveControlSuite software.

You can find information about the software's system requirements, installation process and program interface in the chapter DriveControlSuite [278].

For the components of your axis model, we require one of the following two combinations:

Pilz synchronous servo motor with EnDat 2.2 digital encoder or HIPERFACE DSL encoder (and optional brake)

These motors together with all relevant data for the project configuration are saved in the motor database of DriveControlSuite as well as in the electronic nameplate.
Upon selecting the motor from the database, such as when reading out the nameplate, all data is transferred to the corresponding parameters. There is no need for complex parameterization of the motor, encoder and brake.

Pilz LM Lean motor without encoder (with optional brake)

These motors are stored in the motor database of the DriveControlSuite, along with all the data relevant for project configuration. Furthermore, the motor data and the purging and engaging times of the brake are part of the firmware.
By selecting the desired motor from the database, all data is transmitted to the corresponding parameters. The purging and engaging times of the brake are also stored. If a brake is present, you must only activate this manually. However, complex parameterization of the motor and brake is not necessary.

All other motor types need to have their parameters configured manually.

Note that the system nodes must be wired and supplied with control voltage before commissioning.

Information

Always perform the steps included in the following chapters in the specified order!

Some parameters of the DriveControlSuite are interdependent and do not become accessible to you until you have first configured certain settings. Follow the steps in the specified sequence so that you can finish the parameterization completely.

11.1 Initiating the project

In order to be able to configure all drive controllers and axes of your drive system using DriveControlSuite, you must record them as part of a project.

11.1.1 Projecting the drive controller and axis

Create a new project and project the first drive controller along with the accompanying axis.

Creating a new project

1. Start DriveControlSuite.
2. Click Create new project.

⇨ The project configuration window opens and the Drive controller button is active.

Projecting the drive controller

1. Properties tab:
   Establish the relationship between your circuit diagram and the drive controller to be projected in DriveControlSuite.
   Reference: Specify the reference code (equipment code) of the drive controller.
   Designation: Give the drive controller a unique name.
   Version: Version your project configuration.
   Description: If necessary, specify additional supporting information, such as the change history of the project configuration.
2. Drive controller tab:
   Select the series and device type of the drive controller.
3. Option modules tab:
   Safety module: If the drive controller is part of a safety circuit, select the PMC SR6 or PMC SY6 safety module.
4. Device controller tab:
   Device controller: Select the device controller that defines the underlying activation signals for the drive controller.
   Rx process data, Tx process data: If you control the drive controller using a fieldbus, select the fieldbus-specific receive and send process data.
   If you operate the drive controller in combination with the PMC SY6 safety module, select EtherCAT Rx and EtherCAT Tx for transmitting the EtherCAT process data.
   If you operate the drive controller in combination with the PMC SR6 safety module or without safety technology (PMC SZ6), the fieldbus connection is optional. If you do not use a fieldbus, project No transmission.

Projecting the axis

1. Click on Axis 1.
2. Properties tab:
   Establish the connection between your circuit diagram and the axis to be projected in DriveControlSuite.
   Reference: Specify the reference code (equipment code) of the axis.
   Designation: Give the axis a unique name.
   Version: Version your project configuration.
   Description: If necessary, specify supporting additional information such as the change history of the project configuration.
3. Application tab:
   Select the desired control or drive-based application.
4. Motor tab:
   Select the motor category, the series and the type of motor operated using this axis. If you are working with motors from third-party suppliers, enter the accompanying motor data at a later time.
5. Repeat steps 2 – 4 for the 2nd axis (only for double-axis controllers).
6. Confirm with OK.

11.1.2 Configuring safety technology

In the next step, you have to configure the safety technology in accordance with the commissioning steps outlined in the corresponding manual; see the chapter Detailed information [300].

11.1.3 Creating other modules and drive controllers

We recommend sorting all drive controllers of your project in DriveControlSuite either functionally by groups and combining a group under a module, or organizing several drive controllers in corresponding modules based on their distribution to different control cabinets.

1. Highlight your P1 project in the project tree > Context menu Create new module.
   ⇨ Your M2 module is created in the project tree.
2. Highlight your M2 module in the project tree > Context menu Create new drive controller.
   ⇨ Your T2 drive controller is created in the project tree.
3. Mark your T2 drive controller in the project tree.
4. Change to the project menu and click Project configuration.
5. Project the drive controller and specify the newly created module.
6. Repeat the steps for all other drive controllers and modules of your project.

11.1.4 Specifying a module

After you have created and projected all the drive controllers that you would like to gather under one module, specify the module.

1. Highlight your M1 module in the project tree.
2. Change to the project menu and click Project configuration.
   ⇨ The Module window opens.
3. Establish the relationship between your circuit diagram and the newly created module in DriveControlSuite.
   Reference: Specify the reference code (equipment code) of the module.
   Designation: Give the module a unique name.
   Version: Version the module.
   Description: If necessary, specify additional supporting information, such as the change history of the module.
4. Confirm with OK.

11.1.5 Specifying the project

Finally, specify your project.

1. Highlight your P1 project in the project tree.
2. Change to the project menu and click Project configuration.
   ⇨ The Project window opens.
3. Establish the relationship between your circuit diagram and the newly created project in DriveControlSuite.
   Reference: Specify the reference code (equipment code) of the project.
   Designation: Give the project a unique name.
   Version: Version the project.
   Description: If necessary, specify additional supporting information, such as the change history of the project.
4. Confirm with OK.

11.2 Mapping the mechanical axis model

To be able to put your real drive train with one or more drive controllers into operation, you must map your complete mechanical environment in DriveControlSuite.

11.2.1 Parameterizing the Pilz motor

You have projected one of the following motors:

Pilz synchronous servo motor with EnDat 2.2 digital encoder or HIPERFACE DSL encoder (with optional brake)

By projecting the corresponding motor, limit values for currents and torques as well as associated temperature data are automatically transferred to the respective parameters of the individual wizards. All additional data on the brake and encoder is transferred at the same time.

Pilz Lean motor without encoder (with optional brake)

By projecting the corresponding motor, limit values for currents and torques as well as associated temperature data are automatically transferred to the respective parameters of the individual wizards. You only have to parameterize the cable length in use. Even the brake purging and engaging times are already stored. You just have to activate the brake.

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select the Motor wizard.
3. B101Cable length:
   Select the cable length of the power cable in use.
4. Repeat the steps for the 2nd axis (only for double-axis controllers).

Then activate the brake.

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select the Brake wizard.
3. F00 Brake:
   Select 1: Active.
4. Repeat the steps for the 2nd axis (only for double-axis controllers).

Motor protection

All models of the 6th Pilz drive controller generation feature a certified i²t model, a computational model for thermal monitoring of the motor. In order to activate it and start the protective function, set the parameters as follows (deviating from the default values): U10 = 2: Warning and U11 = 1.00 s. This model can be used instead of or in addition to temperature-monitored motor protection.

11.2.2 Parameterizing the axis model

Parameterize the setup of your drive in this order:

- Define the axis model
- Scale the axis
- Parameterize the position and velocity window
- Limit the axis (optional)
  - Limit the position
  - Limit the velocity, acceleration and jerk
  - Limit the torque and force

Information

Note that when double-axis controllers are used with two projected axes, the axis model has to be parameterized individually for each axis.

11.2.2.1 Define the axis model

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select the Axis model wizard.
3. I05 Type of axis:
   Define whether the axis type is rotational or translational.
   If you would like to configure the units of measure and the number of decimal places individually for specifying and displaying position set values, velocities and accelerations, select 0: User defined, rotational or 1: User defined, translational.
   If the units of measure and the number of decimal places for specifying and displaying position set values, velocities and accelerations are to be fixed, select 2: Rotational or 3: Translational.
4. B26 Motor encoder:
   Define the interface to which the motor encoder is connected.
5. I02 Position encoder (optional):
   Define the interface to which the position encoder is connected.
6. I00 Position range:
   Define whether the travel range of the axis is limited or endless.

11.2.2.2 Scale the axis

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select the Axis model wizard > Axis: Scaling.
3. Scale the axis by configuring the overall gear ratio between the motor and output.
   To simplify this scaling for you, you are provided with the scaling calculator **Conversion of position, velocities, accelerations, torque/force**, which calculates the effects of changed movement variables on the entire system.
4. I06 Decimal places position (optional):
   If you have selected 0: User defined, rotational or 1: User defined, translational when defining your axis type, specify the desired number of decimal places in this parameter.
5. I09 Measure unit (optional):
   If you have selected 0: User defined, rotational or 1: User defined, translational when defining your axis type, specify the desired unit of measure in this parameter.

Information

Note that a change to parameter I06 moves the decimal sign for all axis-specific values!
Ideally, change I06 before parameterizing other axis-specific values and then check them afterwards.

Information

Note that I297 Maximum speed position encoder must be parameterized according to your application case. If I297 is set too low, the permitted maximum speed is exceeded even at normal operating speeds. On the other hand, if I297 is set too high, measuring errors of the encoder can be overlooked.

I297 depends on the following parameters: I05 Type of axis, I06 Decimal places position, I09 Measure unit as well as I07 Distance factor numerator position and I08 Distance factor denominator position for Drive Based or A585 Feed constant for CiA 402. If you have made changes to one of the parameters listed, select I297 accordingly as well.

11.2.2.3 Parameterize the position and velocity window

Enter position limits and velocity zones for set values. To do so, parameterize boundary values for reaching a position or velocity.

1. Select the Axis model wizard > Window position, velocity.
2. C40 Velocity window:
   Parameterize a tolerance range for velocity tests.
3. I22 Target window:
   Parameterize a tolerance range for position tests.
4. I87 Actual position in window time:
   Parameterize how long a drive must stay in the specified position range before a corresponding status message is output.
5. Parameterize a tolerance range for lag tests.

11.2.2.4 Limiting the axis

If necessary, limit the movement variables for position, velocity, acceleration, jerk as well as torque/force according to the applicable conditions for your axis model.

Limiting the position (optional)

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select the Axis model wizard > Limit: Position.
3. If necessary, limit the position of your axis using a software or hardware limit switch to secure the travel range.

Limiting velocity, acceleration, jerk (optional)

The specified default values are designed for slow velocities without gear units. For this reason, adapt the saved values.

Note that the velocity of the motor is parameterized in units other than that of the axis model. Verify the velocity of the motor against the velocity of the output accordingly.

1. Select the Motor wizard.
2. To determine the maximum velocity at the output, copy the value of the B13 Nominal motor speed parameter to the clipboard.
3. Select the Axis model wizard > Axis: Scaling > Conversion of positions, velocities, accelerations, torque/force area.
4. Velocity line:
   Paste the copied value of the B13 parameter from the clipboard without the unit and confirm with ENTER.
   ⇨ The maximum velocity of the motor has been transferred to the output.
5. Select the Axis model wizard > Limit: Velocity, acceleration, jerk.
6. I10 Maximal speed:
   Limit the maximum velocity of the output taking into account the configured Nominal motor speed in B13.
7. Determine the limiting values for acceleration and jerk if necessary and enter them into the associated parameters.

Limiting torque/force (optional)

The specified default values take into account the rated operation together with the overload reserves.

1. Select the Axis model wizard > Limit: Torque/force.
2. If the motor force must be limited, adapt the saved values as necessary.

11.3 Testing the project configuration

Before you continue parameterizing your application, we recommend testing your projected axis model using the jog control panel.

Check your projected axis model as well as your configured electrical and mechanical data for plausibility by transferring your project configuration to one of your drive controllers for test purposes and controlling the drive using the jog control panel instead of using a controller.

1. Highlight the relevant drive controller in the project tree and click on the first projected axis in the project menu > Wizard area.
2. Select Jog control panel.
3. The predefined test movement variables are default values. Check them and, if necessary, change the values such that you can intervene in an emergency before personal injury or material damage can occur.

Information

Always check the reliability of the default values before starting the test. If they appear too large or unsuitable compared with the results of the scaling calculator, always replace them with values that are more suitable for test operation.

Transmitting the configuration

✓ You have verified the plausibility of the predefined test movement variables. To transfer a configuration to a drive controller, you must connect your PC and the drive controller to the network.

✓ The relevant drive controller is switched on.

1. In the project tree, highlight the module under which you have recorded the drive controller and click Assignment and live firmware update in the project menu.
   ⇨ The Add connection window opens. All drive controllers found via IPv4 limited broadcast are displayed.
2. Direct connection tab > IP address column:
   Activate the IP address in question or activate all listed using the context menu. Confirm your selection with OK.
   ⇨ The Assignment and live firmware update window opens. All drive controllers connected through the previously selected IP addresses are displayed.
3. Select the drive controller to which you would like to transfer the configuration. Change the selection of transmission type from Read to Send.
4. Change the selection Create new drive controller: Select the configuration that you would like to transfer to the drive controller.
5. Repeat steps 3 and 4 for all other drive controllers to which you would like to transfer your configuration.
6. Online tab:
   Click on Establish online connection.

⇨ The configurations are transferred to the drive controllers.

Information

During the search, all drive controllers within the broadcast domain are found via IPv4 limited broadcast.

Prerequisites for finding a drive controller in the network:

- Network supports IPv4 limited broadcast
- All drive controllers are in the same subnet (broadcast domain)

Saving the configuration

✓ You have successfully transferred the configuration.

1. Assignment and live firmware update window:
   Click on Save values (A00).
   ⇨ The Save values (A00) window opens.
2. Click on Start action.
   ⇨ The configuration is saved.
3. Close the Save values (A00) window.
4. Assignment and live firmware update window:
   Click on Restart (A09).
   ⇨ The Restart (A09) window opens.
5. Click on Start action.
6. Confirm the safety instruction with OK.
   ⇨ The Restart (A09) window closes.
   ⇨ The fieldbus communication and connection to DriveControlSuite are interrupted.
   ⇨ The drive controllers restart.

Activating the control panel and testing the project configuration

✓ The STO safety function must not be activated.

1. Select Jog control panel.
2. Click Control panel on and then Enable.
   ⇨ The drive is controlled using the activated control panel.
3. Move the axis step-by-step and test the direction of motion, velocity, distances, etc. using the Jog+, Jog−, Jog step+ and Jog step− buttons.
4. Optimize your project configuration based on your test results as necessary.
5. To deactivate the control panel, click on Control panel off.

Information

Jog+ and Jog− cause a continual manual movement in the positive or negative direction. If both buttons are active, no movement is executed.

Jog step+ and Jog step– move the drive relative to the current actual value by the increment specified in I14.

Jog+ and Jog− have a higher priority than Jog step+ and Jog step−.

12 Communication

The following options are available for communicating with the PMC SI6 drive controller:

- Communication between drive controller and controller
  - Fieldbus
  - Terminals
- Communication between drive controller and PC for commissioning, optimization and diagnostics
  - Direct connection
  - Fieldbus

The DriveControlSuite project configuration and commissioning software installed on the PC is able to handle multiple direct connections simultaneously.

12.1 Direct connection

A direct connection is a network connection in which all nodes are in the same network.

In its simplest form, a direct connection is a point-to-point cable connection between the network interface of the PC where DriveControlSuite is installed and the network interface of the drive controller. Switches or routers can also be used in place of a simple network cable.

The IP address required for direct connection is either assigned automatically by DriveControlSuite or using DHCP, or it is specified manually.

Requirements for a direct connection

- The socket of the gateway device and the network connection of the PC must have IP addresses from the same subnet
- The A166 parameter of DriveControlSuite must be set to 2: DHCP + DS6 for the direct connection to be established automatically

Also observe the notes in the chapter Communication requirements [281].

Virtual machines

If you would like to connect Pilz drive controllers to DriveControlSuite from a virtual machine, observe the information in the chapter Configuring virtual machines [282].

12.2 Fieldbus

Detailed information about the fieldbus connection can be found in the corresponding manual, see the chapter Detailed information [300].

13 Optimizing the control cascade

The following chapters describe the structure of the control cascade first as a basis, as well as the general procedure for optimizing it. Then, you learn how you can check your control cascade based on a few parameters for nearly 80% of all applications and, if necessary, optimize the pre-set values for your specific application case. Special cases are addressed at the end of the chapter.

13.1 Structure of the control cascade

The control cascade triggers the appropriate electrical actuation of the motor for a requested movement. The structure of the control cascade depends on the control mode set in B20.

13.1.1 Overview

The following graphic shows the control cascade, using a motor with encoder in vector-controlled operation as an example.

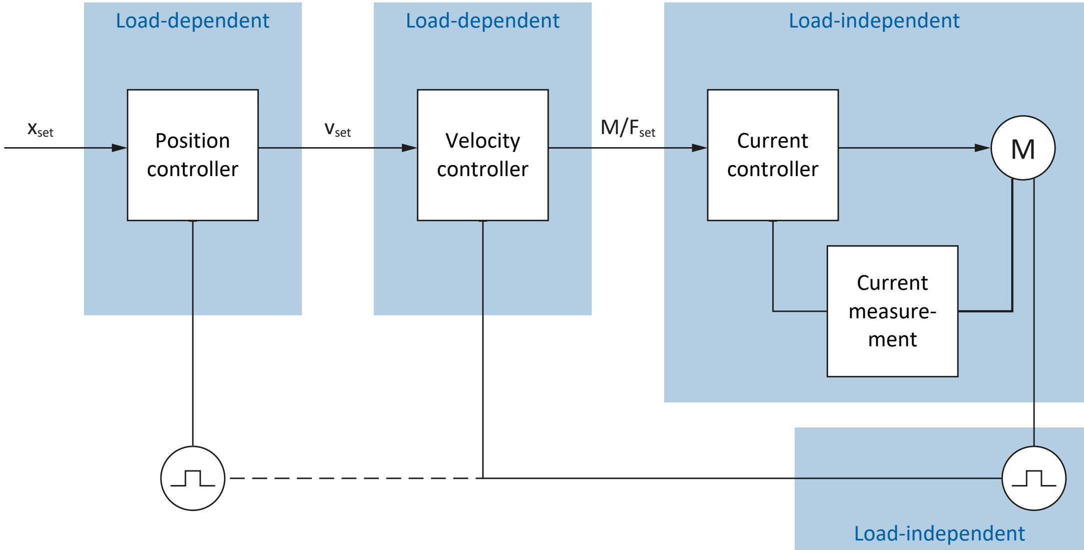


Fig. 46: Structure of the control cascade

The representation of the control cascade follows the signal course: Position controller > Velocity controller > Current controller.

13.1.2 Position controller

The position controller is a P controller (proportional controller) with feedforward control. The settings for the position controller are load-dependent.

The following applications use position control:

- Drive Based applications for the following commands:
  - MC_MoveAbsolute
  - MC_MoveRelative
  - MC_MoveAdditive
  - MC_MoveVelocity
- CiA 402 application in the following operating modes:
  - Cyclic synchronous position mode
  - Profile position mode
- Application-independent with position control in jog mode

13.1.3 Velocity controller

The velocity controller is a PI controller (proportional-integral controller). The settings for the velocity controller are load-dependent.

Velocity control is always required for vector control.

13.1.4 Current controller

The current controller is a PID controller (proportional-integral-differential controller). The settings for the current controller are load-independent.

The current controller is always required for vector control.

13.2 General procedure

Before making changes to your control cascade, observe the following information on the general procedure for optimization.

Defining the optimization goal

First, define the goal that you want to reach through optimization:

- High dynamics
- High energy efficiency
- Positioning accuracy
- Smooth operation
- Minimal control deviation
- High velocity

Some goals can only be combined under certain conditions or are mutually exclusive.

Hardware components as possible limits of optimization

An optimal drive train always consists of a coordinated system of all hardware components (gear unit, motor, encoder, drive controller and cable). Consequently, optimization depends not only on your parameter settings, but also on the hardware components used.

Default drive controller settings

If you use components from Pilz, all data is transmitted to the corresponding parameters when reading out the electronic nameplate or upon selection of the motor from the motor database, eliminating the need for complex parameterization of the motor, encoder and brake. These default values are carefully selected and checked and generally deliver good results. Only change the default values when necessary, taking the following points into consideration:

1. First, record the current behavior of your drive train with a scope image.
2. Carry out the optimization of your control cascade in the opposite order of the signal course: Current controller > velocity controller > position controller, i.e. from the motor back to the set value specification. However, do not make adjustments to the current controller if you are using components from Pilz.
3. If adjustments are necessary, only ever change one setting and then check every change with a scope image.

13.3 Example project

The optimization described in the following chapters is based on the following general conditions and settings.

Specified goal

High dynamics with the highest possible velocity, but without the system overshooting.

System components

- 6th generation Pilz drive controller
- Pilz synchronous servo motor with absolute encoder and electronic nameplate
- DriveControlSuite commissioning software
- Load supplied to the motor

Application and device control

- Drive Based application
- Drive Based device control

13.3.1 Scope settings

For the scope image at the beginning and after each adjustment, we recommend the settings described below to be able to compare the different results with each other.

General settings

- Sensing time: 250 µs
- Pre-trigger: 5%

Channels

Using the Parameter selection and the associated picklists, define the relevant parameters for the scope image.

Trigger condition

- Simple trigger
- Source: Parameter E15 v-motor-encoder
- Amount: Yes
- Condition: Greater
- Edge: Yes
- Adjustment value: 5.0 rpm

13.3.2 Jog settings

During optimization, test each change using the Jog control panel with the following settings:

- I26 Jog control mode:
  - Optimization of the velocity controller: Select 0: Velocity control to receive pure velocity control without a higher-level position controller with the Jog+ and Jog− bit.
  - Optimization of the position controller: Select 1: Position control with the Jog step+ und Jog step− bit.
- I14 Jog step:
  Define the increment.
- I12 Jog velocity:
  Define the jog velocity.
- I13 Jog acceleration:
  For the jog acceleration, select a value that is higher than the velocity by a factor of 10.
- I45 Jog deceleration:
  For the jog deceleration, select a value that is higher than the velocity by a factor of 10.
- I18 Jog jerk:
  For the jog jerk, select a value that is higher than the acceleration by a factor of 10.

13.4 Schematic sequence

The following graphic shows the schematic sequence for optimizing the control cascade. The specific steps that are required depend on the control mode. The chapters on optimization assume the following control modes:

- B20 = 64: SSM - vector control for synchronous servo motors
- B20 = 2: ASM - vector control for asynchronous motors
- B20 = 32: LM - sensorless vector control for Lean motors

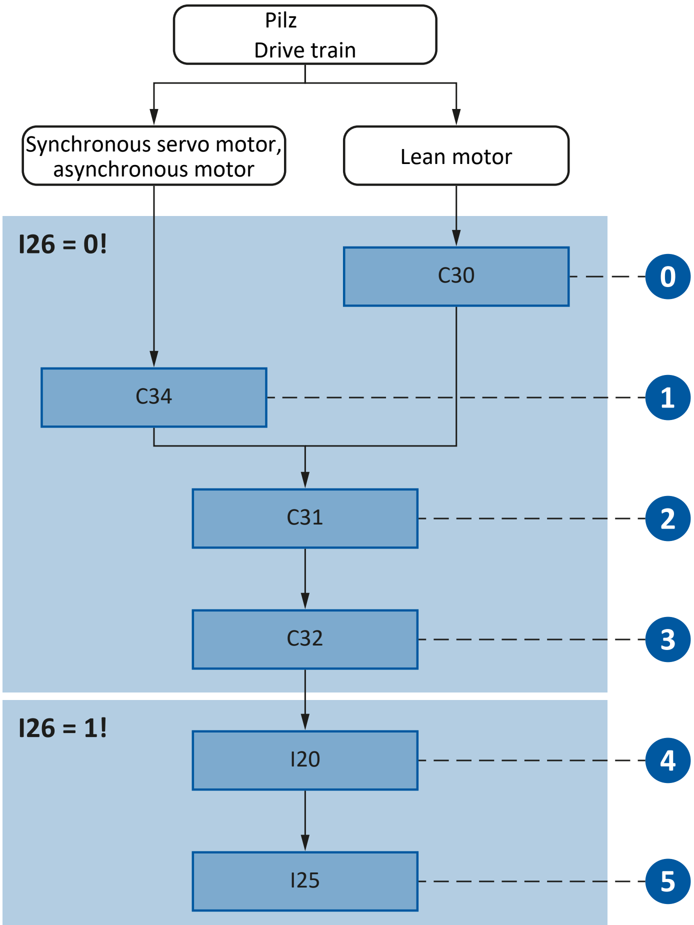


Fig. 47: Schematic sequence of optimization based on relevant parameters

0	Default Lean motors settings — Estimating the speed
1	Velocity controller — Defining filters for the actual velocity
2	Velocity controller — Defining the proportional coefficient
3	Velocity controller — Defining the integral coefficient
4	Position controller — Defining the proportional coefficient
5	Position controller — Defining the feedforward control of the velocity controller

13.5 Current controller — Notes

The current controller settings depend exclusively on the motor type, not on the load or application.

Do not make any changes to the current controller if you are using components from Pilz!

The data of a Pilz motor is part of the DriveControlSuite motor database as well as the electronic nameplate. This data is transferred to the respective parameters during project configuration or when reading out the nameplate. All additional data on the brake and encoder is transferred at the same time. These settings were calibrated in the Pilz test bay and no longer need to be adjusted.

13.6 0: Default Lean motor settings — Speed estimation

When using a Pilz Lean motor, two methods are available in DriveControlSuite for determining the speed. An observer-based process is set by default in parameter B104 which is suitable for most applications. However, the specification of the mass inertia ratio of load to motor in parameter C30 is crucial for this process.

Effects

By specifying the mass inertia ratio, the speed determination of the model adjusts to the real conditions of the machine.

Procedure

1. Work with the default value of B104 = 0: robust.
2. In C30, enter the mass inertia ratio of load to motor based on the estimated mass inertia at the motor shaft.

Information

Only change the setting of B104 if either the mass inertia cannot be determined or the load occurring is changing rapidly.

Information

For C30, note that a deviation up to factor 2 only has a slight influence on the dynamics. If more is still needed, you can optimize the value through a comparison with the actual velocity I88 during acceleration and braking.

13.7 1: Velocity controller – Actual velocity filters

The following graphic shows the influence of the lowpass filter time constant on the velocity controller.

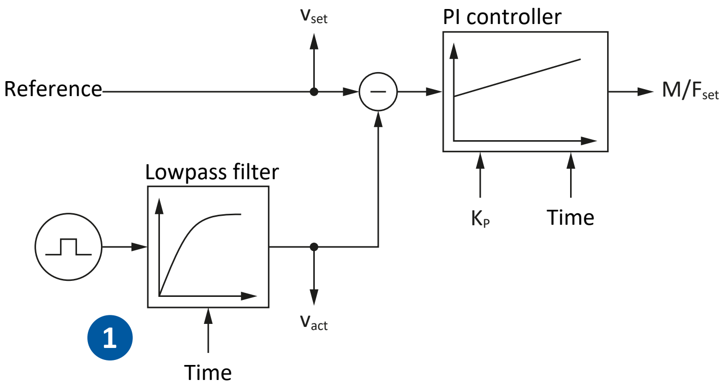


Fig. 48: Velocity controller – Filters for the actual velocity

The lowpass filter time constant for the actual velocity of the motor encoder is defined in C34.

Effects

C34 affects the smooth operation of the motor and the dynamics that can be achieved with the drive; as C34 increases, smooth operation rises and the dynamics drop.

Furthermore, C34 also has a direct influence on the maximum possible coefficient, since a large filter time also requires a large downtime.

Procedure

Select a value for C34 that is large enough to minimize the measurement and quantization noise, but is as small as possible to avoid unnecessary downtime, since this makes the system unstable and reduces dynamics.

Guide values for C34 when using a Pilz motor can be found in the following table.

Encoder model	Encoder interface	Guide value C34 [ms]
ECI 1118-G2	EnDat 2.2 digital	0.4 – 0.6
ECN 1123	EnDat 2.2 digital	0.2 – 0.4
EQI 1131	EnDat 2.2 digital, EnDat 3.0	0.4 – 0.6
EQN 1135	EnDat 2.2 digital	0.2 – 0.4

Guide values for C34

In Lean motors, the value is automatically taken from the drive controller firmware during the initial coupling of the motor and drive controller (prerequisite: B100 is not 0: User defined).

Scope image

Prerequisites:

- I26 = 0: Velocity control
- C34 = Guide value or value taken from firmware

Parameter for the scope image:

- E06 V-reference motor
- E15 v-motor-encoder

13.8 2: Velocity controller – Proportional coefficient

The following graphic shows the influence of the proportional coefficient on the velocity controller.

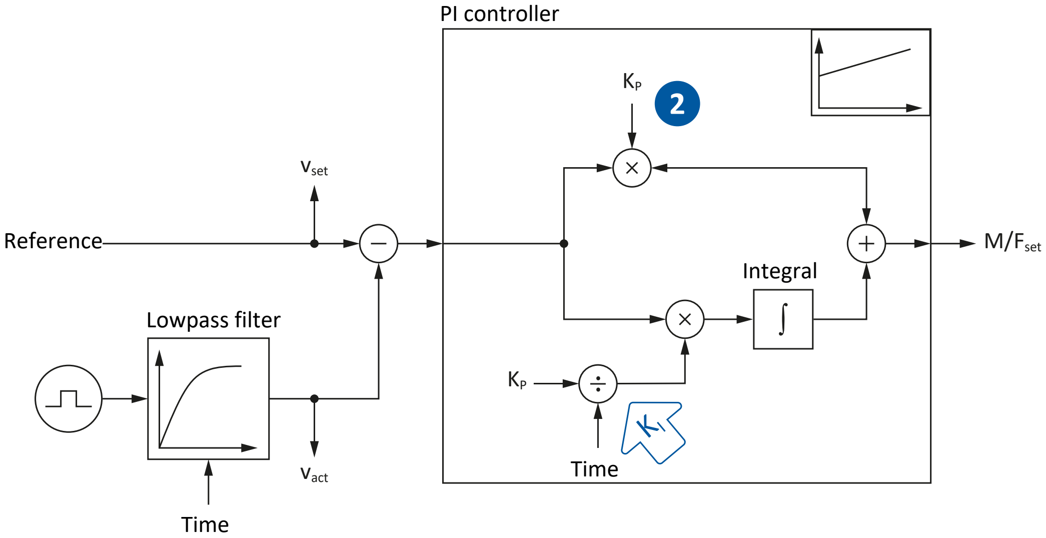


Fig. 49: Velocity controller – Proportional coefficient

The proportional coefficient K_P of the velocity controller can be defined in C31.

Effects

An adjustment of the P-share always has an effect on the I-share as well. The reason for this is the following dependency:

The integral coefficient K_I of the velocity controller results from the proportional coefficient K_P and reset time T_i ($K_I = K_P \div T_i$ = C31 × C35 ÷ C32).

Procedure

1. Start with the default value for C31.
2. First, enter the value 0 ms for the reset time in C32 to deactivate the I-share initially.
3. Increase the value of C31 up to the stability limit.
4. Define the value of C31 about 10% below the stability limit.

Scope image

Prerequisites:

- I26 = 0: Velocity control
- C34 = Guide value or value taken from firmware
- C32 = 0 ms
- C31 = e.g. 10, 20, 50, 150 and 200%

Parameter for the scope image:

- E06 V-reference motor
- E15 v-motor-encoder

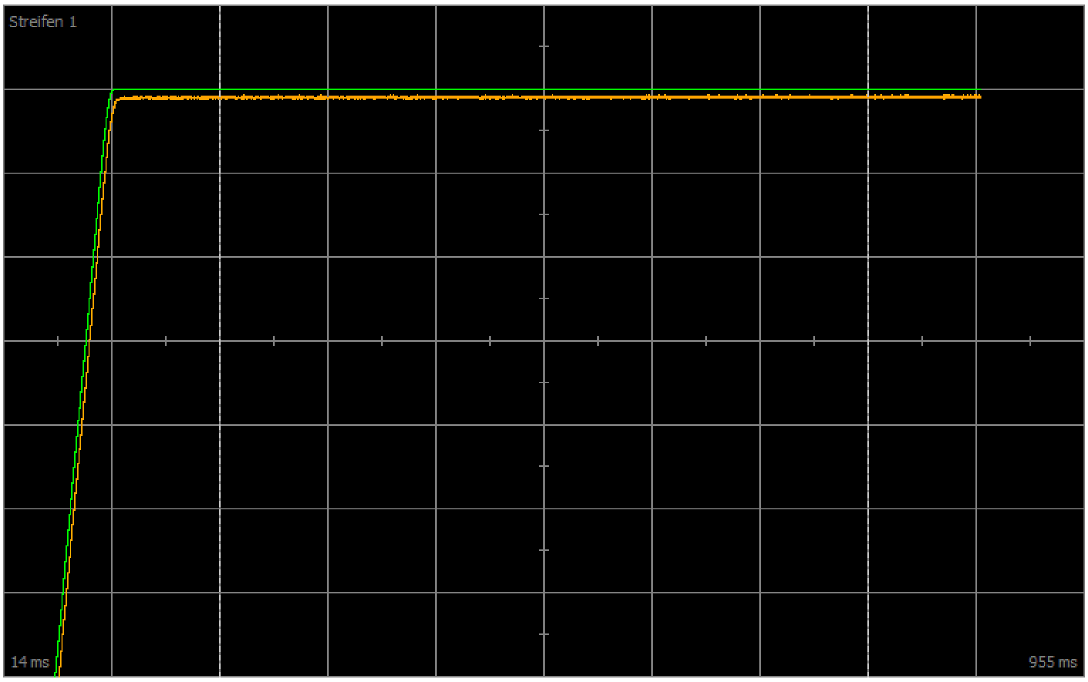


Fig. 50: Scope — Proportional coefficient of the velocity controller (C31), default setting

Green	Set value
Brown	Actual value with default setting

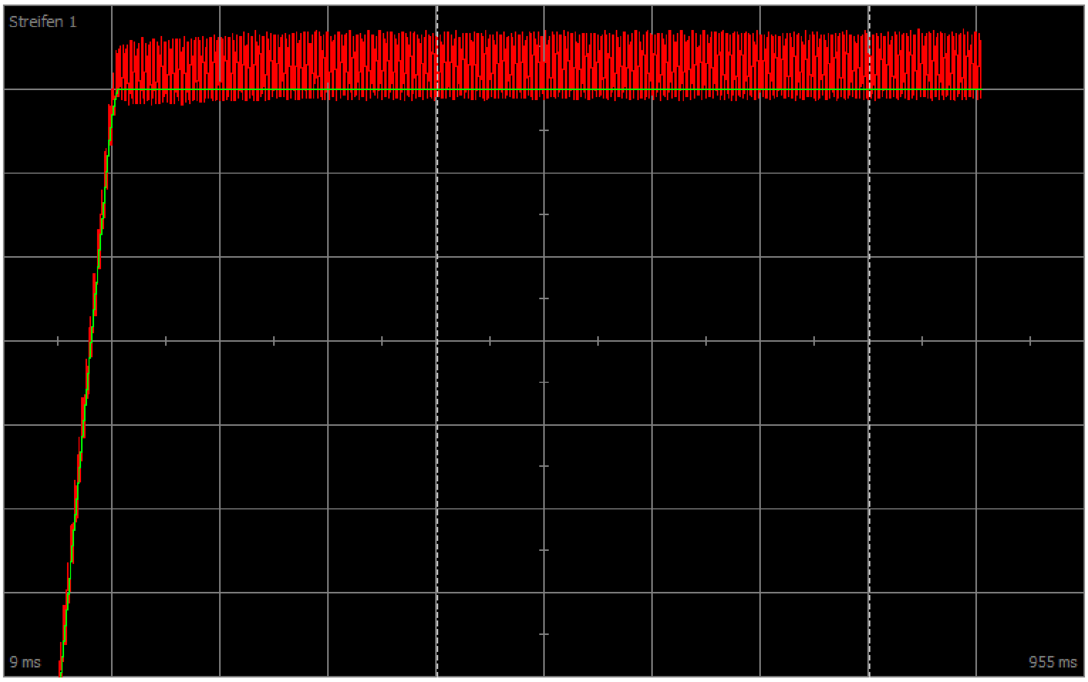


Fig. 51: Scope — Proportional coefficient of the velocity controller (C31), continuous oscillations

Green	Set value
Red	Actual value that exhibits continuous oscillation upon reaching the stability limit

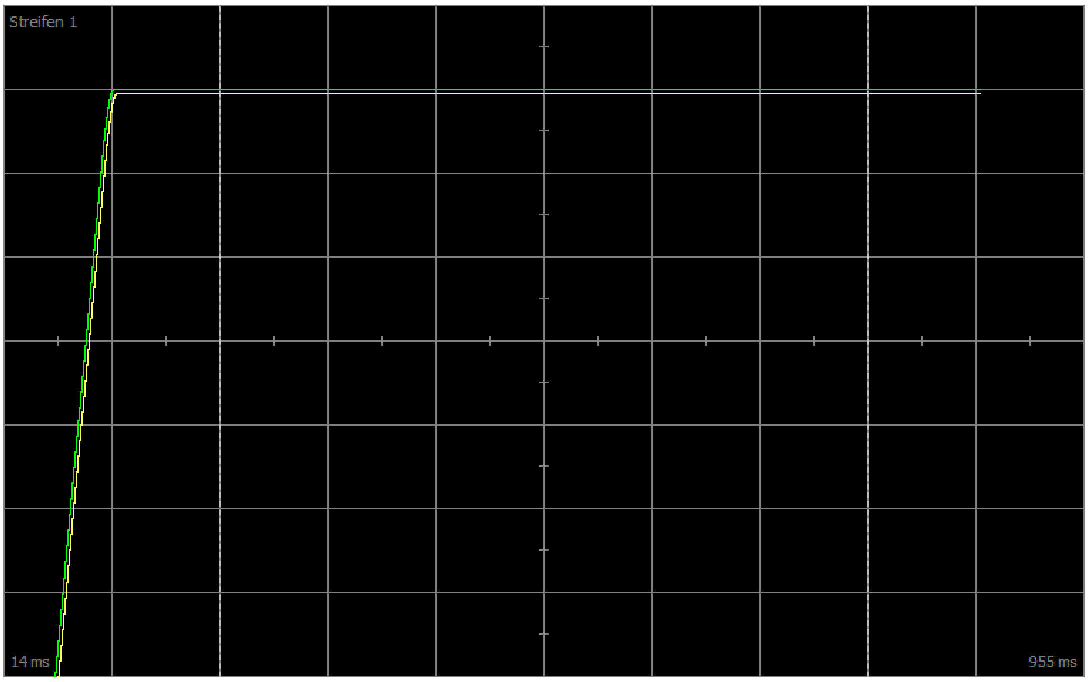


Fig. 52: Scope — Proportional coefficient of the velocity controller (C31), optimized value

Green	Set value
Yellow	Actual value with optimized coefficient

The zoom factor was increased for the following scope image to show overshooting based on additional values, which devolves into continuous oscillations upon reaching the stability limit.

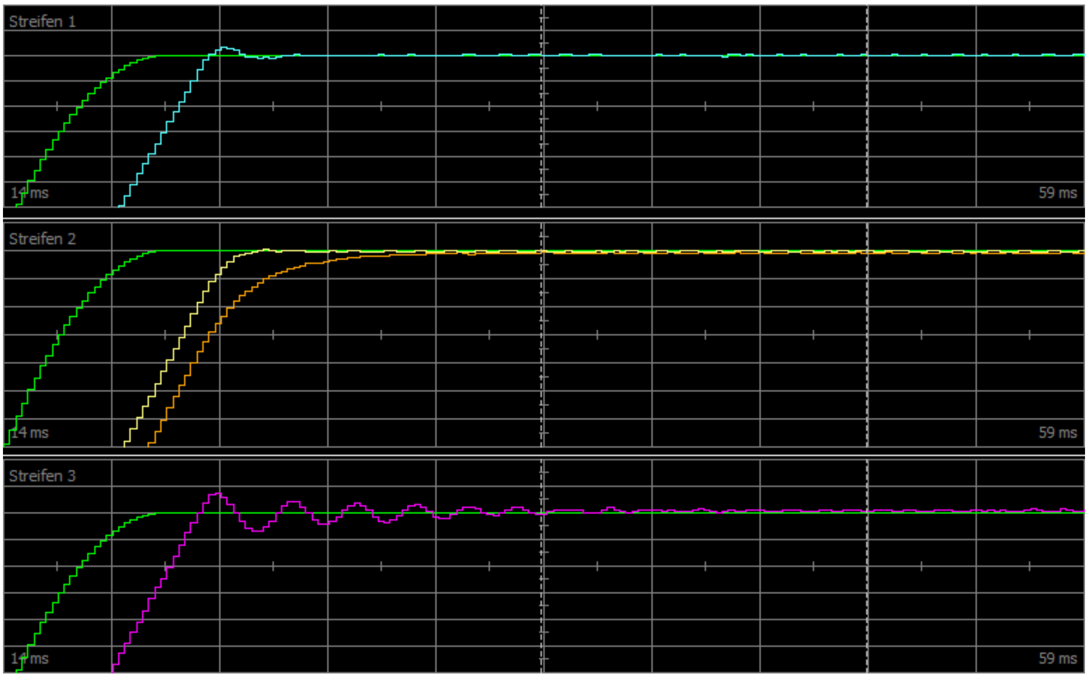


Fig. 53: Scope — Proportional coefficient of the velocity controller (C31), overshooting

Green	Set value
Turquoise	Actual value that shows brief overshooting
Pink	Actual value that shows long overshooting with phase-out

13.9 3: Velocity controller — Integral coefficient

The following graphic shows the influence of the integral coefficient on the velocity controller.

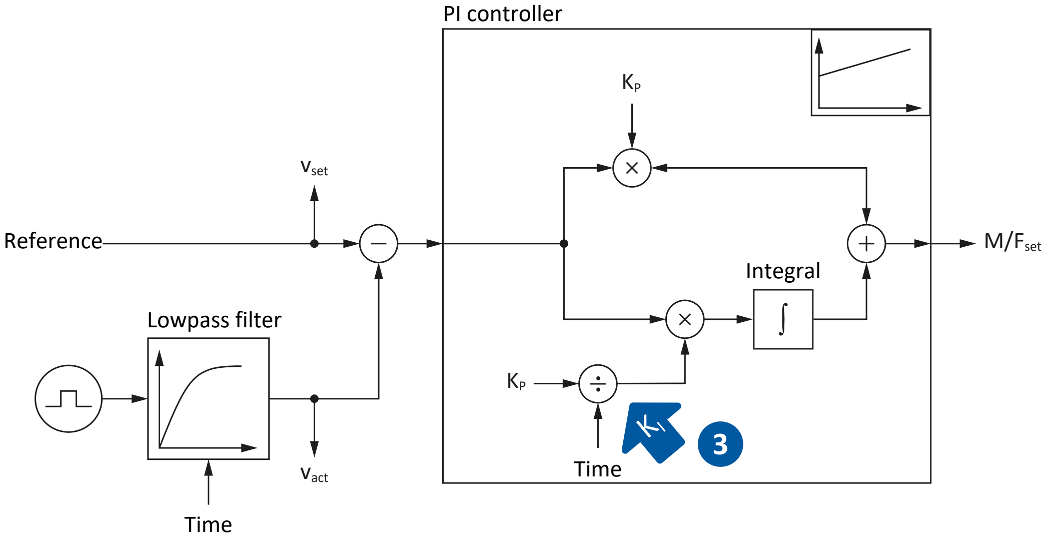


Fig. 54: Velocity controller — Integral coefficient

The integral coefficient K_I of the velocity controller results from the proportional coefficient K_P and reset time T_i ($K_I = K_P \div T_i$ = C31 × C35 ÷ C32).

Effects

Since the value of C31 was already optimized in the previous step, the integral coefficient is optimized in this step by adjusting the reset time in C32.

Procedure

1. Start with the default value for C32.
2. Reduce the value of C32 in order to recover more quickly. In this process, note that if C32 ≤ 1 ms, the I-share is deactivated.
3. Increase the value of C32 up to the stability limit.
4. Define the value of C32 about 10% above the stability limit.

Scope image

Prerequisites:

- I26 = 0: Velocity control
- C34 = Guide value or value taken from firmware
- C31 = Already optimized value
- C32 = e.g. 0, 5, 10 and 50 ms

Parameter for the scope image:

- E06 V-reference motor
- E15 v-motor-encoder

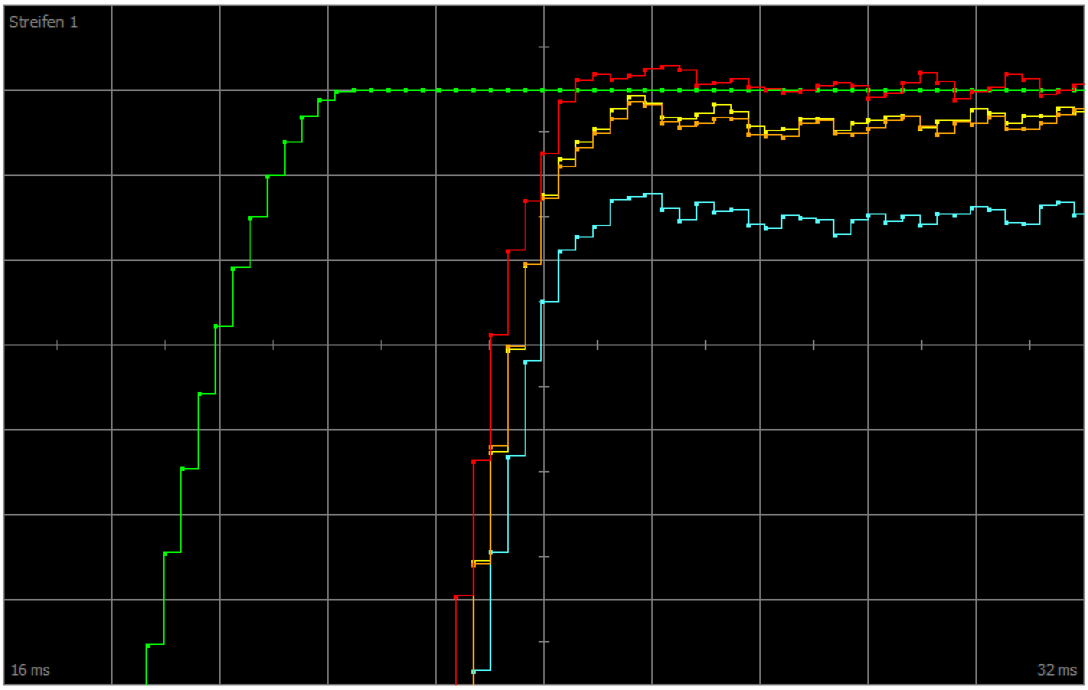


Fig. 55: Scope – Integral coefficient of the velocity controller (C32)

Green	Set value
Red	Actual value that exhibits overshooting
Yellow	Actual value with optimized coefficient
Brown	Actual value with default setting
Turquoise	Actual value with deactivated coefficient (≤ 1)

13.10 Velocity controller – Summary

In summary, the following conclusions can be drawn for the optimization of the velocity controller:

- Simple encoders must be filtered more heavily.
- The maximum possible coefficient is lower with heavier filtering.
- The default coefficient is sufficient in simpler applications.
- You only require a higher coefficient in case of higher dynamics.
- Without the integral coefficient, you do not maintain any stationary accuracy, since the set velocity is not reached.

13.11 4: Position controller ─ Proportional coefficient

The following graphic shows the influence of the proportional coefficient on the position controller.

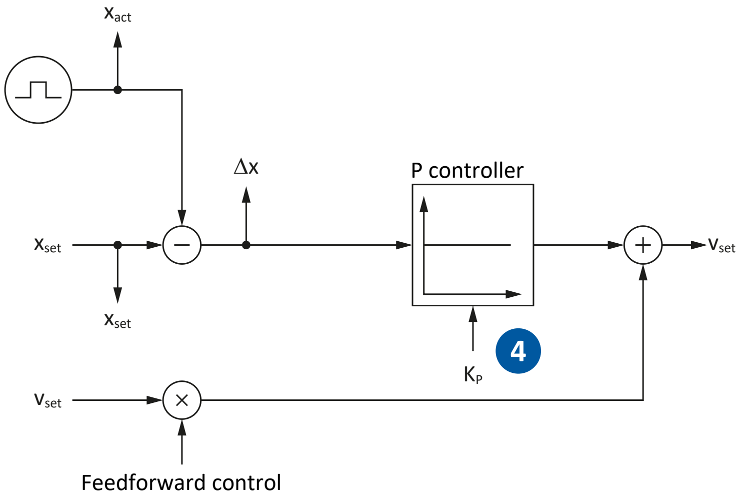


Fig. 56: Position controller ─ Proportional coefficient

The proportional coefficient K_P of the position controller can be defined in I20.

Effects

A higher coefficient produces a lower following error, but the system becomes more sensitive.

Procedure

1. Start with the default value for I20.
2. Increase the value of I20 up to the stability limit.
3. Define the value of I20 about 10% below the stability limit.

Scope image

Prerequisites:

- I26 = 1: Position control
- C34 = Guide value or value taken from firmware
- C31 = Already optimized value
- C32 = Already optimized value
- I20 = e.g. 10, 20, and 50

Parameter for the scope image:

- I96 Reference position
- I80 Current position
- I84 Following error
- E06 V-reference motor
- E15 v-motor-encoder

13.12 5: Position controller — Velocity controller feedforward control

The following graphic shows the influence of the feedforward control on the position controller.

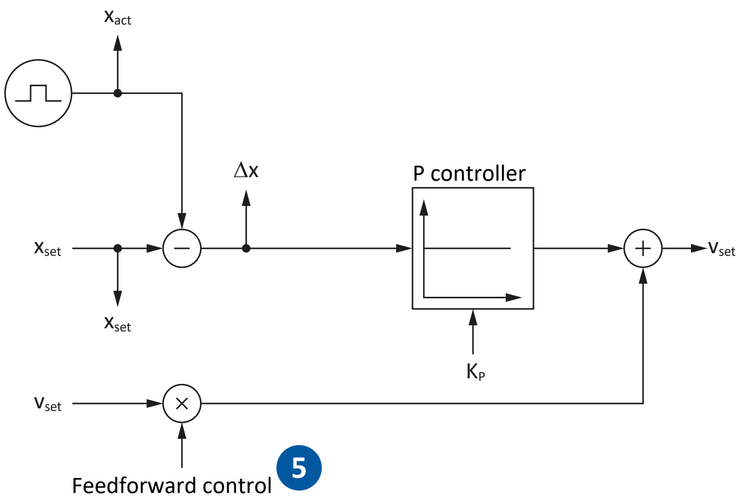


Fig. 57: Position controller — Feedforward control of the velocity controller

In case of external controller-generated or internal drive-generated feedforward control, the set velocity is also calculated in addition to the set position. In I25, you can define how much of that is directly communicated to the velocity controller.

Effects

Feedforward control reduces the load of the position controller and reduces the following error; however, stronger feedforward control makes the system more sensitive.

Procedure

1. Start with the default value of 95% for I25.
2. Reduce the value of I25 if the system is oscillating.

Scope image

Prerequisites:

- I26 = 1: Position control
- C34 = Guide value or value taken from firmware
- C31 = Already optimized value
- C32 = Already optimized value
- I20 = Already optimized value
- I25 = e.g. 50 and 95%

Parameter for the scope image:

- I96 Reference position
- I80 Current position
- I84 Following error
- E06 V-reference motor
- E15 v-motor-encoder

13.13 Position controller – Summary

In summary, the following conclusions can be drawn for the optimization of the position controller:

- If the velocity controller is optimized, only small adjustments are required for the position controller.

13.14 Special cases

In the cases described below, additional parameters are relevant for optimization.

13.14.1 Current controller – Motor reaches saturation

Synchronous servo motors show a saturation effect at high currents.

Effects

Upon reaching the saturation limits, a higher motor current no longer generates higher field strength and it begins to fluctuate if the current continues to increase.

Procedure

1. Carry out the action B41 Measure motor.
   ⇨ The electrical data of the motor is calibrated and the coefficients of the saturation characteristic are defined (B60).
2. Activate current control tracking in B59.
   ⇨ The controller gains are tracked according to the saturation characteristic of the motor.

Scope image

Parameter for the scope image:

- E166 Iq-ref
- E93 Iq

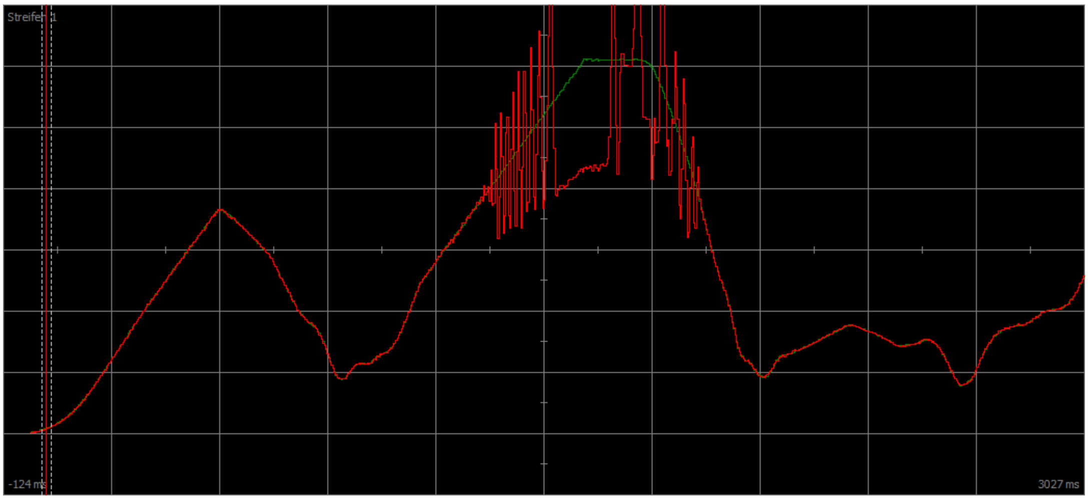


Fig. 58: Scope – Motor reaches saturation without tracking (B59)

Green	Set current
Red	Actual current

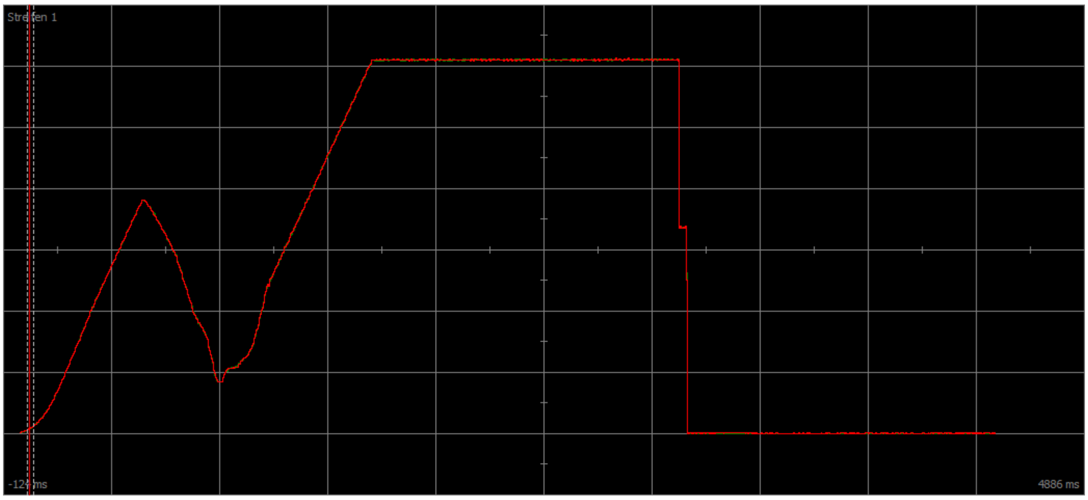


Fig. 59: Scope – Motor reaches saturation with tracking (B59)

Green	Set current
Red	Actual current

13.14.2 Velocity controller – High set torque

C36 Reference torque/force low pass:

If the set torque becomes very high, such as in case of maximum utilization of the drive controller, the set torque can be filtered using this parameter. The filter prevents the overshooting of the torque and thus the occurrence of overcurrents. The effect of C36 is defined using C37.

13.14.3 Position controller – Friction or play

I23 Position controller deadband:

To prevent control oscillations due to friction or play in the mechanics, the position control can be deactivated in a narrow range using this parameter.

13.14.4 Position controller – Poor resolution

C33 Lowpass reference speed:

Using this parameter, the set velocity can be smoothed if the calculation of the set or actual position is too rough due to one of the following conditions:

- In case of controller-based applications with poor or low quantization of the set value
- In case of drive-based applications with poor resolution of the master encoder

14 Diagnostics

LEDs on the top and front give you initial information about the device state of the respective device as well as the states of the physical connection and the communication. In the event of an error or fault, you will receive detailed information through the DriveControlSuite commissioning software.

14.1 Supply module

The PMC PS6 supply module has 3 diagnostic LEDs on the front of the device that light up in different combinations and frequencies and provide information about the state of the supply module.

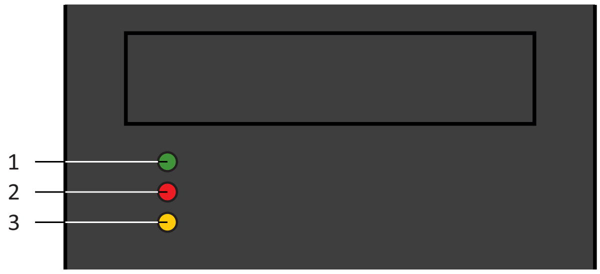


Fig. 60: Diagnostic LEDs on the front of the PMC PS6 device

1	Green: RUN
2	Red: ERROR
3	Yellow: WARNING

States of the supply module

Warning 1 covers all warnings that are likely to result in a fault if the load remains constant. The connected drives must be stopped at the next opportunity.

Causes:

- Overload of the rectifier or increased temperature
- Overload of the braking resistor
- 1 line phase failed

If the braking resistor is overloaded, it can dissipate energy for another 5 s. After this 5 s, the brake chopper can be activated again only if the braking resistor has left the critical temperature range.

Warning 2 covers all warnings that result in a fault in a very short-term period. The connected drives must be stopped immediately.

Causes:

- Power failure

Fault means that the connected drives must be brought to a stop immediately.

Causes:

- Excessive temperature in the rectifier
- Overvoltage
- Short-circuit in the brake chopper path
- Grid
- Activation in the short-circuited DC link

Relay and LED state display

The relay and LEDs always display the same state. The states are displayed using the priority list initialization/ready < Warning 1 < Warning 2 < Fault. The display of states with higher priority replaces the display of states with lower priority (example: warning 2 overwrites warning 1). States with a lower priority are only displayed after the higher prioritized state has been displayed for at least 4 s.

LEDs: Green/Red/ Yellow	Conduct	Description	Relay (X100)		
			READY	WARNING1	WARNING2
	Flashing	Initialization	Open	Closed	Closed
	Off				
	Off				
	On	Ready: DC link is charged, charging relay is closed	Closed	Closed	Closed
	Off				
	Off				
	On	Warning 1: Rectifier overload, overload of the braking resistor or 1 line phase failed	Closed	Open	Closed
	Off				
	Single flash				
	On	Warning 2: Line phases failed	Closed	Closed	Open
	Off				
	2x flash				
	Off	Fault: Overtemperature in rectifier	Open	Closed	Closed
	Single flash				
	Off				
	Off	Fault: Overvoltage	Open	Closed	Closed
	2x flash				
	Off				
	Off	Fault: Short-circuit in the brake chopper path	Open	Closed	Closed
	3x flashing				
	Off				
	Off	Fault: Grid power	Open	Closed	Closed
	4x flashing				
	Off				
	Off	Fault: Switch-on in the short-circuited DC link	Open	Closed	Closed
	5x flashing				
	Off				
	Off	Device is switched off	Open	Open	Open
	Off				
	Off				

Meaning of the 3 LEDs (RUN, ERROR and WARNING) on the front of the PMC PS6 device

UL-compliant operation: For project configuration of warning 1, observe the notes on the braking resistor in the chapter UL-compliant use [📖 22].

14.2 Drive controllers

Pilz drive controllers have diagnostic LEDs that visually indicate the state of the drive controller as well as the states of the physical connection and communication.

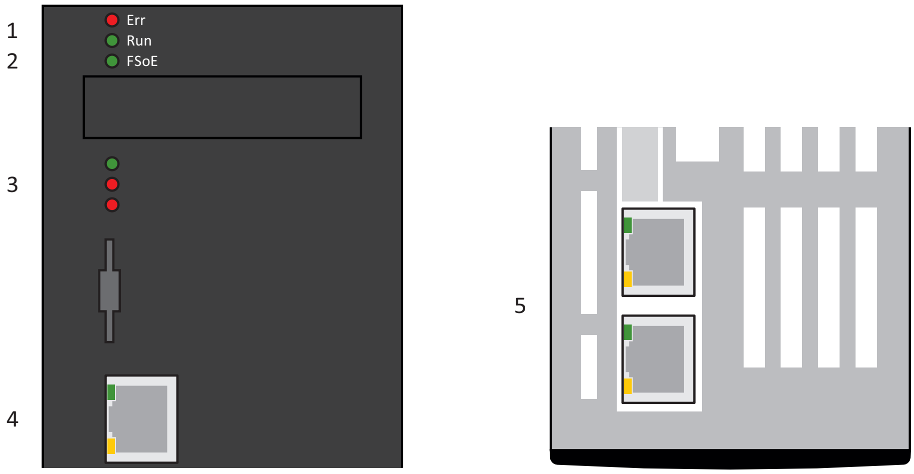


Fig. 61: Positions of the diagnostic LEDs on the front and top of the drive controller

1 Fieldbus state
2 FSoE state
3 Drive controller state
4 Service network connection
5 Fieldbus network connection

14.2.1 Fieldbus state

The LEDs for the diagnostics of the fieldbus state vary depending on the implemented fieldbus system or communication module.

14.2.1.1 EtherCAT state

There are 2 LEDs on the front of the drive controller that provide information about the connection between EtherCAT master and slave and about the state of the data exchange. This information can also be read out in parameter A255 EtherCAT Device State. If the drive controller includes the PMC SY6 safety module, the STO and SS1 safety functions are activated via EtherCAT FSoE. In this case, an additional LED on the front of the device provides information about the FSoE state.

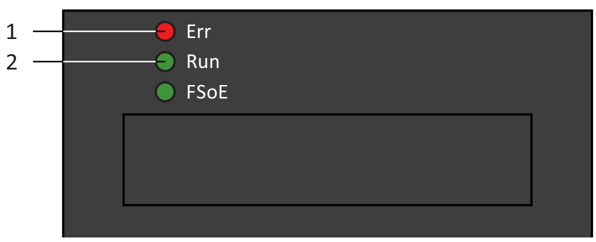


Fig. 62: LEDs for the EtherCAT state

1 Red: Error
2 Green: Run

Red LED	Conduct	Error	Description
	Off	No Error	No error
	Flashing	Invalid Configuration	Invalid configuration
	Single flash	Unsolicited State Change	The EtherCAT slave changed operating states by itself
	2x flashing	Application Watchdog Timeout	The EtherCAT slave did not receive new PDO data during the configured watchdog timeout

Meaning of the red LED (error)

Green LED	Conduct	Operating state	Description
	Off	Init	No communication between the EtherCAT master and slave; the configuration starts, saved values are loaded
	Flashing	Pre-operational	No PDO communication; the EtherCAT master and slave exchange application-specific parameters via SDOs
	1x flash	Safe-operational	The EtherCAT slave sends the current actual values to the EtherCAT master, ignores its set values and refers to internal default values
	On	Operational	Normal operation: The EtherCAT master and slave exchange set and actual values

Meaning of the green LED (Run)

14.2.1.2 PROFINET state

There are 2 LEDs on the front of the drive controller that provide information about the connection between the IO controller and device and about the state of the data exchange. This information can also be read out in parameter A271 PN state.

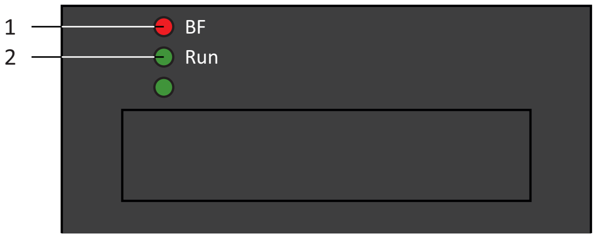


Fig. 63: LEDs for the PROFINET state

1 Red: BF (bus error)

2 Green: Run

Red LED	Conduct	Description
	Off	No error
	Rapid flashing	Data exchange with IO controller not active
	On	No network connection

Meaning of the red LED (BF)

Green LED	Conduct	Description
	Off	No connection
	Flash	Connection is set up to IO controller
	Flash, inverse	IO controller activates DHCP signal service
	Flashing	Existing connection to IO controller; data exchange expected
	On	Existing connection to IO controller

Meaning of the green LED (Run)

14.2.2 FSoE state

If the drive controller includes the PMC SY6 safety module, the STO and SS1 safety functions are activated via EtherCAT FSoE. In this case, an LED on the front of the device provides information about the state of FSoE communication. This information can also be read out in parameter S20 FSoE status indicator.

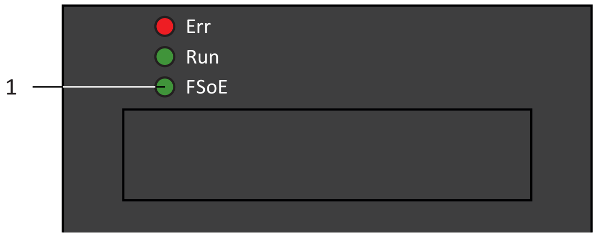


Fig. 64: LED for the FSoE state

1 Green: FSoE

Green LED	Conduct	Description
	Off	Initialization
	Flashing	Ready for parameterization
	On	Normal operation
	Single blink	Failsafe command from FSoE master received
	Rapid blinking	Undefined connection error
	Rapid blinking with 1x flash	Error in the safety-related communication settings
	Rapid blinking with 2x flash	Error in the safety-related application settings
	Rapid blinking with 3x flash	Incorrect FSoE address
	Rapid blinking with 4x flash	Prohibited command received
	Rapid blinking with 5x flash	Watchdog error
	Rapid blinking with 6x flash	CRC error

Meaning of the green LED (FSoE status indicator in accordance with IEC 61784-3)

14.2.3 Drive controller state

3 LEDs on the front of the device provide information about the state of the drive controller.

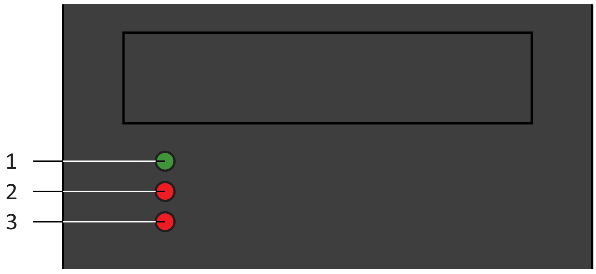


Fig. 65: LEDs for the state of the drive controller

1 Green: Run
2 Red: Error in axis controller A
3 Red: Error in axis controller B (only for double-axis controllers)

Green LED	Conduct	Description
	Off	No supply voltage or axis controller A or B faulty
	Single blink	STO active
	Flashing	At least 1 axis controller ready to switch on; no axis controller faulty
	On	At least 1 axis controller enabled; no axis controller faulty
	Rapid flashing	Data is written to internal memory and the SD card

Meaning of the green LED (Run)

Red LED	Conduct	Description
	Off	No error
	Flashing	Warning
	On	Fault
	Rapid flashing	No configuration active

Meaning of the red LEDs (error)

Pattern when starting the drive controller

LEDs: Green/Red/Red	Conduct	Description
	On	Short phase while the firmware starts up
	On	
	On	

States of the LEDS when starting the drive controller

Pattern when transferring a firmware file using DriveControlSuite

The states of the green and red LEDs also apply as described during a firmware file transfer using DriveControlSuite.

Pattern when transferring a firmware file using an SD card

When a firmware file is being transferred using an SD card, the three LEDs flash in various combinations and frequencies:

LEDs: Green/Red/Red	Conduct	Description
	Off	Deleting the second firmware memory on the drive controller
	Rapid flashing	
	On	
	Rapid flashing	Copying the firmware from the SD card to the second firmware memory of the drive controller
	Rapid flashing	
	Rapid flashing	
	Single blink	Copying process completed successfully; drive controller has to be restarted
	Off	
	Off	
	Off	Error during copying process; remove card and restart drive controller
	Single blink	
	Off	

States of the LEDs when using an SD card to transfer a firmware file

Pattern after transferring a firmware file and restarting the drive controller

After restarting the drive controller during a firmware update, the three LEDs flash in various combinations and frequencies:

LEDs: Green/Red/Red	Conduct	Description
	Off	Deleting the first firmware memory
	Rapid flashing	
	Off	
	Rapid flashing	Copying the second firmware memory into the first
	Off	
	Off	
	Chaser light	Error during firmware update; service required

States of the LEDs after transferring a firmware file and restarting the drive controller

14.2.4 Service network connection

The LEDs at X9 on the front of the device display the state of the service network connection.

Fig. 66: LEDs for the state of the service network connection

1 Green: Link
2 Yellow: Activity

Green LED	Behavior	Description
	Off	No network connection
	On	Network connection present

Meaning of the green LED (link)

Yellow LED	Behavior	Description
	Off	No network connection
	Flashing	Individual data packets are sent or received
	On	Active data exchange

Meaning of the yellow LED (act.)

14.2.5 Fieldbus network connection

The LEDs for communication diagnostics vary depending on implemented fieldbus system or communication module.

14.2.5.1 EtherCAT network connection

The LEDs LA $_{EC}$IN and LA $_{EC}$OUT at X200 and X201 on the top of the device indicate the state of the EtherCAT network connection.

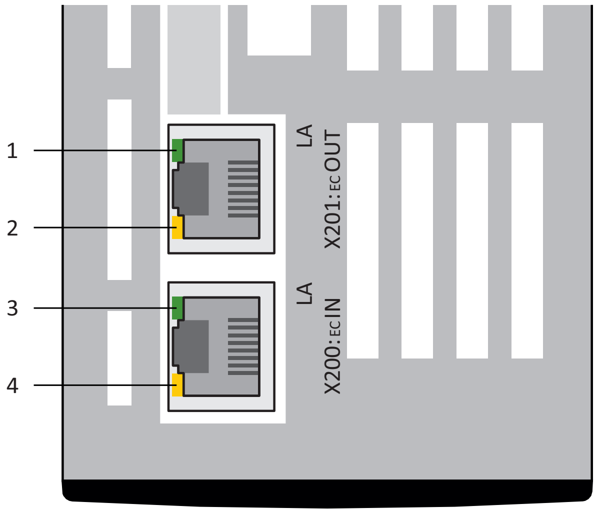


Fig. 67: LEDs for the state of the EtherCAT network connection

1 Green: LA $_{EC}$OUT at X201
2 Yellow: No function
3 Green: LA $_{EC}$IN at X200
4 Yellow: No function

Green LED	Behavior	Description
	Off	No network connection
	Flashing	Active data exchange with other EtherCAT nodes
	On	Network connection exists

Meaning of the green LEDs (LA)

14.2.5.2 PROFINET network connection

The Act. and Link LEDs at X200 and X201 on the top of the device indicate the state of the PROFINET network connection.

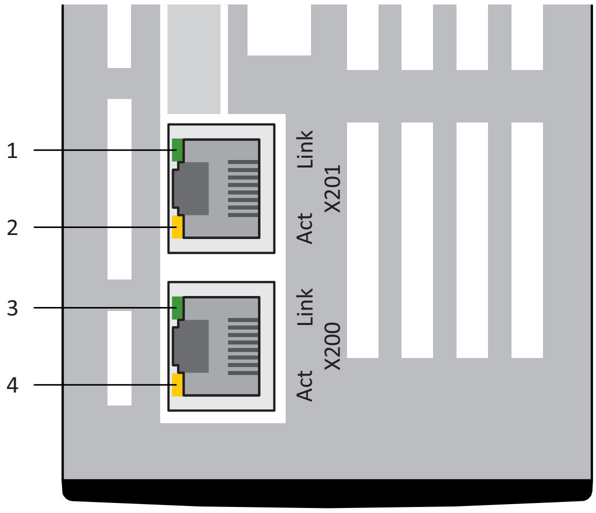


Fig. 68: LEDs for the state of the PROFINET network connection

1 Green: Link at X201
2 Yellow: Activity at X201
3 Green: Link at X200
4 Yellow: Activity at X200

Green LED	Behavior	Description
	Off	No network connection
	On	Network connection exists

Meaning of the green LEDs (Link)

Yellow LED	Behavior	Description
	Off	No data exchange
	Flashing	Active data exchange with IO controller

Meaning of the yellow LEDs (Act.)

14.3 Events

The drive controller has a self-monitoring system that uses test rules to protect the drive system from damage. Violating the test rules triggers a corresponding event. There is no possible way for you as the user to intervene in some events, such as the Short/ground event. In others, you can influence the effects and responses.

Possible effects include:

- Message: Information that can be evaluated by the controller
- Warning: Information that can be evaluated by the controller and becomes a fault after a defined time span has elapsed without the cause being resolved
- Fault: Immediate drive controller response; the power unit is disabled and axis movement is no longer controlled by the drive controller or the axis is brought to a standstill by a quick stop or emergency braking

ATTENTION!

Damage to property due to interruption of a quick stop or emergency braking

If, when executing a quick stop or emergency braking, another fault occurs or a safety function is activated, the quick stop or emergency braking is interrupted. In this case, the machine can be damaged by the uncontrolled axis movement.

Events, their causes and suitable measures are listed below. If the cause of the error is corrected, you can usually acknowledge the error immediately. If the drive controller has to be restarted instead, a corresponding note can be found in the measures.

14.3.1 Overview

The following table shows the possible events at a glance.

Event
Event 31: Short/ground [207]
Event 32: Short/ground internal [207]
Event 33: Overcurrent [208]
Event 34: Hardware fault [209]
Event 35: Watchdog [209]
Event 36: High voltage [210]
Event 37: Motor encoder [210]
Event 38: Temperature drive controller sensor [214]
Event 39: Overtemperature drive controller i2t [215]
Event 40: Invalid data [216]
Event 41: Temp.MotorTMP [216]
Event 44: External fault 1 [217]
Event 45: Overtemp.motor i2t [218]
Event 46: Low voltage [219]

Event
Event 47: Torque limit [220]
Event 50: Safety module [221]
Event 51: Virtual master limit switch [222]
Event 52: Communication [223]
Event 53: Limit switch [224]
Event 54: Following error [225]
Event 56: Overspeed [226]
Event 57: Runtime usage [227]
Event 59: Overtemperature drive controller i2t [228]
Event 60: Application event 0 – Event 67: Application event 7 [229]
Event 68: External fault 2 [230]
Event 69: Motor connection [231]
Event 70: Parameter consistency [232]
Event 71: Firmware [233]
Event 72: Brake test timeout [234]
Event 76: Position encoder [235]
Event 77: Master encoder [238]
Event 78: Position limit cyclic [241]
Event 79: Motor / position monitor [242]
Event 80: Illegal action [243]
Event 81: Motor allocation [243]
Event 85: Excessive jump in reference value [244]
Event 86: Unknown LeanMotor record [245]
Event 87: Reference lostReference loss [246]
Event 88: Control panel [247]
Event 89: Maximum current Lm [248]

Events

14.3.2 Event 31: Short/ground

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

The brake chopper is disabled.

Cause	Check and action
Connection error at the motor	Check the connection and correct it if necessary
Defective power cable	Check the cable and replace it if necessary
Short-circuit in the motor winding	Check the motor and replace it if necessary
Short-circuit in the braking resistor	Check the braking resistor and replace it if necessary
Short-circuit/ground fault inside the device	Check whether the fault occurs when switching on the power unit and replace the drive controller if necessary

Event 31 – Causes and actions

14.3.3 Event 32: Short/ground internal

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

The brake chopper is disabled.

Cause	Check and action
Short-circuit/ground fault inside the device	Replacing the drive controller

Event 32 – Causes and actions

14.3.4 Event 33: Overcurrent

The drive controller is interrupted if:

- U30 = 0: Inactive

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with emergency braking if:

- U30 = 1: Active and
- A29 = 1: Active for Drive Based device controller
  or
- U30 = 1: Active and
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by emergency braking; the brakes are applied in the event of an inactive release override (F06)
- At the end of emergency braking, the power unit is disabled and axis movement is no longer controlled by the drive controller

Emergency braking is only possible for the synchronous servo, torque and Lean motor types.

Cause	Check and action
Short acceleration times	Check the actual current using the scope image and reduce the acceleration values if necessary (E00)
Large torque/force limits	Check the actual current using the scope image (E00) and reduce the torque/force limits if necessary (C03, C05)
Wrong drive controller design	Check the design and change the drive controller type if necessary

Event 33 – Causes and actions

14.3.5 Event 34: Hardware fault

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
1: FPGA – 12: Timer control board	Defective drive controller	Exchange drive controller; fault cannot be acknowledged
23: FPGA – 30: Internal power supply	Defective drive controller	Exchange drive controller; fault cannot be acknowledged

Event 34 – Causes and actions

14.3.6 Event 35: Watchdog

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

The brake chopper and brake release override are non-functional while the runtime system restarts.

Cause		Check and action
1: Core 0 – 2: Core 1	Microprocessor at full load	Check the runtime utilization using the scope image (E191) and reduce it using a longer cycle time if necessary (A150)
	Microprocessor faulty	Check the connection and shielding and correct them if necessary; replace the drive controller if necessary

Event 35 – Causes and actions

14.3.7 Event 36: High voltage

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause	Check and action
Short delay times	Check the DC link voltage during the braking operation using the scope image (E03) and, if necessary, reduce the delay values, use a (larger) braking resistor or connect a DC link
Braking resistor connection error	Check the connection to the braking resistor and supply module and correct them if necessary
Braking resistor overloaded	Check the supply module for Warning 1; check that the maximum permitted braking resistor power loss is suitable for the application; replace the braking resistor if necessary
Pulse power of the braking resistor is too low	Check that the braking resistor pulse power is suitable for the application; replace the braking resistor if necessary
Supply voltage exceeded	Check the supply voltage for an overrun of the permitted input voltage and adjust it if necessary

Event 36 – Causes and actions

14.3.8 Event 37: Motor encoder

The drive controller is interrupted if:

- U30 = 0: Inactive

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with emergency braking if:

- U30 = 1: Active and
- A29 = 1: Active for Drive Based device controller
  or
- U30 = 1: Active and
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by emergency braking; the brakes are applied in the event of an inactive release override (F06)
- At the end of emergency braking, the power unit is disabled and axis movement is no longer controlled by the drive controller

Emergency braking is only possible for the synchronous servo, torque and Lean motor types.

Cause		Check and action
1: Parameter <-> encoder	Inconsistent parameterization	Compare the specification of the connected encoder to the corresponding values of the H parameters and correct them if necessary
2: X4 speed	Exceeded encoder maximum velocity	Check the actual velocity during a movement using the scope image (E15) and adjust the permitted encoder maximum velocity if necessary (B297)
	Connection error	Check the connection and shielding and correct them if necessary
	Mass inertia ratio of load to Lean motor	Check the setting of the mass inertia ratio (C30) and reduce it if necessary
	Dynamic control of the Lean motor	Check the control settings; if necessary, reduce the gain (C31, I20) and increase the reset times (C32)
	Dynamic set values for the Lean motor	Check the dynamics of the application set values and reduce them if necessary
	Dynamic acceleration of the Lean motor	Check the switchover filter time constant and reduce it if necessary (B137)
6: X4 EnDat encoder found	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
7: X4 channel A/incremental	Connection error	Check the connection and correct it if necessary
8: X4 no encoder found	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Defective power supply	Check the encoder power supply and correct it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
10: X4 channel A/Clk – 11: X4 channel B/Dat	Defective encoder cable	Check the cable and replace it if necessary
13: X4-EnDat alarm	Defective EnDat encoder	Replace the motor; fault cannot be acknowledged
14: X4 EnDat CRC – 15: X4 double transmission	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (B298)

Cause		Check and action
16: X4 busy	Defective encoder cable	Check the cable and replace it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the motor if necessary
17: EBI encoder low battery	Battery in battery module weak	Replace the battery; reference remains intact
18: EBI encoder battery empty	Battery in battery module empty	Replace the battery
	Initial connection	–
	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Faulty battery module	Check the battery module and replace it if necessary
20: Resolver carrier – 22: Resolver overvoltage	Defective encoder cable	Check the cable and replace it if necessary
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the encoder or motor if necessary; fault cannot be acknowledged
24: Resolver failure	Defective encoder cable	Check the cable and replace it if necessary
48: X4 zero pulse missing	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Late zero toe	Check number of encoder increments per rotation and correct it if necessary (H02)
49: X4 zero pulse distance too small	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Early zero track	Check number of encoder increments per rotation and correct it if necessary (H02)

Cause		Check and action
60: Hiperface synchronisation – 63: Hiperface link	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (B298)

Event 37 – Causes and actions

14.3.9 Event 38: Temperature drive controller sensor

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Surrounding temperatures too high or too low	Check the surrounding temperature of the drive controller and adjust it to the operating conditions of the drive controller if necessary
Too little air circulation in the control cabinet	Check minimum clearance and adjust it if necessary
Defective or blocked fan	Switch on control unit supply; check that the fan starts and replace the drive controller if necessary
Assembly protection film	Remove the assembly protection film
Wrong drive controller design	Check the design and change the drive controller type if necessary
Increased or reduced mechanical friction	Check the service status of the mechanical system and service them if necessary
Mechanical block	Check the output and remove the block if necessary
Short deceleration/ acceleration times	Check the actual current during the braking process using the scope image (E00); reduce the deceleration and acceleration values if necessary
Clock frequency too high	Check the utilization of the drive, taking into account derating and the configured clock frequency (E20, B24); reduce the configured clock frequency or replace the drive controller if necessary

Event 38 – Causes and actions

14.3.10 Event 39: Overtemperature drive controller i2t

The possible effects depend on the configured level (U02):

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The maximum permitted output current is limited to 100% of $I_{2N,PU}$ (R04). If the i^2t value (E24) increases to 105%, event 59: Overtemperature drive controller i2t is triggered.

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Wrong drive controller design	Check the design and change the drive controller type if necessary
Increased or reduced mechanical friction	Check the service status of the mechanical system and service them if necessary
Mechanical block	Check the output and remove the block if necessary
Short deceleration/ acceleration times	Check the actual current during the braking process using the scope image (E00); reduce the deceleration and acceleration values if necessary
Clock frequency too high	Check the utilization of the drive, taking into account derating and the configured clock frequency (E20, B24); reduce the configured clock frequency or replace the drive controller if necessary

Event 39 – Causes and actions

14.3.11 Event 40: Invalid data

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
1: Fault – 8: Wrong/illegal serial number	Invalid data in the internal memory of the drive controller or option module	Replace the drive controller or option module; fault cannot be acknowledged
32: Electronic nameplate	No data available in the electronic nameplate	Deactivate the evaluation of the nameplate or replace the motor (B04); fault cannot be acknowledged
33: Electronic motor-type limit	Invalid data in the electronic nameplate	Deactivate the evaluation of the nameplate or replace the motor (B04); fault cannot be acknowledged
48: reverse documentation	Defective memory in the SD card or internal memory of the drive controller	Replace the SD card or drive controller; fault cannot be acknowledged

Event 40 – Causes and actions

14.3.12 Event 41: Temp.MotorTMP

The possible effects depend on the configured level (U15):

- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Motor temperature sensor connection error	Check the connection and correct it if necessary
Wrong sensor source for X2 – HIPERFACE DSL	Check the sensor settings and correct them if necessary (B35)
Wrong motor design	Check the design and change the motor type if necessary
Surrounding temperatures at the motor too high	Check the surrounding temperature and adjust it if necessary
Mechanical block of the motor	Check the output and remove the block if necessary
Increased or reduced mechanical friction	Check the service status of the mechanical system and service them if necessary

Event 41 – Causes and actions

14.3.13 Event 44: External fault 1

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Application-specific	Application-specific

Event 44 – Causes and actions

14.3.14 Event 45: Overtemp.motor i2t

The possible effects depend on the parameterized level (U10):

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Wrong motor design	Check the design and change the motor type if necessary
Mechanical block of the motor	Check the output and remove the block if necessary
Increased or reduced mechanical friction	Check the service status of the mechanical system and service them if necessary

Event 45 – Causes and actions

14.3.15 Event 46: Low voltage

The possible effects depend on the configured level (U00):

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Supply voltage does not correspond to the configured supply voltage	Check the supply voltage, parameterized supply voltage and undervoltage limit and correct them if necessary (A36, A35)
Supply voltage below undervoltage limit	Check undervoltage limit and correct it if necessary (A35)

Event 46 – Causes and actions

14.3.16 Event 47: Torque limit

The possible effects depend on the configured level (U20):

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Incorrectly selected torque/ force limits	Check the general machine limit and adjust it if necessary (C03, C05); check the application limits and the parameters dependent on the operating mode and adjust them if necessary (Drive Based C132, C133 or CiA 402 A559)
Wrong motor design	Check the design and change the motor type if necessary
Mechanical block	Check the output and remove the block if necessary
Brake closed	Check the connection, supply voltage and parameterization and correct them if necessary (F00)
Connection error at the motor	Check the connection and correct it if necessary
Connection error at the encoder	Check the connection and correct it if necessary
Wrong encoder measurement direction	Compare the attachment and measurement direction of the encoder with the corresponding values of the H parameters and correct them if necessary

Event 47 – Causes and actions

14.3.17 Event 50: Safety module

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
2: Wrong safety module	The projected E53 safety module does not match the E54[0] detected by the system	Check the project configuration and drive controller and correct the project configuration or exchange the drive controller if necessary; fault cannot be acknowledged
3: Internal error	Defective safety module	Exchange drive controller; fault cannot be acknowledged
16: Remove enable!	STO request with active power unit	Only request STO with inactive power unit
		Request Enable-off without quick stop at the same time as the STO request (Drive Based A44)

Event 50 – Causes and actions

14.3.18 Event 51: Virtual master limit switch

The possible effects depend on the configured level (U24).

- 0: Inactive
- 1: Message
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		**Check and action**
1: SW-limit switch positive – 2: SW-limit switch negative	End of the travel range reached	Move in the travel range in the direction opposite the limit switch
	Travel range too small	Check the positions of the software limit switch and correct them if necessary (G146, G147)
3: +/- 31 bit computing limit reached	Computing limit of the data type reached	Check the command sequences for multiple successive commands without a breakpoint 3: MC_MoveAdditive and the number of decimal places of the axis model and reduce them if necessary (G46)

Event 51 – Causes and actions

14.3.19 Event 52: Communication

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
4: PZD-Timeout	Missing process data	Check the IO cycle time in the PROFINET IO controller and the timeout time in the drive controller and correct them if necessary (A109)
6: EtherCAT PDO-Timeout	Missing process data	Check the task cycle time in the EtherCAT master and the timeout time in the drive controller and correct them if necessary (A258)
7: Reserved	Synchronization error	Check the synchronization settings in the EtherCAT master and correct them if necessary
	Connection error	Check the connection and shielding and correct them if necessary
14: PZD parameter figure faulty	Missing mapping	Check the mapping for unmappable parameters and correct them if necessary
15: Wrong firmware for applicataion	Projected fieldbus identification and that of the drive controller do not match	Check the projected fieldbus identification and the fieldbus identification of the drive controller and change the fieldbus if necessary (E59[2], E52[3])

Event 52 – Causes and actions

14.3.20 Event 53: Limit switch

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
1: Hardware-Limit-Switch positive – 2: Hardware-Limit-Switch negative	End of the travel range reached	Move in the travel range in the direction opposite the limit switch
	Connection error	Check the connection and source parameters and correct them if necessary (I101, I102)
	Defective connection cable	Check the cable and replace it if necessary
3: SW-limit switch positive – 4: SW-limit switch negative	End of the travel range reached	Move in the travel range in the direction opposite the limit switch
	Travel range too small	Check the positions of the software limit switches and correct them if necessary (Drive Based I50, I51 or CiA A570[0], A570[1])
5: +/- 31 bit computing limit reached	Computing limit of the data type reached	Check the command sequences for multiple successive 3: MC_MoveAdditive commands without a breakpoint and the number of decimal places of the axis model and reduce them if necessary (I06)
7: Both limit switches not connected	Connection error	Check the connection and source parameters and correct them if necessary (I101, I102)
	Defective connection cable	Check the cable and replace it if necessary

Event 53 – Causes and actions

14.3.21 Event 54: Following error

The possible effects depend on the configured level (U22).

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Incorrectly selected torque/ force limits	Check the general machine limit and adjust it if necessary (C03, C05); check the application limits and adjust them if necessary (Drive Based C132, C133 and the parameters dependent on the operating mode or CiA 402 A559)
Maximum permitted drag distance too small	Check the maximum permitted drag error and correct it if necessary (Drive Based I21 or CiA A546)
Mechanical block	Check the output and remove the block if necessary
Brake closed	Check the connection, supply voltage and parameterization and correct them if necessary (F00)

Event 54 – Causes and actions

14.3.22 Event 56: Overspeed

The drive controller is interrupted if:

- U30 = 0: Inactive

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with emergency braking if:

- U30 = 1: Active and
- A29 = 1: Active for Drive Based device controller
  or
- U30 = 1: Active and
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by emergency braking; the brakes are applied in the event of an inactive release override (F06)
- At the end of emergency braking, the power unit is disabled and axis movement is no longer controlled by the drive controller

Emergency braking is only possible for the synchronous servo, torque and Lean motor types.

Cause	Check and action
Maximum permitted velocity too small	Check the maximum permitted velocity and increase it if necessary (I10)
Overshooting control system	Check the actual velocity using the scope image (scope Sensing time: 250 µs, actual motor velocity: E15, E91; actual position velocity I88) and, if necessary, reduce the intensity of the control system (I20, C31)
Wrong commutation offset	Check the commutation offset using the test phases action (B40)
Faulty encoder	Check the velocity display of the encoder at a standstill (motor: E15, E91; position I88) and replace the encoder if necessary

Event 56 – Causes and actions

14.3.23 Event 57: Runtime usage

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
3: RT3 – 5: RT5	Exceeding the cycle time	Check the utilization (E191) and increase the cycle time if necessary (A150)

Event 57 – Causes and actions

14.3.24 Event 59: Overtemperature drive controller i2t

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Wrong drive controller design	Check the design and change the drive controller type if necessary
Increased or reduced mechanical friction	Check the service status of the mechanical system and service them if necessary
Short deceleration/ acceleration times	Check the actual current during the braking process using the scope image (E00); reduce the deceleration and acceleration values if necessary
Clock frequency too high	Check the utilization of the drive, taking into consideration derating and the configured clock frequency (E20, B24); reduce the configured clock frequency or replace the drive controller if necessary

Event 59 – Causes and actions

14.3.25 Event 60: Application event 0 – Event 67: Application event 7

The possible effects depend on the configured level (U100, U110, U120, U130, U140, U150, U160, U170):

- 0: Inactive
- 1: Message
- 2: Warning
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Application-specific	Application-specific

Events 60 – 67 – Causes and actions

14.3.26 Event 68: External fault 2

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Application-specific	Application-specific

Event 68 – Causes and actions

14.3.27 Event 69: Motor connection

The possible effects depend on the configured level (U12).

- 0: Inactive
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
2: No motor connected	Connection error	Check the connection and correct it if necessary
	Defective power cable	Check the cable and replace it if necessary

Event 69 – Causes and actions

14.3.28 Event 70: Parameter consistency

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
1: Wrong encoder model	Encoder model unsuitable for control type	Check the control mode, motor encoder and encoder and correct them if necessary (B20, B26, H parameters)
3: B12<->B20	Nominal current of the motor exceeds the drive controller nominal current (4 kHz)	Check the motor nominal current against 150% of the drive controller nominal current at a clock frequency of 4 kHz and, if necessary, reduce the motor nominal current or change the drive controller type (B12, R04[0])
4: B10<->H31	Unsupported combination of resolver/motor number of poles	Check number of poles of the resolver and number of poles of the motor and correct them if necessary (H08, H148, B10)
5: Negative slip frequency	Negative slip	Check the nominal velocity, nominal frequency and number of poles of the motor and, if necessary, correct them (B13, B15, B10)
8: v-max (I10) exeeds maximum (B83)	Maximum permitted velocity exceeds the maximum motor velocity	Check the maximum permitted velocity and the maximum motor velocity and correct them if necessary (I10, B83)
11: Reference retaining	Conditions for reference without tracking not met	Check that the reference is retained and that the measurement range covers the travel range and make corrections if necessary (I46, limited travel range I00: Software limit switches must be parameterized; infinite travel range I00: Measurement range must correspond to the revolution length Drive Based I01 or CiA 402 A568[1] or a whole multiple)
13: Motor temperature sensor	Unsupported temperature sensors	Check the motor temperature sensor type in the motor and the drive controller series and, if necessary, change the motor or drive controller series
14: I11>B143	Maximum permitted velocity is above maximum motor acceleration	Check the maximum permitted velocity and maximum motor acceleration and correct if necessary (Drive Based I11 or CiA 402 minimum (A604,A605), B143)

Cause		Check and action
15: FSoE watchdog time	Ratio of FSoE watchdog time to EtherCAT PDO timeout too small	Check the FSoE watchdog time in the FSoE master and EtherCAT PDO timeout in the drive controller; if necessary, increase the watchdog time or reduce the PDO timeout (guide value: FSoE watchdog time = EtherCAT PDO timeout + 100 ms; S27, A258)

Event 70 – Causes and actions

14.3.29 Event 71: Firmware

Cause 1:

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause 3:

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
1: Firmware defective	Defective firmware	Update the firmware; fault cannot be acknowledged
	Defective drive controller	Exchange drive controller; fault cannot be acknowledged
3: CRC-error	Defective firmware	Update the firmware; fault cannot be acknowledged

Event 71 – Causes and actions

14.3.30 Event 72: Brake test timeout

The possible effects depend on the cause. Cause 1 and 2 lead to a fault, cause 3 is output as a message.

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
1: B311timeout:B300 mandatory	Brake management is active and the timeout for the brake test runs out twice	Test the brake (B300, S18); can be acknowledged for a period of 5 min in order to be able to carry out the test brake action
2: Brake defective:B300 mandatory	Test holding torque not met during the test brake action	Bed in the brake (B301, B302) and repeat the brake test (B300, S18); can be acknowledged for a period of 5 min in order to be able to carry out the brake test
	Faulty encoder test run during test brake action	Replace the encoder or motor and repeat the brake test (B300, S18); can be acknowledged for a time period of 5 min in order to be able to carry out the brake test
3: Brake test necessary	Brake management is active and the timeout for the brake test runs out once	Carry out the test brake action (B300, S18); can be acknowledged for a period of 5 min in order to be able to carry out the brake test

Event 72 – Causes and actions

14.3.31 Event 76: Position encoder

The drive controller is interrupted if:

- U30 = 0: Inactive and
- A29 = 0: Inactive for Drive Based device controller
  or
- U30 = 1: Active and
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with emergency braking if:

- U30 = 1: Active and
- A29 = 1: Active for Drive Based device controller
  or
- U30 = 1: Active and
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by emergency braking; the brakes are applied in the event of an inactive release override (F06)
- At the end of emergency braking, the power unit is disabled and axis movement is no longer controlled by the drive controller

Emergency braking is only possible for the synchronous servo, torque and Lean motor types.

The reference is deleted (I86).

Cause		Check and action
1: Parameter <-> encoder	Inconsistent parameterization	Compare the specification of the connected encoder to the corresponding values of the H parameters and correct them if necessary
2: X4 speed	Exceeded encoder maximum velocity	Check the actual velocity during a movement using the scope image (E15) and adjust the permitted encoder maximum velocity if necessary (B297)
	Connection error	Check the connection and shielding and correct them if necessary
	Mass inertia ratio of load to Lean motor	Check the setting of the mass inertia ratio (C30) and reduce it if necessary
	Dynamic control of the Lean motor	Check the control settings; if necessary, reduce the gain (C31, I20) and increase the reset times (C32)
	Dynamic set values for the Lean motor	Check the dynamics of the application set values and reduce them if necessary
	Dynamic acceleration of the Lean motor	Check the switchover filter time constant and reduce it if necessary (B137)
6: X4 EnDat encoder found	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
7: X4 channel A/incremental	Connection error	Check the connection and correct it if necessary
8: X4 no encoder found	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Defective power supply	Check the encoder power supply and correct it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
9: Reference failed	Reference set for inactive Lean motor position determination	Check device status (E48) and, if necessary, activate the enable signal
10: X4 channel A/Clk – 11: X4 channel B/Dat	Defective encoder cable	Check the cable and replace it if necessary
14: X4 EnDat CRC – 15: X4 double transmission	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (I298)

Cause		Check and action
16: X4 busy	Defective encoder cable	Check the cable and replace it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the encoder or motor if necessary
17: EBI encoder low battery	Battery in battery module weak	Replace the battery; reference is not deleted by the event
18: EBI encoder battery empty	Battery in battery module empty	Replace the battery
	Initial connection	–
	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Faulty battery module	Check the battery module and replace it if necessary
20: Resolver carrier – 22: Resolver overvoltage	Defective encoder cable	Check the cable and replace it if necessary
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the encoder or motor if necessary; fault cannot be acknowledged
24: Resolver failure	Defective encoder cable	Check the cable and replace it if necessary
48: X4 zero pulse missing	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Late zero toe	Check number of encoder increments per rotation and correct it if necessary (H02)
49: X4 zero pulse distance too small	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Early zero track	Check number of encoder increments per rotation and correct it if necessary (H02)

Cause		Check and action
60: Hiperface synchronisation – 63: Hiperface link	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (I298)

Event 76 – Causes and actions

14.3.32 Event 77: Master encoder

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

The reference is deleted (G89).

Cause		Check and action
1: Parameter <-> encoder	Inconsistent parameterization	Compare the specification of the connected encoder to the corresponding values of the H parameters and correct them if necessary
2: X4 speed	Exceeded encoder maximum velocity	Check the actual velocity during a movement using the scope image (G105) and adjust the permitted encoder maximum velocity if necessary (G297)
	Connection error	Check the connection and shielding and correct them if necessary
6: X4 EnDat encoder found	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)

Cause		Check and action
7: X4 channel A/incremental	Connection error	Check the connection and correct it if necessary
8: X4 no encoder found	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Defective power supply	Check the encoder power supply and correct it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
10: X4 channel A/Clk – 11: X4 channel B/Dat	Defective encoder cable	Check the cable and replace it if necessary
13: X4-EnDat alarm	Defective EnDat encoder	Replace the encoder; fault cannot be acknowledged
14: X4 EnDat CRC – 15: X4 double transmission	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (G298)
16: X4 busy	Defective encoder cable	Check the cable and replace it if necessary
	Inconsistent parameterization	Compare the connected encoder to the parameterized encoder and correct it if necessary (H00)
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the encoder if necessary
17: EBI encoder low battery	Battery in battery module weak	Replace the battery; reference is not deleted by the event
18: EBI encoder battery empty	Battery in battery module empty	Replace the battery
	Initial connection	–
	Connection error	Check the connection and correct it if necessary
	Defective encoder cable	Check the cable and replace it if necessary
	Faulty battery module	Check the battery module and replace it if necessary
20: Resolver carrier – 22: Resolver overvoltage	Defective encoder cable	Check the cable and replace it if necessary
	Incompatible encoder	Compare the specification of the encoder with the corresponding specifications from Pilz and replace the encoder or motor if necessary; fault cannot be acknowledged

Cause		Check and action
24: Resolver failure	Defective encoder cable	Check the cable and replace it if necessary
48: X4 zero pulse missing	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Late zero toe	Check number of encoder increments per rotation and correct it if necessary (H02)
49: X4 zero pulse distance too small	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Early zero track	Check number of encoder increments per rotation and correct it if necessary (H02)
60: Hiperface synchronisation – 63: Hiperface link	Defective encoder cable	Check the cable and replace it if necessary
	Connection error	Check the connection and correct it if necessary
	Electromagnetic interference	Take EMC recommendations into account [115] and, if necessary, increase the fault tolerance (G298)

Event 77 – Causes and actions

14.3.33 Event 78: Position limit cyclic

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		**Check and action**
1: Illegal direction	Set position outside of the software limit switch	Check the set position in the controller and software limit switch in the drive controller and correct it if necessary (Drive Based I50, I51 or CiA 402 A570)
2: Reference value outside of circular length I01	Set position outside of the travel range	Check the set position in the controller and travel range in the drive controller and correct it if necessary (Drive Based I01 or CiA 402 A568)
3: Maximum extrapolation time I423 exceeded	Missing update of the set position	Check the task cycle time in the fieldbus master of the controller and maximum permitted extrapolation in the drive controller and correct it if necessary (I423)

Event 78 – Causes and actions

14.3.34 Event 79: Motor / position monitor

The possible effects depend on the configured level (U28).

- 0: Inactive
- 1: Message
- 3: Fault

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Connection error	Check the connection and shielding and correct them if necessary
Slip	Check the mechanics between the motor and position encoder and maximum permitted slip and correct them if necessary (I291, I292)
Mechanical damage	Check the mechanics between the motor and position encoder and correct any damage if necessary

Event 79 – Causes and actions

14.3.35 Event 80: Illegal action

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Cause		Check and action
1: Illegal	Not supported by the control type	Check the control type and correct it if necessary (B20)
2: Brake	Loaded axis	Remove the axis load and start the action again

Event 80 – Causes and actions

14.3.36 Event 81: Motor allocation

The drive controller is interrupted:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are no longer controlled by the drive controller and engage in the event of an inactive release override (F06)

Depending on the cause, data for the motor (in the case of a change to the motor or motor type), current controller (in the case of a change to the motor type), brake (in the case of a change to the brake or motor type), temperature sensor (in the case of a change to the temperature sensor or motor type) or motor adapter, gear unit and geared motor (in the case of a change to the gear unit type) are read out of the electronic nameplate and entered in the respective parameters. In the event of a change to the motor, motor type or even just the commutation, the commutation offset (B05) is reset.

Cause		Check and action
1: Different motor type	Modified motor assignment	Check the change to the motor assignment and save the new motor assignment if necessary (A00)
	Modified gear unit assignment	Check the change to the gear unit assignment and save the new assignment if necessary (A00)
32: Different motor – 131: Different brake & temperature sensor	Modified motor assignment	Check the change to the motor assignment and save the new assignment if necessary (A00)
Z781 – Z781	Modified motor and gear unit assignment	Check the change to the motor and gear unit assignment and save the new assignment if necessary (A00)
150: Temperature sensor unknown	Motor with unknown temperature sensor type	Update the firmware or change the motor

Event 81 – Causes and actions

14.3.37 Event 85: Excessive jump in reference value

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
1: Item	Fast set position change leads to acceleration that cannot be performed	Check the current set acceleration against the maximum permitted acceleration in the drive controller (E64, E69) and reduce the set value change in the controller or change the motor type if necessary
2: Velocity	Fast set velocity change leads to acceleration that cannot be performed	Check the current set acceleration against the maximum permitted acceleration in the drive controller (E64, E69) and reduce the set value change in the controller or change the motor type if necessary

Event 85 – Causes and actions

14.3.38 Event 86: Unknown LeanMotor record

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		Check and action
1: Motor	Motor type not supported by firmware	Update the firmware or change the motor (B100)
2: Cable length	Cable length not supported by firmware	Update the firmware or change the cable (B101)

Event 85 – Causes and actions

14.3.39 Event 87: Reference lostReference loss

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Power unit switched off on moving axis	Reference the drive again and, if necessary, only shut off the power unit when stationary (I199)
Actual position (motor) changes when power unit is shut off	Do not change the actual position (motor) when the power unit is shut off and, if applicable, switch to a motor with a brake (F00)

Event 87 – Causes and actions

14.3.40 Event 88: Control panel

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause	Check and action
Commissioning and parameterization computer heavily loaded	Check the number of open windows (DS6) and the number of active programs and reduce the number if necessary
Connection error	Check the connection and correct it if necessary
Defective network cable	Check the cable and replace it if necessary
Faulty network connection	Check the network settings and, if applicable, the switch, router or wireless connections and correct them or contact your network service provider if necessary

Event 88 – Causes and actions

14.3.41 Event 89: Maximum current Lm

The drive controller is interrupted if:

- A29 = 0: Inactive for Drive Based device controller
  or
- A540 = 0: disable drive, motor is free to rotate for CiA 402 device controller

Response:

- The power unit is disabled and axis movement is no longer controlled by the drive controller
- The brakes are applied in the event of an inactive release override (F06)

The drive controller is interrupted with a quick stop if:

- A29 = 1: Active for Drive Based device controller
  or
- A540 = 2: slow down on quick stop ramp for CiA 402 device controller

Response:

- The axis is stopped by a quick stop; meanwhile, the brakes remain released
- At the end of the quick stop, the power unit is disabled and the axis movement is no longer controlled by the drive controller; the brakes are applied in the event of an inactive release override (F06)

Cause		**Check and action**
1: Id – 2: Iq	Excessive controller gain at low speeds	Check the controller gain and speed controller factors and reduce them if necessary (I19, C31, B146, B147)

Event 89 – Causes and actions

15 Replacement

The following chapters describe the replacement of a drive controller and the available accessories.

15.1 Safety instructions for device replacement

Replacement work is permitted only when no voltage is present. Observe the 5 safety rules; see the chapter Working on the machine [21].

When the power supply voltage is turned on, hazardous voltages may be present on the connection terminals and the cables connected to them.

The device is not reliably de-energized simply because the voltage supply is switched off and all displays are blank!

Information

Note that you can only determine that voltage is no longer present once the discharge time has elapsed. The discharge time depends on the self-discharge of the drive controller and, if applicable, the fast discharge. You can find the discharge time in the general technical data.

Information

You can check the output voltage at the marked measuring points at the front of the housing of the PMC PS6 supply module that are used for the DC link connection of the drive controllers.

ATTENTION!

Material damage due to overload!

Insufficient electrical strength of the voltage measuring device can cause damage to or failure of the measuring device.

- Make sure that the measuring device has an electrical strength of at least 1000 V_{DC}.

Protect the devices against falling parts (bits or strands of wire, pieces of metal, etc.) during installation or other work in the control cabinet. Parts with conductive properties may result in a short circuit inside the devices and device failure as a result.

Opening the housing, plugging in or unplugging connection terminals, connecting or removing a connecting wiring, and installing or removing accessories are prohibited while the voltage supply is switched on.

Make sure that all Quick DC-Link modules are covered again after the replacement, i.e. built over with a PMC PS6 supply module or PMC SI6 drive controller.

The device housing must be closed before you turn on the supply voltage.

15.2 Replacing the drive controller

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

ATTENTION!

Loss of absolute position!

The absolute position in the encoder is lost if the encoder cable is disconnected from the PMC AES battery module.

- Do not disconnect the encoder cable from the PMC AES during service work! Disconnect the PMC AES from the drive controller.

Information

Note that the SD card from the drive controller being replaced can be re-used only for drive controllers of the same series.

Information

The safety module is a permanently integrated component in the drive controller where any design, technical and electrical modifications are prohibited!

Tools and material

You will need:

- Tool for loosening and tightening the fastening screws

Requirements and replacement

- ✓ Drive controllers of the same series and same power can be replaced interchangeably.
- ✓ The fieldbus variants of the firmware for the drive controller to be installed and to be replaced match. Information on differing fieldbus variants can be found in the chapter Changing the fieldbus using DS6 [254].
- ✓ The hardware and firmware of the drive controller to be installed is of the same or a newer version as that of the drive controller to be replaced. You can find information about firmware updates in chapter Updating firmware [252].
- ✓ Optional: The SD card is present in the drive controller being replaced; the original project is stored on the SD card. Or: The control unit of the drive controller being replaced still works; copy the original project to the SD card before removing the drive controller.

1. Optional: If an PMC AES battery module is present, disconnect the PMC AES from the drive controller.
2. Remove all terminals from the drive controller being uninstalled.
3. Loosen the fastening screws and take the drive controller out of the control cabinet.
4. Optional: Insert the SD card with the original project into the drive controller being installed.
5. Install the new drive controller in the control cabinet.
6. Connect the grounding conductor to the ground bolt of the supply module. Note the instructions and requirements in the chapter Protective grounding [112].
7. Reattach the terminals.
8. Optional: If an PMC AES battery module was present, attach it to the drive controller with the associated encoder cable. Tighten the knurled screws so that PMC AES is securely connected to the drive controller.
9. Optional: In order to be able to identify the PMC SY6 safety module in the FSoE network, you must transfer its unique address in the FSoE network from the replaced drive controller to the new drive controller (DIP switches). Further information can be found in the manual for the PMC SY6 safety module.

15.3 Replacing the supply module

WARNING!

Electrical voltage! Risk of fatal injury due to electric shock!

- Always switch off all power supply voltage before working on the devices!
- Note the discharge time of the DC link capacitors in the general technical data. You can only determine the absence of voltage after this time period.

Tool and material

You will need:

- Tool for loosening and tightening the fastening screws

Requirements and replacement

✓ Supply modules of the same series and same power can be replaced interchangeably.

✓ The hardware and firmware of the supply module being installed are of the same or a newer version than that of the supply module being uninstalled.

1. Remove all terminals from the supply module being uninstalled.
2. Loosen the fastening screws and take the supply module out of the control cabinet.
3. Install the new supply module in the control cabinet.
4. Reattach the terminals.

15.4 Updating firmware

Drive controllers from Pilz are normally delivered with the latest firmware version. You can use the DriveControlSuite commissioning software to update the firmware version of one or more drive controllers simultaneously and then monitor the successful update. On the other hand, if a PC with a network connection is not available at the drive controller location, you also have the option of using an SD card to transfer a more current firmware version.

15.4.1 Replacing or updating firmware using DS6

If you need a different firmware version or a drive controller needs to be updated with an older firmware version, you can change the firmware using the DriveControlSuite commissioning software. You can prepare a live firmware update while the drive controller and machine are operating. The update does not take effect until after a restart. This dual firmware behavior prevents a firmware loss or appearance of a case of service, since it ensures, for example, that the existing firmware can be accessed if the connection is interrupted.

In order to perform a live firmware update, you must connect your PC and the drive controller to the network.

✓ Your PC is connected to the drive controller. The drive controller is switched on.

1. Start DriveControlSuite.
2. Click Assignment and live firmware update.
   ⇨ The Add connection window opens.
3. Direct connection tab > IP address column:
   Activate the IP address in question or activate all listed using the context menu. Confirm your selection with OK.
   ⇨ The Assignment and live firmware update window opens. All drive controllers connected through the selected IP addresses are displayed.
4. Live firmware update tab:
   By default, the newest firmware version suitable for the DriveControlSuite version is selected.
   Click Assign default version to all drive controllers.
   ⇨ The selection No live firmware update for the drive controller changes to Default version.
5. Optional: If you want to assign an alternative, locally saved firmware version to a drive controller, proceed as follows:
   5.1. Click on Add new firmware version, navigate to the directory and load the file.
   5.2. Then change the selection from Default version of the drive controller to Alternative version and select the previously uploaded firmware version from the associated picklist.
6. Live firmware update tab:
   Click Start live firmware update.
7. Confirm the safety instruction with OK.
   ⇨ The firmware update is transferred.
8. Since the firmware update only takes effect after the drive controller is restarted, click Restart all drive controllers after completing the transfer.
9. Confirm the restart with Yes.

⇨ The fieldbus communication and connection to DriveControlSuite are interrupted and the drive controllers restart.

15.4.2 Updating firmware using an SD card

If you would like to update a drive controller with an older firmware version, but do not have access to a PC with a network connection, you can use an SD card to transfer a more current firmware version to the drive controller.

- ✓ Hardware and firmware of the drive controller being updated have at least Version 6.4-A.
- ✓ A more current version of DriveControlSuite is installed on your PC.
- ✓ Prepare an SD card with the more current firmware version: To do so, create the Firmware directory on the SD card. Then use Windows Explorer to copy the firmware.slf file from the installation directory of DriveControlSuite (C:\Program Files (x86)\STOBER\DriveControlSuite \Suite) into this directory. For information about usable SD cards, refer to the chapter X700: SD slot [📖 141].
- ✓ When a firmware file is being transferred using an SD card, the three LEDs flash in various combinations and frequencies. Information about this can be found in the chapter Drive controller state [📖 200].

1. Insert the prepared SD card into the drive controller to be updated.
2. Start the drive controller.
   - ⇨ The transfer of the firmware file begins.
3. Remove the SD card when the transfer is complete.
   - ⇨ The copying process is successfully completed as soon as the green LED of the drive controller flashes with a single blink.
4. Since the firmware update only takes effect after the drive controller is restarted, restart the drive controller after completing the transfer.

15.5 Changing the fieldbus using DS6

Fieldbus communication is determined by the firmware. The PMC SI6 drive controller is delivered with the firmware version in the required fieldbus variant. You can subsequently change the fieldbus using the DriveControlSuite commissioning software.

For warranty reasons, when changing the fieldbus, you are prompted to notify our service department by email about the change. The information relevant for this can be transferred directly from DriveControlSuite to your email program.

Information

Changing the fieldbus variant of the drive controller without contacting our Service department voids any warranty claims.

In order to perform a fieldbus change, you must connect your PC and the drive controller to the network.

✓ Your PC is connected to the drive controller. The drive controller is switched on.

1. Start DriveControlSuite.
2. Click Assignment and live firmware update.
   ⇨ The Add connection window opens.
3. Direct connection tab > IP address column:
   Activate the IP address in question or activate all listed using the context menu. Confirm your selection with OK.
   ⇨ The Assignment and live firmware update window opens. All drive controllers connected through the selected IP addresses are displayed.
4. Live firmware update tab:
   Change the drive controller selection of No live firmware update to Change fieldbus and click on Select fieldbus and start.
5. Confirm the safety instruction with OK.
   ⇨ The Select fieldbus and start dialog box opens.
6. Click on the Send email link to open your default email program. As an alternative, you can copy the information to the clipboard using the second link in order to paste it manually into your preferred email program.
7. Send the information to Pilz Service (replace@stoeber.de).
8. Then mark the option that indicates the email has been sent successfully in the dialog window and click on Start live update.
   ⇨ The firmware update is transferred.
9. Repeat steps 4 through 8 for each additional drive controller for which you want to change the fieldbus.
10. Since the firmware update only takes effect after the drive controller is restarted, click Restart all drive controllers after completing the transfer.
11. Confirm the restart with Yes.

⇨ The fieldbus communication and connection to DriveControlSuite are interrupted and the drive controllers restart.

16 Reverse documentation

If you have questions concerning commissioning and would like to contact our service department, start by first creating reverse documentation and send this to our Support email address.

16.1 Creating reverse documentation in a new project

✓ Your PC is connected to the drive controller.

✓ The drive controller is ready for operation.

1. Start DriveControlSuite.
2. Click on Read project.
   ⇨ The Add connection window opens.
3. Direct connection tab > IP address column:
   Activate the IP address in question or activate all listed using the context menu. Confirm your selection with OK.
   ⇨ The Assignment and live firmware update window opens. All drive controllers connected through the previously selected IP addresses are displayed.
4. Online tab:
   Click on Establish online connection.
   ⇨ The data connection is established and the project configuration data is transmitted from the drive controllers to the PC.
   ⇨ The drive controllers are created in the project tree and are active.
5. Then in the Assignment and live firmware update window > Online tab, click on Set all drive controllers to offline (with reverse documentation).
6. Confirm the Reverse documentation dialog box with OK.
   ⇨ The connection is disconnected.
   ⇨ The drive controllers are write-protected (lock status with red R).
7. Save the project in a local directory and send the file to us.

16.2 Loading reverse documentation in an existing project

- ✓ Your PC is connected to the drive controller.
- ✓ The drive controller is ready for operation.
- ✓ A project file for your drive system already exists.

1. Start DriveControlSuite.
2. Click on Open project.
3. Navigate to the directory and load the file.
4. In the project menu, click Assignment and live firmware update.
   - ⇨ The Add connection window opens.
5. Direct connection tab > IP address column:
   Activate the IP address in question or activate all listed using the context menu. Confirm your selection with OK.
   - ⇨ The Assignment and live firmware update window opens. All drive controllers connected through the previously selected IP addresses are displayed and are ignored by default for the data synchronization.
6. Online tab:
   Click Set all to read in order to activate all drive controllers for read data synchronization.
7. Click Assign all based on reference to assign all drive controllers to the configured drive controllers.
8. Then click Establish online connection.
   - ⇨ The data connection is established and the project configuration data is transmitted from the drive controllers to the PC.
   - ⇨ The drive controllers are created in the project tree and are active.
9. Then in the Assignment and live firmware update window > Online tab, click on Set all drive controllers to offline (with reverse documentation).
10. Confirm the Reverse documentation dialog box with OK.
    - ⇨ The connection is disconnected.
    - ⇨ The drive controllers are write-protected (lock status with red R).
11. Save the project in a local directory and send the file to us.

17 Appendix

17.1 Weights

Description	Type		Weight without packaging [g]	Weight with packaging [g]
Single-axis controller sz. 0	PMC SI6A061	EC	2980	4600
		PN		
Double-axis controller sz. 0	PMC SI6A062	EC	3460	5060
		PN		
Single-axis controller sz. 1	PMC SI6A161	EC	3880	5260
		PN		
Double-axis controller sz. 1	PMC SI6A162	EC	4820	6240
		PN		
Single-axis controller sz. 2	PMC SI6A261	EC	4760	6200
		PN		
Double-axis controller sz. 2	PMC SI6A262	EC	6240	7420
		PN		
Single-axis controller sz. 3	PMC SI6A361	EC	6180	7360
		PN		
Supply module sz. 2	PMC PS6A24		2680	4180
Supply module sz. 3	PMC PS6A34		3820	4920
Terminal set for supply module or drive controller	All		100	100
Quick DC-Link for supply module sz. 2	PMC DL6B20		480	520
Quick DC-Link for supply module sz. 3	PMC DL6B21		740	780
Quick DC-Link for drive controller sz. 0	PMC DL6B10		440	480
Quick DC-Link for drive controller sz. 1 or 2 (single-axis controller)	PMC DL6B11		560	600
Quick DC-Link for drive controller sz. 2 (double-axis controller) or 3	PMC DL6B12		880	920
Quick DC-Link insulation end section	—		50	50
Option module without safety technology	PMC SZ6		50	50
Safety module — STO using terminals	PMC SR6		50	50
Safety module — STO and SS1 using FSoE	PMC SY6		50	50
EtherCAT cable approx. 0.2 m	—		15	15
EtherCAT cable approx. 0.35 m	—		20	20
PC connecting cables	—		190	190
USB 2.0 Ethernet adapter	—		50	50

Description	Type	Weight without packaging [g]	Weight with packaging [g]
Braking resistor	PMC KWADQU 420×91	2600	2600
	PMC FZZMQU 400×65	4200	4200
	PMC FGFKQU 31005	7500	7500
Power choke	PMC TEP4010-2US00	9900	9900
Output choke	PMC TEP3720-0ES41	2900	2900
	PMC TEP3820-0CS41	5900	5900
	PMC TEP4020-0RS41	8800	8800
Battery module	PMC AES	60	60
HTL-to-TTL adapter	PMC HT6	30	30
Interface adapters	PMC AP6A00	30	30

Weights of PMC PS6, PMC SI6 and accessories

17.2 Terminal specifications

Relevant information for projecting the connecting wiring can be taken from the following chapters.

DIN EN 60204-1 contains basic recommendations that should be taken into account when selecting conductors. The chapter "Conductors and cables" provides specifications for the maximum current carrying capacity of conductors based on the way they are laid as well as tips for derating, for example in the case of increased surrounding temperatures or lines with multiple loaded individual conductors.

> **WARNING!**
>
> **Risk of personal injury or material damage due to electric shock and thermal overload!**
>
> - Prepare the conductor ends according to the terminal specifications.
> - In the case of pre-made cables and conductors, check the conductor ends and adjust them if necessary.

17.2.1 Overview

The following tables clarify which specifications must be observed for which connections depending on the type of drive controller and accessory as well as the supply module.

Drive controller

<table>
<tr><th>Type</th><th>X2A, X2B</th><th>X11, X300</th><th>X20A, X20B</th><th>X22</th><th>X101, X103</th></tr>
<tr><td>PMC SI6A061</td><td rowspan="5">BCF 3,81 180 SN [262]</td><td rowspan="7">BLDF 5.08 180 SN [263]</td><td rowspan="3">GFKC 2,5 - ST-7,62 [264]</td><td rowspan="3">ISPC 5 - STGCL-7,62 [265]</td><td rowspan="7">FMC 1,5 - ST-3,5 [261]</td></tr>
<tr><td>PMC SI6A062</td></tr>
<tr><td>PMC SI6A161</td></tr>
<tr><td>PMC SI6A162</td><td rowspan="2">SPC 5 - ST-7,62 [265]</td><td rowspan="2">ISPC 16 - ST-10,16 [266]</td></tr>
<tr><td>PMC SI6A261</td></tr>
<tr><td>PMC SI6A262</td><td rowspan="2">BFL 5.08HC 180 SN [262]</td><td rowspan="2">SPC 16 - ST-10,16 [266]</td><td rowspan="2">BUZ 10.16IT 180 MF [267]</td></tr>
<tr><td>PMC SI6A361</td></tr>
</table>

Terminal specifications for the base device

Safety technology

Type	X12
PMC SR6	BCF 3,81 180 SN [262]

Terminal specifications of the safety technology

Supply module

Type	X10	X11	X21	X22	X23	X100
PMC PS6A24	SPC 16 -ST-10,16 [266]	BLDF 5.08 180 SN [263]	ISPC 5 -STGCL-7,62 [265]	ISPC 5 -STGCL-7,62 [265]	FKC 2,5 -ST-5,08 [263]	FMC 1,5 -ST-3,5 [261]
PMC PS6A34	BUZ 10.16IT 180 MF [267]			BUZ 10.16IT 180 MF [267]		

Terminal specifications for the supply module

17.2.2 FMC 1,5 -ST-3,5

Feature	Line type	Value
Contact spacing	—	3.5 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 8 A
Max. conductor cross-section	Flexible without end sleeve	1.5 mm²
	Flexible with end sleeve without plastic collar	1.5 mm²
	Flexible with end sleeve with plastic collar	0.75 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	16
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	24
Insulation stripping length	—	10 mm
Tightening torque	—	—

FMC 1,5 -ST-3,5 specification

17.2.3 BCF 3,81 180 SN

Feature	Line type	Value
Contact spacing	—	3.81 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 16 A/10 A/11 A
Max. conductor cross-section	Flexible without end sleeve	1.5 mm²
	Flexible with end sleeve without plastic collar	1.0 mm²
	Flexible with end sleeve with plastic collar	1.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	16
Min. conductor cross-section	Flexible without end sleeve	0.14 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	26
Insulation stripping length	—	10 mm
Tightening torque	—	—

BCF 3.81 180 SN BK specification

17.2.4 BFL 5.08HC 180 SN

Feature	Line type	Value
Contact spacing	—	5.08 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 16 A/10 A/10 A
Max. conductor cross-section	Flexible without end sleeve	2.5 mm²
	Flexible with end sleeve without plastic collar	2.5 mm²
	Flexible with end sleeve with plastic collar	2.5 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	12
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.2 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	26
Insulation stripping length	—	10 mm
Tightening torque	—	—

BFL 5.08HC 180 SN specification

17.2.5 BLDF 5.08 180 SN

Feature	Line type	Value
Contact spacing	—	5.08 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 14 A/10 A/10 A
Max. conductor cross-section	Flexible without end sleeve	2.5 mm²
	Flexible with end sleeve without plastic collar	2.5 mm²
	Flexible with end sleeve with plastic collar	2.5 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	12
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.2 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	—
	AWG according to UL/CSA	26
Insulation stripping length	—	10 mm
Tightening torque	—	—

BLDF 5.08 180 SN specification

17.2.6 FKC 2,5 -ST-5,08

Feature	Line type	Value
Contact spacing	—	5.08 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 12 A/10 A/10 A
Max. conductor cross-section	Flexible without end sleeve	2.5 mm²
	Flexible with end sleeve without plastic collar	2.5 mm²
	Flexible with end sleeve with plastic collar	2.5 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	1.0 mm²
	AWG according to UL/CSA	12
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.5 mm²
	AWG according to UL/CSA	26
Insulation stripping length	—	10 mm
Tightening torque	—	—

Specification for FKC 2,5 -ST-5,08

17.2.7 GFKC 2,5 -ST-7,62

Feature	Line type	Value
Contact spacing	—	7.62 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 12 A/10 A/10 A
Max. conductor cross-section	Flexible without end sleeve	2.5 mm²
	Flexible with end sleeve without plastic collar	2.5 mm²
	Flexible with end sleeve with plastic collar	2.5 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	1.0 mm²
	AWG according to UL/CSA	12
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.5 mm²
	AWG according to UL/CSA	26/24
Insulation stripping length	—	10 mm
Tightening torque	—	—

GFKC 2,5 -ST-7,62 specification

17.2.8 GFKIC 2.5 -ST-7.62

Feature	Line type	Value
Contact spacing	—	7.62 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 12 A/10 A/10 A
Max. conductor cross-section	Flexible without end sleeve	2.5 mm²
	Flexible with end sleeve without plastic collar	2.5 mm²
	Flexible with end sleeve with plastic collar	2.5 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	1.0 mm²
	AWG according to UL/CSA	12
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.5 mm²
	AWG according to UL/CSA	26
Insulation stripping length	—	10 mm
Tightening torque	—	—

Specification for GFKIC 2.5 -ST-7.62

17.2.9 SPC 5 -ST-7,62

Feature	Line type	Value
Contact spacing	—	7.62 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 32 A/35 A/35 A
Max. conductor cross-section	Flexible without end sleeve	6.0 mm²
	Flexible with end sleeve without plastic collar	6.0 mm²
	Flexible with end sleeve with plastic collar	4.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	1.5 mm²
	AWG according to UL/CSA	8
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.25 mm²
	AWG according to UL/CSA	24
Insulation stripping length	—	12 – 15 mm
Tightening torque	—	—

SPC 5 -ST-7,62 specification

17.2.10 ISPC 5 -STGCL-7,62

Feature	Line type	Value
Contact spacing	—	7.62 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 32 A/35 A/35 A
Max. conductor cross-section	Flexible without end sleeve	6.0 mm²
	Flexible with end sleeve without plastic collar	6.0 mm²
	Flexible with end sleeve with plastic collar	4.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	1.5 mm²
	AWG according to UL/CSA	8
Min. conductor cross-section	Flexible without end sleeve	0.2 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.25 mm²
	AWG according to UL/CSA	24
Insulation stripping length	—	15 mm
Tightening torque	—	—

ISPC 5 -STGCL-7,62 specification

17.2.11 SPC 16 -ST-10,16

Feature	Line type	Value
Contact spacing	—	10.16 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 55 A/66 A/66 A
Max. conductor cross-section	Flexible without end sleeve	16.0 mm²
	Flexible with end sleeve without plastic collar	16.0 mm²
	Flexible with end sleeve with plastic collar	10.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	4.0 mm²
	AWG according to UL/CSA	4
Min. conductor cross-section	Flexible without end sleeve	0.75 mm²
	Flexible with end sleeve without plastic collar	0.75 mm²
	Flexible with end sleeve with plastic collar	0.75 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.75 mm²
	AWG according to UL/CSA	20
Insulation stripping length	—	18 mm
Tightening torque	—	—

SPC 16 -ST-10,16 specification

17.2.12 ISPC 16 -ST-10,16

Feature	Line type	Value
Contact spacing	—	10.16 mm
Nominal current at ϑ_{amb} = 40 °C	—	CE/UL/CSA: 55 A/66 A/66 A
Max. conductor cross-section	Flexible without end sleeve	16.0 mm²
	Flexible with end sleeve without plastic collar	16.0 mm²
	Flexible with end sleeve with plastic collar	10.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	4.0 mm²
	AWG according to UL/CSA	4
Min. conductor cross-section	Flexible without end sleeve	0.75 mm²
	Flexible with end sleeve without plastic collar	0.75 mm²
	Flexible with end sleeve with plastic collar	0.75 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	0.75 mm²
	AWG according to UL/CSA	20
Insulation stripping length	—	18 mm
Tightening torque	—	—

SPC 16 -ST-10,16 specification

17.2.13 BUZ 10.16IT 180 MF

Feature	Line type	Value
Contact spacing	–	10.16 mm
Nominal current at ϑ_{amb} = 40 °C	–	CE/UL/CSA: 61 A/60 A/60 A
Max. conductor cross-section	Flexible without end sleeve	16.0 mm²
	Flexible with end sleeve without plastic collar	16.0 mm²
	Flexible with end sleeve with plastic collar	10.0 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	–
	AWG according to UL/CSA	4
Min. conductor cross-section	Flexible without end sleeve	0.5 mm²
	Flexible with end sleeve without plastic collar	0.25 mm²
	Flexible with end sleeve with plastic collar	0.25 mm²
	2 conductors, flexible, with double end sleeve with plastic collar	–
	AWG according to UL/CSA	22
Insulation stripping length	–	12 mm
Tightening torque	–	2.0 Nm (18 Lb.inch)

Specification for BUZ 10.16IT 180 MF

17.3 Wiring examples

The following chapters show the basic connection using examples.

Information

For UL-compliant operation: The connections marked with PE are intended solely for the functional grounding.

17.3.1 Operation with 1 supply module

The following graphic shows the principal connection of a PMC PS6 supply module and an PMC SI6 drive controller based on a DC link connection with PMC DL6B Quick DC-Link.

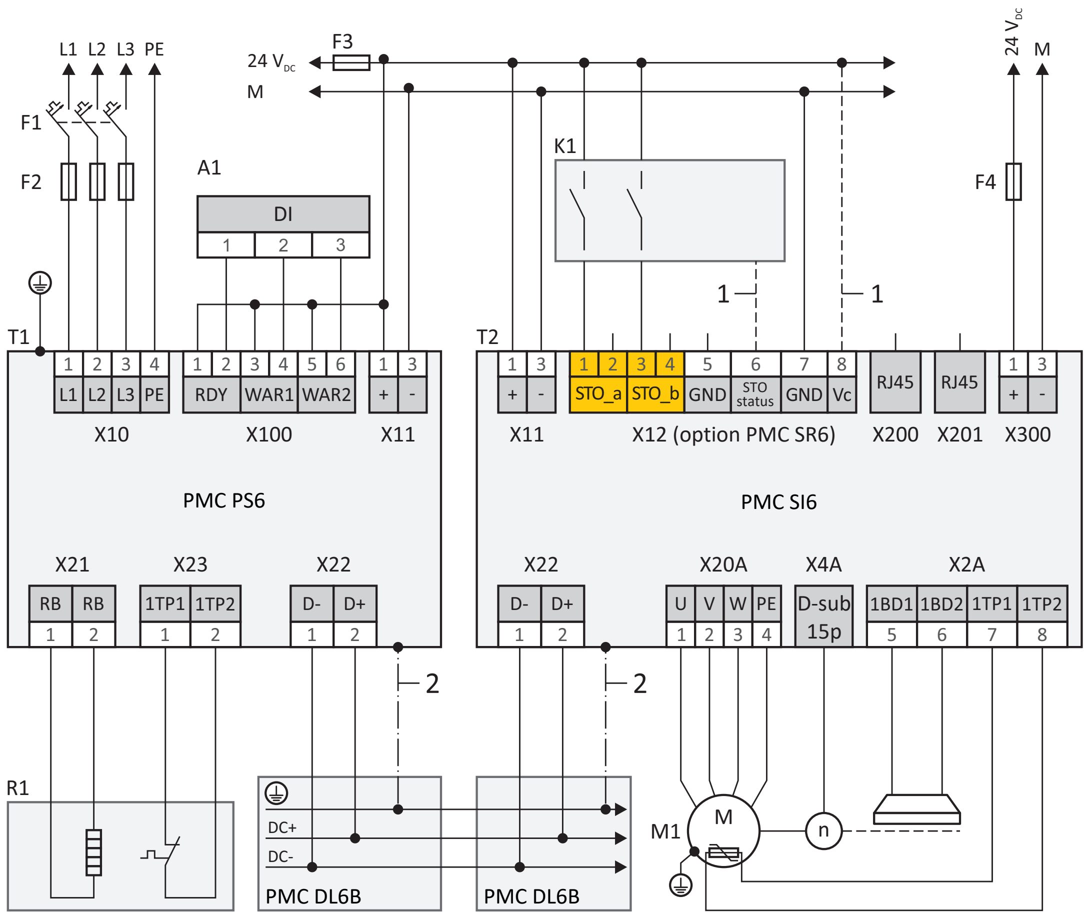


Fig. 69: Wiring example with one supply module and one drive controller

A1	Controller
F1 – F4	Fuse
K1	Safety relay
L1 – L3	Three-phase power supply
M	Reference ground
M1	Motor
R1	Braking resistor
T1	Supply module
T2	Drive controller
1	Optional connection
2	Spring-loaded contact between PMC DL6B and PMC PS6 or PMC SI6

For UL-compliant operation:

The protective grounding of motors connected to the drive controller must not be connected using terminals X20A and X20B. The grounding conductor connection of the motor must be ensured for the respective application in accordance with the valid electrical standards.

17.3.2 Parallel connection

The following graphic shows the principal connection of 3 PMC PS6 supply modules and several PMC SI6 drive controllers based on the DC link connection with PMC DL6B Quick DC-Link.

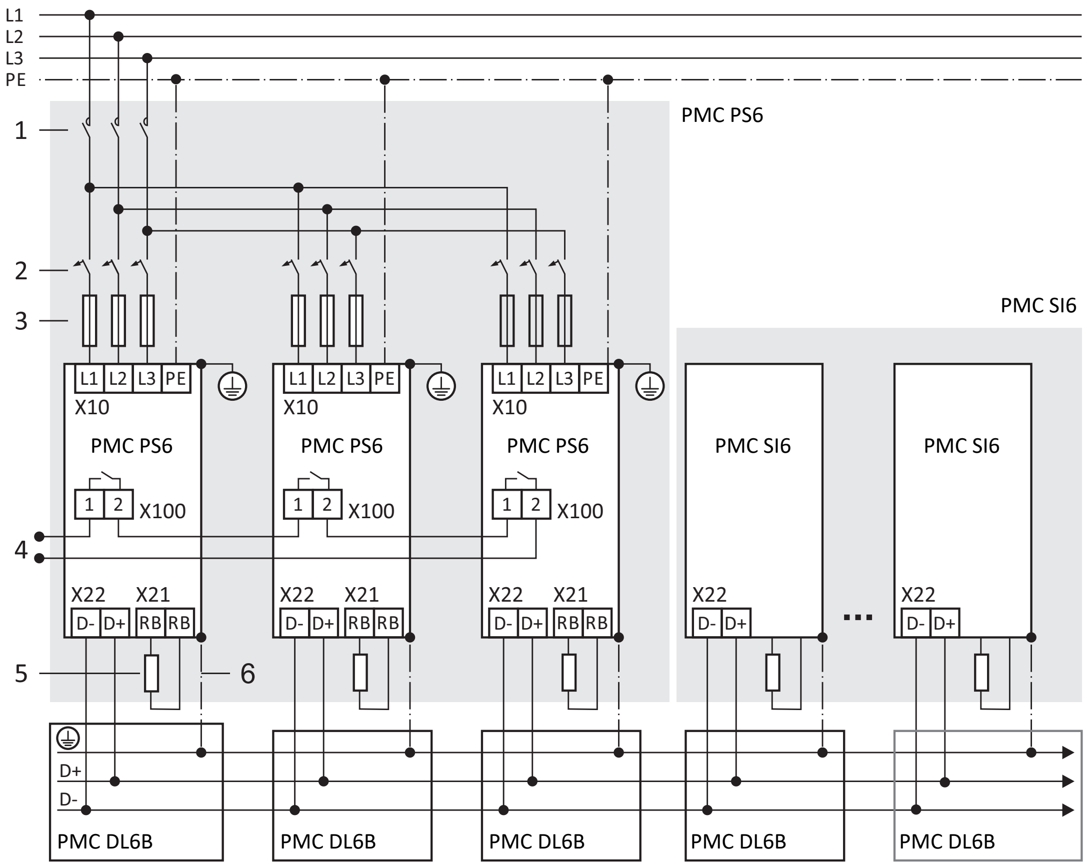


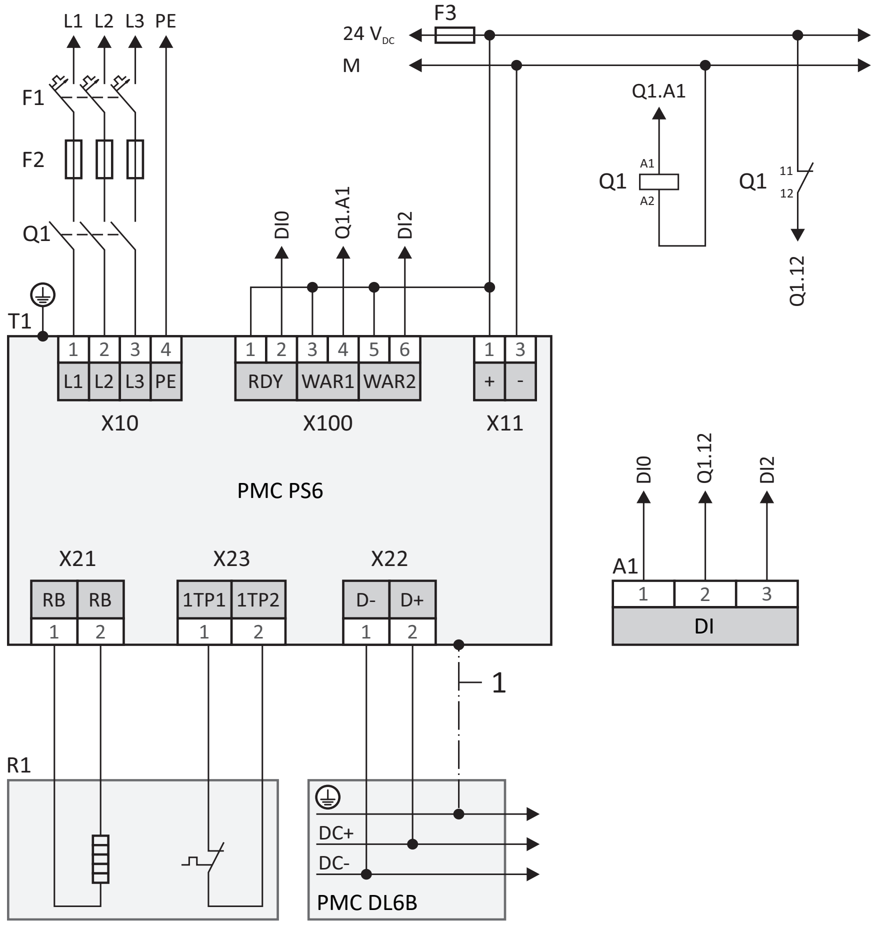
Fig. 70: Wiring example with supply modules connected in parallel

1 Contactor
2 Overload protection
3 Short-circuit protection
4 Status relay
5 Braking resistor
6 Spring-loaded contact between PMC DL6B and PMC PS6 or PMC SI6

For UL-compliant operation:

A single PMC PS6A24 or PMC PS6A34 supply module converts the 3-phase AC input voltage into a common DC bus output voltage, which can be used to feed one or more PMC SI6 drive controllers.

17.3.3 UL-compliant connection of the supply module



A1	Controller
F1 – F3	Fuse
L1 – L3	Three-phase power supply
T1	Supply module
R1	Braking resistor
Q1	Circuit breakers
1	Spring-loaded contact between PMC DL6B and PMC PS6

For project configuration of the braking resistor, observe the notes in the chapter UL-compliant use.

For UL-compliant operation:

The grounding at terminal X10 of the PMC PS6 supply module must not be used for the protective grounding of the PMC PS6 drive system in combination with PMC SI6. The housing for the PMC PS6 supply modules must be connected to the protective grounding using the M6 ground bolt (4.0 Nm, 35 Lb.inch).

17.4 Example design for UL-compliant operation

The information and examples in this chapter are based on an input voltage of 480 V_{AC}. For a more detailed design, SERVOsoft is helpful mechanical and electrical sizing software for drive systems.

The maximum number of devices in the device group is limited by certain variables. The nominal output current $I_{2N,PU}$ of the supply module, the charging capacity C_{PU} of the supply module and the maximum copper rail length of 1500 mm must not be exceeded.

The following rules must be observed when determining the maximum number of devices and the total load of the modular drive system:

- The sum of all input currents of the drive controllers connected to the supply module must not exceed the maximum nominal output current of the supply module.
- The sum of the self-capacitance of the drive controllers connected to the supply module must not exceed the maximum charging capacity of the supply module.
- The total length of the copper rails used for the device group must not exceed 1500 mm.

Type	Charging capacity C_{max} [µF]
PMC PS6A24	5000
PMC PS6A34	10000

Maximum charging capacity of the PMC PS6 supply module

Type	Self-capacitance C_{PU} [µF]
PMC SI6A061	180
PMC SI6A062	270
PMC SI6A161	470
PMC SI6A162	940
PMC SI6A261	940
PMC SI6A262	2250
PMC SI6A361	2250

Self-capacitance of the PMC SI6 drive controllers connected to the PMC PS6 supply module

17.4.1 Maximum operation on PMC PS6A24

Drive controller				Quick DC-Link	Limiting factor			Examples[22]	
Type	Self-capacitance C_{PU} [µF]	Nominal input current (DC) $I_{1N,PU}$ [A][23]	Width [mm]	Type	Charging capacity ($C_{max,PU}$ = 5000 µF)	Nominal output current ($I_{2N,PU}$ = 21.4 A)	Length of the copper rails [max. 1500 mm]	Partial load of 50%	Partial load of 25%
PMC SI6A061	180	4.2	45	PMC DL6B10	27 devices	5 devices	32 devices	10 devices	20 devices
PMC SI6A062	270	8.4	45	PMC DL6B10	18 devices	2 devices	32 devices	5 devices	10 devices
PMC SI6A161	470	10.4	65	PMC DL6B11	10 devices	2 devices	22 devices	4 devices	8 devices
PMC SI6A162	940	20.7	65	PMC DL6B11	5 devices	1 device	22 devices	2 devices	4 devices
PMC SI6A261	940	19.0	65	PMC DL6B11	5 devices	1 device	22 devices	2 devices	4 devices
PMC SI6A262	2250	41.2	105	PMC DL6B12	2 devices	0 devices	13 devices	1 device	2 devices
PMC SI6A361	2250	41.2	105	PMC DL6B12	2 devices	0 devices	13 devices	1 device	2 devices

Maximum operation on a PMC PS6A24 supply module with PMC DL6B20 rear section module

[22] Different partial loads and different configurations are also possible, please observe the rules described.
[23] Measured value

17.4.2 Maximum operation on PMC PS6A34

Drive controller				Quick DC-Link	Limiting factor			Examples[24]	
Type	Self-capacitance C_{PU} [µF]	Nominal input current (DC) $I_{1N,PU}$ [A][25]	Width [mm]	Type	Charging capacity ($C_{max,PU}$ = max. 10000 µF)	Nominal output current ($I_{2N,PU}$ = max. 42.8 A)	Length of the copper rails [max. 1500 mm]	Partial load of 50%	Partial load of 25%
PMC SI6A061	180	4.2	45	PMC DL6B10	55 devices	10 devices	32 devices	20 devices	40 devices
PMC SI6A062	270	8.4	45	PMC DL6B10	37 devices	5 devices	32 devices	10 devices	20 devices
PMC SI6A161	470	10.4	65	PMC DL6B11	21 devices	4 devices	22 devices	8 devices	16 devices
PMC SI6A162	940	20.7	65	PMC DL6B11	10 devices	2 devices	22 devices	4 devices	8 devices
PMC SI6A261	940	19.0	65	PMC DL6B11	10 devices	2 devices	22 devices	4 devices	8 devices
PMC SI6A262	2250	41.2	105	PMC DL6B12	4 devices	1 device	13 devices	2 devices	3 devices
PMC SI6A361	2250	41.2	105	PMC DL6B12	4 devices	1 device	13 devices	2 devices	3 devices

Maximum operation on a PMC PS6A34 supply module with PMC DL6B21 rear section module

[24] Different partial loads and different configurations are also possible, please observe the rules described.
[25] Measured value

17.4.3 Sample calculation

Assume 20 motors, each with a nominal current of 2 A and an operating time of 100% (full load). The design calls for 10 double-axis controllers of type PMC SI6A062 with a nominal output current of 2 × 5 A.

1. Checking the self-capacitance of the drive controllers versus the charging capacity of the supply module

The DC link capacitance in the group to be charged corresponds to the sum of the self-capacitances of all drive controllers in the group: 10 × 270 μF = 2700 μF.

The maximum charging capacity of the PMC PS6A24 supply module is 5 mF.

This means one PMC PS6A24 supply module is sufficient.

2. Determining current requirements and checking utilization

The nominal input current (DC) of a PMC SI6A062 is 8.4 A; the nominal output current is 5 A per axis. The motor's nominal current is 2 A.

The current requirement for the specific application is 8.4 A ÷ 5 A × 2 A = 3.36 A per drive controller. As a result, 10 drive controllers would need 33.6 A.

The nominal input current of a PMC PS6A24 supply module is 21 A; the nominal input current of a PMC PS6A34 is 42 A.

The PMC PS6A24 supply module is not sufficient for the current requirements. A PMC PS6A34 supply module is needed.

3. Checking the length of the copper rails

The width of an PMC SI6A062 drive controller is 45 mm; the width of the PMC PS6A34 supply module is 65 mm.

The total length of the group corresponds to: 10 × 45 mm + 65 mm − 2 × 2.5 mm = 510 mm.

At 1500 mm, the length of a standard copper rail is sufficient.

17.5 Order overview of the hardware components

Note that the basic device is delivered without terminals. Suitable terminal sets are available separately for each size.

Device			Safety technology	Terminal set	Quick DC-Link		
Type	**Option**	**ID No.**	**Option**	**ID No.**	**Type**	**ID No.**	**Width [mm]**
PMC PS6A24	—	8C000001	—	8C000002	PMC DL6B20	8C000089	45
PMC PS6A34	—	8C000003	—	8C000004	PMC DL6B21	8C000090	65
PMC SI6A061	EtherCAT (EC)	8C000011	PMC SZ6[a)]	8C000006	PMC DL6B10	8C000086	45
		8C000009	PMC SY6[b)]				
		8C000007	PMC SR6[c)]	8C000005			
	PROFINET (PN)	8C000012	PMC SZ6	8C000006	PMC DL6B10	8C000086	45
		8C000010	PMC SY6				
		8C000008	PMC SR6	8C000005			
PMC SI6A062	EC	8C000019	PMC SZ6	8C000014	PMC DL6B10	8C000086	45
		8C000017	PMC SY6				
		8C000015	PMC SR6	8C000013			
	PN	8C000020	PMC SZ6	8C000014	PMC DL6B10	8C000086	45
		8C000018	PMC SY6				
		8C000016	PMC SR6	8C000013			
PMC SI6A161	EC	8C000027	PMC SZ6	8C000022	PMC DL6B11	8C000087	65
		8C000025	PMC SY6				
		8C000023	PMC SR6	8C000021			
	PN	8C000028	PMC SZ6	8C000022	PMC DL6B11	8C000087	65
		8C000026	PMC SY6				
		8C000024	PMC SR6	8C000021			
PMC SI6A162	EC	8C000035	PMC SZ6	8C000030	PMC DL6B11	8C000087	65
		8C000033	PMC SY6				
		8C000031	PMC SR6	8C000029			
	PN	8C000036	PMC SZ6	8C000030	PMC DL6B11	8C000087	65
		8C000034	PMC SY6				
		8C000032	PMC SR6	8C000029			
PMC SI6A261	EC	8C000043	PMC SZ6	8C000038	PMC DL6B11	8C000087	65
		8C000041	PMC SY6				
		8C000039	PMC SR6	8C000037			
	PN	8C000044	PMC SZ6	8C000038	PMC DL6B11	8C000087	65
		8C000042	PMC SY6				
		8C000040	PMC SR6	8C000037			

Device			Safety technology	Terminal set	Quick DC-Link		
Type	**Option**	**ID No.**	**Option**	**ID No.**	**Type**	**ID No.**	**Width [mm]**
PMC SI6A262	EC	8C000051	PMC SZ6	8C000046	PMC DL6B12	8C000088	105
		8C000049	PMC SY6				
		8C000047	PMC SR6	8C000045			
	PN	8C000052	PMC SZ6	8C000046	PMC DL6B12	8C000088	105
		8C000050	PMC SY6				
		8C000048	PMC SR6	8C000045			
PMC SI6A361	EC	8C000059	PMC SZ6	8C000054	PMC DL6B12	8C000088	105
		8C000057	PMC SY6				
		8C000055	PMC SR6	8C000053			
	PN	8C000060	PMC SZ6	8C000054	PMC DL6B12	8C000088	105
		8C000058	PMC SY6				
		8C000056	PMC SR6	8C000053			

Overview of hardware components with ID No.

a) PMC SZ6 option: Without safety technology

b) PMC SY6 safety module: STO and SS1 using FSoE

c) PMC SR6 safety module: STO using terminals

For each device group, another two insulation end sections are needed for the left and right termination of the Quick DC-Link modules (ID No. 8C000085, 2 pieces).

The quick fastening clamps for attaching the copper rails and an insulation connection piece are contained in the scope of delivery of the Quick DC-Link.

All delivered components (drive controllers, supply modules and accessories) are marked to make it easy to assign connected components (e.g. assignment of a terminal set to the drive controller or supply module).

Copper rails

Each device group requires 3 copper rails (DC+, DC−, grounding). The copper rails (EATON CU12X5 034121) with a standard length of 1500 mm must be ordered from Pilz under the ID No. on request.

The required length of the copper rails corresponds to the total length of the group minus 5 mm:

- V = Number of PMC DL6B20 × 45 mm
- W = Number of PMC DL6B21 × 65 mm
- X = Number of PMC DL6B10 × 45 mm
- Y = Number of PMC DL6B11 × 65 mm
- Z = Number of PMC DL6B12 × 105 mm

Total length = V + W + X + Y + Z − 5 mm

Ensure that the length of at least 3 of the ordered copper rails is sufficient for the calculated total length. During installation, the copper rails must be cut to the actual length of the device group; see the chapter Length of copper rails [98].

17.6 Device addressing

MAC address

A MAC address consists of a fixed and a variable portion. The fixed portion designates the manufacturer and the variable portion distinguishes the individual network nodes and must be universally unique.

The MAC addresses of the interfaces are issued by STOBER and cannot be changed.

Information

The MAC address range of the STOBER hardware is: 00:11:39:00:00:00 – 00:11:39:FF:FF:FF

IP address – Value range

An IPv4 address always consists of 4 decimal numbers, each in a range from 0 to 255, and separated by periods. It must be unique within a (sub)network.

Subnet and subnet mask – Value range

Subnets are created in order to provide standalone networks with their own address range. Each IP address is divided into a network and host address. The subnet mask determines where this division takes place.

Like the IP address, the subnet mask consists of 4 decimal numbers, each in a range from 0 to 255, separated by periods.

Assignment for direct connection

In the default factory settings, both the IP address and the subnet mask are automatically assigned by DriveControlSuite or using DHCP for a direct connection. Alternatively, you can switch to manual parameterization using parameter A166.

The active address is displayed in parameter A157 and the active subnet mask in parameter A158.

Assignment for fieldbus connection

Note that the IP address and subnet mask are assigned by the controller for a fieldbus connection.

17.7 DriveControlSuite

The DriveControlSuite commissioning software uses wizards to guide you step by step through the installation process. You can find more detailed information on the system requirements and installation in the following chapters.

17.7.1 System requirements

The following minimum requirements for the PC system apply to the installation and operation of the DriveControlSuite commissioning software and the integrated PASmotion component for configuring the PMC SE6 safety module:

- Operating system: Windows 7 SP1 (32-bit, 64-bit), Windows 10 (32-bit, 64-bit *)
- Processor: Intel Pentium 4 (2 GHz, Dual Core) or equivalent
- Memory: 2 GB
- Free disk space on the hard disk: 1 GB
- Graphics: 1024 × 768 pixel resolution, 65536 colors
- Font size: 100% (default)
- Interfaces: 100 Mbps Ethernet (Fast Ethernet, copper)
- Display of documentation: Adobe Acrobat Reader version 7.1.0 or later**

*) Only DriveControlSuite

**) Only PASmotion

17.7.2 Installation types

Choose between one of two installation types for the installation.

Standard installation

Select this installation type if you want to install the latest version of DriveControlSuite.

DriveControlSuite is installed in the version-independent .../Programme/STOBER/DriveControlSuite/ directory. During the installation process, you do not need to specify any additional installation instructions.

Provided that you are connected to the Internet, a check is performed prior to installation to determine if a newer software version is available. If a newer version is already available, it is downloaded and installed in place of the started version.

If an older software version is already installed on your PC, it is deleted prior to installation. However, if the latest version is already installed on your PC, a new installation is not performed.

User-defined installation

Select this installation type if you want to install a specific version of DriveControlSuite or if you still need an older version that is already installed on your PC.

You can use this setting to change the default installation directory and manage the version-dependent destination folders.

Checking whether the software version is up-to-date before installation is optional.

17.7.3 Installing software

You can find current versions of DriveControlSuite at https://www.pilz.com/en-INT.

> **Information**
>
> If you use the expanded safety function via the PMC SE6 safety module, you also need the PASmotion component integrated into DriveControlSuite. To this end, the PASmotion installation wizard starts at the end of the DriveControlSuite installation process. You can either perform installation of the component for the safety configuration or cancel it if you do not need it.

Installing DriveControlSuite

✓ You must have administrator rights to perform the installation.

1. Save the setup file in any directory on your PC.
2. Exit all versions of DriveControlSuite if they have already been started.
3. Run the setup file and follow the installation instructions.
4. Optional: If you use the expanded safety function via the PMC SE6 safety module, click Next and follow the installation instructions after the PASmotion installation wizard has started.
5. Confirm the communication test.

   ⇨ If a firewall is active, you will receive a safety instruction.
6. In this case, enable all associated checkboxes to permit communication in DriveControlSuite in public and private networks.
7. Exit the installation and start DriveControlSuite.

17.7.4 Structure of the program interface

The DriveControlSuite commissioning software (DS6) offers a graphic interface that you can use to project, parameterize and start up your axis model quickly and efficiently.

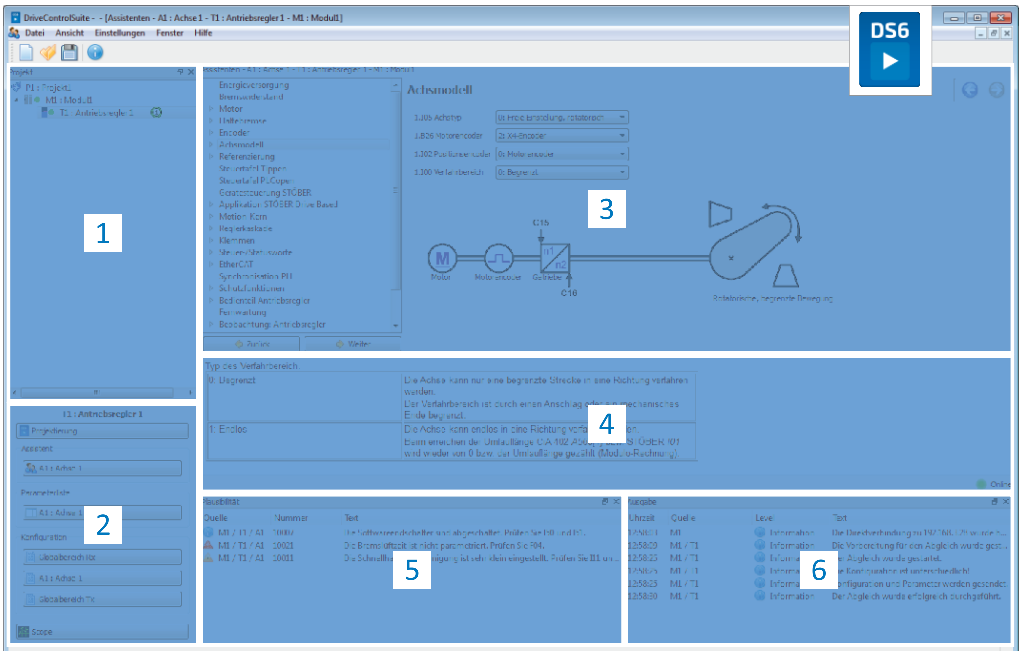


Fig. 71: DS6: Program interface

1	Project tree
2	Project menu
3	Workspace
4	Parameter description
5	Parameter check
6	Messages

17.7.4.1 Individualized workspace

The project tree (1) and project menu (2) are connected and, like the parameter check and messages (5, 6), can also be docked at the left, right or bottom edge of the screen. This program window can also be displayed or hidden using the View menu.

The workspace (3) and parameter description (4) are also connected to each other and always positioned in the middle. Both areas can be minimized or maximized.

17.7.4.2 Navigation using sensitive circuit diagrams

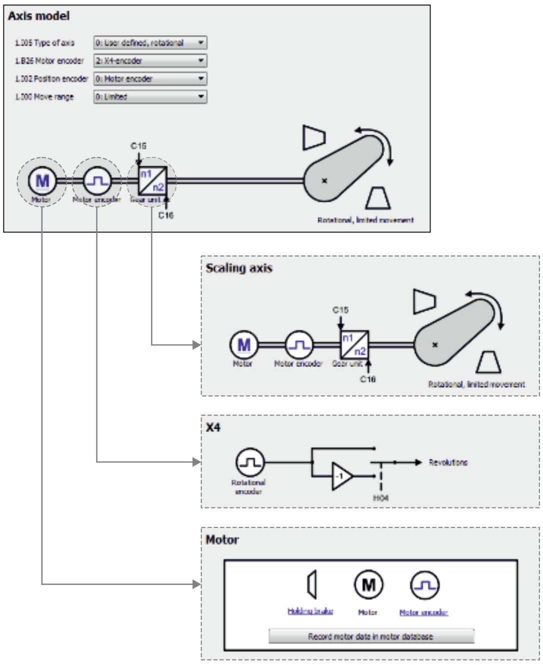


Fig. 72: DriveControlSuite: Navigation using text links and symbols

In order to illustrate graphically the processing sequence of actual and set values, the use of signals or certain drive component arrangements and to make configuring the accompanying parameters easier, they are displayed on the respective wizard pages of the workspace in the form of circuit diagrams.

Blue text links or clickable icons indicate links within the program. These refer to the corresponding wizard pages and, as a result, allow you to reach additional helpful detail pages with just a click.

17.7.5 Communication requirements

Note the following requirements for the direct connection.

17.7.5.1 Personal firewall

For communication, both DriveControlSuite and the SATMICL communication service must be enabled in the PC's firewall.

Test communication is initiated during the installation of DriveControlSuite that opens a dialog box for enabling communication in case of an activated firewall. Note that operation on public networks must also be enabled for communication using mobile network adapters.

The required setup file can be found at https://www.pilz.com/en-INT.

Program/service	Path
DS6A.exe (DriveControlSuite)	Standard installation: C:\Program Files (x86)\STOBER\DriveControlSuite\bin Parallel installation of different versions (version 6.X-X): C:\Program Files (x86)\STOBER\DriveControlSuite (V 6.X-X)\bin
SATMICLSVC.exe (SATMICL service)	32-bit Windows 7 or 32-bit Windows 10: C:\Windows\System32 64-bit Windows 7 or 64-bit Windows 10: C:\Windows\SysWOW64

Programs and services

17.7.5.2 Protocols and ports for communication using routers

For communication using routers, the protocols and ports used by DriveControlSuite and the SATMICL communication service must be enabled in the routers, if applicable.

Protocol	Port	Use	Program/service
UDP/IP	37915	Connection test (inquiry)	SATMICL service
UDP/IP	37916	Node search	SATMICL service
UDP/IP	30001	Primary port for connection response (response)	SATMICL service
	30002 – 39999	Alternative ports for connection response (response)	
UDP/IP	40000	Primary port for IP address specification	DriveControlSuite
	40001 – 50000	Alternative ports for IP address specification	
TCP/IP	37915	Data transmission	DriveControlSuite

Protocols and ports for a direct connection

17.7.6 Configuring virtual machines

If you would like to connect Pilz drive controllers to DriveControlSuite from a virtual machine, you have to configure the communication between the virtual machine and host so that, from the perspective of the network, the virtual machine is no different from a physical PC.

VMware, Inc. VMware

If you use the VMware software from the company of the same name as a virtual machine, configure it in the VMware Workstation. For the direct connection, the virtual network card is operated as a network bridge.

Microsoft Windows Virtual PC

If you use the Windows Virtual PC software from Microsoft as a virtual machine, configure it in the Virtual PC software and in the Virtual Server. In both components, the name of the virtual network card has to match the physical network card.
For Virtual PC network connections, Microsoft distinguishes between the **Public** and **Private** types. For the direct connection, the virtual network card is operated on the Virtual Server with the Public connection type.

Microsoft Hyper-V

If you use the Hyper-V software from Microsoft as a virtual machine, configure a Virtual Switch Manager in the Hyper-V Manager.
For network connections through Virtual Switch, Microsoft distinguishes between the **External**, **Internal** and **Private** types. For the direct connection, the virtual network card is operated with the External connection type.

Oracle VirtualBox

If you use the VirtualBox software from Oracle as a virtual machine, configure the network directly in VirtualBox. For the direct connection, a virtual network adapter is operated in bridge mode.

17.7.7 Updates

In the Help menu of the DriveControlSuite commissioning software, you can search for a newer version and, if available, download and install it.

Information

If the DriveControlSuite version is outdated, but the latest version is already installed on the computer, the check will yield the result that no newer version is available.

17.7.8 Script mode

Script mode is an automation feature of DriveControlSuite. In Script mode, commands can be processed automatically. For example, this includes opening and closing project files or changing parameters. Processing commands can be used for transferring various actions (such as a firmware update) to multiple drive controllers.

When Script mode is called up, a window with the same name opens. Here, you can transfer commands to DriveControlSuite in the form of a command script.

When you switch from Script mode to DriveControlSuite, the instance of DriveControlSuite being carried out in the background becomes visible.

17.7.8.1 Program interface

The DriveControlSuite – Script mode window opens when a script is run.

It is divided into 4 areas.

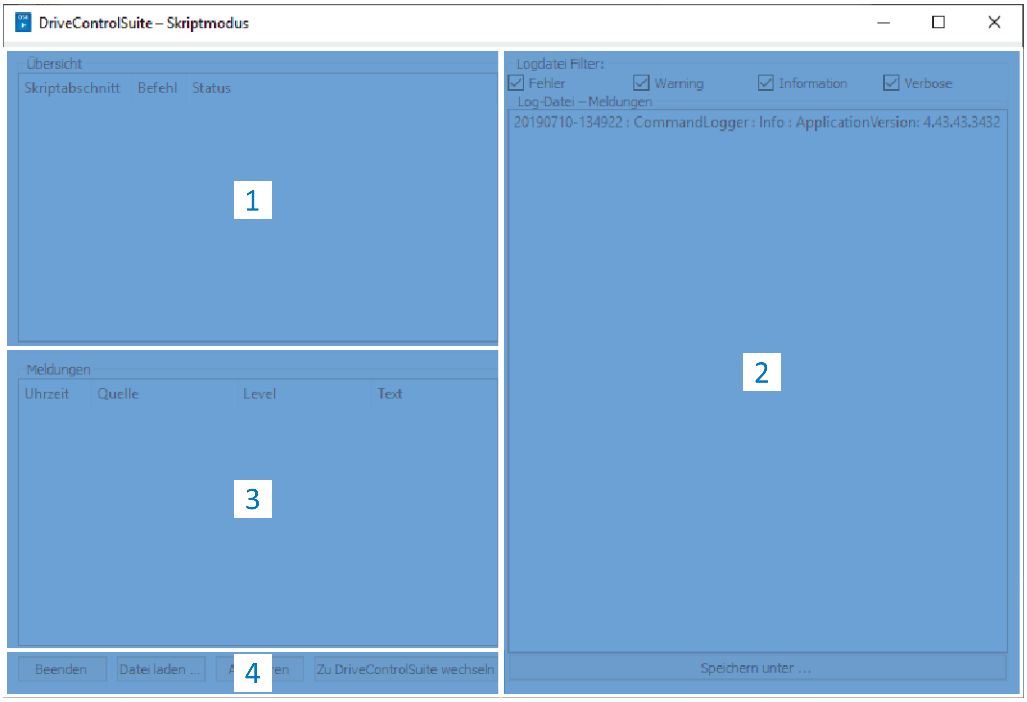


Fig. 73: Script mode: Program interface

1	Overview
2	Log file – messages
3	Messages
4	Button area

Overview

The window provides an overview of the progress of the parameterized script sections.

Log file filter

The window displays the log file messages in the form of a list. All generated messages are displayed with their relevance. They can be filtered according to category (ERROR, WARNING, INFO and VERBOSE). A timestamp, domain, warning level and a message are displayed for each message. You can save the message list locally by using the Save as ... button.

Messages

Displayed by the DriveControlSuite output window.

Button bar

You can use the button bar to carry out the following actions:

- End: Ends Script mode.
- Load file...: Loads a script in Script mode.
- Run: Runs the loaded script.
- Switch to DriveControlSuite: Exits Script mode and switches to DriveControlSuite.

17.7.8.2 Structure of a command script for DriveControlSuite

The script is structured in the JSON data format with UTF-8 encoding with BOM. The text file has the *.json extension. You can find an introduction to JSON at:
https://www.json.org/json-en.html

Information

To create a script for DriveControlSuite, use a JSON editor such as JSON Editor Online, JSONViewer or Visual Studio Code.

Three data types are used in the script based on the standard JSON RFC-7159:

- Boolean
- String
- Integer

The script is divided into three sections: settings, sequence and commands.

17.7.8.2.1 Settings

In this section, comprehensive settings can be defined for the script. The entire section is optional. If omitted, a log file will not be created and the DriveControlSuite will not be ended after the script is run.

Parameters

- "logFilePath": The path to the log file, <optional> <string>
- "quitWhenDone" : The behavior of DriveControlSuite after the processing is finished, <optional> <string>

Example

```
"setting": {
"logFilePath": "%COMMANDFILE%/LoadNewConfig.log",
"quitWhenDone": "never"
},
```

Specification of a log file (logFilePath)

A command sequence generally contains multiple steps. Since each individual step has a result, the progress is recorded chronologically with the results in a log file. If a file is specified, the script is started only if this file can be created successfully. The name of the file to be created is specified in the "filePath" parameter. The specification can be made either as an absolute directory or relative to the command script directory `(%COMMANDFILE%)`. `\\` or `/` serves as a separator for the path. The file name can be extended by the current timestamp when the `%TIMESTAMP%` is specified. The timestamp is transferred in the form of YYYYMMDD-hhmmss.

Quit when done (quitWhenDone)

quitWhenDone can have three values assigned to it, which determine the behavior after the script is done.

"never"	DriveControlSuite remains open after the script has ended (default setting).
"noErrors"	DriveControlSuite is closed after the script has ended, insofar as no errors have occurred.
"always"	DriveControlSuite is closed after the script has ended in every case.

17.7.8.2.2 Sequence

This section defines the sequence of the individual commands. If individual commands are dependent on others, then the corresponding prerequisites must be ensured so that the process is not interrupted with an error. The commands are specified as an array of strings with the "sequence" key. The sequence in the array corresponds to the action sequence during the execution. The command names to be used must be defined in the file, but can come up in the array any number of times.

Example

```
"sequence": [
"commandName 1",
"commandName 2",
"commandName 1",
"commandName 3"
],
```

17.7.8.2.3 Commands

The sections of the individual commands are provided with the corresponding name. They always contain the entry "command" as the value. This entry defines the command and thus the further parameters of the commands.

Example

```
"commandName1": {
"command": "commandName",
"parameterKey": "parameterValue"
},
```

17.7.8.3 Commands

In the following, all available commands are described with the corresponding parameters.

17.7.8.3.1 Overview

The following table shows an overview of the available commands.

Command	Description
openProject [288]	Open project file
closeProject [288]	Close project file
connect [289]	Establish connection
disconnect [290]	Disconnect connection
setOnline [290]	Send/read out configuration
setOffline [291]	Set offline
updateFirmware [292]	Multiple live firmware updates
setParameter [292]	Modify parameters
performAction [293]	Execute action
openMessageBox [294]	Open message window
wait [294]	Wait

Commands of Script mode

17.7.8.3.2 openProject

Many commands require a *.ds6 project to be open. This command is used to select and open the file.

Parameters

- "filePath": Path to the project file, <binding> <string>

Description

The name of the ds6 file to be opened is specified in the "filePath" parameter. The specification can be made either as an absolute directory or relative to the command script directory (`%COMMANDFILE%`).

Example

```
"openProjectfile": {
"command": "openProject",
"filePath": "<your path>"
},
```

17.7.8.3.3 closeProject

This command closes an open project file. If "openProject" is used to open another project, then this command is automatically called up for the current project.

Parameters

- "saveAs": Storage location of the file, <optional> <string>
- "saveBeforeClose": <optional> <Boolean>

Description

saveAs specifies the storage location of the project. Alternatively, the project can be saved at the path specified in the filePath parameter before it is closed with `saveBeforeClose: true`. By default, a dialog box opens if the project has been modified.

Example

```
"closeProjectfile": {
"command": "closeProject",
"saveBeforeClose": true
},
```

17.7.8.3.4 connect

Prerequisites for communication with the drive controllers include a direct connection to the drive controller and assignment to the module within the project under which this drive controller is recorded.

Parameters

- "module": Reference of the module in the project, <binding> <string>

One of the parameters listed below must be specified for the assignment. The IP address can always be used. The production number can be used only if the drive controller can be found by searching in a network. The reference can be used only if the drive controller can be found by searching in a network and a unique reference is defined for each drive controller that is found:

- "ipAddress": IPv4 address of the direct connection, <optional> <string>
- "serialNumber": Production number of the drive controller, <optional> <integer>
- "reference": Reference of the drive controller, <optional> <string>

Information

During the search, all drive controllers within the broadcast domain are found via IPv4 limited broadcast.

Prerequisites for finding a drive controller in the network:

- Network supports IPv4 limited broadcast
- All drive controllers are in the same subnet (broadcast domain)

Description

The command establishes a direct connection to the drive controller with the corresponding IP address, production number or reference.

Example

```
"ipConnect": {
"command": "connect",
"module": "M1",
"ipAdress": !192.168.3.2"
},
"serialnumberConnect": {
"command": "connect",
"module": "M1",
"serialNumber": 70012345
},
"referenceConnect": {
"command": "connect",
"module": "M1",
"reference": "T123"
},
```

17.7.8.3.5 disconnect

This command disconnects all established connections without reverse documentation.

Example

```
"DisconnectAll"; {
"command": "disconnect"
},
```

17.7.8.3.6 setOnline

This command sends a configuration from the project file opened with openproject to a drive controller or reads out a configuration from the drive controller and saves it in the project file.

Parameters

- "reference": Reference of the drive controller in the opened project file, <binding> <string>
- "direction": Read or send, <binding> <string>
- "targetId": ID of the target drive controller, <binding> <string> or <integer>
- "targetType": igbPosition, serialNumber or reference, <binding> <string>

Description

The configuration of the active project file specified with "reference" is loaded into the specified drive controller or vice versa. Here, it is necessary to make sure the specification is unique. Based on the content of targetType, a decision is made about how to interpret the content of targetId.

Value set of targetType:

1. "igbPosition": For position 0 (zero), the assignment is made using the most recently connected drive controller
2. "serialNumber": The assignment is made using the production number of the drive controller
3. "reference": The assignment is made based on the reference already existing in the drive controller (E120); this was assigned during the most recently executed project configuration

It is always a prerequisite that a drive controller with this igbPosition, production number or reference must be in the established connection.

Examples

Example 1

The configuration of the projected drive controller T1 is loaded into the device with the production number 7000026.

```
"sendConfigFromT1to7000026": {
"command": "setOnline",
"direction": "write",
"reference": "T1",
"targetId": 7000026,
"targetType": "serialNumber"
},
```

Example 2

```
"readConfigOutOfIgb5intoT2": {
"command": "setOnline",
"direction": "read",
"reference": "T2",
"targetId": 5,
"targetType": "igbPosition"
},
```

Example 3

```
"writeFromT3ToArAlt": {
"command": "setOnline",
"direction": "write",
"reference": "T3",
"targetId": "ArAlt",
"targetType": "reference"
},
```

17.7.8.3.7 setOffline

This command disconnects the connection to individual drive controllers with or without reverse documentation. Changes can be saved.

Parameters

- "reverseDocumentation": For true or false, reverse documentation is either created or not, <optional> <Boolean> <default = false>
- "saveValues": For true, the parameter A00 is set to active before setOffline is carried out, <optional> <Boolean> <default = false>

Example

```
"setOfflineAndSaveValues":
{
"command": "setOffline",
"reverseDocumentation": false,
"saveValues": true
},
```

17.7.8.3.8 updateFirmware

This command transfers the desired firmware to a defined list of drive controllers in the network.

Parameters

- "ipAddresses": List of IP addresses of the drive controllers at the gateways
- "serialNumbers": List of production numbers of the drive controllers at the gateways
- "references": List of references of the drive controllers at the gateways
- "firmwarePath": Directory in which the firmware files are stored, <optional>
- "firmware": Version text of the target firmware
- "restart": Restart after the update is finished, <optional> <Boolean> <default = false>
- "waitForRenewedAvailability": Wait until the update has been completed and the drive controllers are available again in the network, <optional> <Boolean> <default = false>

Example

```
"updateFirmwareToV_6_4_D": {
"command": "updateFirmware",
"firmware": "V 6.4-D",
"firmwarePath": "<your path>",
"ipAddresses": ["192.168.3.101",
"192.168.3.102",
"192.168.3.103"
],
"restart": true,
"waitForRenewedAvailability": true
}
```

17.7.8.3.9 setParameter

A parameter can be modified either online or offline.

Parameters

- "module": Reference of the project module, <binding> <string>
- "reference": Reference of the project drive controller, <binding> <string>
- "coordinate": Coordinate of the desired parameter, <binding> <string>
- "value": Value of the desired parameter, <binding> <string>

Example

```
"setA101[3]: {
"command": "setParameter",
"module": "M1",
"reference": "T2",
"coordinate". "A101[3]",
"value": "321"
},
```

17.7.8.3.10 performAction

An action can only be triggered online.

Parameters

- "reference": Reference of the project drive controller, <binding> <string>
- "module": Reference of the project module, <binding> <string>
- "coordinate": Coordinate of the desired action; parameter must be an action, <binding> <string>
- "waitForDone": Wait until the action has been completed, <optional> <bool><default=true>
- "timeout", <optional> <integer><default=60>(timeout in seconds):
  - If waitForDone is true: If the timeout is reached before the action has been fully completed, the command was unsuccessful and the sequence has been interrupted
  - If waitForDone is false: After the action is started, there is a wait until the timeout has expired; then the sequence is continued; the command is considered successfully processed
- "livingSpace": Axis (in the case of multiple axes, those to which a parameter is assigned), <optional> <string><default="Global">
  Possible values:

```
"livingSpace": "Global",
"livingSpace": "Axis1",
"livingSpace": "Axis2",
"livingSpace": "Axis3",
"livingSpace": "Axis4",
```

Example

```
"restartSIAx1": {
"command": "performAction",
"module": "M1",
"reference": "SIAx1",
"coordinate": "A09",
"livingSpace": "Global",
"waitForDone": false,
"timeout": 10
},
```

17.7.8.3.11 openMessageBox

This command opens an information window and displays the parameterized text. The execution of the commands is interrupted until the OK button is pressed.

Parameters

- "text": Displayed text of the message box, <binding> <string>

Example

```
"ShowMsgBox": {
"command": "openMessageBox",
"text": "Please press OK!",
},
```

17.7.8.3.12 wait

This command triggers a wait for the time specified in seconds before the process is continued.

Parameters

- "seconds": Waiting time in seconds, <binding> <integer>

Example

```
"Wait15Secs": {
"command": "wait",
"seconds": 15
},
```

17.7.8.4 Running a script

The following example gives you detailed instructions for how to run a script.

You create a *.bat file (UpdateFirmware.bat) and a *.json file (UpdateFirmware.json). You also create a *.log file. The script transfers a firmware update to firmware version 6.4-D to the drive controllers with the IP addresses 200.0.0.1 - 200.0.0.8.

Prerequisites

- DriveControlSuite version 6.4-D or later is the default installation
- All drive controllers are operated with firmware of 6.4-A or later
- All drive controllers can be reached through a direct connection using IP addresses 200.0.0.1 - 200.0.0.8

Procedure

1. Create a *.json file by creating an empty text file and renaming the file extension.
2. Then open the file and apply the following content:

```
{
"settings": {
"logFilePath": "%COMMANDFILE%/FirmwareUpdate.log",
"quitWhenDone": "never"
},
"sequence": [
"UpdateFirmware"
],
"UpdateFirmware": {
"command": "updateFirmware",
"firmware": "V 6.4-D",
"ipAddresses":
[ "200.0.0.1",
"200.0.0.2",
"200.0.0.3",
"200.0.0.4",
"200.0.0.5",
"200.0.0.6",
"200.0.0.7",
"200.0.0.8"
],
"restart": true
}
}
```

3. In the script file, adjust the firmware version to match the update version and the IP addresses to match your drive controllers.
4. Create a *.bat file in which you assign the *.json file to DriveControlSuite. The file must be stored in the same directory as the script file. Create the file by creating an empty text file and renaming the file extension.
5. Open the file and enter the address of the *.json file. The content of the *.bat file can look as follows:
   "C:\Program Files (x86)\STOBER\DriveControlSuite\bin\DS6A.exe" UpdateFirmware.json
   ⇨ This is how you transfer the *.json file as a command line parameter to the *.exe of DriveControlSuite
6. Create a *.log file named FirmwareUpdate.log. The file must be stored in the same directory as the script file.
7. Run the script, such as by double-clicking the *.bat file.
   ⇨ The DriveControlSuite – Script mode window opens.

You get an overview of the progress of the script sections, log file messages and messages of DriveControlSuite in the DriveControlSuite – Script mode window that opens.

If the action was carried out successfully, the firmware update to firmware version 6.4-D was transferred. The drive controllers are then restarted.

Information

Be aware that changed values that have not been stored in non-volatile memory are lost and that fieldbus communication and the connection to DriveControlSuite are interrupted in the event of a drive controller restart.

If a command cannot be executed, the script stops at this point. If you have given the "quitWhenDone" parameter the value of "never" or "noError", the script window stays open. After the cause of the stop has been found and the error has been remedied, click on Load file to reload the script and then on Run to restart it.

17.7.8.5 Application examples for EtherCAT

Examples are provided to illustrate how Script mode functions and how you can use it.

The files required for running the application examples can be found at https://www.pilz.com/en-INT. Enter "Script mode" in the search field.

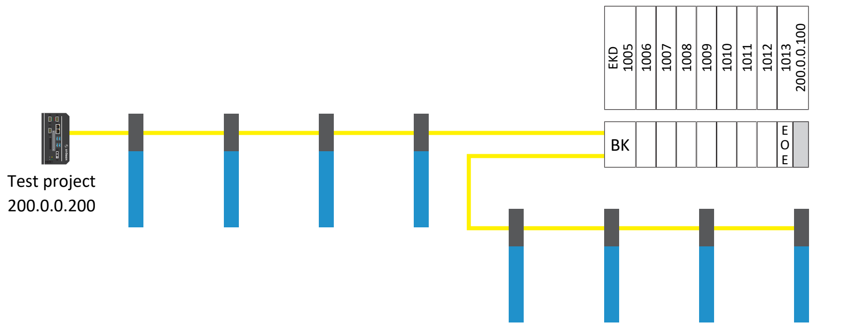
The package contains the example files for the following actions:

- Carry out a firmware update (FirmwareUpdate); also refer to the chapter Running a script [294].
- Load the prepared configuration (Backup)
- Save the current configuration (Restore)

The requirements for carrying out the actions are nearly identical for all example files and can be taken from the chapter Running a script [294].

If you would like to use the example files, you have to adapt them (file names and paths, addressing of the drive controller).

Test setup



	Drive Controller 1	Drive Controller 2	Drive Controller 3	Drive Controller 4	Drive Controller 5	Drive Controller 6	Drive Controller 7	Drive Controller 8
ECAT addr.:	1001	1002	1003	1004	1014	1015	1016	1017
IP address:	200.0.0.1	200.0.0.2	200.0.0.3	200.0.0.4	200.0.0.5	200.0.0.6	200.0.0.7	200.0.0.8
Type:	SI6A162	SI6A162	SI6A162	SI6A162	SI6A162	SI6A161	SI6A161	SI6A161
S/N:	9004034	9004002	9004029	9001837	9004016	9008011	9001135	9001151
Reference:	T1	T2	T3	T4	T5	T6	T7	T8

Fig. 74: Test setup of the application examples

Eight drive controllers of the PMC SI6 series with fixed IP addresses 200.0.0.1 - 200.0.0.8 assigned by the EtherCAT master.

Variant 1

The DriveControlSuite runs on the same IPC as the EtherCAT master.

Variant 2

The DriveControlSuite runs on a PC or laptop. The PC or laptop are on the same network as the IPC, but not on the same network as the EoE device group. A route must also be set here. More information can be found in the chapter Network route [299].

17.7.8.5.1 Carrying out a firmware update

Prerequisites

- DriveControlSuite version 6.4-D or later is the default installation
- All drive controllers are operated with firmware of 6.4-A or later
- All drive controllers can be reached through a direct connection using IP addresses 200.0.0.1 - 200.0.0.8

Behavior of the script

The script for the drive controllers with the IP addresses 200.0.0.1 - 200.0.0.8 transfers a firmware update to firmware version 6.4-D. The drive controllers are then restarted.

> **Information**
>
> Be aware that changed values that have not been stored in non-volatile memory are lost and that fieldbus communication and the connection to DriveControlSuite are interrupted in the event of a drive controller restart.

17.7.8.5.2 Load the prepared configuration (Restore)

Prerequisites

- DriveControlSuite version 6.4-D or later is the default installation
- All drive controllers are operated with firmware of 6.4-A or later
- All drive controllers can be reached through a direct connection using IP addresses 200.0.0.1 - 200.0.0.8
- A project file Restore.ds6 with the drive controllers

Behavior of the script

The configurations of the drive controllers projected in the Restore.ds6 project are transferred to the drive controllers with the parameterized IP addresses by a script.

> **Information**
>
> Be aware that changed values that have not been stored in non-volatile memory are lost and that fieldbus communication and the connection to DriveControlSuite are interrupted in the event of a drive controller restart.

ATTENTION!

Machine damage from uncontrolled stopping!

Note that sending a configuration includes a brief stop of the device configuration. Communication with the EtherCAT master is interrupted. For this reason, the script may be run only in the pre-operational state.

17.7.8.5.3 Saving the current configuration (Backup)

Prerequisites

- DriveControlSuite version 6.4-D or later is the default installation
- All drive controllers are operated with firmware of 6.4-A or later
- All drive controllers can be reached through a direct connection using IP addresses 200.0.0.1 - 200.0.0.8
- A project file Backup.ds6 with the drive controllers.

Behavior of the script:

The configurations of the drive controllers with the parameterized IP addresses are saved in the Backup.ds6 file by a script.

17.7.8.5.4 Network route

The Internet Protocol (IP) ensures that data packets are communicated across network boundaries. Routing is the determination of a suitable path for transferring the data packets.

Particularly when EoE is used, it is often necessary to create a route manually.

Information

Note that manually routing to the controller will function only if the IP address of the controller and the IP address of the PC in question are in the same network. Otherwise, the network administration has to add a static route to the router's routing table.

Creating a network route

In Windows, the route is created as follows:

```
route ADD 200.0.0.0 MASK 255.0.0.0 192.168.12.36
```

Explanation:

200.0.0.0 is the EoE network with a network mask of 255.0.0.0.
192.168.12.36 is the address of the controller that connects to the EoE network.

Deleting a network route

In Windows, the route is deleted as follows:

```
route delete 200.0.0.0
```

17.8 Detailed information

The documentation listed in the following table provides additional relevant information about the multi-axis drive system.

Current document versions can be found at https://www.pilz.com/en-INT.

Device/Software	Documentation	Contents	ID
Multi-axis drive system with PMC SI6 and PMC PS6	Commissioning instructions	System design, technical data, storage, installation, connection, commissioning	1005356
Connection method	Manual	Selection of encoder, power and hybrid cables, accessories, technical data, connection	
CiA 402 application – PMC SC6, PMC SI6	Manual	Project planning, configuration, parameterization, function test, detailed information	1005347
Drive Based (DB) application	Manual	Project planning, configuration, parameterization, function test, detailed information	
PMC SR6 safety technology – STO via terminals	Manual	Technical data, installation, commissioning, diagnostics	1005344
PMC SY6 safety technology – STO and SS1 via FSoE	Manual	Technical data, installation, commissioning, diagnostics	1005345
EtherCAT communication – PMC SC6, PMC SI6	Manual	Installation, electrical installation, data transfer, commissioning, detailed information	1005346
PROFINET communication – PMC SC6, PMC SI6	Manual	Installation, electrical installation, data transfer, commissioning, detailed information	

Additional information and sources that form the basis of this documentation or are referenced by the documentation:

EtherCAT Technology Group (ETG), 2012. *ETG.1300 : EtherCAT Indicator and Labeling*. ETG.1300 S (R) V1.1.0. Specification. 2012-01-27.

17.9 Symbols in formulas

Symbol	Unit	Explanation
C_{1max}	F	Maximum input capacitance
C_{maxPU}	F	Charging capacity of the power unit
C_{PU}	F	Self-capacitance of the power unit
D_{IA}	%	Reduction in the nominal current depending on the installation altitude
D_T	%	Reduction in the nominal current depending on the surrounding temperature
E_{2max}	J	Maximum switch-off energy at the output
f_{1max}	Hz	Maximum input frequency
f_{2max}	Hz	Maximum output frequency
f_{2PU}	Hz	Output frequency of the power unit
f_N	Hz	Rotating magnetic field frequency at nominal speed
$f_{PWM,PU}$	Hz	Frequency of the pulse width modulation of the power unit
I_0	A	Stall current
I_{1max}	A	Maximum input current
I_{1maxCU}	A	Maximum input current of the control unit
I_{1maxPU}	A	Maximum input current of the power unit
$I_{1N,PU}$	A	Nominal input current of the power unit
I_{2max}	A	Maximum output current
I_{2maxPU}	A	Maximum output current of the power unit
$I_{2PU(A)}$	A	Output current of the power unit for axis A
$I_{2PU(B)}$	A	Output current of the power unit for axis B
$I_{2N,PU}$	A	Nominal output current of the power unit
I_N	A	Nominal current
$I_{N,MF}$	A	Nominal current of the choke or motor filter
K_I		Integral coefficient
K_P		Proportional coefficient
M/F_{set}	Nm/N	Set torque or set force
M_N	Nm	Nominal torque of the motor
n_N	rpm	Nominal speed: The speed for which the nominal torque M_N is specified
p	–	Number of pole pairs
P_{effRB}	W	Effective power at the external braking resistor
P_{maxRB}	W	Maximum power at the external braking resistor
$P_{N,PU}$	W	Nominal power of the power unit
$P_{N,RB}$	W	Nominal power of the external braking resistor
P_V	W	Power loss
$P_{V,CU}$	W	Power loss of the control unit
R_{2minRB}	Ω	Minimum resistance of the external braking resistor

Symbol	Unit	Explanation
ϑ_{amb}	°C	Surrounding temperature
$\vartheta_{amb,max}$	°C	Maximum surrounding temperature
ϑ_{NAT}	°C	Nominal response temperature
T_M	Year, a	Mission time
T_i	ms	Reset time
t_{min}	ms	Minimum cycle time of the application
τ_{th}	°C	Thermal time constant
U_1	V	Input voltage
U_{1CU}	V	Input voltage of the control unit
U_{1max}	V	Maximum input voltage
U_{1PU}	V	Input voltage of the power unit
U_2	V	Output voltage
U_{2max}	V	Maximum output voltage
U_{2PU}	V	Output voltage of the power unit
U_{max}	V	Maximum voltage
U_{offCH}	V	Switch-off threshold of the brake chopper
U_{onCH}	V	On limit of the brake chopper
v_{act}	m/min	Actual velocity
v_{set}	m/min	Set velocity
x_{act}	m	Actual position
x_{set}	m	Set position

17.10 Abbreviations

Abbreviation	Meaning
AC	Alternating Current
AWG	American Wire Gauge
BAT	Battery
BG	Baugröße (en: size)
CiA	CAN in Automation
CNC	Computerized Numerical Control
CSA	Canadian Standards Association
csp	Cyclic synchronous position mode
cst	Cyclic synchronous torque mode
csv	Cyclic synchronous velocity mode
DC	Direct Current
DHCP	Dynamic Host Configuration Protocol
DI	Digital Input
EMC	Electromagnetic Compatibility
ETG	EtherCAT Technology Group
EtherCAT	Ethernet for Control Automation Technology
FSoE	Fail Safe over EtherCAT
HTL	High Threshold Logic
ip	Interpolated position mode
IP	International Protection
IP	Internet Protocol
NAT	Nennansprechtemperatur (en: Nominal response temperature)
P controller	Proportional controller
PE	Protective Earth (i.e. grounding conductor)
PELV	Protective Extra Low Voltage
PI controller	Proportional-integral controller
PID controller	Proportional-integral-differential controller
PL	Performance Level
pp	Profile position mode
pt	Profile torque mode
PTC	Positive Temperature Coefficient
pv	Profile velocity mode
RCD	Residual Current protective Device
RCM	Residual current monitoring device
RoHS	Restriction of Hazardous Substances
SD	Secure Digital (memory card)
SDHC	Secure Digital High Capacity (memory card)

Abbreviation	Meaning
S/FTP	Screened/Foiled Twisted Pair
SF/FTP	Screened Foiled/Foiled Twisted Pair
SF/UTP	Screened Foiled/Unshielded Twisted Pair
SIL	Safety Integrity Level
PLC	Programmable Logic Controller
SS1	Safe Stop 1
SSI	Serial Synchronous Interface
STO	Safe Torque Off
TCP	Transmission Control Protocol
TTL	Transistor-Transistor Logic
UL	Underwriters Laboratories

100Base-TX

Ethernet network standard based on symmetrical copper cables in which the nodes are connected to a switch via copper cables twisted in pairs (shielded twisted pair, CAT 5e quality level). 100Base-TX is the subsequent progression from 10Base-T and includes those properties with the option of a transfer speed of 100 Mbps (Fast Ethernet).

Braking resistor

Electrical resistor that is switched on by a brake chopper in order to avoid a hazard to electrical components in the event of significant brake energy by limiting the DC link voltage. Braking energy, which is usually only present for brief periods, is converted into heat in the resistor.

Broadcast domain

Logical grouping of network devices within a local network that reaches all nodes via broadcast.

Control cascade

Complete model of the control structure with the position controller, velocity controller and current controller components.

Current controller

Controller that is part of the control cascade and makes sure the deviation between the set and actual torque/force is small. In addition, it uses the deviation to calculate a value for the set current and transfers this to the power unit. The controller has a part that controls torque/force and a part that controls the magnetic flux.

DC link discharge

Process that causes the DC link capacitors to discharge. Requirements for the discharge process: The power grid supply is disconnected and no energy flows back from the motor to the device.

DC link discharge time

Time until the DC link capacitors are discharged enough that the device can be worked on safely.

Differential (HTL/TTL)

In the context of signal transmission, a process for being able to transmit signals with the highest possible fault tolerance even with longer transmission paths. In this approach, transmission takes place using a pair of signal conductors instead of just one signal conductor. The actual signal is transmitted on one line and the inverse signal on the other.

Electronic nameplate

Pilz synchronous servo motors are generally equipped with absolute encoders that provide special memory. This memory includes the electronic nameplate, i.e. all type-relevant master data as well as special mechanical and electronic values of a motor. When you operate a drive controller with a Pilz synchronous servo motor and an absolute encoder, the electronic nameplate is read and all motor data transferred if the drive controller is connected online. The drive controller automatically determines the associated limit values and control parameters from this data.

Fail Safe over EtherCAT (FSoE)

Protocol for transferring safety-related data via EtherCAT using a FSoE master and an indefinite number of FSoE slaves (i.e. devices that have a Safety over EtherCAT interface). The protocol enables the realization of functional safety via EtherCAT. FSoE and its implementation are TÜV-certified and comply with the SIL 3 requirements in accordance with IEC 61508.

Fast discharge

Active running process that causes the capacitors to discharge. This process is completed significantly faster than the self-discharge process. For example, the supply module has a fast discharge function but it is only active when a braking resistor is connected and the 24 V power supply is switched on. No fast discharge is possible for overloaded braking resistors.

IPv4 limited broadcast

Type of broadcast in a network with IPv4 (Internet Protocol version 4). The IP address 255.255.255.255 is entered as the destination. The content of the broadcast is not redirected by a router, which limits it to the local network.

I-share

Integral share of the controller that acts on the manipulated variable through the temporal integration of the control deviation with the weighting caused by the reset time: the longer the control difference is present, the stronger the response is.

MV number

The number of the material variant ordered and delivered as stored in the enterprise resource planning system, i.e. the device-specific combination of all hardware and software components.

Output choke

This type of choke is used to reduce high-frequency currents on electric lines and thus increase the interference immunity and availability of drive systems. They reduce current peaks caused by line capacity at the power output of the drive controller. It makes long power cables possible and increases the motor service life.

P controller

Controller type in which the manipulated variable is always proportional to the recorded control difference. As a result of this, the controller responds to the control deviation without a delay and only creates a manipulated variable if a deviation is present.

It is a fast and stable controller with a permanent control deviation that can be used for non-critical controls where permanent control deviation can be accepted when faults occur, e.g. pressure, flow, fill level and temperature control.

Performance Level (PL)

In accordance with DIN EN 13849-1: Measure for the reliability of a safety function or a component. The Performance Level is measured on a scale of a – e (lowest – highest PL). The higher the PL, the safer and more reliable the function in question is. The PL can be assigned to a specific SIL. A reversed inference from a SIL to a PL is not possible.

PI controller

Controller type that results from a parallel connection of a P and an I controller. With the right layout, it combines the advantages of both types (stable and fast, no permanent control deviation) and compensates for the disadvantages simultaneously.

PID controller

Universal controller type with a P-, I- and D-share. These three adjustment parameters make the controller flexible and ensure exact and highly dynamic control. However, by implication, it also necessitates a wide variety of variants. It is that much more important to ensure careful construction that is well-coordinated to the system. The application areas for this controller type are control circuits with systems of the second order and higher, which must be stabilized quickly and do not allow for any permanent control deviation.

Position controller

Controller that is part of the control cascade and makes sure the deviation between the set and actual position is small. To do so, it calculates a set velocity from the deviation and passes it to the velocity controller.

Power choke

Choke type that delays the current increase at the input of the drive controller or supply module in order to reduce the harmonics in the supply grid and reduces the load of the power feed-in of the devices.

P-share

Proportional share of the controller gain: the greater this share is, the stronger the influence on the manipulated variable.

PTC thermistor

Thermistor whose resistance significantly changes with the temperature. When a PTC reaches its defined nominal response temperature, the resistance increases dramatically, by two or more times the original resistance, to several kOhms. Since PTC triplets are used, each thermistor monitors one phase of the motor winding. For 3 thermistors, this means all 3 phases are monitored, achieving effective motor protection.

Quantization

Conversion of analog signals into numbers and measurable variables. For this purpose, the analog signals are scanned in regular intervals at the sampling rate and their voltage rating is converted at each of these scanning points to a digital value. The analog signal can only be expressed in a finite number of digital values.

Reforming

Protective measure for drive controllers. In case of a longer storage time, the oxide layer of the capacitors reacts with the electrolytes. This influences the electrical strength and capacitance. The process, which is to be performed before commissioning, re-establishes the dielectric in the capacitors.

Safe Stop 1 (SS1)

In accordance with DIN EN 61800-5-2: Procedure for stopping a PDS(SR). With the SS1 safety function, the PDS(SR) performs one of the following functions: a) Triggering and controlling the motor delay variable within defined limits and triggering the STO function if the motor speed falls below a specified limit value (SS1-d), or b) triggering and monitoring the motor delay variable within defined limits and triggering the STO function if the motor speed falls below a specified limit value (SS1-r), or c) triggering the motor delay and triggering the STO function after an application-specific delay (SS1-t). In this case, SS1(-t) corresponds to the time-controlled stop in accordance with IEC 60204-1, stop category 1(-t).

Safe Torque Off (STO)

In accordance with DIN EN 61800-5-2: Procedure for stopping a PDS(SR). The STO safety function prevents the motor from being supplied with any energy that could cause rotation (or motion in a linear motor). The PDS(SR) does not supply the motor with any energy that could generate torque (or force in a linear motor). STO is the most fundamental drive-integrated safety function. It corresponds to an uncontrolled stop in accordance with DIN EN 60204-1, stop category 0.

Safety Integrity Level (SIL)

In accordance with DIN EN 61800-5-2: Probability of a safety function failure. SIL is divided into levels 1 – 4 (lowest – highest level). SIL precisely assesses systems or subsystems based on the reliability of their safety functions. The higher the SIL, the safer and more reliable the function in question is.

Self-discharge

Passive running process that causes the capacitors to discharge even when no electrical load is connected.

Serial number

Consecutive number stored for a product in the enterprise resource planning system and used for individual identification of the product and for determining the associated customer information.

Single-ended (HTL/TTL)

In the context of signal transmission, electrical signal transmission takes place using a voltage that changes in relation to a constant reference potential.

Synchronous operation

Synchronous movement of the individual axes in multi-axis systems.

Velocity controller

Controller that is part of the control cascade and makes sure the deviation between the set and actual velocity is small. In addition, it uses the deviation to calculate a value for the set torque/force and transfers this to the current controller.

Intern

Support

Technical support is available from Pilz round the clock.

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Pilz develops environmentally-friendly products using ecological materials and energy-saving technologies. Offices and production facilities are ecologically designed, environmentally-aware and energy-saving. So Pilz offers sustainability, plus the security of using energy-efficient products and environmentally-friendly solutions.

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1005342-en-US-07, 11/2020 Printed in Germany