ACOPOS
User´s Manual

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ACOPOS

User's Manual

Version: **1.43 (April 2011)**

Model number: **MAACP2-ENG**

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1. Manual history

Information:

B&R does its best to keep the printed versions of its user's manuals as current as possible. However, newer versions of the User's Manual are always available first for download in electronic form (PDF) from the B&R homepage www.br-automation.com.

Version	Date	Comment
1.43	26.03.2011	Changes / new features • Safety Guidelines: New section „Kennwerte für die Funktionale Sicherheit“ added • Safety Technology: Revision of safety functions/characteristics, Proof Test Interval adapted to 20 years
1.42	031.07.2010	Changes / new features • Technical data / 8Vxxxx: Power loss values modified • Wiring / AC121: Input/output circuit diagram added. • Plug-in module 8AC125.60-1 added: - Technical data - Wiring • Indicators: LED status adjusted to firmware > V2.130 • Technical data / 8AC122.60-3: ParIDs for setting the gear ratio added to footnote
1.41	2008-10-31	Start of revision history publication

Table 1: Manual history

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2 ACOPOS

2.1 High-performance servo drive concept

The ACOPOS servo drive family is an important component of the complete automation solutions provided by B&R. Industry-specific functions and intuitive tools form the basis for short development times.

An important criteria for the performance of an automation solution is a fast and precise reaction to events dependent on the application or immediate changes in the production process. Therefore, ACOPOS servo drives work with very short scan times and communication cycles of 400 µs, which only amount to 50 µs in the control loop.

2.2 More room for innovation

The successful application of ACOPOS servo drives in the following industries demonstrates the impressive innovative power of their pioneering design: performance and function coupled with user-friendliness.

- Packaging industry
- Handling technology
- Plastics processing
- Paper and printing
- Textile industry
- Wood industry
- Metalworking industry
- Semiconductor industry

2.2 Maximum Security

The ACOPOS servo family was tested thoroughly during the development phase. Under difficult conditions, such as heavy vibrations or increased temperatures, the devices were subject to loads that greatly exceed the values that occur in normal everyday operation.

Figure 1: EMC test on the ACOPOS servo drives - maximum security for the user

EMC was given special attention to facilitate use in a rough industrial environment. Field tests have been carried out under difficult conditions in addition to the tests defined in the standard. The results confirm the excellent values measured by the testing laboratory and during operation. The necessary filters, which meet CE guidelines, are also integrated in the device. Using computer-aided models, the thermal behavior of the entire system is pre-calculated based on measured currents and temperatures. This results in maximum performance by taking advantage of the system's full capabilities. ACOPOS servo drives use the information on the motor's embedded parameter chip, which contains all relevant mechanical and electronic data. The work-intensive and error-prone task of manually setting parameters is no longer necessary and start-up times are substantially reduced. During service, relevant data can be requested and the cause of problems that may exist can be determined.

The ACOPOS servo family is also available with partially-coated circuit boards. These versions are - with identical specifications - more robust in regard to environmental influences such as dust, aggressive vapors or moisture.

2.[illegible] Modular and precise with communication options

The I/O points needed to operate a servo axis are part of the standard equipment for ACOPOS servo drives. The user is provided two trigger inputs for tasks requiring precise measurements or print mark control.

Figure 2: Plug-in modules allow optimized, application-specific configuration of ACOPOS servo drives

Further configuration of the ACOPOS servo drive to meet the respective application-specific demands takes place using plug-in modules. Plug-in modules are available to make network connections with other drives, controllers and visualization devices as well as for the connection of encoders, sensors and actuators. Additionally, CPU modules for controller and drive integration are also available for drive-based automation.

2.5 Configuring instead of programming

ACOPOS servo drives can be configured for demanding positioning tasks such as electronic gears or cam profiles. Based on long-term cooperation with customers from all over the world, B&R shares its know-how in the form of compact function blocks for many applications. Industry-specific functionality can be quickly and easily implemented in an application program.

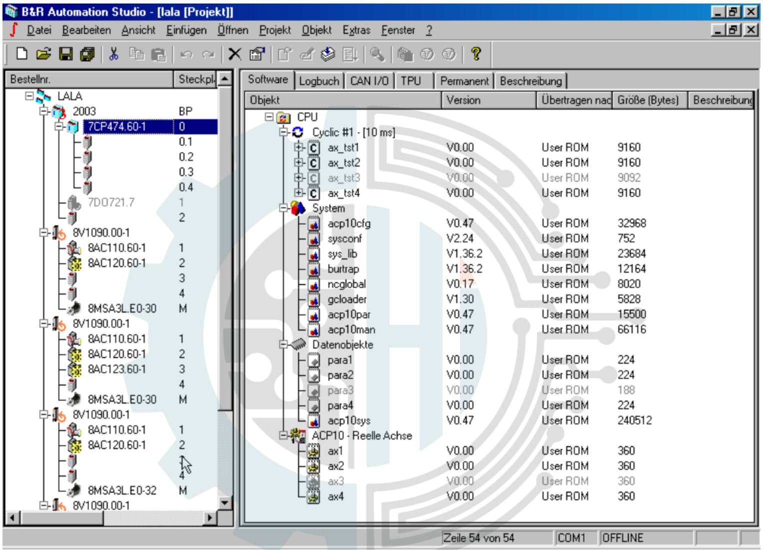

Figure 3: Configuring ACOPOS servo drives using B&R Automation Studio guarantees fast and easy implementation of application requirements

2.6 PLCopen motion control function blocks

The area of motion control is one of the central topics in automation technology. This is partly due to its high portion of the entire automation expenses and the resulting savings potential.

The PLCopen motion control function blocks (conforming to IEC 61131-3) support the user when implementing these possibilities by providing vendor-independence and reducing development times. The user can choose between the programming languages Ladder Diagram (LD), Structured Text (ST) and the high-level language "C".

The function range of the function blocks is divided into the areas of single and multi-axis movements. In addition to the usual relative and absolute movements, the first of the two areas also includes the possibility of overlapping movements. In the area of multi-axis movements, functions such as gears, cam profile functions, up/down synchronization and differential gear (changing phase angles) are supported.

2.7 Higher productivity with smart process technology

Smart process technology meets the customer's need for cost-effective solutions and high production speeds. This freely configurable technology library, is seamlessly integrated into the existing Motion Control product.

Using indirect process parameters makes it possible to eliminate sensors, which are often not fast enough to keep up with high production speeds. Synchronous processing and short response times make it possible to achieve excellent productivity and precision. For example, highly efficient and intelligent decentralized units allow seamless quality control. In the field, this significantly reduces cycle times while improving component quality.

This meets the requirements of modern motion control products such as high product quality, machine productivity along with short maintenance and down times and, to a greater extent, seamless quality control during production.

2.8 ACOPOS also perfectly suited for CNC applications

The integrated "Soft" CNC system from B&R unites all of the software components necessary for machine automation on a 64-bit processor platform. It provides sufficient computing power for complex processing machines. The integrated system architecture, together with ACOPOS servo drives, provides many opportunities regarding reaction speed, data throughput and precision, and also allows cost savings to be made.

- Uniformly integrated ACOPOS servo drive technology
- Powerful and fast-reacting
- Unlimited flexibility of PLC and CNC systems provides room for automation ideas
- 8 independent CNC channels
- Up to a total of 100 axes for positioning, CNC, electronic gears
- Individual graphic interface
- Nearly unlimited system memory for programs, diagnostics, and process data
- Internet or intranet connection for inspection or remote maintenance

Leading manufacturers of water jet, laser and torch cutting production technologies are already utilizing these technological advantages.

2.9 Quick and easy commissioning

All B&R products are programmed in a uniform manner using B&R Automation Studio with the Windows look and feel. Complex drive solutions can be created after a short orientation period. Adding hardware components and program sections, as well as their configuration, is done in dialog boxes; this reduces project development times considerably.

Axis movements can be checked without programming using NC Test. All types of movements, ranging from point-to-point to gear functions, can be carried out interactively. The reaction of the axis can be seen online in the monitor window. The trace function records relevant drive data for clear evaluation.

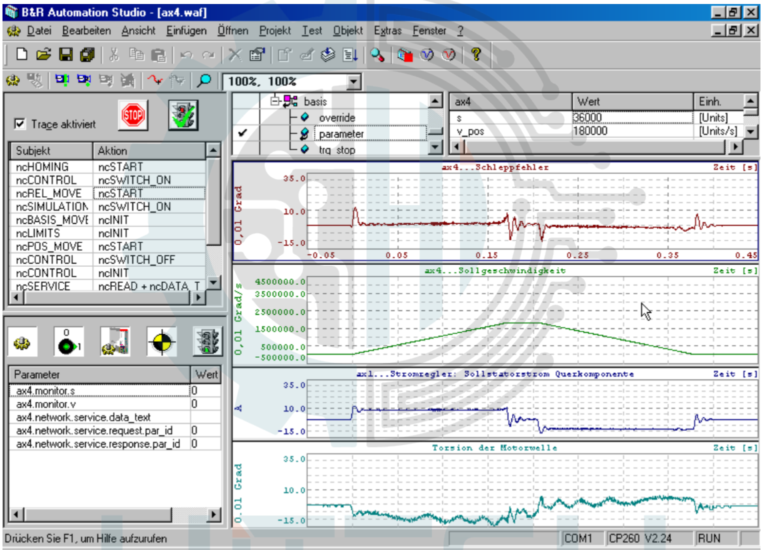

Figure 4: Optimal control of the movement using NC Test and Trace function

2.2 Tools for straightforward and efficient diagnostics

The drive is monitored in real-time using the oscilloscope function. Many trigger possibilities generate informative data for analyzing the movement during operation. The graphic display allows the user to make fine adjustments and optimizations of the movement in the microsecond range. The integration of powerful tools, such as the cam editor, reduces programming for complex coupled movements to simple drag-and-drop procedures. The results and effects on speed, acceleration and jolt can be immediately analyzed graphically.

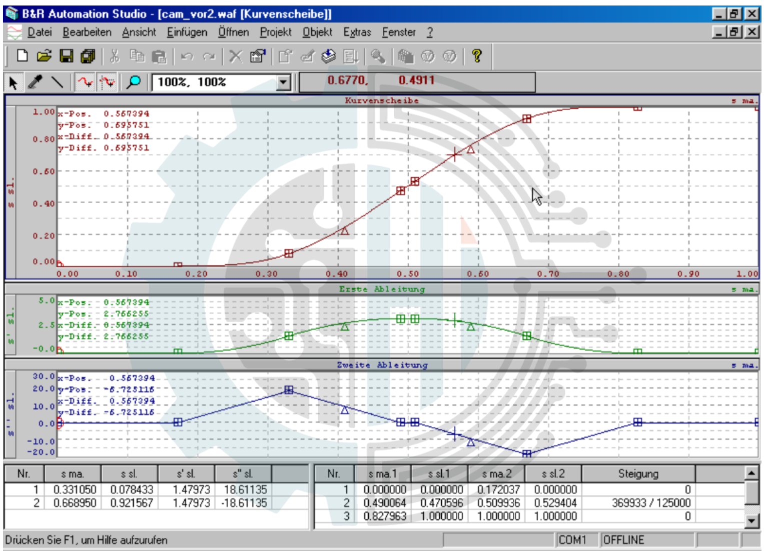

Figure 5: Cam editor - create movement profiles simply and precisely

3 ACOPOS configurations

ACOPOS servo drives include multiple technology-specific functions with performance, flexibility and capability in the field which has been remarkably proven in countless applications. The ACOPOS functions listed below are basic functions which the user can switch between as needed within 400 µs. Furthermore, manipulations such as changes in product length, print mark control, overlying torque control, brief process adaptations and quality checks can be carried out at any time.

- Point-to-point
- Electronic gears
- Electronic differential gears
- Cutting unit
- Electronic cam profiles
- Flying saws
- Line shaft
- CNC

ACOPOS servo drives can be used in various configurations depending on the network type and the requirements of the application. The functions listed above are available to the user in each of the topology examples shown.

Reaction speeds are not influenced by the network and control system being used if technology functions are processed directly on the ACOPOS servo drive. Additional sensors and actuators must be integrated in the control and adaptation for more complex processes. In these cases, the level of performance depends mostly on the type of network and control system being used.

The topology examples shown on the following pages provide an overview of the bandwidths which are possible with B&R automation components.

3.1 ACOPOS in the POWERLINK network

High-performance machine architectures require flexible networks and fieldbuses. With POWERLINK, a network is available to the user that fully meets the high demands of dynamic motion systems. POWERLINK adapts to the requirements of the machine and the system. The rigid coupling of many axes with controllers, industrial PCs, I/O systems and operator panels allows machines and systems to be created with the highest level of precision. Compatibility to standard Ethernet also reduces the number of networks and fieldbuses on the machine level.

Successful areas of use for these topologies:

- Packaging industry
- Handling technology
- Plastics processing
- Paper and printing
- Textile industry
- Wood industry
- Metalworking industry
- Semiconductor industry

3.1.1 Recommended topology for POWERLINK networks

In the POWERLINK network (seen from the manager), the tree structure should always come first followed then by the line structure. Otherwise, the line structure delay affects the entire tree beneath it.

Information:

It should be noted that the longest path is allowed a maximum of 10 hubs by the manager.

Information:

Communication to all POWERLINK stations connected to the POWERLINK network in a line-formed network via the mini-hub of this ACOPOS servo drive is interrupted during the network initialization (startup) of an ACOPOS servo drive.

3.1.2 Further literature

Unless otherwise stated, the recommendations in the following documents apply:

- "Industrial Ethernet Planning and Installation Guide", Draft 2.0,
  IAONA (www.iaona-eu.com)
- "Guide to Understanding and Obtaining High Quality Generic Cabling",
  3P Third Party Testing (www.3ptest.dk)

3.2 Compact, modular motion control applications

All ACOPOS servo drives serve as mini-hub for cabling, and allow line-formed routing of the POWERLINK network. This considerably reduces the cabling expenditure (without reducing functionality).

- Modular machine architecture, up to 100m between the individual axes
- Minimal wiring required due to line structure (no ring)
- No additional infrastructure components are needed
- Synchronization from the PLC program to the drive control loop

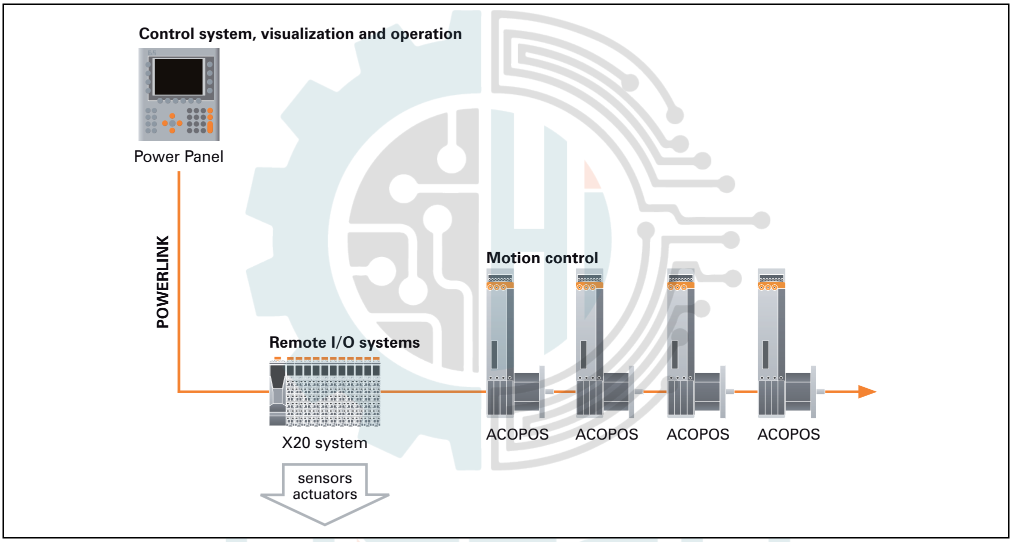

Figure 6: Compact, modular motion control applications

3.2 Extensive, modular motion control applications with up to 253 axes

ACOPOS servo drives are connected to the POWERLINK network in both star-form using hubs and line-form.

- Modular machine architecture, up to 100 m between the individual axes
- Optimized wiring, due to mixed star-line structure
- Nodes with fast and slow scan rates can be operated within one network, eliminating the need to divide the network into fast and slow segments
- Synchronization from the PLC program to the drive control loop

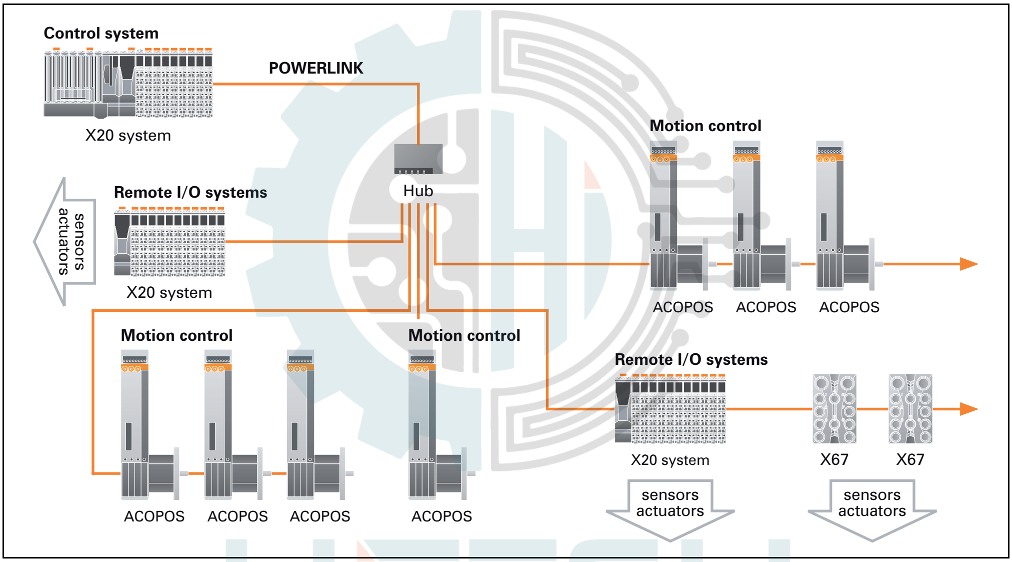

Figure 7: Extensive, modular motion control applications with up to 253 axes

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3.[illegible] ACOPOS in a CAN bus network

The dynamic requirements for small and mid-sized machines with several axes can be handled efficiently using a CAN bus.
The CAN bus is a cost-effective fieldbus for networking ACOPOS servo drives with controllers, industrial PCs, I/O systems and operator panels.

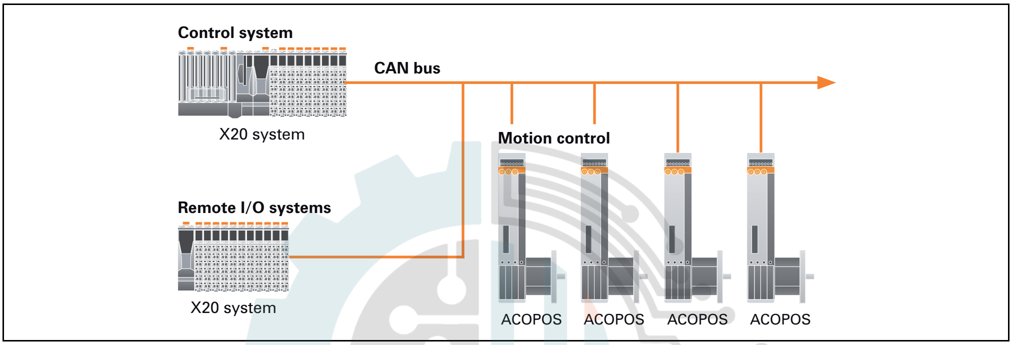

Figure 8: ACOPOS in a CAN bus network

3.5 Drive-based control

The controller is located centrally on an ACOPOS servo drive. The drives are networked and synchronized with each other via the CAN bus. As a result, electronic gear and cam profile applications as well as CNC applications are possible in addition to simple point-to-point movements. Control of the simple operation/visualization is handled by the controller on the ACOPOS servo drive. I/O signals are connected in the switching cabinet or directly in the machine room. By eliminating the need for an external controller, even very limited space can be used optimally.

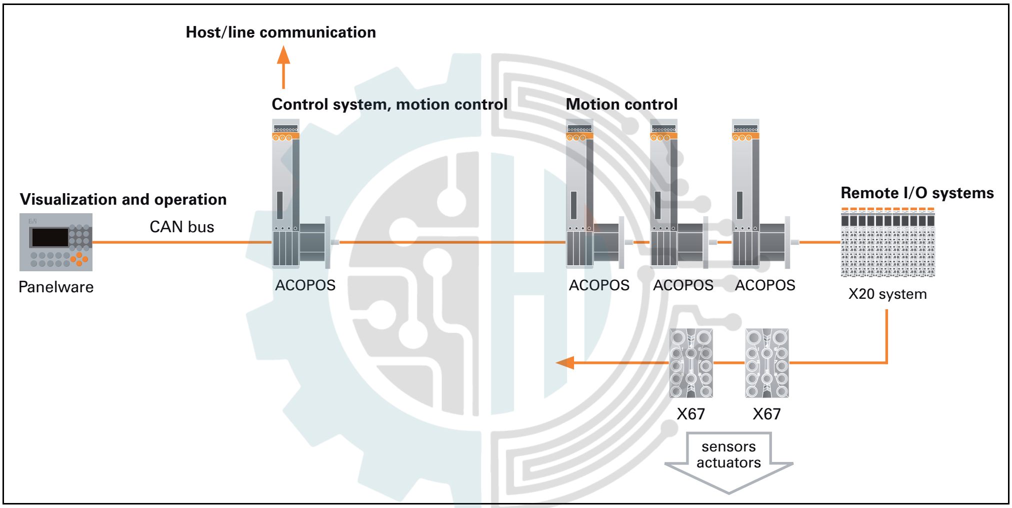

Figure 9: Drive-based Automation with ACOPOS

4 Safety guidelines

4.1 Organization of safety notices

The safety notices in this user's manual are organized as follows:

Safety notice	Description
Danger!	Disregarding the safety regulations and guidelines can be life-threatening.
Warning!	Disregarding the safety regulations and guidelines can result in severe injury or major damage to material.
Caution!	Disregarding the safety regulations and guidelines can result in injury or damage to material.
Information:	Important information for preventing errors.

Table 2: Description of the safety notices used in this user's manual

4.2 General information

B&R servo drives and servo motors have been designed, developed and manufactured for conventional use in industry. They were not designed, developed, and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage, or loss of any kind without the implementation of exceptionally stringent safety precautions.
Such risks include in particular the use of these devices to monitor nuclear reactions in nuclear power plants, flight control systems, flight safety, the control of mass transportation systems, medical life support systems and the control of weapons systems.

Danger!

Servo drives and servo motors can have bare parts with voltages applied (e. g. terminals) or hot surfaces. Additional sources of danger result from moving machine parts. Improperly removing the required covers, inappropriate use, incorrect installation or incorrect operation can result in severe personal injury or damage to property.

All tasks, such as transport, installation, commissioning and service, are only permitted to be carried out by qualified personnel. Qualified personnel are persons familiar with transport, mounting, installation, commissioning and operation of the product and have the respective qualifications (e. g. IEC 60364). National accident prevention guidelines must be followed.

The safety guidelines, connection descriptions (type plate and documentation), and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

Danger!

Handling servo drives and servo motors incorrectly can cause severe personal injury or damage to property!

4.3 Intended use

Servo drives are components designed to be installed in electrical systems or machines. They are not being used as intended unless the machine meets EC directive 2006/42/EG (machine directive) as well as directive 2004/108/CE (EMC directive).

Servo drives are only permitted to be operated directly on grounded, three-phase industrial mains (TN, TT power mains). When used in living areas, shops and small businesses, additional filtering measures must be implemented by the user.

Danger!

Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!

Technical data as well as connection and environmental specifications can be found on the type plate and in the user's manual. The connection and environmental specifications must be met!

Danger!

Electronic devices are generally not failsafe. If the servo drive fails, the user is responsible for making sure that the motor is placed in a secure state.

4.4 Protection against electrostatic discharges

Electrical components that are vulnerable to electrostatic discharge (ESD) must be handled accordingly.

4.4.1 Packaging

Electrical components with housing do not require special ESD packaging, but must be handled properly (see "Electrical components with housing").

Electrical components without housing must be protected by ESD-suitable packaging.

4.4 Guidelines for proper ESD handling

Electrical components with housing

- Do not touch the connector contacts on connected cables.
- Do not touch the contact tips on the circuit boards.

Electrical components without housing

In addition to "Electrical components with housing", the following also applies:

- Any persons handling electrical components or devices that will be installed in the electrical components must be grounded.
- Components can only be touched on the small sides or on the front plate.
- Components should always be stored in a suitable medium (ESD packaging, conductive foam, etc.).
  Metallic surfaces are not suitable storage surfaces!
- Electrostatic discharges should be avoided on the components (e.g. through charged plastics).
- A minimum distance of 10 cm must be kept from monitors and TV sets.
- Measurement devices and equipment must be grounded.
- Measurement probes on potential-free measurement devices must be discharged on sufficiently grounded surfaces before taking measurements.

Individual components

- ESD protective measures for individual components are thoroughly integrated at B&R (conductive floors, footwear, arm bands, etc.).
- The increased ESD protective measures for individual components are not necessary for our customers for handling B&R products.

4.5 Transport and storage

During transport and storage, devices must be protected from excessive stress (mechanical load, temperature, humidity, aggressive atmospheres, etc.).

Servo drives contain components sensitive to electrostatic charges which can be damaged by inappropriate handling. It is therefore necessary to provide the required safety precautions against electrostatic discharges during installation or removal of servo drives.

4.6 Installation

Installation must take place according to the user's manual using suitable equipment and tools.

Devices must be installed without voltage applied and by qualified personnel. Before installation, voltage to the switching cabinet should be switched off and prevented from being switched on again.

The general safety regulations and national accident prevention guidelines (e. g. VBG 4) must be observed when working with high voltage systems.

The electrical installation must be carried out according to the relevant guidelines (e.g. line cross section, fuse, protective ground connection, also see chapter 4 "Dimensioning").

4.7 Operation

4.7.1 Protection against touching electrical parts

> **Danger!**
>
> **To operate servo drives, it is necessary that certain parts are carrying voltages over 42 VDC. A life-threatening electrical shock could occur if you come into contact with these parts. This could result in death, severe injury or material damage.**

Before turning on a servo drive, make sure that the housing is properly connected to ground (PE rail). The ground connection must be made, even when testing the servo drive or when operating it for a short time!

Before turning the device on, make sure that all parts with voltage applied are securely covered. During operation, all covers and switching cabinet doors must remain closed.

Control and high power contacts can have voltage applied, even when the motor is not turning. Touching the contacts when the device is switched on is not permitted.

Before working on servo drives, they must be disconnected from the power mains and prevented from being switched on again.

> **Danger!**
>
> **After switching off the servo drive, wait until the DC bus discharge time of at least five minutes has passed. The voltage currently on the DC bus must be measured between -DC1 and +DC1 with a suitable measuring device before beginning work. This voltage must be less than 42 VDC to rule out danger. The Run LED going out does not indicate that voltage is not present on the device!**

The servo drives are labeled with the following warning:

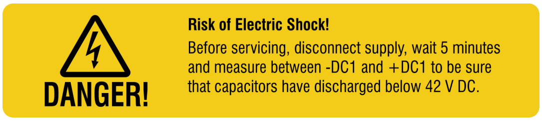

Figure 10: Warning on the servo drives

The connections for the signal voltages (5 to 30 V) found on the servo drives are isolated circuits. Therefore, the signal voltage connections and interfaces are only permitted to be connected to devices or electrical components with sufficient isolation according to IEC 60364-4-41 or EN 61800-5-1.

Never remove the electrical connections from the servo drive with voltage applied. In unfavorable conditions, arcs can occur causing personal injury and damage to contacts.

4.7.2 Protection from dangerous movements

Danger!

Incorrect control of motors can cause unwanted and dangerous movements! Such incorrect behavior can have various causes:

- **Incorrect installation or an error when handling the components**
- **Incorrect or incomplete wiring**
- **Defective devices (servo drive, motor, position encoder, cable, brake)**
- **Incorrect control (e. g. caused by software error)**

Some of these causes can be recognized and prevented by the servo drive using internal monitoring. However, it is generally possible for the motor shaft to move every time the device is switched on! Therefore protection of personnel and the machine can only be guaranteed using higher level safety precautions.

The movement area of machines must be protected to prevent accidental access. This type of protection can be obtained by using stable mechanical protection such as protective covers, protective fences, protective gates or photocells.

Removing, bridging or bypassing these safety features and entering the movement area is prohibited.

A sufficient number of emergency stop switches are to be installed directly next to the machine. The emergency stop equipment must be checked before commissioning the machine.

On free running motors, remove shaft keys or prevent them from being catapulted.

The holding brake built into the motors cannot prevent hoists from allowing the load to sink.

4.7.3 Protection against burns

The surfaces of servo drives and servo motors can become very hot during operation.

Therefore, the servo drives are labeled with the following warning:

Figure 11: "Hot surface" warning

4.8 Specifications for functional safety

Specifications for functional safety are listed in chapter 6 "Safety technology".

The specifications are determined based on a proof test interval of maximum 20 years. A proof test cannot be carried out for B&R drive systems, so the proof test interval is the service life of the system.

According to the standards EN ISO 13849, EN 62061 and IEC 61508, the safety function described in Chapter 6 "Safety technology" cannot be used beyond the specified service life.

> **Danger!**
>
> **The user must ensure that all B&R drive systems that fulfill a safety function are replaced with new B&R drive systems or removed from operation before their service life expires.**

4.9 Environmentally-friendly disposal

All B&R drive systems and servo motors are designed to inflict as little harm on the environment as possible.

4.9 Separation of materials

It is necessary to separate different materials so the device can undergo an environmentally-friendly recycling process.

Component	Disposal
Drive systems, servo motors, cables	Electronics recycling
Cardboard box / paper packaging	Paper/cardboard recycling

Table 3: Environmentally-friendly separation of materials

Disposal must comply with the respective legal regulations.

Chapter 2 • Technical data

1. ACOPOS servo drives

Controlling your power transmission system with B&R ACOPOS servo drives allows you to fully use the advantages of an optimized system architecture. In this way, applications that require additional positioning tasks such as torque limitation or torque control can be created quickly and elegantly. The flexible system concept for B&R servo drives is made possible by coordinated hardware and software components. You can select the optimal system configuration for your application and increase your competitiveness.

- Perfect integration in all B&R product families
- Object-oriented axis programming minimizes development time and increases reusability
- Integrated technology functions for industry-specific tasks
- Operation of synchronous and induction motors possible
- Current controller scan time up to 50 µs
- Reduced commissioning and service times using "embedded motor parameter chip"
- CAN bus and POWERLINK network connection
- Input voltage range from 400 - 480 VAC (±10%) for many areas of use
- Connection possibilities for all standard encoder systems
- Up to two free slots for optional technology modules
- Electronic secure restart inhibit integrated
- Optionally available as version with partially-coated circuit boards - more robust in regard to environmental influences

1.2 Overview

The ACOPOS servo drive series covers a current range from 1.0 - 128 A and a power range from 0.5 - 64 kW with 11 devices in 4 groups that have the same basic concept. The devices in a group are designed using the same basic concept. They offer connection possibilities for all standard encoder systems and modular fieldbus interfaces.

Group	8V1010.xxx-2 8V1010.5xx-2 8V1016.xxx-2 8V1016.5xx-2	8V1022.0xx-2 8V1045.0xx-2 8V1090.0xx-2	8V1180.0xx-2 8V1320.0xx-2	8V1640.0xx-2 8V128M.0xx-2
Power connections	Plug connection	Plug connection	Plug connection	Fixed
Integrated line filter	Yes	Yes	Yes	Yes
Power failure monitoring	Yes	Yes	Yes	Yes
DC bus connection	Yes	Yes	Yes	Yes
24 VDC supply	External 1)	External 1)	External or internal via the DC bus	External or internal via the DC bus
24 VDC output	No	No	24 V / 0.5 A	24 V / 0.5 A
Integrated brake chopper	Yes	Yes	Yes	Yes
Internal braking resistor	Yes	Yes	Yes	Yes 2)
Connection of External Braking Resistor Possible	No	No	Yes	Yes
Monitored output for motor holding brake	Yes	Yes	Yes	Yes
Monitored input for motor temperature sensor	Yes	Yes	Yes	Yes
Max. number of plug-in modules	3	4	4	4

Table 4: Overview of the ACOPOS servo drive series

1) External DC bus power supply can be used.
2) The braking resistor integrated in the ACOPOS servo drives 1640 and 128M is dimensioned so that it is possible to brake to a stop (in a typical drive situation).

ACOPOS servo drives are suitable for both synchronous and asynchronous servo motors and have built-in line filters to meet the limit values for CISPR11, Group 2, Class A.

Warning!

ACOPOS servo drives are suitable for power mains which can provide a maximum short circuit current (SCCR) of 10000 A_{eff} at a maximum of 528 V_{eff}.

1.1 24 VDC supply during power failures

In order to be able to provide the stop function for category 1 according to IEC 60204-1 during a power failure, the 24 VDC supply voltage for the servo drives as well as encoders, sensors and the safety circuit must remain active during the entire stopping procedure.

The ACOPOS servo drives recognize a power failure and can immediately initiate active braking of the motor. The brake energy that occurs when braking is returned to the DC bus and the DC bus power supply can use it to create the 24 VDC supply voltage.

> ## Danger!
>
> **In some applications, the DC bus is not ready for operation or there is not enough brake energy provided to guarantee that the 24 VDC supply voltage remains active until the system is stopped.**
>
> **Internal DC bus power supplies are not ready for operation during the ACOPOS servo drive switch-on interval, external DC bus power supplies are not ready for operation while booting.**

An external DC bus power supply must be used for ACOPOS servo drives 8V1010 to 8V1090. A DC bus power supply is integrated in ACOPOS servo drives 8V1180 to 8V128M.

The ACOPOS servo drives with an integrated DC bus power supply provide the 24 VDC supply for the servo drive and also a 24 VDC output to supply encoders, sensors and the safety circuit. In may cases, it is not necessary to use an uninterruptible power supply (UPS) which is otherwise needed.

1.2 Indicators

The ACOPOS servo drives are equipped with three LEDs for direct diagnosis:

Figure 12: Indicators - ACOPOS servo drives

Label	Color	Function	Description	
READY	Green	Ready	Green (lit)	The module is operational and the power stage can be enabled (operating system present and booted, no permanent or temporary errors).
			Green (blinking) [1]	Module is not ready for operation Examples: • No signal on one or both enable inputs • DC bus voltage exceeds the tolerance range • Over-temperature on the motor (temperature sensor) • Motor feedback not connected or defective • Motor temperature sensor not connected or defective • Over-temperature on the module (IGBT junction, heat sink, etc.) • Network fault
RUN	Orange	Run	Orange (lit)	The module' power stage is enabled.
ERROR	Red	Error	Red (lit) [1]	There is a permanent error on the module. Examples: • Permanent overcurrent • Data in EPROM not valid

Table 5 : LED status - ACOPOS servo drives

1) Firmware V2.130 and higher.

If no LEDs are lit, the ACOPOS servo drive is not being supplied with 24 VDC.

Danger!

After switching off the device, wait until the DC bus discharge time of at least five minutes has passed. The voltage currently on the DC bus must be measured with a suitable measuring device before beginning work. This voltage must be less than 42 VDC to rule out danger. The Run LED going out does not indicate that voltage is not present on the device!

1.2 LED status

The following timing is used for the indication diagrams:

Block size: 125 ms

Repeats after: 3000 ms

Status changes when booting the operating system loader

Status	LED	Display
1. Boot procedure for basic hardware active	Green	
	Orange	
	Red	
2. Configuration of network plug-in module active	Green	
	Orange	
	Red	
3. Waiting for network telegram	Green	
	Orange	
	Red	
4. Network communication active	Green	
	Orange	
	Red	

Table 6: Status changes when booting the operating system loader

Error status with reference to the CAN plug-in module AC110

Status	LED	Display
Invalid hardware ID 1)	Green	
	Orange	
	Red	
Boot error on CAN basic hardware	Green	
	Orange	
	Red	
Bus Off	Green	
	Orange	
	Red	
CAN node number is 0	Green	
	Orange	
	Red	

Table 7: Error status with reference to the CAN plug-in module AC110

1) Possible errors:
- ACOPOS servo drive defect
- Plug-in module defect
- Plug-in module is not inserted correctly in the slot

Error status with reference to the POWERLINK plug-in module AC112Error status with reference to the POWERLINK V2 plug-in module AC114

Status	LED	Display
Invalid hardware ID 1)	Green	
	Orange	
	Red	
Boot error on POWERLINK basic hardware	Green	
	Orange	
	Red	
Error when booting the AC114-ARM	Green	
	Orange	
	Red	
POWERLINK node number is 0	Green	
	Orange	
	Red	

Table 8: Error status with reference to the POWERLINK V2 plug-in module AC114

1) Possible errors:
- ACOPOS servo drive defect (plug-in module not recognized)
- Plug-in module defect
- Plug-in module is not inserted correctly in the slot
- Plug-in module functions, but is not automatically recognized by the ACOPOS servo drive (old bootstrap loader)

1.3 Module overview

1.3.1 ACOPOS servo drives

Model number	Short description	Page
8V1010.00-2	ACOPOS servo drive 3x 400-480 V, 1.0 A, 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated	48
8V1010.001-2	ACOPOS servo drive 3x 400-480 V, 1.0 A, 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	48
8V1010.50-2	ACOPOS servo drive 3 x 110-230 V / 1 x 110-230 V, 2.3 A, 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated	48
8V1010.501-2	ACOPOS servo drive 3 x 110-230 V / 1 x 110-230 V, 2.3 A, 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	48
8V1016.00-2	ACOPOS servo drive 3x 400-480 V, 1.6 A, 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated	48
8V1016.001-2	ACOPOS servo drive 3x 400-480V, 1.6 A, 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	48
8V1016.50-2	ACOPOS servo drive 3 x 110-230 V / 1 x 110-230 V, 3.6 A, 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated	48
8V1016.501-2	ACOPOS servo drive 3 x 110-230 V / 1 x 110-230 V, 3.6 A, 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	48
8V1022.00-2	ACOPOS servo drive 3x 400-480 V, 2.2 A, 1 kW, line filter, braking resistor and electronic secure restart inhibit integrated	54
8V1022.001-2	ACOPOS servo drive 3x 400-480 V, 2.2 A, 1 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	54
8V1045.00-2	ACOPOS servo drive 3x 400-480 V, 4.4 A, 2 kW, line filter, braking resistor and electronic secure restart inhibit integrated	54
8V1045.001-2	ACOPOS servo drive 3x 400-480 V, 4.4 A, 2 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	54
8V1090.00-2	ACOPOS servo drive 3x 400-480 V, 8.8 A, 4 kW, line filter, braking resistor and electronic secure restart inhibit integrated	54
8V1090.001-2	ACOPOS servo drive 3x 400-480 V, 8.8 A, 4 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	54
8V1180.00-2	ACOPOS servo drive 3x 400-480 V, 19 A, 9 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	59
8V1180.001-2	ACOPOS servo drive 3x 400-480 V, 19 A, 9 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	59
8V1320.00-2	ACOPOS servo drive 3x 400-480 V, 34 A, 16 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	59
8V1320.001-2	ACOPOS servo drive 3x 400-480 V, 34 A, 16 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	59
8V1640.00-2	ACOPOS servo drive 3x 400-480 V, 64 A, 32 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	65
8V1640.001-2	ACOPOS servo drive 3x 400-480 V, 64 A, 32 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	65
8V128M.00-2	ACOPOS servo drive 3x 400-480 V, 128 A, 64 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	65
8V128M.001-2	ACOPOS servo drive 3x 400-480 V, 128 A, 64 kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	65

Table 9: Module overview - ACOPOS servo drives

1.3.2 Braking resistors

Model number	Short description	Page
8B0W0045H000.001-1	ACOPOSmulti braking resistor, 450 W, 50 R, IP65, terminals	71
8B0W0079H000.001-1	ACOPOSmulti braking resistor, 790 W, 33 R, IP65, terminals	71

Table 10: Module overview - Braking resistors

1.3.3 ACOPOS plug-in modules

Encoder modules

Model number	Short description	Page
8AC110.60-2	ACOPOS plug-in module, CAN interface	74
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	77
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	81
8AC121.60-1	ACOPOS plug-in module, HIPERFACE encoder interface	85
8AC122.60-3	ACOPOS plug-in module, resolver interface	88
8AC123.60-1	ACOPOS plug-in module, incremental position encoder and SSI absolute encoder interface	91
8AC125.60-1	ACOPOS plug-in module, BiSS interface	94

Table 11: Module overview - ACOPOS plug-in modules (encoder modules)

IO modules

Model number	Short description	Page
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	97
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24V input or 45mA output, order TB712 terminal block separately	101

Table 12: Module overview - ACOPOS plug-in modules (I/O modules)

CPU modules

Model number	Short description	Page
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	105
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	121
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	121

Table 13: Module overview - ACOPOS plug-in modules (CPU modules)

1.4 ACOPOS 1010, 1016

1.4.1 Order data

Model number	Short description	Images
	Servo drives	 8V1010.xxx-2  8V1016.xxx-2
8V1010.00-2	Servo drive 3x 400-480V 1.0A 0.45kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1010.001-2	Servo drive 3x 400-480 V, 1.0 A, 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	
8V1010.50-2	Servo drive 3x 110-230 V / 1x 110-230 V 2.3A 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1010.501-2	Servo drive 3x 110-230 V / 1x 110-230 V 2.3A 0.45 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	
8V1016.00-2	Servo drive 3x 400-480V, 1.6A, 0.7kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1016.001-2	Servo drive 3x 400-480V, 1.6A, 0.7kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	
8V1016.50-2	Servo drive 3x 110-230 V / 1x 110-230 V 3.6A 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1016.501-2	Servo drive 3x 110-230 V / 1x 110-230 V 3.6A 0.7 kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	

Table 14: Order data - ACOPOS 1010, 1016

Optional accessories		
Model number	Short description	Page
8AC110.60-2	ACOPOS plug-in module, CAN interface	74
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	77
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	81
8AC121.60-1	ACOPOS plug-in module, HIPERFACE interface	85
8AC122.60-3	ACOPOS plug-in module, resolver interface	88
8AC123.60-1	ACOPOS plug-in module, incremental position encoder and SSI absolute encoder interface	91
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	97
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24V input or 45mA output, order TB712 terminal block separately.	101
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	105
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	121
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	121
8CM005.12-1	Motor cable, length 5m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM007.12-1	Motor cable, length 7m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM010.12-1	Motor cable, length 10m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM015.12-1	Motor cable, length 15m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136

Table 15: Optional accessories - ACOPOS 1010, 1016

1.4 Technical data

Product ID	8V1010.0xx-2	8V1016.0xx-2	8V1010.5xx-2	8V1016.5xx-2
General information				
C-UL-US Listed	Yes			
Power mains connection				
Mains input voltage	3 x 400 VAC to 480 VAC ± 10% Power filter according to IEC 61800-3-A11, category C3 1)		3 x 110 VAC to 230 VAC ± 10% or 1 x 110 VAC to 230 VAC ± 10% Power filter according to IEC 61800-3-A11, category C3 1)	
Frequency	50 / 60 Hz ± 4%		50 / 60 Hz ± 4%	
Installed load	Max. 1.35 kVA	Max. 2.1 kVA	Max. 1.35 kVA	Max. 2.1 kVA
Starting current	2 A (at 400 VAC)		5 A (at 230 VAC)	
Switch-on interval	> 10 s			
Power loss during continuous current without braking resistor	70 W	80 W	60 W	70 W
24 VDC supply				
Input voltage 2)	24 VDC +25% / -20%			
Input capacitance	5600 µF			
Current requirements 3)	Max. 1.47 A + current for motor holding brake +			
DC bus				
DC bus capacitance	165 µF		2040 µF	
Motor connection				
Continuous current	1 A_{eff} 4)	1.6 A_{eff} 4)	2.3 A_{eff} 5)	3.6 A_{eff} 5)
Reduction of continuous current depending on ambient temperature 6) Mains Input Voltage: 400 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz Mains Input Voltage: 480 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz	 No reduction **No reduction** No reduction 0.13 A_{eff} per °C (starting at 45°C) **No reduction** No reduction	 No reduction **No reduction** No reduction 0.13 A_{eff} per °C (starting at 40°C) **No reduction** No reduction	 No reduction **No reduction** No reduction No reduction **No reduction** No reduction	 No reduction **No reduction** No reduction No reduction **No reduction** No reduction
Reduction of continuous current depending on altitude Starting at 500 m above sea level	 0.1 A_{eff} per 1,000 m	 0.16 A_{eff} per 1,000 m	 0.23 A_{eff} per 1,000 m	 0.36 A_{eff} per 1,000 m
Peak current	2.8 A_{eff}	5 A_{eff}	7.8 A_{eff}	12 A_{eff}
Rated switching frequency	10 kHz			
Electrical stress of the connected motor according to IEC TS 60034-25	Limit value curve A			
Maximum motor line length	15 m			
Protective measures / safeguards	Short circuit & overload protection			

Table 16: Technical data - ACOPOS 1010, 1016

Product ID	8V1010.0xx-2	8V1016.0xx-2	8V1010.5xx-2	8V1016.5xx-2
Motor holding brake connection				
Maximum output current	1.3 A			
Max. number of switching cycles	Unlimited since done electronically			
Braking resistor				
Peak power output	2 kW	2 kW	1.9 kW	1.9 kW
Continuous power	130 W			
Trigger inputs				
Number of inputs	2			
Wiring	Sink			
Electrical isolation Input - ACOPOS Input - Input	 Yes No			
Input voltage Rated Maximum	 24 VDC 30 VDC			
Switching threshold LOW HIGH	 < 5 V >15 V			
Input current at nominal voltage	Approx. 10 mA			
Switching delay Positive edge Negative edge	 52 µs ± 0.5 µs (digitally filtered) 53 µs ± 0.5 µs (digitally filtered)			
Modulation compared to ground potential	Max. ±38 V			
Limit switch and reference inputs				
Number of inputs	3			
Wiring	Sink			
Electrical isolation Input - ACOPOS Input - Input	 Yes No			
Input voltage Rated Maximum	 24 VDC 30 VDC			
Switching threshold LOW HIGH	 < 5 V >15 V			
Input current at nominal voltage	Approx. 4 mA			
Switching delay	Max. 2.0 ms			
Modulation compared to ground potential	Max. ±38 V			

Table 16: Technical data - ACOPOS 1010, 1016 (cont.)

Product ID	8V1010.0xx-2	8V1016.0xx-2	8V1010.5xx-2	8V1016.5xx-2
Enable input				
Number of inputs	1			
Wiring	Sink			
Electrical isolation Input - ACOPOS	 Yes			
Input voltage Rated Maximum	 24 VDC 30 VDC			
Switching threshold LOW HIGH	 < 5 V >15 V			
Input current at nominal voltage	Approx. 30 mA			
Switching delay Enable 1 -> 0, PWM off Enable 0 -> 1, Ready for PWM	 Max. 2.0 ms Max. 100 µs			
Modulation compared to ground potential	Max. ±38 V			
Operating conditions				
Ambient temperature during operation Max. ambient temperature	5 to 40°C +55°C 7)			
Relative humidity during operation	5 to 85%, non-condensing			
Installation at altitudes above sea level Maximum installation altitude 8)	0 to 500 m 2,000 m			
Degree of pollution according to EN 60664-1	2 (non-conductive pollution)			
Overvoltage cat. according to IEC 60364-4-443:1999	II			
EN 60529 protection	IP20			
Storage and transport conditions				
Storage temperature	-25 to +55°C			
Relative humidity during storage	5 to 95%, non-condensing			
Transport temperature	-25 to +70°C			
Relative humidity during transport	95% at +40°C			

Table 16: Technical data - ACOPOS 1010, 1016 (cont.)

Product ID	8V1010.0xx-2	8V1016.0xx-2	8V1010.5xx-2	8V1016.5xx-2
Mechanical characteristics				
Dimensions Width Height Depth	 58.5 mm 257 mm 220 mm			
Weight	2.5 kg	2.5 kg	2.5kg	2.5 kg

Table 16: Technical data - ACOPOS 1010, 1016 (cont.)

1) Limit values from CISPR11, group 2, class A (second environment).
2) When using motor holding brakes, the valid input voltage range is reduced. The input voltage range should be selected so that the proper supply voltage for the motor holding brake can be maintained.
3) The current requirements depend on the configuration of the ACOPOS servo drive.
4) Valid in the following conditions: Mains input voltage 3 x 400 VAC, nominal switching frequency, 40°C ambient temperature, installation altitudes < 500 m above sea level.
5) Valid in the following conditions: Mains input voltage 230 VAC, nominal switching frequency, 40°C ambient temperature, installation altitudes < 500 m above sea level.
6) The nominal switching frequency values for the respective ACOPOS servo drive are marked in bold.
7) Continuous operation of ACOPOS servo drives at ambient temperatures ranging from 40°C to max. 55°C is possible (taking the continuous current reductions listed into consideration), but results in a shorter lifespan.
8) Continuous operation of ACOPOS servo drives at altitudes ranging from 500 m to 2,000 m above sea level is possible (taking the continuous current reductions listed into consideration). Additional requirements are to be arranged with B&R.

1.5 ACOPOS 1022, 1045, 1090

1.5.1 Order data

Model number	Short description	Images
	Servo drives	
8V1022.00-2	Servo drive 3 x 400-480V 2.2A 1kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1022.001-2	Servo drive 3 x 400-480V 2.2A 1kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	
8V1045.00-2	Servo drive 3 x 400-480V 4.4A 2kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1045.001-2	Servo drive 3 x 400-480V 4.4A 2kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	
8V1090.00-2	Servo drive 3 x 400-480V 8.8A 4kW, line filter, braking resistor and electronic secure restart inhibit integrated	
8V1090.001-2	Servo drive 3 x 400-480V 8.8A 4kW, line filter, braking resistor and electronic secure restart inhibit integrated, coated	

8V1022.xxx-2

8V1045.xxx-2

8V1090.xxx-2

Table 17: Order data - ACOPOS 1022, 1045, 1090

Optional accessories		
Model number	Short description	Page
8AC110.60-2	ACOPOS plug-in module, CAN interface	74
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	77
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	81
8AC121.60-1	ACOPOS plug-in module, HIPERFACE interface	85
8AC122.60-3	ACOPOS plug-in module, resolver interface	88
8AC123.60-1	ACOPOS plug-in module, incremental position encoder and SSI absolute encoder interface	91
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	97
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24V input or 45mA output, order TB712 terminal block separately.	101
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	105
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	121
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	121
8CM005.12-1	Motor cable, length 5m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM007.12-1	Motor cable, length 7m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM010.12-1	Motor cable, length 10m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM015.12-1	Motor cable, length 15m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM020.12-1	Motor cable, length 20m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM025.12-1	Motor cable, length 25m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136

Table 18: Optional accessories - ACOPOS 1022, 1045, 1090

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1.5 Technical data

Product ID	8V1022.0xx-2	8V1045.0xx-2	8V1090.0xx-2
General information			
C-UL-US Listed	Yes		
Power mains connection			
Mains input voltage	3 x 400 VAC to 480 VAC ± 10%, line filter according to EN 61800-3-A11, category C3 [1]		
Frequency	50 / 60 Hz ± 4%		
Installed load	Max. 3 kVA	Max. 5 kVA	Max. 10 kVA
Starting current at 400 VAC	4 A	7 A	7 A
Switch-on interval	> 10 s		
Power loss during continuous current without braking resistor	120 W	160 W	200 W
24 VDC supply			
Input voltage [2]	24 VDC +25% / -25%		
Input capacitance	8200 µF		
Current requirements [3]	Max. 2.5 A + current for motor holding brake		
DC bus			
DC bus capacitance	235 µF		470 µF
Motor connection			
Continuous current [4]	2.2 A_{eff}	4.4 A_{eff}	8.8 A_{eff}
Reduction of continuous current depending on ambient temperature [5] Mains Input Voltage: 400 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz Mains Input Voltage: 480 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz	**No reduction** No reduction No reduction **0.13 A_{eff} per °C (starting at 51°C)** No reduction No reduction	**0.13 A_{eff} per °C (starting at 45°C)** No reduction No reduction **0.13 A_{eff} per °C (starting at 35°C)** No reduction No reduction	0.18 A_{eff} per °C (starting at 30°C) **0.18 A_{eff} per °C (starting at 54°C)** No reduction 0.18 A_{eff} per °C (starting at 18°C) **0.18 A_{eff} per °C (starting at 48°C)** No reduction
Reduction of continuous current depending on altitude Starting at 500 m above sea level	0.22 A_{eff} per 1,000 m	0.44 A_{eff} per 1,000 m	0.88 A_{eff} per 1,000 m
Peak current	14 A_{eff}	24 A_{eff}	24 A_{eff}
Rated switching frequency	20 kHz		10 kHz
Electrical stress of the connected motor according to IEC TS 60034-25	Limit value curve A		
Maximum motor line length	25 m		
Protective measures / safeguards	Short circuit & overload protection		

Table 19: Technical data - ACOPOS 1022, 1045, 1090

Product ID	8V1022.0xx-2	8V1045.0xx-2	8V1090.0xx-2
Motor holding brake connection			
Maximum output current	1 A		
Max. number of switching cycles	Approx. 240000		
Braking resistor			
Peak power output	3.5 kW	7 kW	7 kW
Continuous power	130 W	200 W	200 W
Trigger inputs			
Number of inputs	2		
Wiring	Sink		
Electrical isolation Input - ACOPOS Input - Input	 Yes No		
Input voltage Rated Maximum	 24 VDC 30 VDC		
Switching threshold LOW HIGH	 < 5 V >15 V		
Input current at nominal voltage	Approx. 10 mA		
Switching delay Positive edge Negative edge	 52 µs ± 0.5 µs (digitally filtered) 53 µs ± 0.5 µs (digitally filtered)		
Modulation compared to ground potential	Max. ±38 V		
Limit switch and reference inputs			
Number of inputs	3		
Wiring	Sink		
Electrical isolation Input - ACOPOS Input - Input	 Yes No		
Input voltage Rated Maximum	 24 VDC 30 VDC		
Switching threshold LOW HIGH	 < 5 V >15 V		
Input current at nominal voltage	Approx. 4 mA		
Switching delay	Max. 2.0 ms		
Modulation compared to ground potential	Max. ±38 V		
Enable input			
Number of inputs	1		
Wiring	Sink		
Electrical isolation Input - ACOPOS	 Yes		

Table 19: Technical data - ACOPOS 1022, 1045, 1090 (cont.)

<table>
<tr><th>Product ID</th><th>8V1022.0xx-2</th><th>8V1045.0xx-2</th><th>8V1090.0xx-2</th></tr>
<tr><td>Input voltage
Rated
Maximum</td><td colspan="3">
24 VDC
30 VDC</td></tr>
<tr><td>Switching threshold
LOW
HIGH</td><td colspan="3">
< 5 V
>15 V</td></tr>
<tr><td>Input current at nominal voltage</td><td colspan="3">Approx. 30 mA</td></tr>
<tr><td>Switching delay
Enable 1 -> 0, PWM off
Enable 0 -> 1, Ready for PWM</td><td colspan="3">
Max. 2.0 ms
Max. 100 µs</td></tr>
<tr><td>Modulation compared to ground potential</td><td colspan="3">Max. ±38 V</td></tr>
<tr><td>Operating conditions</td><td></td><td></td><td></td></tr>
<tr><td>Ambient temperature during operation
Max. ambient temperature [6)]</td><td colspan="3">5 to 40°C
+55°C</td></tr>
<tr><td>Relative humidity during operation</td><td colspan="3">5 to 85%, non-condensing</td></tr>
<tr><td>Installation at altitudes above sea level
Maximum installation altitude [7)]</td><td colspan="3">0 to 500 m
2,000 m</td></tr>
<tr><td>Degree of pollution according to EN 60664-1</td><td colspan="3">2 (non-conductive pollution)</td></tr>
<tr><td>Overvoltage cat. according to
IEC 60364-4-443:1999</td><td colspan="3">II</td></tr>
<tr><td>EN 60529 protection</td><td colspan="3">IP20</td></tr>
<tr><td>Storage and transport conditions</td><td></td><td></td><td></td></tr>
<tr><td>Storage temperature</td><td colspan="3">-25 to +55°C</td></tr>
<tr><td>Relative humidity during storage</td><td colspan="3">5 to 95%, non-condensing</td></tr>
<tr><td>Transport temperature</td><td colspan="3">-25 to +70°C</td></tr>
<tr><td>Relative humidity during transport</td><td colspan="3">95% at +40°C</td></tr>
<tr><td>Mechanical characteristics</td><td></td><td></td><td></td></tr>
<tr><td>Dimensions
Width
Height
Depth</td><td colspan="3">
70.5 mm
375 mm
235.5 mm</td></tr>
<tr><td>Weight</td><td>4.0 kg</td><td>4.1 kg</td><td>4.4 kg</td></tr>
</table>

Table 19: Technical data - ACOPOS 1022, 1045, 1090 (cont.)

1) Limit values from CISPR11, group 2, class A (second environment).
2) When using motor holding brakes, the valid input voltage range is reduced. The input voltage range should be selected so that the proper supply voltage for the motor holding brake can be maintained.
3) The current requirements depend on the configuration of the ACOPOS servo drive.
4) Valid in the following conditions: Mains input voltage 3 x 400 VAC, nominal switching frequency, 40°C ambient temperature, installation altitudes < 500 m above sea level.
5) The nominal switching frequency values for the respective ACOPOS servo drive are marked in bold.
6) Continuous operation of ACOPOS servo drives at ambient temperatures ranging from 40°C to max. 55°C is possible (taking the continuous current reductions listed into consideration), but results in a shorter lifespan.
7) Continuous operation of ACOPOS servo drives at altitudes ranging from 500 m to 2,000 m above sea level is possible (taking the continuous current reductions listed into consideration). Additional requirements are to be arranged with B&R.

1.6 ACOPOS 1180, 1320

1.6.1 Order data

Model number	Short description	Images
	Servo drives	
8V1180.00-2	Servo drive 3 x 400-480V 19A 9kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	
8V1180.001-2	Servo drive 3 x 400-480V 19A 9kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	
8V1320.00-2	Servo drive 3 x 400-480V 34A 16kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	
8V1320.001-2	Servo drive 3 x 400-480V 34A 16kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	

8V1180.xxx-2

8V1320.xxx-2

Table 20: Order data - ACOPOS 1180, 1320

Optional accessories		
Model number	Short description	Page
8B0W0045H000.001-1	ACOPOSmulti braking resistor, 450 W, 50 R, IP65, terminals	71
8B0W0079H000.001-1	ACOPOSmulti braking resistor, 790 W, 33 R, IP65, terminals	71
8AC110.60-2	ACOPOS plug-in module, CAN interface	74
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	77
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	81
8AC121.60-1	ACOPOS plug-in module, HIPERFACE interface	85
8AC122.60-3	ACOPOS plug-in module, resolver interface	88
8AC123.60-1	ACOPOS plug-in module, incremental position encoder and SSI absolute encoder interface	91
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	97
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24V input or 45mA output, order TB712 terminal block separately.	101
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	105
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	121
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	121
8CM005.12-3	Motor cable, length 5m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM007.12-3	Motor cable, length 7m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM010.12-3	Motor cable, length 10m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM015.12-3	Motor cable, length 15m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM020.12-3	Motor cable, length 20m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM025.12-3	Motor cable, length 25m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136

Table 21: Optional accessories - ACOPOS 1180, 1320

1.6 Technical data

Product ID	8V1180.0xx-2	8V1320.0xx-2
General information		
C-UL-US Listed	Yes	
Power mains connection		
Mains input voltage	3 x 400 VAC to 480 VAC ± 10%, line filter according to EN 61800-3-A11, category C3 [1]	
Frequency	50 / 60 Hz ± 4%	
Installed load	Max. 17 kVA	Max. 30 kVA
Starting current at 400 VAC	13 A	
Switch-on interval	> 10 s	
Power loss during continuous current without braking resistor	210 W	310 W
24 VDC supply		
Input voltage	24 VDC +25% / -20%	
Input capacitance	40,000 µF	
Current requirements at 24 VDC [2] Mains input voltage applied Mains input voltage not applied	 --- [3] Max. 2.8 A + current for the motor holding brake + current on the 24 VDC output	
DC bus power supply Switch-on voltage	 455 VDC	
24 VDC output		
Output voltage Mains input voltage applied Mains input voltage not applied	 22 to 24 VDC 16.7 to 30 VDC [4]	
Output current	Max. 0.5 A	
DC bus		
DC bus capacitance	940 µF	1645 µF
Motor connection		
Continuous current [5]	19 A_{eff}	34 A_{eff}
Reduction of continuous current depending on ambient temperature [6] Mains Input Voltage: 400 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz Mains Input Voltage: 480 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz	 No reduction **No reduction** No reduction No reduction **No reduction** No reduction	 0.61 A_{eff} per °C (starting at 40°C) **No reduction** No reduction 0.61 A_{eff} per °C (starting at 25°C) **No reduction** No reduction
Reduction of continuous current depending on altitude Starting at 500 m above sea level	 1.9 A_{eff} per 1,000 m	 3.4 A_{eff} per 1,000 m
Peak current	50 A_{eff}	80 A_{eff}
Rated switching frequency	10 kHz	

Table 22: Technical data - ACOPOS 1180, 1320

Product ID	8V1180.0xx-2	8V1320.0xx-2
Electrical stress of the connected motor according to IEC TS 60034-25	Limit value curve A	
Maximum motor line length	25 m	
Protective measures / safeguards	Short circuit & overload protection	
Motor holding brake connection		
Maximum output current	1.5 A	
Max. number of switching cycles	Unlimited since done electronically	
Braking resistor [7]		
Peak power output Internal External	 14 kW 40 kW	
Continuous power Internal External	 0.4 kW --- [8]	
Minimum braking resistance (ext.)	15 Ω	
Rated current of the built-in fuse	10 A (fast-acting)	
Trigger inputs		
Number of inputs	2	
Wiring	Sink	
Electrical isolation Input - ACOPOS Input - Input	 Yes No	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 10 mA	
Switching delay Positive edge Negative edge	 52 µs ± 0.5 µs (digitally filtered) 53 µs ± 0.5 µs (digitally filtered)	
Modulation compared to ground potential	Max. ±38 V	

Table 22: Technical data - ACOPOS 1180, 1320 (cont.)

Product ID	8V1180.0xx-2	8V1320.0xx-2
Limit switch and reference inputs		
Number of inputs	3	
Wiring	Sink	
Electrical isolation Input - ACOPOS Input - Input	 Yes No	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 4 mA	
Switching delay	Max. 2.0 ms	
Modulation compared to ground potential	Max. ±38 V	
Enable input		
Number of inputs	1	
Wiring	Sink	
Electrical isolation Input - ACOPOS	 Yes	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 30 mA	
Switching delay Enable 1 -> 0, PWM off Enable 0 -> 1, Ready for PWM	 Max. 2.0 ms Max. 100 µs	
Modulation compared to ground potential	Max. ±38 V	
Operating conditions		
Ambient temperature during operation Max. ambient temperature [9)]	5 to 40°C +55°C	
Relative humidity during operation	5 to 85%, non-condensing	
Installation at altitudes above sea level Maximum installation altitude [10)]	0 to 500 m 2,000 m	
Degree of pollution according to EN 60664-1	2 (non-conductive pollution)	
Overvoltage cat. according to IEC 60364-4-443:1999	II	
EN 60529 protection	IP20	

Table 22: Technical data - ACOPOS 1180, 1320 (cont.)

Product ID	8V1180.0xx-2	8V1320.0xx-2
Storage and transport conditions		
Storage temperature	-25 to +55°C	
Relative humidity during storage	5 to 95%, non-condensing	
Transport temperature	-25 to +70°C	
Relative humidity during transport	95% at +40°C	
Mechanical characteristics		
Dimensions Width Height Depth	 200 mm 375 mm 234 mm	
Weight	10.1 kg	10.6 kg

Table 22: Technical data - ACOPOS 1180, 1320 (cont.)

1) Limit values from CISPR11, group 2, class A (second environment).
2) The current requirements depend on the configuration of the ACOPOS servo drive.
3) If the mains input voltage (3 x 400 VAC to 480 VAC ±10%) is applied, the 24 VDC supply voltage for the ACOPOS servo drive is created by the internal DC bus power supply, which reduces the 24 VDC current requirements (I_{24VDC}) to 0.
4) If the mains input voltage (3 x 400 VAC to 480 VAC ±10%) is not applied, the voltage is created at the 24 VDC output from the ACOPOS servo drive's 24 VDC supply voltage; in this case it is between the maximum allowable and the minimum allowable (reduced by max. 2.5 V) 24 VDC supply voltage of the ACOPOS servo drive.
5) Valid in the following conditions: Mains input voltage 3 x 400 VAC, nominal switching frequency, 40°C ambient temperature, installation altitudes < 500 m above sea level.
6) The nominal switching frequency values for the respective ACOPOS servo drive are marked in bold.
7) The power calculations are based on a DC bus voltage of 800 VDC.

   Danger!

   A component malfunction in the ACOPOS servo drive can lead to a continuous power output on the external braking resistor and cause it to overheat. This must be considered when selecting (e.g. intrinsic safety), organizing and operating the external braking resistor. Thermal monitoring and external turn-off devices should be implemented if necessary.

   If B&R 8B0W braking resistors are used and the ACOPOS servo drive is operated with a mains voltage of 3 x 380 to 3 x 500 VAC ±10%, there is no need for thermal monitoring since B&R 8B0W braking resistors are intrinsically safe under these conditions.
8) Application-dependent (see Chapter 4 "Braking resistor", Section "Determining braking resistor data", on page 199).
9) Continuous operation of ACOPOS servo drives at ambient temperatures ranging from 40°C to max. 55°C is possible (taking the continuous current reductions listed into consideration), but results in a shorter lifespan.
10) Continuous operation of ACOPOS servo drives at altitudes ranging from 500 m to 2,000 m above sea level is possible (taking the continuous current reductions listed into consideration). Additional requirements are to be arranged with B&R.

1.7 ACOPOS 1640, 128M

1.7.1 Order data

Model number	Short description	Images
	Servo drives	
8V1640.00-2	Servo drive 3 x 400-480V 64A 32kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	
8V1640.001-2	Servo drive 3 x 400-480V 64A 32kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	
8V128M.00-2	Servo drive 3 x 400-480V 128A 64kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated	
8V128M.001-2	Servo drive 3 x 400-480V 128A 64kW, line filter, braking resistor, DC bus power supply and electronic secure restart inhibit integrated, coated	

8V1640.xxx-2

8V128M.xxx-2

Table 23: Order data - ACOPOS 1640, 128M

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Optional accessories		
Model number	Short description	Page
8B0W0045H000.001-1	ACOPOSmulti braking resistor, 450 W, 50 R, IP65, terminals	71
8B0W0079H000.001-1	ACOPOSmulti braking resistor, 790 W, 33 R, IP65, terminals	71
8AC110.60-2	ACOPOS plug-in module, CAN interface	74
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	77
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	81
8AC121.60-1	ACOPOS plug-in module, HIPERFACE interface	85
8AC122.60-3	ACOPOS plug-in module, resolver interface	88
8AC123.60-1	ACOPOS plug-in module, incremental position encoder and SSI absolute encoder interface	91
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	97
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24V input or 45mA output, order TB712 terminal block separately.	101
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	105
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	105
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	121
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	121
8CM005.12-5	Motor cable, length 5m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM007.12-5	Motor cable, length 7m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM010.12-5	Motor cable, length 10m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM015.12-5	Motor cable, length 15m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM020.12-5	Motor cable, length 20m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136
8CM025.12-5	Motor cable, length 25m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	136

Table 24: Optional accessories - ACOPOS 1640, 128M

1.7 Technical data

Product ID	8V1640.0xx-2	8V128M.0xx-2
General information		
C-UL-US Listed	Yes	
Power mains connection		
Mains input voltage	3 x 400 VAC to 480 VAC ± 10% Power filter according to IEC 61800-3-A11, category C3 [1]	
Frequency	50 / 60 Hz ± 4%	
Installed load	Max. 54 kVA	Max. 98 kVA
Starting current at 400 VAC	26 A	
Switch-on interval	> 10 s	
Power loss during continuous current without braking resistor	780 W	1400 W
24 VDC supply		
Input voltage	24 VDC +25% / -20%	
Input capacitance	32800 µF	
Current requirements at 24 VDC [2] Mains input voltage applied Mains input voltage not applied	--- [3] Max. 4.6 A + 1.4 * (current for the motor holding brake + current on the 24 VDC output)	--- [3] Max. 5.7 A + 1.4 * (current for the motor holding brake + current on the 24 VDC output)
DC bus power supply Switch-on voltage	455 VDC	
24 VDC output		
Output voltage Mains input voltage applied Mains input voltage not applied	22 to 24 VDC 16.7 to 30 VDC [4]	
Output current	Max. 0.5 A	
DC bus		
DC bus capacitance	3300 µF	6600 µF
Motor connection		
Continuous current [5]	64 A_{eff}	128 A_{eff}
Reduction of continuous current depending on ambient temperature [6] Mains Input Voltage: 400 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz Mains Input Voltage: 480 VAC Switching frequency 20 kHz Switching frequency 10 kHz Switching frequency 5 kHz	0.96 A_{eff} per °C (starting at 25°C) **No reduction** No reduction 0.96 A_{eff} per °C (starting at 10°C) **0.96 A_{eff} per °C (starting at 50°C)** No reduction	1.65 A_{eff} per °C (starting at 12°C) 1.65 A_{eff} per °C (starting at 52°C) **No reduction** 1.65 A_{eff} per °C (starting at 10°C) [7] 1.65 A_{eff} per °C (starting at 36°C) **No reduction**
Reduction of continuous current depending on altitude Starting at 500 m above sea level	6.4 A_{eff} per 1,000 m	12.8 A_{eff} per 1,000 m
Peak current	200 A_{eff}	300 A_{eff}

Table 25: Technical data - ACOPOS 1640, 128M

Product ID	8V1640.0xx-2	8V128M.0xx-2
Rated switching frequency	10 kHz	5 kHz
Electrical stress of the connected motor according to IEC TS 60034-25	Limit value curve A	
Maximum motor line length	25 m	
Protective measures / safeguards	Short circuit & overload protection	
Motor holding brake connection		
Maximum output current	3 A	
Max. number of switching cycles	Approx. 80000	
Braking resistor [8)]		
Peak power output Internal External	 7 kW 250 kW	 8.5 kW 250 kW
Continuous power Internal External	 0.2 kW --- [9)]	 0.24 kW --- [9)]
Minimum braking resistance (ext.)	2.5 Ω	
Rated current of the built-in Fuse	30 A (fast-acting)	
Trigger inputs		
Number of inputs	2	
Wiring	Sink	
Electrical isolation Input - ACOPOS Input - Input	 Yes No	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 10 mA	
Switching delay Positive edge Negative edge	 52 µs ± 0.5 µs (digitally filtered) 53 µs ± 0.5 µs (digitally filtered)	
Modulation compared to ground potential	Max. ±38 V	

Table 25: Technical data - ACOPOS 1640, 128M (cont.)

Product ID	8V1640.0xx-2	8V128M.0xx-2
Limit switch and reference inputs		
Number of inputs	3	
Wiring	Sink	
Electrical isolation Input - ACOPOS Input - Input	 Yes No	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 4 mA	
Switching delay	Max. 2.0 ms	
Modulation compared to ground potential	Max. ±38 V	
Enable input		
Number of inputs	1	
Wiring	Sink	
Electrical isolation Input - ACOPOS	 Yes	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V >15 V	
Input current at nominal voltage	Approx. 30 mA	
Switching delay Enable 1 -> 0, PWM off Enable 0 -> 1, Ready for PWM	 Max. 2.0 ms Max. 100 µs	
Modulation compared to ground potential	Max. ±38 V	
Operating conditions		
Ambient temperature during operation Max. ambient temperature [10)]	5 to 40°C +55°C	
Relative humidity during operation	5 to 85%, non-condensing	
Installation at altitudes above sea level Maximum installation altitude [11)]	0 to 500 m 2,000 m	
Degree of pollution according to EN 60664-1	2 (non-conductive pollution)	
Overvoltage cat. according to IEC 60364-4-443:1999	II	
EN 60529 protection	IP20	

Table 25: Technical data - ACOPOS 1640, 128M (cont.)

Product ID	8V1640.0xx-2	8V128M.0xx-2
Storage and transport conditions		
Storage temperature	-25 to +55°C	
Relative humidity during storage	5 to 95%, non-condensing	
Transport temperature	-25 to +70°C	
Relative humidity during transport	95% at +40°C	
Mechanical characteristics		
Dimensions Width Height Depth	 276 mm 460 mm 295 mm	 402 mm 460 mm 295 mm
Weight	24.1 kg	33.8 kg

Table 25: Technical data - ACOPOS 1640, 128M (cont.)

1) Limit values from CISPR11, group 2, class A (second environment).
2) The current requirements depend on the configuration of the ACOPOS servo drive.
3) If the mains input voltage (3 x 400 VAC to 480 VAC ±10%) is applied, the 24 VDC supply voltage for the ACOPOS servo drive is created by the internal DC bus power supply, which reduces the 24 VDC current requirements (I_{24VDC}) to 0.
4) If the mains input voltage (3 x 400 VAC to 480 VAC ±10%) is not applied, the voltage is created at the 24 VDC output from the ACOPOS servo drive's 24 VDC supply voltage; in this case it is between the maximum allowable and the minimum allowable (reduced by max. 2.5 V) 24 VDC supply voltage of the ACOPOS servo drive.
5) Valid in the following conditions: Mains input voltage 3 x 400 VAC, nominal switching frequency, 40°C ambient temperature, installation altitudes < 500 m above sea level.
6) The nominal switching frequency values for the respective ACOPOS servo drive are marked in bold.
7) For a mains input voltage of 3 x 480 VAC and a switching frequency of 20 kHz, a maximum continuous current of 95 A_{eff} is permitted. At ambient temperatures > 10°C, a reduction of the continuous current of 1.65 A_{eff} per °C must be taken into consideration.
8) The power calculations are based on a DC bus voltage of 800 VDC.

   Danger!

   A component malfunction in the ACOPOS servo drive can lead to a continuous power output on the external braking resistor and cause it to overheat. This must be considered when selecting (e.g. intrinsic safety), organizing and operating the external braking resistor. Thermal monitoring and external turn-off devices should be implemented if necessary.

   If B&R 8B0W braking resistors are used and the ACOPOS servo drive is operated with a mains voltage of 3 x 380 to 3 x 500 VAC ±10%, there is no need for thermal monitoring since B&R 8B0W braking resistors are intrinsically safe under these conditions.
9) Application-dependent (see Chapter 4 "Braking resistor", Section "Determining braking resistor data", on page 199).
10) Continuous operation of ACOPOS servo drives at ambient temperatures ranging from 40°C to max. 55°C is possible (taking the continuous current reductions listed into consideration), but results in a shorter lifespan.
11) Continuous operation of ACOPOS servo drives at altitudes ranging from 500 m to 2,000 m above sea level is possible (taking the continuous current reductions listed into consideration). Additional requirements are to be arranged with B&R.

2 8B0W external braking resistors

8B0W external braking resistors are used to dissipate braking energy on ACOPOS servo drives.

2.1 Order data

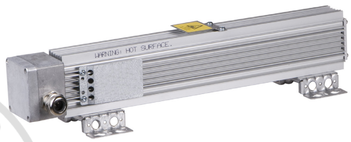
Model number	Short description	Figure
	IP65 protection	 8B0W0079H000.001-1
8B0W0045H000.001-1	ACOPOSmulti braking resistor, 450 W, 50 R, IP65, terminals	
8B0W0079H000.001-1	ACOPOSmulti braking resistor, 790 W, 33 R, IP65, terminals	

Table 26: Order data - 8B0W external braking resistors

2.2 Technical data

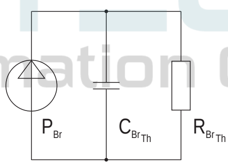
Product ID	8B0W0045H000.001-1	8B0W0079H000.001-1
General information		
C-UL-US Listed	Yes	Yes
RoHS compliant	Yes	Yes
Cooling and mounting method	Wall mounting	Wall mounting
Resistance		
Continuous power depending on the mounting orientation Horizontal Vertical	 360 W 450 W	 632 W 790 W
Reduction of continuous power according to ambient temperature above 40°C	7.5 W/K	13.2 W/K
Ohmic resistance	50 Ω ±10%	33 Ω ±10%
Max. operating voltage	850 VDC	850 VDC
Isolation voltage type test	4,000 VAC	4,000 VAC
Intrinsically Safe	Yes 1)	Yes 1)
Temperature model data 2)		
Maximum permissible over-temperature	680°C	670°C
Thermal resistance between braking resistor and the environment	1.517 K/W	0.852 K/W
Heat capacitance of the filament	16.3 J/K	22.6 J/K

Table 27: Technical data - 8B0W external braking resistors

Product ID	8B0W0045H000.001-1	8B0W0079H000.001-1
Resistor connection		
Design RB1, RB2 PE Shield connection	 Terminals with tension spring technology M4 threaded bolt Yes, to the terminal box via high strength cable gland	
Terminal connection cross section Flexible and fine wire lines with wire tip sleeves UL/cUlus CSA	 1.5 - 10 mm² 24-6 22-6	
Terminal cable outer-cross-section dimension of the connection cable	9 - 16.6 mm	
Operating conditions		
Mounting orientation Horizontal Vertical, bottom of terminal box Vertical, top of terminal box	 Yes Yes No	
Ambient temperature during operation	-40°C to +90°C	
Relative humidity during operation	5 to 95%, non-condensing	
EN 60529 protection	IP65	
Mechanical characteristics		
Dimensions Width Height Depth	 124 mm 121 mm 332 mm	 124 mm 121 mm 532 mm
Weight	2.4 kg	3.9 kg

Table 27: Technical data - 8B0W external braking resistors (cont.)

1) 8B0W external braking resistors can be considered intrinsically safe if they are connected to an ACOPOS servo drive operated with a mains supply voltage of 3 x 380 - 500 VAC. The maximum time until the 8B0W external braking resistors are damaged is approximately 5.5 min in this case; a maximum surface temperature of approximately 480°C is achieved when this happens.
A lower mains supply voltage on the ACOPOS servo drive allows a longer maximum time before the 8B0W external braking resistor is damaged, which also results in higher temperatures.
2) The parameters are based on the following thermal equivalent circuit for the external braking resistor:



3 ACOPOS plug-in modules

3.1 General information

The ACOPOS drives are equipped with up to four plug-in module slots depending on the size.

	8V1010.0xx-2 8V1010.5xx-2 8V1016.0xx-2 8V1016.5xx-2	8V1022.0xx-2 8V1045.0xx-2 8V1090.0xx-2	8V1180.0xx-2 8V1320.0xx-2	8V1640.0xx-2 8V128M.0xx-2
Max. number of plug-in modules	3	4		

Table 28: The maximum number of plug-in modules depends on the size of the servo drive

You can select the plug-in modules required for your application and insert them into the ACOPOS servo drive.

3.2 AC110 - CAN interface

3.2.1 General description

The AC110 plug-in module can be used in an ACOPOS slot. The module is equipped with a CAN interface. This fieldbus interface is used for communication and setting parameters on the ACOPOS servo drive for standard applications.

3.2.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC110.60-2	ACOPOS plug-in module, CAN interface	

Table 29: Order data - AC110

Optional accessories	
Model number	**Short description**
7AC911.9	Bus connector, CAN
0AC912.9	Bus adapter, CAN, 1 CAN interface
0AC913.92	Bus adapter, CAN, 2 CAN interfaces, including 30 cm attachment cable (DSUB connector)

Table 30: Optional accessories - AC110

3.2 Technical data

Product ID	8AC110.60-2
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot	Slot 1
Power consumption	Max. 0.7 W
CAN interface	
Connection, module-side	9-pin DSUB connector
Indicators	RXD/TXD LEDs
Electrical isolation CAN - ACOPOS	Yes
Maximum distance	60 m
Baud rate	500 kbit/s
Network-capable	Yes
Bus termination resistor	Externally wired
Operating conditions	
Ambient temperature during operation	--- 1)
Relative humidity during operation	--- 1)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 31: Technical data - AC110

1) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.2.4 CAN node number settings

The CAN node number can be set using two HEX code switches:

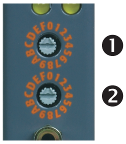
Figure	Code switch	CAN node ID
	❶	16s position (high)
	❷	1s position (low)
	Changing the node number using software is not possible (Basis CAN ID can be changed). The ACOPOS Manager only supports node numbers from 1 - 32. When using the NC157 positioning module, only node numbers from 1 - 8 are possible.	

Table 32: Setting the CAN node number

The node number change takes effect the next time the ACOPOS servo drive is switched on.

There must be a terminating resistor (120Ω, 0.25 W) between CAN_H and CAN_L at the beginning and end of the CAN bus.

3.2.5 Indicators

The status LEDs show if data is being received (RXD) or sent (TXD).

3.2.6 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.3 AC114 - POWERLINK V2 interface

3.3.1 General description

The AC114 plug-in module can be used in an ACOPOS slot. The module is equipped with a POWERLINK V2 interface. This fieldbus interface is used for communication and setting parameters on the ACOPOS servo drive for complex and time critical applications.

The plug-in module is set up as a 2x hub. This makes it easy to establish a device-to-device connection (line topology).

3.3.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC114.60-2	ACOPOS plug-in module, POWERLINK V2 interface	

Table 33: Order data - AC114

Optional accessories	
Model number	**Short description**
X20CA0E61.xxxx	EPL connection cable RJ45 to RJ45, xxxx m

Table 34: Optional accessories - AC114

3.3 Technical data

Product ID	8AC114.60-2
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot	Slot 1
Power consumption	Max. 3 W
POWERLINK interface	
Connection, module-side	2 x RJ45 socket
Indicators	Status LED + 2 x Link LED
Electrical isolation ETHERNET - ACOPOS	 Yes
Maximum distance per segment	100 m 1)
Baud rate	100 Mbit/s
Network-capable	Yes
Hub, 2x	Yes
Maximum number of hub levels	10
Cabling topology	Star or tree with level 2 hubs
Possible station operating modes	Synchronous to POWERLINK cycle
Watchdog function Hardware Software	 Yes (via ACOPOS servo drive) Yes (via ACOPOS servo drive)
Operating conditions	
Ambient temperature during operation	--- 2)
Relative humidity during operation	--- 2)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95 %, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 35: Technical data - AC114

1) With a cycle time of 400 µs and 10 ACOPOS servo drives, the maximum total cable length is 200 m.

2) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.3.4 POWERLINK station number settings

The POWERLINK station number can be set using two HEX code switches:

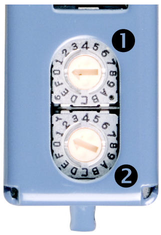
Figure	Code switch	POWERLINK station number
	❶	16s position (high)
	❷	1s position (low)
	The POWERLINK station number change takes effect the next time the ACOPOS servo drive is switched on. **Information:** **In principle, station numbers between $01 and $FD are permitted.** **However, station numbers between $F0 and $FD are reserved for future system expansions. For reasons of compatibility, we recommend avoiding these station numbers.** **Station numbers $00, $FE and $FF are reserved and are therefore not allowed to be set.**	

Table 36: Setting the POWERLINK station number

3.3.5 Indicators

Figure	LED	Label	Color	Function	Description
	❶	R/E	Green/red	Ready/Error	See section "LED status - POWERLINK", on page 80.
	❷	L/D1	Green	Link / Data activity Port 1	
	❸	L/D2	Green	Link / Data activity Port 2	

Table 37: AC114 status LEDs

LED status - POWERLINK

Label	Color	Function	Description	
R/E	Green/red	Ready/Error	LED isn't lit	Supply voltage is not applied to the module or initialization of the network interface has failed.
			Red (lit)	The POWERLINK node number of the module is 0.
			Red/green blinking	The client is in an error state (drops out of cyclic operation).
			Green blinking (1x)	The client recognizes a valid POWERLINK frame on the network.
			Green blinking (2x)	Cyclic operation on the network; however the client itself is not yet participating in cyclic operation.
			Green blinking (3x)	Cyclic operation of the client is in preparation.
			Green (lit)	The client is participating in cyclic operation.
			Green (flickering)	The client is not participating in cyclic operation and also does not detect any other stations on the network that are participating in cyclic operation.
L/D1	Green	Link / Data activity Port 1	Green (lit)	There is a physical connection to another station on the network.
			Green (blinking)	Activity Port 1
L/D2	Green	Link / Data activity Port 2	Green (lit)	There is a physical connection to another station on the network.
			Green (blinking)	Activity Port 2

Table 38 : LED status - POWERLINK

3.3.6 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.4 AC120 - EnDat encoder interface

3.4.1 General description

The AC120 plug-in module can be used in an ACOPOS slot. The module has an EnDat encoder interface, but can also be used to evaluate simple incremental encoders with sine formed output signal [1)].

This module can be used to evaluate encoders which are built into B&R servo motors and also encoders for external axes (encoders that evaluate any machine movement). The input signals are monitored. In this way, broken connections, shorted lines and encoder supply failure can be recognized.

EnDat Encoder:

EnDat is a standard developed by Johannes Heidenhain GmbH (www.heidenhain.de), incorporating the advantages of absolute and incremental position measurement and also offers a read/write parameter memory in the encoder. With absolute position measurement (absolute position is read in serially), the homing procedure is usually not required. When necessary, a multi-turn encoder (4096 revolutions) should be installed. To save costs, a single-turn encoder and a reference switch can also be used. In this case, a homing procedure must be carried out.

The incremental process allows the short delay times necessary for position measurement on drives with exceptional dynamic properties. With the sinusoidal incremental signal and the fine resolution in the EnDat module, a very high positioning resolution is achieved in spite of the moderate signal frequencies used.

The parameter memory in the EnDat encoder is used by B&R to store motor data (among other things). In this way, the ACOPOS servo drives are always automatically provided the correct motor parameters and limit values. This is referred to as the "embedded parameter chip".

During start-up, the module is automatically identified, configured and its parameters set by the ACOPOS servo drive operating system.

Incremental encoder with sine formed output signal:

When using the AC120 plug-in module to evaluate simple incremental encoders with sine formed output signal, only the incremental transfer channel is now used.The "embedded parameter chip" it not available in this case because this encoder does not have parameter memory. The absolute position is also not available immediately after switching the device on. In this situation, a homing procedure normally has to be carried out. The module is equipped with a reference pulse input for this purpose.

1) Starting with revision F0.

3.4 Order data

Model number	Short description	Figure
	Plug-in module	
8AC120.60-1	ACOPOS plug-in module, EnDat encoder and sine incremental encoder interface	

Table 39: Order data - AC120

Optional accessories		
Model number	**Short description**	**Page**
8CE005.12-1	EnDat cable, length 5m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144
8CE007.12-1	EnDat cable, length 7m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144
8CE010.12-1	EnDat cable, length 10m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144
8CE015.12-1	EnDat cable, length 15m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144
8CE020.12-1	EnDat cable, length 20m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144
8CE025.12-1	EnDat cable, length 25m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	144

Table 40: Optional accessories - AC120

3.4 Technical data

Product ID	8AC120.60-1
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot [1)]	Slots 2, 3 and 4
Power consumption E0 ... EnDat single-turn, 512 lines E1 ... EnDat multi-turn, 512 lines E2 ... EnDat single-turn, 32 lines (inductive) E3 ... EnDat multi-turn, 32 lines (inductive) E4 ... EnDat single-turn, 512 lines E5 ... EnDat multi-turn, 512 lines	Depends on the encoder connected Max. 2.3 W Max. 3.1 W Max. 3.1 W Max. 3.1 W Max. 2.4 W Max. 2.7 W
Encoder input [2)]	
Connection, module-side	15-pin DSUB socket
Indicators	UP/DN LEDs
Electrical isolation Encoder - ACOPOS	 No
Encoder monitoring	Yes
Encoder supply Output voltage Load capability Sense lines	 Typ. 5 V 250 mA [3)] 2, compensation of max. 2 x 0.7 V
Sine-cosine inputs Signal transfer Differential voltage Common mode voltage Terminating resistor Signal frequency (-5 dB) Signal frequency (-3 dB) Resolution [4)] Accuracy [5)]	 Differential signals, symmetric 0.5 to 1.25 V_{ss} max. ± 7 V 120 Ω DC up to 400 kHz DC up to 300 kHz 16384 * number of encoder lines ---
Reference input Signal transfer Differential voltage for high Differential voltage for low Common mode voltage Terminating resistor	 Differential signal, symmetric +0.2 V ≤ -0.2 V max. ± 7 V 120 Ω
Serial interface Signal transfer Baud rate	Synchronous RS485 625 kBaud
Operating conditions	
Ambient temperature during operation	--- [6)]
Relative humidity during operation	--- [6)]

Table 41: Technical data - AC120

Product ID	8AC120.60-1
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 41: Technical data - AC120 (cont.)

1) The AC120 is an encoder module. Several encoder modules can also be inserted. In this case, the encoder module in the slot with the lowest number is automatically used for motor feedback.
2) The EnDat encoder must be wired using a cable with a single shield.
3) This value only applies to the encoder. The actual load capacity of the encoder supply is approx. 300 mA. The difference of approx. 50 mA covers the consumption of the terminating resistors that are always present. For longer encoder cables, it is important to note that the maximum voltage drop permitted on the supply wires (there and back) is 1.45V. This can reduce the permissible load current.
4) Depending on the resolution of the connected encoder, in practical applications only a part of this resolution can be used. The usable resolution can be further reduced by signal interferences from the connected encoder.
5) In actual operation, precision is limited by the encoder.
6) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.4.4 Indicators

The UP/DN LEDs are lit depending on the rotational direction and the speed of the connected encoder.

UP LED ... lit when the encoder position changes in the positive direction.
DN LED ... lit when the encoder position changes in the negative direction.

The faster the encoder position changes, the brighter the respective LED is lit.

3.4.5 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.5 AC121 - HIPERFACE encoder interface

3.5.1 General description

The AC121 plug-in module can be used in an ACOPOS slot. The module is equipped with a HIPERFACE encoder interface.

This module can be used to evaluate encoders which are built into OEM motors and also encoders for external axes (encoders that evaluate any machine movement). The input signals are monitored. In this way, broken connections, shorted lines and encoder supply failure can be recognized.

HIPERFACE is a standard developed by Max Stegmann GmbH (www.stegmann.de), similar to EnDat, incorporating the advantages of absolute and incremental position measurement and also offers a read/write parameter memory in the encoder. With absolute position measurement (absolute position is read in serially), the homing procedure is usually not required. When necessary, a multi-turn encoder (4096 revolutions) should be installed. To save costs, a single-turn encoder and a reference switch can also be used. In this case, a homing procedure must be carried out.

The incremental process allows the short delay times necessary for position measurement on drives with exceptional dynamic properties. With the sinusoidal incremental signal and the fine resolution in the HIPERFACE module, a very high positioning resolution is achieved in spite of the moderate signal frequencies used.

The parameter memory contained in the HIPERFACE encoder is currently not used by B&R. Therefore, the "embedded parameter chip" function is not available.

During start-up, the module is automatically identified, configured and its parameters set by the ACOPOS servo drive operating system.

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3.5.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC121.60-1	ACOPOS plug-in module, HIPERFACE encoder interface	

Table 42: Order data - AC121

3.5.3 Technical data

Name	8AC121.60-1
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot 1)	Slots 2, 3 and 4
Power consumption With encoder current requirement of 0 mA With encoder current requirement of 100 mA With encoder current requirement of 170 mA	 0.35 W 1.4 W 2.1 W
Encoder input 2)	
Connection, module-side	15-pin DSUB socket, 2 pins closed
Indicators	UP/DN LEDs
Electrical isolation Encoder - ACOPOS	No
Encoder monitoring	Yes
Encoder supply Output voltage Load capability Sense lines	 8 ... 9 V 170 mA --- 3)

Table 43: Technical data - AC121

Name	8AC121.60-1
Sine-cosine inputs	
Signal transfer	Differential signal, asymmetric
Differential voltage	0.5 to 1.25 V_{ss}
Common mode voltage	max. ± 7 V
Terminating resistor	120 Ω
Signal frequency	DC up to 200 kHz
Resolution 4)	16384 * number of encoder lines
Accuracy 5)	---
Serial interface	Asynchronous
Signal transfer	RS485
Baud rate	9600 baud
Operating conditions	
Ambient temperature during operation	--- 6)
Relative humidity during operation	--- 6)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 43: Technical data - AC121 (cont.)

1) The AC121 is an encoder module. Several encoder modules can also be inserted. In this case, the module in the slot with the lowest number is automatically used for motor feedback.
2) The HIPERFACE encoder must be wired using a cable with a single shield.
3) No sense lines are present because the supply voltage for the HIPERFACE encoder is permitted to lie between 7 and 12 V.
4) Noise on the encoder signal reduces the resolution that can be used by approx. 5 bits (factor of 32).
5) In actual operation, precision is limited by the encoder.
6) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.5.4 Indicators

The UP/DN LEDs are lit depending on the rotational direction and the speed of the connected encoder.

UP LED ... lit when the encoder position changes in the positive direction.
DN LED ... lit when the encoder position changes in the negative direction.

The faster the encoder position changes, the brighter the respective LED is lit.

3.5.5 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.6 AC122 - resolver interface

3.6.1 General description

The AC122 plug-in module can be used in an ACOPOS slot. The module is equipped with a resolver interface.

The plug-in module handles the output from resolvers which are built into B&R servo motors or used as an encoder for external axes. This resolver delivers the absolute position over one revolution. Normally, the movement path is longer than one revolution. In this case, a reference switch must be used and a homing procedure carried out.

The encoder input signals are monitored. In this way, broken connections, shorted lines and encoder supply failure (reference signal) can be recognized.

During start-up, the AC122 module is automatically identified by the ACOPOS operating system. Making automatic adjustments to the motor (motor parameters, limit values, encoder resolution, etc.) is not possible because the resolver does not have parameter memory like the EnDat encoder.

If the precision, resolution, bandwidth or ease of setting parameters is not sufficient with the resolver, the EnDat system should be used (see section 3.4 "AC120 - EnDat encoder interface", on page 81).

3.6.2 Order data

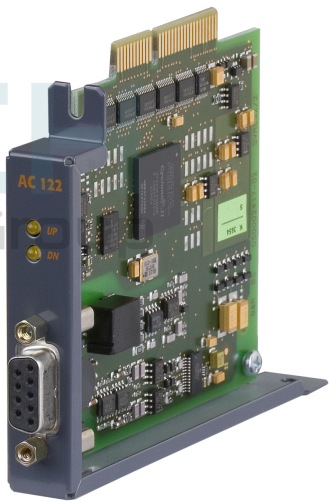
Model number	Short description	Figure
	Plug-in module	
8AC122.60-3	ACOPOS plug-in module, resolver interface	

Table 44: Order data - AC122

Optional accessories		
Model number	Short description	Page
8CR005.12-1	Resolver cable, length 5m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146
8CR007.12-1	Resolver cable, length 7m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146
8CR010.12-1	Resolver cable, length 10m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146
8CR015.12-1	Resolver cable, length 15m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146
8CR020.12-1	Resolver cable, length 20m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146
8CR025.12-1	Resolver cable, length 25m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	146

Table 45: Optional accessories - AC122

3.6.3 Technical data

Product ID	8AC122.60-3
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot 1)	Slots 2, 3 and 4
Power consumption	Max. 2.5 W
Resolver input 2)	
Resolver type Number of poles Nominal conversion ratio 3) Input frequency Input voltage Max. phase shift Max. elec. angular error	BRX 4) 2-pin 0.5 ± 10% 10 kHz 3 to 7 V_{rms} ± 45° ± 10 angular minutes
Connection, module-side	9-pin DSUB socket
Indicators	UP/DN LEDs
Electrical isolation Resolver - ACOPOS	 No
Encoder monitoring	Yes
Resolution	14 bits/rev 5)
Bandwidth	2.5 kHz
Accuracy	± 8 angular minutes
Reference output Signal transfer Differential voltage Output current Frequency	 Differential signals Typically 3 V_{eff} Max. 50 mA_{eff} 10 kHz

Table 46: Technical data - AC122

Product ID	8AC122.60-3
Sine-cosine inputs Signal transfer Input impedance at 10 kHz (per pin) Electrical isolation encoder-ACOPOS	 Differential signals 10.4 kΩ - j 11.1 kΩ No, common-mode voltage on the sine cosine inputs max ± 20 V
Operating conditions	
Ambient temperature during operation	--- 6)
Relative humidity during operation	--- 6)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 46: Technical data - AC122 (cont.)

1) The 8AC122.60-3 is an encoder module. Several encoder modules can also be inserted. In this case, the encoder module in the slot with the lowest number is automatically used for motor feedback.
2) The resolver must be wired using a cable with a single shield and twisted pair signal lines.
3) Starting with firmware V2.040, the nominal conversion ratio can be configured in the range from 0.3 ... 0.5 (default value). (ParID 1048 - encoder1: Resolver ratio; ParID 951 - encoder2: Resolver ratio; ParID 952 - encoder3: Resolver ratio).
4) BRX resolvers are fed with a sine signal (reference signal) from the module and provide two sine signals with a 90° phase shift as a result. The amplitudes of these signals change with the angular position of the resolver.

   Unlike BRX resolvers, BRT resolvers can be fed with two sine signals which are offset by 90°. A single sine signal with constant amplitude is returned. The phase position of this signal changes with the angular position of the resolver.
   An evaluation of BRT resolvers with the 8AC122.60-3 is fundamentally possible starting with firmware V2.040; however, resolution and accuracy are limited by the inverse operation of the resolver. Additionally, the nominal conversion ratio deviates from the default value of 0.5 and must be configured accordingly.
5) A resolution of 12 Bit/rev is set by default, but the resolution can be changed to 14 Bit/rev. (Slot 2: ParID 109 / Slot 3: ParID 289 / Slot 4: ParID 703).
6) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.6.4 Indicators

The UP/DN LEDs are lit depending on the rotational direction and the speed of the connected encoder.

UP LED ... lit when the encoder position changes in the positive direction.
DN LED ... lit when the encoder position changes in the negative direction.

The faster the encoder position changes, the brighter the respective LED is lit.

3.7 AC123 - Incremental encoder and SSI absolute encoder interface

3.7.1 General description

The ACOPOS plug-in module AC123 is used to connect standard industrial incremental or absolute encoders with a synchronous serial interface (SSI) to ACOPOS servo drives. For example, this allows electronic gears to be configured which read master movements using external encoders. If the encoder resolution is high enough, motor feedback for induction motors is also possible.

With incremental encoders, the maximum counter frequency is 200 kHz. Single and multi-turn encoders with a maximum of 31 bits at 200 kBaud can be read as absolute SSI encoders.

The position is determined cyclically (initiated by the module) and is exactly synchronized with the ACOPOS controller clock. The input signals are monitored for both encoder types. In this way, broken connections, shorted lines and encoder supply failure can be recognized.

With incremental encoders the counter frequency and distance between edges is also monitored. With absolute encoders, the parity bit is evaluated and a plausibility check carried out.

3.7.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC123.60-1	ACOPOS plug-in module, incremental encoder and SSI absolute encoder interface	

Table 47: Order data - AC123

3.7 Technical data

Product ID	8AC123.60-1
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot [1)]	Slots 2, 3 and 4
Power consumption Encoder supply 5V Encoder supply 15V	 P_{Module} [W] = ($U_{Encoder}$ [V] · $I_{Encoder}$ [A] · 1.75) + 0.6 W P_{Module} [W] = ($U_{Encoder}$ [V] · $I_{Encoder}$ [A] · 1.2) + 0.6 W
Encoder connection	
Connection, module-side	15-pin DSUB socket
Indicators	UP/DN LEDs
Electrical isolation Encoder - ACOPOS	 Yes
Encoder monitoring	Yes
Signal transfer	Differential signal transfer
Cable length	50 m [2) 3)]
Encoder supply 5V	
Output voltage	5 V +25% / -0%
Load capability	350 mA
Sense lines Amount Max. compensation	 2 2 x 2 V
Protective measures Overload protection Short circuit protection	 Yes Yes
Encoder supply 15V	
Output voltage	15 V +25% / -20%
Load capability	350 mA
Sense lines	No
Protective measures Overload protection Short circuit protection	 Yes Yes
Inputs A, B, R, D	
Signal transfer	RS422
Differential voltage	±2.5 V to ±6.0 V
Common mode voltage	-50 V up to +50 V
Terminating resistor	120 Ω (difference)
Incremental encoder operation	
Signal form	Square wave pulse
Evaluation	4x
Input frequency	Max. 200 kHz
Counter frequency	Max. 800 kHz

Table 48: Technical data - AC123

Product ID	8AC123.60-1
Reference frequency	Max. 200 kHz
Distance between edges	Min. 0.6 µs
SSI absolute encoder operation	
Coding	Gray, binary
Baud rate	200 kBaud
Word size	Max. 31-bit
Differential voltage clock output to 120 Ω	Typ. 2.5 V
Operating conditions	
Ambient temperature during operation	--- 4)
Relative humidity during operation	--- 4)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 48: Technical data - AC123 (cont.)

1) The AC123 is an encoder module. Several encoder modules can also be inserted. In this case, the encoder module in the slot with the lowest number is automatically used for motor feedback.
2) The encoder must be wired using a cable with a single shield and twisted pair signal lines (e. g. 4 x 2 x 0.14 mm^2 + 2 x 0.5 mm^2).
3) A cable with at least 4 x 2 x 0.14 mm^2 + 2 x 0.5 mm^2 is required for the maximum cable length and the sense lines must be used.
4) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.7.4 Indicators

The UP/DN LEDs are lit depending on the rotational direction and the speed of the connected encoder.

UP LED ... lit when the encoder position changes in the positive direction.
DN LED ... lit when the encoder position changes in the negative direction.

The faster the encoder position changes, the brighter the respective LED is lit.

3.7.5 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.8 AC125 - BISS encoder interface

3.8.1 General description

The AC125 plug-in module can be used in an ACOPOS slot. The module has a BISS encoder interface (MODE 3).

This module can be used to evaluate encoders which are built into B&R servo motors and also encoders for external axes (encoders that evaluate any machine movement). The input signals are monitored. In this way, broken connections, shorted lines and encoder supply failure can be recognized.

3.8.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC125.60-1	ACOPOS plug-in module, BISS encoder interface	

Table 49: Order data - AC125

3.9 Technical data

Product ID	8AC125.60-1
General information	
C-UL-US Listed	No
Module type	ACOPOS plug-in module
Slot [1)]	Slots 2, 3 and 4
Power consumption	In preparation

Table 50: Technical data - AC125

Product ID	8AC125.60-1
Encoder input 2)	
Connection, module-side	15-pin DSUB socket
Indicators	UP/DN LEDs
Electrical isolation Encoder - ACOPOS	 No
Encoder monitoring	Yes
Encoder supply Output voltage Load capability Sense lines	 Typ. 5 V 250 mA 3) No
Sine-cosine inputs 4) Signal transfer Differential voltage Common mode voltage Terminating resistor Signal frequency (-5 dB) Signal frequency (-3 dB) Resolution 5) Accuracy 6)	 Differential signals, symmetric 0.5 to 1.25 V_{ss} max. ± 7 V 120 Ω DC up to 400 kHz DC up to 300 kHz 16384 * number of encoder lines ---
Reference input Signal transfer Differential voltage for high Differential voltage for low Common mode voltage Terminating resistor	 Differential signal, symmetric +0.2 V ≤ -0.2 V max. ± 7 V 120 Ω
Serial interface Signal transfer Baud rate	Synchronous RS485 625 kBaud
Operating conditions	
Ambient temperature during operation	--- 7)
Relative humidity during operation	--- 7)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 50: Technical data - AC125 (cont.)

1) The AC125 is an encoder module. Several encoder modules can also be inserted. In this case, the encoder module in the slot with the lowest number is automatically used for motor feedback.
2) The BISS encoder must be wired using a cable with a single shield.
3) This value only applies to the encoder. The actual load capacity of the encoder supply is approx. 300 mA. The difference of approx. 50 mA covers the consumption of the terminating resistors that are always present. For longer encoder cables, it is important to note that the maximum voltage drop permitted on the supply wires (there and back) is 1.45V. This can reduce the permissible load current.
4) Currently not supported.
5) Depending on the resolution of the connected encoder, in practical applications only a part of this resolution can be used. The usable resolution can be further reduced by signal interferences from the connected encoder.
6) In actual operation, precision is limited by the encoder.
7) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.9.1 Indicators

The UP/DN LEDs are lit depending on the rotational direction and the speed of the connected encoder.

UP LED ... lit when the encoder position changes in the positive direction.
DN LED ... lit when the encoder position changes in the negative direction.

The faster the encoder position changes, the brighter the respective LED is lit.

3.9.2 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.10 AC130 - Digital mixed module

3.10.1 General description

The AC130 plug-in module can be used in an ACOPOS slot. A maximum of 8 digital inputs or 10 digital outputs are available.

I/O points can be configured in pairs as inputs or outputs. The first three inputs have incremental encoder functionality (A, B, R).

The inputs are divided into 4 standard (max. 10 kHz) and 4 high speed (max. 100 kHz) inputs.

The outputs include 4 high speed (push-pull) outputs with a maximum current of 100 mA, 4 standard (high-side) outputs with a maximum current of 400 mA and 2 low speed (high-side) outputs with a maximum current of 2 A. All outputs can be read.

3.10.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC130.60-1	ACOPOS plug-in module, 8 digital I/O configurable in pairs as 24V input or as output 400/100mA, 2 digital outputs 2A, Order TB712 terminal block separately.	
Order TB712 terminal block separately.		

Table 51: Order data - AC130

Required accessories	
Model number	**Short description**
7TB712.9	Terminal block, 12-pin, screw clamps
7TB712.91	Terminal block, 12-pin, cage clamps

Table 52: Optional accessories - AC130

3.1[illegible]3 Technical data

Product ID	8AC130.60-1
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot 1)	Slots 2, 3 and 4
Power consumption	Max. 0.8 W
Inputs/outputs	
Connection, module-side	12-pin connector
Configuration of the inputs/outputs	Configured in pairs as input or output
Display	24 V LED
Supply voltage	
Supply voltage Minimum Rated Maximum	 18 VDC 24 VDC 30 VDC
Reverse polarity protection	Yes
Voltage monitoring (24 V - LED)	Yes, supply voltage > 18 V
Digital inputs 2)	
Number of inputs	Max. 8
Wiring	Sink
Electrical isolation Input - ACOPOS Input - Input	 Yes No
Input voltage Rated Maximum	 24 VDC 30 VDC
Switching threshold LOW HIGH	 < 5 V > 15 V
Input current at nominal voltage Inputs 1 - 4 Inputs 5 - 8	 Approx. 10 mA Approx. 5.5 mA
Switching delay Inputs 1 - 4 Inputs 5 - 8	 Max. 5 µs Max. 35 µs
Modulation compared to ground potential	---
Event counter	
Signal form	Square wave pulse
Input frequency	Max. 100 kHz
Counter size	16-bit
Inputs Input 1 Input 2	 Counter 1 Counter 2

Table 53: Technical data - AC130

Product ID	8AC130.60-1
Incremental encoder	
Signal form	Square wave pulse
Evaluation	4x
Encoder monitoring	No
Input frequency	Max. 62.5 kHz
Counter frequency	Max. 250 kHz
Reference frequency	Max. 62.5 kHz
Distance between edges	Min. 2.5 µs
Counter size	16-bit
Inputs Input 1 Input 2 Input 3	 Channel A Channel B Reference pulse R
Outputs	
Number of outputs	Max. 10
Type Outputs 1 - 4 Outputs 5 - 10	Transistor outputs Push-pull High-side
Electrical isolation Output - ACOPOS Output - Output	 Yes No
Switching voltage Minimum Rated Maximum	 18 VDC 24 VDC 30 VDC
Continuous current Outputs 1 - 4 Outputs 5 - 8 Outputs 9 - 10	 Max. 100 mA Max. 400 mA Max. 2 A
Switching delay 0 -> 1 and 1 -> 0 Outputs 1 - 4 Outputs 5 - 8 Outputs 9 - 10	 Max. 5 µs Max. 50 µs Max. 500 µs
Switching frequency (resistive load) Outputs 1 - 2 Outputs 3 - 4 Outputs 5 - 8 Outputs 9 - 10	 Max. 10 kHz Max. 10 kHz Max. 5 kHz Max. 100 Hz
Protection Short circuit protection Overload protection	 Yes Yes
Short circuit current at 24 V (until cut-off) Outputs 1 - 4 Outputs 5 - 8 Outputs 9 - 10	 Approx. 1 A Approx. 1.2 A Approx. 24 A
Readable outputs	Yes

Table 53: Technical data - AC130 (cont.)

Product ID	8AC130.60-1
Operating conditions	
Ambient temperature during operation	--- 3)
Relative humidity during operation	--- 3)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 53: Technical data - AC130 (cont.)

1) The AC130 can also be used as an encoder module. Several encoder modules can also be inserted. In this case, the encoder module in the slot with the lowest number is automatically used for motor feedback.
2) Shielded cables must be used for inputs 1 - 4.
3) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.10.4 Indicators

The 24V LED is lit as soon as the supply voltage for the plug-in module goes above 18 VDC.

3.10.5 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.11 AC131 - Mixed module

3.11.1 General description

The AC131 plug-in module can be used in an ACOPOS slot. A maximum of 2 analog inputs (±10 V differential inputs or single-ended inputs) and 2 digital inputs or digital outputs are available.

The analog inputs have a resolution of 12 bits and are scanned synchronously using the 50 µs clock for the ACOPOS servo drive. The analog inputs have a 10 kHz analog input filter (low pass 3rd order).

The digital inputs and outputs can be configured individually as input or output. The digital inputs are equipped with a counter function. The digital outputs (push-pull) can be read.

3.11.2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC131.60-1	ACOPOS plug-in module, 2 analog inputs ±10V, 2 digital I/O points which can be configured as a 24 V input or 45 mA output, order TB712 terminal block separately.	
Order TB 712 terminal block separately!		

Table 54: Order data - AC131

Required accessories	
Model number	**Short description**
7TB712.9	Terminal block, 12-pin, screw clamps
7TB712.91	Terminal block, 12-pin, cage clamps

Table 55: Optional accessories - AC131

3.1[illegible] Technical data

Product ID	8AC131.60-1
General information	
C-UL-US Listed	Yes
Module type	ACOPOS plug-in module
Slot	Slots 2, 3 and 4
Power consumption	Max. 1 W
Inputs/outputs	
Connection, module-side	12-pin connector
Configuration of the digital inputs/outputs	Can be configured individually as digital input or output
Display	24 V LED
Supply voltage	
Supply voltage Minimum Rated Maximum	 18 VDC 24 VDC 30 VDC
Reverse polarity protection	Yes
Voltage monitoring (24 V - LED)	Yes, supply voltage > 18 V
Digital inputs	
Number of inputs	Max. 2
Wiring	Sink
Electrical isolation Input - ACOPOS Input - Input	 Yes No
Input voltage Rated Maximum	 24 VDC 30 VDC
Switching threshold LOW HIGH	 < 5 V > 15 V
Input current at nominal voltage	Approx. 8 mA
Switching delay Counter Digital input	 Max. 5 µs Max. 55 µs (digitally filtered)
Modulation compared to ground potential	Max. ±50 V
Event counter	
Signal form	Square wave pulse
Input frequency	Max. 100 kHz
Counter size	16-bit
Inputs Input 1 Input 2	 Counter 1 Counter 2

Table 56: Technical data - AC131

Product ID	8AC131.60-1
Digital outputs	
Number of outputs	Max. 2
Type	Transistor outputs push-pull
Electrical isolation Output - ACOPOS Output - Output	 Yes No
Switching voltage Minimum Rated Maximum	 18 VDC 24 VDC 30 VDC
Continuous current	Max. 45 mA
Switching delay 0 -> 1 and 1 -> 0	Max. 5 µs
Switching frequency (resistive load)	Max. 100 kHz
Protection Short circuit protection Overload protection	 Yes Yes
Short circuit current at 24 V (until cut-off)	Approx. 0.3 A
Readable outputs	Yes
Analog inputs	
Number of inputs	Max. 2
Design	Differential input or single ended input
Electrical isolation Input - ACOPOS Input - Input	 Yes No
Input signal Rated Maximum	 -10 V up to +10 V -15 V up to +15 V
Operating mode	Cyclic measurement synchronous to 50 µs ACOPOS clock
Digital converter resolution	12-bit
Non-linearity	±1 LSB
Output format	INT16 $8000 - $7FF0 LSB = $0010 = 4.883 mV
Conversion procedure	Successive approximation
Conversion time for both inputs	< 50 µs
Differential input impedance	> 10 MΩ
Input filter	Analog low pass 3rd order / cut-off frequency: 10 kHz
Basic accuracy at 25° C	±0.05% 1)
Offset drift	Max. ±0.0005% /°C 1)
Gain drift	Max. ±0.006% /°C 1)
Cross-talk between the analog inputs	Min. -90 dB at 1kHz
Common-mode rejection DC 50 Hz	 Min. -73 dB Min. -73 dB
Modulation compared to ground potential	Max. ±50 V

Table 56: Technical data - AC131 (cont.)

Product ID	8AC131.60-1
Modulation between the analog input channels	Max. ±5 V
Operating conditions	
Ambient temperature during operation	--- 2)
Relative humidity during operation	--- 2)
Storage and transport conditions	
Storage temperature	-25 to +55°C
Relative humidity during storage	5 to 95%, non-condensing
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 56: Technical data - AC131 (cont.)

1) Refers to the measurement range limit.
2) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.11.4 Indicators

The 24V LED is lit as soon as the supply voltage for the plug-in module goes above 18 VDC.

3.11.5 Firmware

The firmware is part of the operating system for the ACOPOS servo drives. The firmware is updated by updating the ACOPOS operating system.

3.12 AC140 - CPU module

3.12.1 General description

The AC140 plug-in module can be used in an ACOPOS slot (requires two slots).

The CPU module makes it possible to operate an ACOPOS servo drive without external PLC and is also available with integrated "Soft CNC" system (8AC140.61-3).

Communication in the ACOPOS network occurs as described in section 3.5 "Drive-based control", on page 31.

The ACOPOS servo drive connection which the AC140 is plugged into, has an emulation of an AC110 - CAN interface plug-in module on slot 1. All other CAN stations are connected via the CAN interface IF2.

The module offers interchangeable application memory in the form of a Compact Flash card as well as a separate backup battery for the module. [1]

It is equipped with up to four application interfaces:

- One RS232 interface (IF1) for programming and configuring using B&R Automation Studio™
- One CAN interface (IF2) for connecting to a CAN network
- one PROFIBUS DP slave interface (IF3) for connecting to a PROFIBUS network
- one Ethernet interface (IF6) for connecting to an Ethernet network (only 8AC140.61-3)

In addition, a maximum of three digital inputs / outputs are provided as well as one analog input (±10 V differential input).

The digital inputs and outputs can be configured individually as input or output. Additional functions such as a counter function with direction switching (stepper motor) or period and gate measurement are integrated.
The inputs and outputs are scanned directly by the CPU module; the ACOPOS servo drive does not have direct access to these inputs and outputs.

The analog input has a resolution of 12 bits and an analog input filter with 10 kHz (low pass 3rd order).

1) Application memory must be ordered separately.

3.1[illegible]2 Order data

Model number	Short description	Figure
	Plug-in module	
8AC140.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	 8AC140.60-2
8AC140.60-3	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 32MB DRAM, 32 kB SRAM, removable application memory: Compact Flash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately.	
8AC140.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 1 CAN interface, 1 Ethernet interface 100 Base-T, 1 PROFIBUS DP slave interface, 1 RS232 interface, 3 digital I/O can be configured as 24 VDC input or 500 mA output, 1 analog input ±10V, order program memory and 0TB708 terminal block separately	
Order application memory and TB 708 terminal block separately!		 8AC140.60-3, 8AC140.61-3

Table 57: Order data - AC140

Required accessories	
Model number	**Short description**
5CFCRD.0064-03	CompactFlash 64 MB ATA/IDE SiliconSystems
5CFCRD.0128-03	CompactFlash 128 MB ATA/IDE SiliconSystems
5CFCRD.0256-03	CompactFlash 256 MB ATA/IDE SiliconSystems
5CFCRD.0512-03	CompactFlash 512 MB ATA/IDE SiliconSystems
5CFCRD.1024-03	CompactFlash 1024 MB ATA/IDE SiliconSystems
5CFCRD.2048-03	CompactFlash 2048 MB ATA/IDE SiliconSystems
5CFCRD.4096-03	CompactFlash 4096 MB ATA/IDE SiliconSystems

Table 58: Optional accessories - AC140

Required accessories	
Model number	**Short description**
5CFCRD.8096-03	CompactFlash 8096 MB ATA/IDE SiliconSystems
0TB708.91	Accessory terminal block, 8-pin, cage clamps 1.5 mm²
0TB708:91-02	Accessory terminal block, 20 pcs., 8-pin cage clamps 1.5 mm²

Table 58: Optional accessories - AC140 (cont.)

Optional accessories	
Model number	**Short description**
0G0001.00-090	Cable PC <-> PLC/PW, RS232 online cable
0AC201.91	Lithium batteries, 4 pcs., 3 V / 950 mAh, button cell
7AC911.9	Bus connector, CAN
0AC912.9	Bus adapter, CAN, 1 CAN interface
0AC913.92	Bus adapter, CAN, 2 CAN interfaces including 30 cm connection cable (DSUB)

Table 59: Optional accessories - AC140

3.12.3 Technical data

Product ID	8AC140.60-2	8AC140.60-3	8AC140.61-3
General information			
C-UL-US Listed	Yes		
Module type	ACOPOS plug-in module double-width		
Slot [1)]	Slots 1 + 2		
Power consumption	Max. 4.5 W		
CPU			
Clock rate	100 MHz		
SRAM	32 kB		
DRAM	16 MB	32 MB	
Operating system	AC140 (version V2.67 and higher)		
IF1 application interface			
Interface type	RS232		
Electrical isolation	No		
Design	9-pin DSUB connector		
Max. distance	15m / 19,200 baud		
Max. baud rate	115.2 kBaud		
Display	X1 LED		

Table 60: Technical data - AC140

Section 2
Technical data

Product ID	8AC140.60-2	8AC140.60-3	8AC140.61-3
IF2 application interface			
Interface type	CAN		
Electrical isolation	Yes		
Design	9-pin DSUB connector		
Max. distance	1,000 m		
Max. baud rate Bus length up to 60 m Bus length up to 200 m Bus length up to 1,000 m	 500 kbit/s 250 kbit/s 50 kbit/s		
Indicators	RX / TX LEDs		
Network-capable	Yes		
Bus termination resistor	Externally wired		
Application interface IF3			
Interface type	RS485		
Transfer protocol	PROFIBUS DP		
Electrical isolation	Yes		
Design	9-pin DSUB socket		
Controller	ASIC SPC3		
RAM	1.5 kB		
Max. distance	1,000 m		
Max. baud rate Bus length up to 100 m Bus length up to 200 m Bus length up to 400 m Bus length up to 1,000 m	 12 Mbit/s 1.5 Mbit/s 500 kbit/s 187.5 kbit/s		
Indicators	RX / TX LEDs	PB LED	
Network-capable	Yes		
Bus termination resistor	External T-connector		
Application interface IF5			
Interface type	---	Ethernet	
Electrical isolation	---	Yes	
Design	---	RJ45 socket	
Max. distance	---	100 m	
Baud rate	---	10/100 MBaud	
Display	---	ACT LED	
Network-capable	---	Yes	
Inputs/outputs			
Connection, module-side	8-pin connector		
Configuration of the digital inputs/outputs	Can be configured individually as input or output		

Table 60: Technical data - AC140 (cont.)

Product ID	8AC140.60-2	8AC140.60-3	8AC140.61-3
Digital inputs [2]			
Number of inputs	Max. 3		
Wiring	Sink		
Electrical isolation Input - ACOPOS Input - Input	 Yes No		
Input voltage Rated Maximum	 24 VDC 30 VDC		
Switching threshold LOW HIGH	 < 5 V > 15 V		
Input current at nominal voltage	Approx. 4.2 mA		
Input delay	< 5 µs		
Modulation compared to ground potential	max. ± 30 V		
Event counter			
Signal form	Square wave pulse		
Input frequency	Max. 100 kHz		
Pulse length	Min. 5 µs		
Counter size	32-bit		
Inputs Input 1 Input 2 Input 3	 Counter 1 --- ---		
Incremental counter			
Signal form	Square wave pulse		
Evaluation	4x		
Encoder monitoring	No		
Input frequency	Max. 20 kHz		
Counter frequency	Max. 80 kHz		
Reference frequency	Max. 20 kHz		
Distance between edges	Min. 5 µs		
Counter size	16-bit		
Inputs Input 1 Input 2 Input 3	 Channel A Channel B Reference pulse R		

Table 60: Technical data - AC140 (cont.)

Product ID	8AC140.60-2	8AC140.60-3	8AC140.61-3
Gate measurement			
Signal form	Square wave pulse		
Gate frequency	Max. 100 kHz		
Pulse length	Min. 5 µs		
Counter frequency Internal External	 31.25 kHz or 4 MHz Max. 100 kHz		
Period measurement			
Signal form	Square wave pulse		
Input frequency	Max. 100 kHz		
Pulse length	Min. 5 µs		
Counter frequency Internal External	 31.25 kHz or 4 MHz Max. 100 kHz		
Digital outputs			
Number of outputs	Max. 3		
Type	High-side transistor outputs		
Electrical isolation Output - ACOPOS Output - Output	 Yes No		
Switching voltage Minimum Rated Maximum	 18 VDC 24 VDC 30 VDC		
Continuous current	Max. 500 mA		
Switching delay 0 -> 1 and 1 -> 0	Max. 500 µs (typ. 250 µs)		
Switching frequency (resistive load)	Max. 100 Hz		
Protection Short circuit protection Overload protection	 Yes Yes		
Continuous short circuit current at 24 V	Typ. 4 A		
Readable outputs	Yes		

Table 60: Technical data - AC140 (cont.)

Product ID	8AC140.60-2	8AC140.60-3	8AC140.61-3
Analog input			
Design	Differential input		
Electrical isolation Input - ACOPOS [3]	No, max. modulation: ± 13 V		
Input signal Rated Maximum	-10 V up to +10 V -13 V up to +13 V		
Operating mode	Cyclic measurement non-synchronous to 50 µs ACOPOS clock		
Digital converter resolution	12-bit		
Non-linearity	± 2 LSB		
Output format	INT 16 $8001 - $7FFF LSB = $0010 = 4.88 mV		
Conversion procedure	Successive approximation		
Conversion time	< 50 µs		
Differential input impedance	20 MOhm		
Input filter	Analog low pass 3rd order / cut-off frequency: 10 kHz		
Common-mode rejection DC 50 Hz	Min. 73 dB Min. 73 dB		
Operating conditions			
Ambient temperature during operation	--- [4]		
Relative humidity during operation	--- [4]		
Storage and transport conditions			
Storage temperature	-25 to +55°C		
Relative humidity during storage	5 to 95%, non-condensing		
Transport temperature	-25 to +70°C		
Relative humidity during transport	95% at +40°C		

Table 60: Technical data - AC140 (cont.)

1) The AC140 is a module with double-width and occupies slots 1 and 2.
2) Shielded cables must be used for inputs 1 - 3.
3) An external electrical isolation of the connected sensors is recommended because the analog input is not electrically isolated.
4) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.1[illegible]4 Indicators

8AC140.60-3

Figure	LED	Name	Color	Description
	❶	Status (RUN)	Red Red with orange blinking Red/green blinking (1 Hz) Orange Green Green with orange blinking	ERROR/RESET Load/unload and start BOOT AR Startup of BOOT or CF - AR SERVICE/DIAG/BOOT mode RUN RUN - BATTERY LOW
	❷	RS232 (X1)	Orange blinking	Data transfer to application interface IF1 (RS232)
	❸	PROFIBUS (RX)	Orange	Receive data on application interface IF3 (PROFIBUS)
	❹	PROFIBUS (TX)	Orange	Send data to application interface IF3 (PROFIBUS)
	❺	CAN (RX)	Orange	Receive data on application interface IF2 (CAN)
	❻	CAN (TX)	Orange	Send data to application interface IF2 (CAN)

Table 61: Indicators - 8AC140.60-3

8AC140.60-3, 8AC140.61-3

Figure	LED	Name	Color	Description
	❶	Status (RUN)	Red Red with orange blinking Red/green blinking (1 Hz) Orange Green Green with orange blinking	ERROR/RESET Load/unload and start BOOT AR Startup of BOOT or CF - AR SERVICE/DIAG/BOOT mode RUN RUN - BATTERY LOW
	❷	RS232 (X1)	Orange blinking	Data transfer to application interface IF1 (RS232)
	❸	PROFIBUS (PB)	Orange	Data transfer on application interface IF3 (PROFIBUS)
	❹	Ethernet (ACT)	Orange Orange blinking	Ethernet LINK (IF6) Ethernet ACTIVE (IF6)
	❺	CAN (RX)	Orange	Receive data on application interface IF2 (CAN)
	❻	CAN (TX)	Orange	Send data to application interface IF2 (CAN)

Table 62: Indicators - 8AC140.60-3, 8AC140.61-3

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3.12.5 CAN node number setting (IF2)

The CAN node number can be set using two HEX code switches:

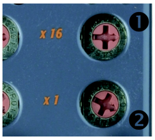
Figure	Code switch	Description
	❶	CAN node number 16s position (high)
	❷	CAN node number 1s position (low)
	The settings $00, and $FF are reserved for special functions. **$00:** In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. **$FF:** Diagnostics mode.	

Table 63: Setting the CAN node number

The CAN node number change takes effect the next time the ACOPOS servo drive is switched on.

There must be a terminating resistor (120 Ω, 0.25 W) between CAN_H and CAN_L at the beginning and end of the CAN bus.

Information:

The CAN bus IF2 is always made up of at least two stations that are integrated in the AC140. These are the AC140 CPU and an AC110 emulation, which the ACOPOS uses for communication. Therefore, the AC140 CPU prevents a potential error in which no other stations are found on the CAN bus. This is why the AC140 CPU does not register a hardware error if there is no physical connection to external CAN devices.

3.12.6 PROFIBUS station number setting (IF3)

The PROFIBUS station number can be set using two HEX code switches:

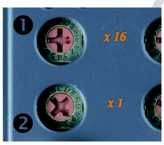
Figure	Code switch	Description
	❶	PROFIBUS station number 16s position (high)
	❷	PROFIBUS station number 1s position (low)

Table 64: Setting the PROFIBUS station number

The PROFIBUS station number change takes effect the next time the ACOPOS servo drive is switched on.

3.12.7 Ethernet station number setting (IF6)

The Ethernet station number can be set with software (B&R Automation Studio™).

3.12.8 Reset button

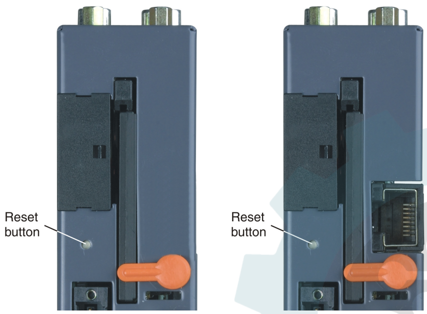
View (view from below)	Description
 8AC140.60-3 8AC140.61-3	The reset button can be pressed with any small pointed object (e.g. paper clip). Pressing the reset button triggers a hardware reset, which means: • All application programs are stopped. • All outputs are set to zero. The AC140 then switches to SERVICE mode.

Table 65: Reset button

3.12.9 Application memory slot (CompactFlash)

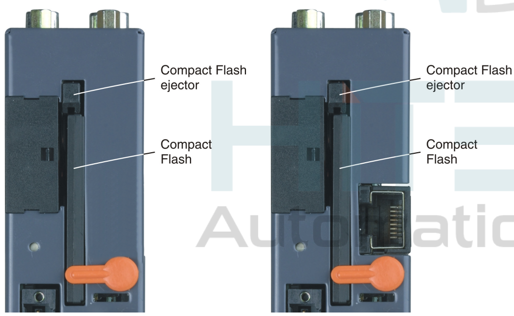
View (view from below)	Description
 8AC140.60-3 8AC140.61-3	Program memory is required to operate the AC140. The application memory is CompactFlash. This is not included with the delivery of the AC140. Compact Flash must be ordered separately as an accessory! The Compact Flash memory card is used in the slot on the bottom of the AC140. Press the eject button to remove the card. The CompactFlash memory card can be secured using a safety clip.

Table 66: Application memory

3.1?.10 Backup battery

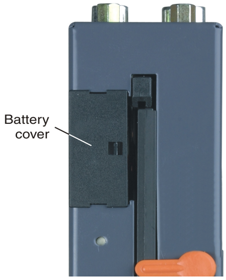
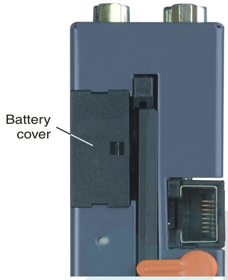
View (view from below)		Description	
 8AC140.60-3	 8AC140.61-3	The AC140 is equipped with a lithium battery. The lithium battery is placed in a separate compartment on the bottom of the module and protected by a cover.	
		Backup battery data	
		Lithium battery	3 V / 950 mAh
		Model number	0AC201.91
		Short description	Lithium batteries, 4 pcs., 3 V / 950 mAh, button cell
		Storage temperature	-20 to +60°C
		Storage time	Max. 3 years at 30° C
		Relative humidity	0 to 95% (non-condensing)

Table 67: Backup battery

Data / real-time buffering

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Battery monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available from the system library function "BatteryInfo".

Battery change interval

Caution!

The battery should be changed every 4 years. The change interval refers to the average life span and operating conditions and are recommended by B&R. It is not the maximum buffer duration.

Information:

Data stored in the AC140 RAM will be lost if the battery is changed with the PLC switched off! The battery can be changed with power applied, but this is not allowed in all countries!

Warning:

Replace battery with Renata, type CR2477N only. Use of another battery may present a risk of fire or explosion.

Battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

Procedure for changing the battery

1) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.

2) Remove the cover from the lithium battery holder using a screwdriver.

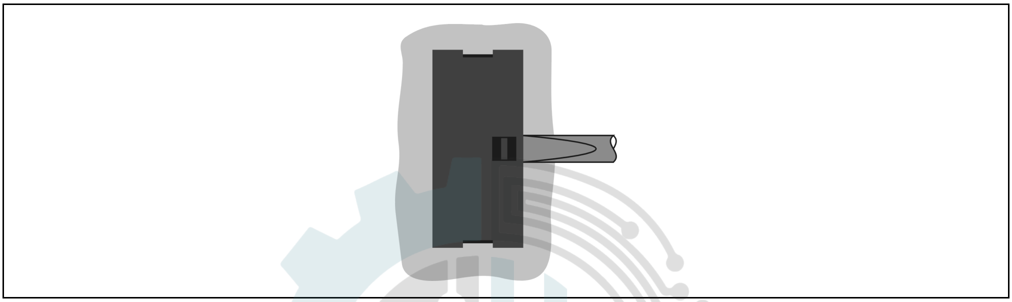


Figure 13: Remove the cover for the lithium battery

3) Remove the battery from the holder by pulling the removal strip (don't use uninsulated tools because of risk of > short circuiting). The battery should not be held by its edges. **<u>Insulated</u>** tweezers may also be used for removing the battery.

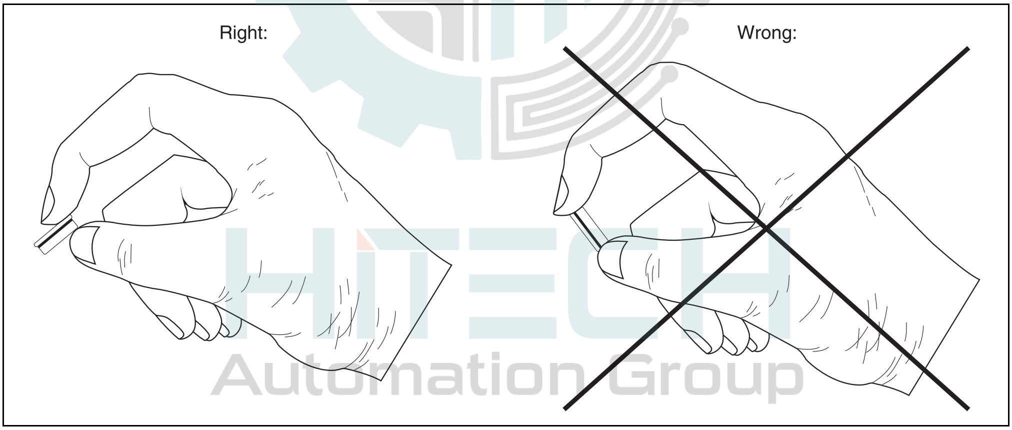


Figure 14: Hold the battery correctly

4) Insert the new battery with correct polarity. The removal strip should be pulled to the right of the battery holder and the "+" side of the battery should be facing left. In order to be able to remove the battery again in future, the removal strip **must be on the** right side of the battery.

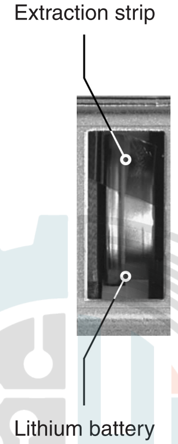


Figure 15: Removal strip should be pulled to the right

5) Now wrap the end of the removal strip over the top of the battery and insert it underneath the battery so that it does not protrude from the battery holder.

6) Replace cover. Insert the lower edge of the cover in the battery holder opening. Press the upper end of the cover home firmly.

Information:

Lithium batteries are considered hazardous waste. Used batteries should be disposed of appropriately.

3.1[illegible]11 Input / output register

Digital in r/- (16 Bit):

Bit No.	Value	Description
0		Logical status of digital I/O 1
1		Logical status of digital I/O 2
2		Logical status of digital I/O 3
3 - 15		Reserved

Digital out r/w (16 Bit):

All reserved bits must be written with 0.

Bit No.	Value	Description
0	0	Digital output 1 is inactive
	1	Digital output 1 is active
1	0	Digital output 2 is inactive
	1	Digital output 2 is active
2	0	Digital output 3 is inactive
	1	Digital output 3 is active
3 - 15		Reserved

Analog in (16 Bit) r/-:

±10V (12 bit resolution)

Counter (32 Bit) r/(w):

In addition to the typical counter modes, this counter has a "Stepper motor counter mode" (see Configuration register bits 4-6).

In stepper motor counter mode, the count direction is set using digital I/O 2 (0…increment, 1…decrement), and the counter clock is on digital I/O 1. Only one clock edge is used for counting (can be configured with bit 3 of the counter configuration register).

Counter configuration (16 bit) r/w:

All reserved bits must be written with 0.

Bit No.	Value	Description
0		Reserved
1	0	AB(R) counter mode: R input disabled
	1	AB(R) counter mode: R input enabled
2		Reserved
3	0	Measurement starts at increasing edge
	1	Measurement starts at falling edge
4 - 6	000	No counter operation
	001	AB(R) counter mode
	010	Event counter mode
	011	Period measurement mode
	100	Stepper motor counter mode
	101	Gate measurement mode
	110	Not allowed
	111	Not allowed
7 - 8	00	Counter frequency 4MHz
	01	External counter frequency
	10	Counter frequency 31.25 kHz
	11	Not allowed
9	0	Counter overflow recognition disabled / Reset counter overflow bit
	1	Overflow recognition of the continuous counter is enabled (value limited to $FFFF)
10 - 14		Reserved
15	0	Time / counter reset
	1	Time / counter enabled (ATTENTION: Only set bit after counter configuration is complete)

Status (16 Bit) r/- :

Bit No.	Value	Description
0 - 8		Reserved
9	0	Period or gate measurement within the counter range 0 - $FFFF (only valid if bit 9 is set in the counter configuration word).
	1	Counter overflow during period or gate measurement. Acknowledge by resetting bit 9 of the counter configuration word.
10 - 14		Reserved
15	0	Output supply voltage monitoring 24 VDC - OK
	1	Output supply voltage monitoring 24 VDC error

3.13 AC141 - CPU module

3.13.1 General description

The AC141 plug-in module can be used in an ACOPOS slot (requires two slots).

The CPU module makes it possible to operate an ACOPOS servo drive without external PLC and is also available with integrated "Soft CNC" system (8AC141.61-3).

Communication in the ACOPOS network occurs as described in section 3.5 "Drive-based control", on page 31.

The ACOPOS servo drive connection which the AC141 is plugged into, has an emulation of an AC110 - CAN interface plug-in module on slot 1. All other CAN stations are connected via the CAN interface IF2.

The module offers interchangeable application memory in the form of a Compact Flash card as well as a separate backup battery for the module. 1)

It is equipped with five application interfaces:

- One RS232 interface (IF1) for programming and configuring using B&R Automation Studio™
- Two CAN interfaces (IF2, IF3) for connecting to CAN networks
- One X2X Link interface (IF4)
- One Ethernet interface (IF6) for connecting to an Ethernet network.

In addition, a maximum of three digital inputs / outputs are provided as well as one analog input (±10 V differential input).

The digital inputs and outputs can be configured individually as input or output. Additional functions such as a counter function with direction switching (stepper motor) or period and gate measurement are integrated.
The inputs and outputs are scanned directly by the CPU module; the ACOPOS servo drive does not have direct access to these inputs and outputs.

The analog input has a resolution of 12 bits and an analog input filter with 10 kHz (low pass 3rd order).

Section 2
Technical data

1) Application memory must be ordered separately.

3.1 .2 Order data

Model number	Short description	Figure
	Plug-in module	 8AC141.xx-x
8AC141.60-2	ACOPOS plug-in module, CPU, x86 100 MHz Intel compatible, 16 MB DRAM, 32 kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately.	
8AC141.61-3	ACOPOS plug-in module, CPU, ARNC0, x86 100MHz Intel compatible, 32 MB DRAM, 32kB SRAM, removable application memory: CompactFlash, 2 CAN interfaces, 1 Ethernet interface 100 Base-T, 1 RS232 interface, 1 X2X Link Master interface, 3 digital I/O can be configured as 24 VDC input or output 500mA, 1 analog input ±10V, order program memory and 0TB704 and 0TB708 terminal blocks separately	
Order application memory and TB704 / TB708 terminal blocks separately!		

Table 68: Order data - AC141

Required accessories	
Model number	**Short description**
5CFCRD.0064-03	CompactFlash 64 MB ATA/IDE SiliconSystems
5CFCRD.0128-03	CompactFlash 128 MB ATA/IDE SiliconSystems
5CFCRD.0256-03	CompactFlash 256 MB ATA/IDE SiliconSystems
5CFCRD.0512-03	CompactFlash 512 MB ATA/IDE SiliconSystems
5CFCRD.1024-03	CompactFlash 1024 MB ATA/IDE SiliconSystems
5CFCRD.2048-03	CompactFlash 2048 MB ATA/IDE SiliconSystems
5CFCRD.4096-03	CompactFlash 4096 MB ATA/IDE SiliconSystems
5CFCRD.8096-03	CompactFlash 8096 MB ATA/IDE SiliconSystems
0TB708.91	Accessory terminal block, 8-pin, cage clamps 1.5 mm²
0TB708:91-02	Accessory terminal block, 20 pcs., 8-pin cage clamps 1.5 mm²
0TB704.9	Accessory, terminal block, 4-pin, screw clamps, 1.5 mm²
0TB704.91	Accessory, terminal block, 4-pin, cage clamps, 2.5 mm²

Table 69: Optional accessories - AC141

Optional accessories	
Model number	Short description
0G0001.00-090	Cable PC <-> PLC/PW, RS232 online cable
0AC201.91	Lithium batteries, 4 pcs., 3 V / 950 mAh, button cell
7AC911.9	Bus connector, CAN
0AC912.9	Bus adapter, CAN, 1 CAN interface
0AC913.92	Bus adapter, CAN, 2 CAN interfaces including 30 cm connection cable (DSUB)

Table 70: Optional accessories - AC141

3.13.3 Technical data

Product ID	8AC141.60-2	8AC141.61-3
General information		
C-UL-US Listed	Yes	
Module type	ACOPOS plug-in module double-width	
Slot [1)]	Slots 1 + 2	
Power consumption	Max. 4.5 W	
CPU		
Clock rate	100 MHz	
SRAM	32 kB	
DRAM	16 MB	32 MB
Operating system	AC140 (version S2.80 and higher)	
IF1 application interface		
Interface type	RS232	
Electrical isolation	No	
Design	9-pin DSUB connector	
Max. distance	15m / 19,200 baud	
Max. baud rate	115.2 kBaud	
Display	232 LED	
Application interfaces IF2, IF3		
Interface type	CAN	
Electrical isolation	Yes	
Design	9-pin DSUB connector	
Max. distance	1,000 m	
Max. baud rate Bus length up to 60 m Bus length up to 200 m Bus length up to 1,000 m	 500 kbit/s 250 kbit/s 50 kbit/s	
Indicators IF2 IF3	 CAN1 LED CAN2 LED	
Network-capable	Yes	
Bus termination resistor	Externally wired	

Table 71: Technical data - AC141

Product ID	8AC141.60-2	8AC141.61-3
IF4 application interface		
Interface type	X2X	
Electrical isolation	Yes	
Design	4-pin connector	
Max. distance	100 m	
Display	X2X LED	
Application interface IF6		
Interface type	Ethernet	
Electrical isolation	Yes	
Design	RJ45 socket	
Max. distance	100 m	
Baud rate	10/100 MBaud	
Display	ACT LED	
Network-capable	Yes	
Inputs/outputs		
Connection, module-side	8-pin connector	
Configuration of the digital inputs/outputs	Can be configured individually as input or output	
Digital inputs [2)]		
Number of inputs	Max. 3	
Wiring	Sink	
Electrical isolation Input - ACOPOS Input - Input	 Yes No	
Input voltage Rated Maximum	 24 VDC 30 VDC	
Switching threshold LOW HIGH	 < 5 V > 15 V	
Input current at nominal voltage	Approx. 4.2 mA	
Input delay	< 5 µs	
Modulation compared to ground potential	max. ± 30 V	
Event counter		
Signal form	Square wave pulse	
Input frequency	Max. 100 kHz	
Pulse length	Min. 5 µs	
Counter size	32-bit	
Inputs Input 1 Input 2 Input 3	 Counter 1 Count direction (only in stepper motor mode) ---	

Table 71: Technical data - AC141 (cont.)

<table>
<tr><th>Product ID</th><th>8AC141.60-2</th><th>8AC141.61-3</th></tr>
<tr><th>Incremental counter</th><th></th><th></th></tr>
<tr><td>Signal form</td><td colspan="2">Square wave pulse</td></tr>
<tr><td>Evaluation</td><td colspan="2">4x</td></tr>
<tr><td>Encoder monitoring</td><td colspan="2">No</td></tr>
<tr><td>Input frequency</td><td colspan="2">Max. 20 kHz</td></tr>
<tr><td>Counter frequency</td><td colspan="2">Max. 80 kHz</td></tr>
<tr><td>Reference frequency</td><td colspan="2">Max. 20 kHz</td></tr>
<tr><td>Distance between edges</td><td colspan="2">Min. 5 µs</td></tr>
<tr><td>Counter size</td><td colspan="2">16-bit</td></tr>
<tr><td>Inputs
Input 1
Input 2
Input 3</td><td colspan="2">
Channel A
Channel B
Reference pulse R</td></tr>
<tr><th>Gate measurement</th><th></th><th></th></tr>
<tr><td>Signal form</td><td colspan="2">Square wave pulse</td></tr>
<tr><td>Gate frequency</td><td colspan="2">Max. 100 kHz</td></tr>
<tr><td>Pulse length</td><td colspan="2">Min. 5 µs</td></tr>
<tr><td>Counter frequency
Internal
External</td><td colspan="2">
31.25 kHz or 4 MHz
Max. 100 kHz</td></tr>
<tr><th>Period measurement</th><th></th><th></th></tr>
<tr><td>Signal form</td><td colspan="2">Square wave pulse</td></tr>
<tr><td>Input frequency</td><td colspan="2">Max. 100 kHz</td></tr>
<tr><td>Pulse length</td><td colspan="2">Min. 5 µs</td></tr>
<tr><td>Counter frequency
Internal
External</td><td colspan="2">
31.25 kHz or 4 MHz
Max. 100 kHz</td></tr>
<tr><th>Digital outputs</th><th></th><th></th></tr>
<tr><td>Number of outputs</td><td colspan="2">Max. 3</td></tr>
<tr><td>Type</td><td colspan="2">High-side transistor outputs</td></tr>
<tr><td>Electrical isolation
Output - ACOPOS
Output - Output</td><td colspan="2">
Yes
No</td></tr>
<tr><td>Switching voltage
Minimum
Rated
Maximum</td><td colspan="2">
18 VDC
24 VDC
30 VDC</td></tr>
<tr><td>Continuous current</td><td colspan="2">Max. 500 mA</td></tr>
<tr><td>Switching delay 0 -> 1 and 1 -> 0</td><td colspan="2">Max. 500 µs (typ. 250 µs)</td></tr>
<tr><td>Switching frequency (resistive load)</td><td colspan="2">Max. 100 Hz</td></tr>
<tr><td>Protection
Short circuit protection
Overload protection</td><td colspan="2">
Yes
Yes</td></tr>
<tr><td>Continuous short circuit current at 24 V</td><td colspan="2">Typ. 4 A</td></tr>
<tr><td>Readable outputs</td><td colspan="2">Yes</td></tr>
</table>

Table 71: Technical data - AC141 (cont.)

Product ID	8AC141.60-2	8AC141.61-3
Analog input		
Design	Differential input	
Electrical isolation Input - ACOPOS 3)	No, max. modulation: ± 13 V	
Input signal Rated Maximum	-10 V up to +10 V -13 V up to +13 V	
Operating mode	Cyclic measurement non-synchronous to 50 µs ACOPOS clock	
Digital converter resolution	12-bit	
Non-linearity	± 2 LSB	
Output format	INT 16 $8001 - $7FFF LSB = $0010 = 4.88 mV	
Conversion procedure	Successive approximation	
Conversion time	< 50 µs	
Differential input impedance	20 MΩ	
Input filter	Analog low pass 3rd order / cut-off frequency: 10 kHz	
Common-mode rejection DC 50 Hz	Min. 73 dB Min. 73 dB	
Operating conditions		
Ambient temperature during operation	--- 4)	
Relative humidity during operation	--- 4)	
Storage and transport conditions		
Storage temperature	-25 to +55°C	
Relative humidity during storage	5 to 95%, non-condensing	
Transport temperature	-25 to +70°C	
Relative humidity during transport	95% at +40°C	

Table 71: Technical data - AC141 (cont.)

1) The AC141 is a module with double-width and occupies slots 1 and 2.
2) Shielded cables must be used for inputs 1 - 3.
3) An external electrical isolation of the connected sensors is recommended because the analog input is not electrically isolated.
4) ACOPOS plug-in modules can be used in an ACOPOS servo drive; the corresponding values can be found in the technical data of the respective ACOPOS servo drive.

3.13.4 Indicators

Figure	LED	Name	Color	Description
	❶	Status (RUN)	Red Red with orange blinking Red/green blinking (1 Hz) Orange Green Green with orange blinking	ERROR/RESET Load/unload and start BOOT AR Startup of BOOT or CF - AR SERVICE/DIAG/BOOT mode RUN RUN - BATTERY LOW
	❷	RS232 (232)	Orange blinking	Data transfer to application interface IF1 (RS232)
	❸	CAN2 (CAN2)	Orange	Data transfer on application interface IF3 (CAN2)
	❹	Ethernet (ACT)	Orange Orange blinking	Ethernet LINK (IF6) Ethernet ACTIVE (IF6)
	❺	CAN1 (CAN1)	Orange	Data transfer on application interface IF2 (CAN)
	❻	X2X (X2X)	Orange	Data transfer on application interface IF4 (X2X)

Table 72: AC141 displays

3.13.5 CAN node number setting (IF2)

The CAN node number can be set using two HEX code switches:

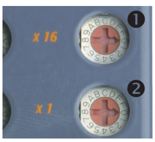
Figure	Code switch	Description
	❶	CAN node number 16s position (high)
	❷	CAN node number 1s position (low)
	The settings $00, and $FF are reserved for special functions. **$00:** In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. **$FF:** Diagnostics mode.	

Table 73: Setting the CAN node number (IF2)

The CAN node number change takes effect the next time the ACOPOS servo drive is switched on.

There must be a terminating resistor (120 Ω, 0.25 W) between CAN_H and CAN_L at the beginning and end of the CAN bus.

Information:

The CAN bus IF2 is always made up of at least two stations that are integrated in the AC141. These are the AC141 CPU and an AC110 emulation, which the ACOPOS servo drive uses for communication. Therefore, the AC141 CPU prevents a potential error that occurs when no other stations are found on the CAN bus. This is why the AC141 CPU does not register a hardware error if there is no physical connection to external CAN devices.

3.13.6 CAN node number setting (IF3)

The CAN node number can be set using two HEX code switches:

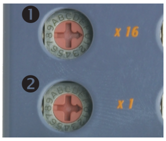
Figure	Code switch	Description
	❶	CAN node number 16s position (high)
	❷	CAN node number 1s position (low)
	The settings $00, and $FF are reserved for special functions. **$00:** In this switch position, the operating system can be programmed via the online interface. User Flash is only deleted after the update begins. **$FF:** Diagnostics mode.	

Table 74: Setting the CAN node number (IF3)

The CAN node number change takes effect the next time the ACOPOS servo drive is switched on.

There must be a terminating resistor (120 Ω, 0.25 W) between CAN_H and CAN_L at the beginning and end of the CAN bus.

3.13.7 Ethernet station number setting (IF6)

The Ethernet station number can be set with software (B&R Automation Studio™).

3.13.8 Reset button

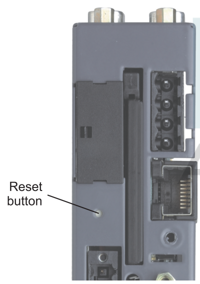
Figure	Description
 View from below	The reset button can be pressed with any small pointed object (e.g. paper clip). Pressing the reset button triggers a hardware reset, which means: • All application programs are stopped. • All outputs are set to zero. The AC141 then switches to SERVICE mode.

Table 75: Reset button

3.13.9 Application memory slot (CompactFlash)

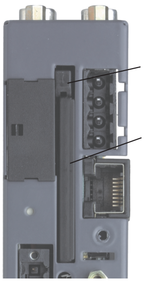
Figure	Description
 View from below	Program memory is required to operate the AC141. The application memory is CompactFlash. This is not included with the delivery of the AC141. Compact Flash must be ordered separately as an accessory! The Compact Flash memory card is used in the slot on the bottom of the AC141. Press the eject button to remove the card. The CompactFlash memory card can be secured using a safety clip.

Table 76: Application memory

3.13.10 Backup battery

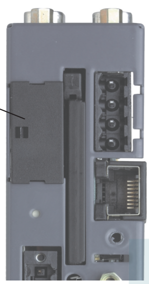
Figure	Description	
 View from below	The AC141 is equipped with a lithium battery. The lithium battery is placed in a separate compartment on the bottom of the module and protected by a cover.	
	Backup battery data	
	Lithium battery	3 V / 950 mAh
	Model number	0AC201.91
	Short description	Lithium batteries, 4 pcs., 3 V / 950 mAh, button cell
	Storage temperature	-20 to +60°C
	Storage time	Max. 3 years at 30° C
	Relative humidity	0 to 95% (non-condensing)

Table 77: Backup battery

Data / real-time buffering

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Battery monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten the battery life, instead it gives an early warning of weakened buffer capacity.

The status information, "Battery OK" is available from the system library function "BatteryInfo".

Battery change interval

Caution!

The battery should be changed every 4 years. The change interval refers to the average life span and operating conditions and are recommended by B&R. It is not the maximum buffer duration.

Information:

Data stored in the AC141 RAM will be lost if the battery is changed with the PLC switched off! The battery can be changed with power applied, but this is not allowed in all countries!

Warning:

Replace battery with Renata, type CR2477N only. Use of another battery may present a risk of fire or explosion.

Battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

Procedure for changing the battery

1) Touch the mounting rail or ground connection (not the power supply!) in order to discharge any electrostatic charge from your body.

2) Remove the cover from the lithium battery holder using a screwdriver.

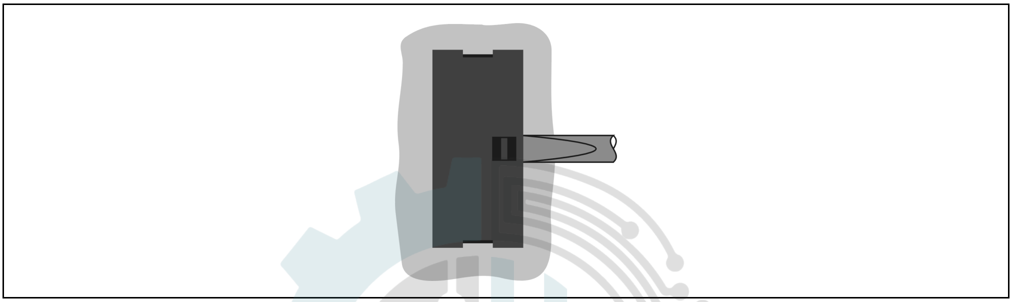


Figure 16: Remove the cover for the lithium battery

3) Remove the battery from the holder by pulling the removal strip (don't use uninsulated tools because of risk of > short circuiting). The battery should not be held by its edges. **Insulated** tweezers may also be used for removing the battery.

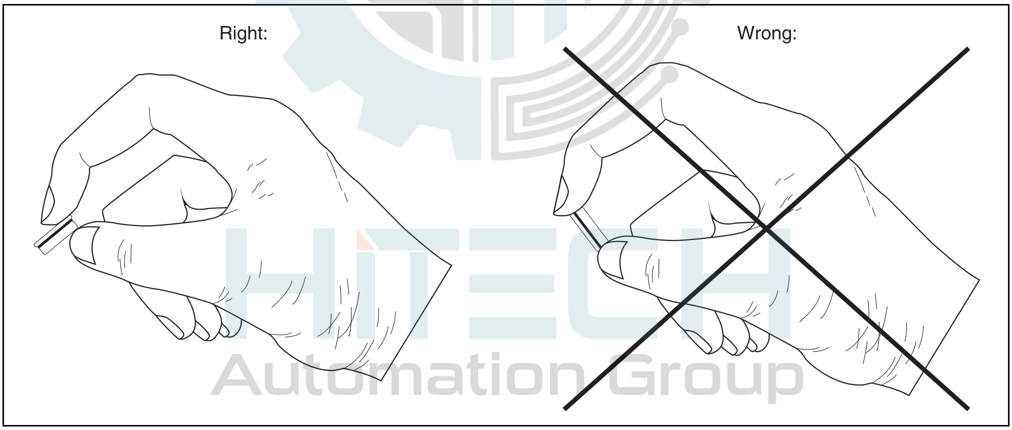


Figure 17: Hold the battery correctly

Section 2 Technical data

4) Insert the new battery with correct polarity. The removal strip should be pulled to the right of the battery holder and the "+" side of the battery should be facing left. In order to be able to remove the battery again in future, the removal strip **must be on the** right side of the battery.

Figure 18: Removal strip should be pulled to the right

5) Now wrap the end of the removal strip over the top of the battery and insert it underneath the battery so that it does not protrude from the battery holder.

6) Replace cover. Insert the lower edge of the cover in the battery holder opening. Press the upper end of the cover home firmly.

Information:

Lithium batteries are considered hazardous waste. Used batteries should be disposed of appropriately.

3.1[illegible].11 Input / output register

Digital in r/- (16 Bit):

Bit No.	Value	Description
0		Logical status of digital I/O 1
1		Logical status of digital I/O 2
2		Logical status of digital I/O 3
3 - 15		Reserved

Digital out r/w (16 Bit):

All reserved bits must be written with 0.

Bit No.	Value	Description
0	0	Digital output 1 is inactive
	1	Digital output 1 is active
1	0	Digital output 2 is inactive
	1	Digital output 2 is active
2	0	Digital output 3 is inactive
	1	Digital output 3 is active
3 - 15		Reserved

Analog in (16 Bit) r/-:

±10V (12 bit resolution)

Counter (32 Bit) r/(w):

In addition to the typical counter modes, this counter has a "Stepper motor counter mode" (see Configuration register bits 4-6).

In stepper motor counter mode, the count direction is set using digital I/O 2 (0…increment, 1…decrement), and the counter clock is on digital I/O 1. Only one clock edge is used for counting (can be configured with bit 3 of the counter configuration register).

Counter configuration (16 bit) r/w:

All reserved bits must be written with 0.

Bit No.	Value	Description
0		Reserved
1	0	AB(R) counter mode: R input disabled
	1	AB(R) counter mode: R input enabled
2		Reserved
3	0	Measurement starts at increasing edge
	1	Measurement starts at falling edge
4 - 6	000	No counter operation
	001	AB(R) counter mode
	010	Event counter mode
	011	Period measurement mode
	100	Stepper motor counter mode
	101	Gate measurement mode
	110	Not allowed
	111	Not allowed
7 - 8	00	Counter frequency 4MHz
	01	External counter frequency
	10	Counter frequency 31.25 kHz
	11	Not allowed
9	0	Counter overflow recognition disabled / Reset counter overflow bit
	1	Overflow recognition of the continuous counter is enabled (value limited to $FFFF)
10 - 14		Reserved
15	0	Time / counter reset
	1	Time / counter enabled (ATTENTION: Only set bit after counter configuration is complete)

Status (16 Bit) r/- :

Bit No.	Value	Description
0 - 8		Reserved
9	0	Period or gate measurement within the counter range 0 - $FFFF (only valid if bit 9 is set in the counter configuration word).
	1	Counter overflow during period or gate measurement. Acknowledge by resetting bit 9 of the counter configuration word.
10 - 14		Reserved
15	0	Output supply voltage monitoring 24 VDC - OK
	1	Output supply voltage monitoring 24 VDC error

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4 Cables

4.1 General information

B&R offers the cables for ACOPOS servo drives in six different lengths. All cables can be used for drag chain installations. [1)]

To prevent disturbances to encoder signals, the holding brake and temperature sensor wires are in the motor cable and not in the encoder cable.

4.1.1 Assembled cables

Using B&R cables guarantees that the EMC limits are not exceeded. The cables are prefabricated in the EU and are therefore subject to the strictest quality standards.

> **Information:**
>
> **If cables from other manufacturers are used, make sure that they have the same wave parameters and the same design as the respective B&R cable. If deviations exist, additional measures are necessary to ensure that EMC directives are met.**

1) Custom fabrication of motor cables is available on request. For custom fabrication of motor cables, the plug size must be matched to the motor used!

4.2 Motor cables

4.2.1 Motor cables 1.5 mm²

Order data [1)]

Model number	Short description	Figure
8CM005.12-1	Motor cable, length 5m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM007.12-1	Motor cable, length 7m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM010.12-1	Motor cable, length 10m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM015.12-1	Motor cable, length 15m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM020.12-1	Motor cable, length 20m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM025.12-1	Motor cable, length 25m, 4 x 1.5mm² + 2 x 2 x 0.75mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	

Table 78: Order data - 1,5 mm² motor cable

Technical data

Product ID	8CMxxx.12-1
General information	
C-UL-US Listed	Yes
Cable cross section	4 x 1.5 mm² + 2 x 2 x 0.75 mm²
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20234, 80°C, 1000 V, E63216 and CSA AWM I/II A/B, 90°C, 1000 V, FT2 LL46064
Lines	
Power lines Wire insulation Wire colors	1.5 mm², tinned Cu wire Special thermoplastic material Black, brown, blue, yellow/green
Signal lines Wire insulation Wire colors	0.75 mm², tinned Cu wire Special thermoplastic material White, white/red, white/blue, white/green
Cable structure	
Power lines Stranding Shield	 No No
Signal lines Stranding Shield	 White with white/red and white/blue with white/green Separate shielding for pairs, tinned Cu mesh, Optical coverage > 85% and foil banding
Cable stranding	With filler elements and foil banding
Cable shield	Tinned Cu mesh, optical coverage > 85% and wrapped in isolating fabric

Table 79: Technical data - 1.5 mm² motor cable

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CMxxx.12-1
Outer sheathing Item Color Labeling	 PUR Orange, similar to RAL 2003 flat BERNECKER + RAINER 4x1.5+2x2x0.75 FLEX
Electrical characteristics	
Conductor resistance Power lines Signal lines	 ≤ 14 Ω/km ≤ 19 Ω/km
Insulation resistance	> 200 MΩ per km
Test voltage Wire/wire Wire/shield	 1500 VAC 1500 VAC
Max. current loading capacity according to IEC 60364-5-523 depending on the type of installation [1)] Installed in conduit or cable duct Mounted on walls Installed in a cable tray	 17.8 A 20 A 20.9 A
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +70°C -20°C to +90°C
Outer diameter	12.8 mm ± 0.4 mm
Flex radius	> 96 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	0.26 kg/m

Table 79: Technical data - 1.5 mm² motor cable (cont.)

1) Valid in the following conditions: 40°C ambient temperature and 90°C maximal line temperature.

The maximum current load value in IEC60364-5-523 is for an ambient temperature of 30°C. The values are converted for use at 40°C ambient temperature using the factor k_{Temp} = 0.91 given in the standard.

The motor cable cross section is chosen for B&R motor cables so that the valid current load capacity for the selected cable cross section is greater than or equal to the thermal equivalent effective value of the motor current (I_q).

If information concerning load torque, inertia and friction are available, the thermal equivalent effective value of the motor current I_q for the motor being used is calculated as follows:

$$I_q[A] = \sqrt{\frac{1}{T_{Zyklus}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

Section 2
Technical data

4.2 Motor cables 4 mm²

Order data [1)]

Model number	Short description	Figure
8CM005.12-3	Motor cable, length 5m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM007.12-3	Motor cable, length 7m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM010.12-3	Motor cable, length 10m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM015.12-3	Motor cable, length 15m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM020.12-3	Motor cable, length 20m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM025.12-3	Motor cable, length 25m, 4 x 4mm² + 2 x 2 x 1mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	

Table 80: Order data - 4 mm² motor cable

Technical data

Product ID	8CMxxx.12-3
General information	
Cable cross section	4 x 4 mm² + 2 x 2 x 1 mm²
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20234, 80°C, 1000 V, E63216 and CSA AWM I/II A/B, 90°C, 1000 V, FT2 LL46064
Lines	
Power lines	4 mm², tinned Cu wire
Wire insulation Wire colors	Special thermoplastic material Black, brown, blue, yellow/green
Signal lines	1 mm², tinned Cu wire
Wire insulation Wire colors	Special thermoplastic material White, white/red, white/blue, white/green
Cable structure	
Power lines Stranding Shield	 No No
Signal lines Stranding Shield	 White with white/red and white/blue with white/green Separate shielding for pairs, tinned Cu mesh, Optical coverage > 85% and foil banding
Cable stranding	With filler elements and foil banding
Cable shield	Tinned Cu mesh, optical coverage > 85% and wrapped in isolating fabric
Outer sheathing Item Color	 PUR Orange, similar to RAL 2003 flat
Labeling	BERNECKER + RAINER 4x4.0+2x2x1.0 FLEX

Table 81: Technical data - 4 mm² motor cable

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CMxxx.12-3
Electrical characteristics	
Conductor resistance Power lines Signal lines	 ≤ 5.2 Ω/km ≤ 19 Ω/km
Insulation resistance	> 200 MΩ per km
Test voltage Wire/wire Wire/shield	 1500 VAC 1500 VAC
Max. current loading capacity according to IEC 60364-5-523 depending on the type of installation [1)] Installed in conduit or cable duct Mounted on walls Installed in a cable tray	 31.9 A 36.4 A 38.2 A
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +70°C -20°C to +90°C
Outer diameter	15.8 mm ± 0.5 mm
Flex radius	> 118.5 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	0.45 kg/m

Table 81: Technical data - 4 mm² motor cable (cont.)

1) Valid in the following conditions: 40°C ambient temperature and 90°C maximal line temperature.
The maximum current load value in IEC60364-5-523 is for an ambient temperature of 30°C. The values are converted for use at 40°C ambient temperature using the factor k_{Temp} = 0.91 given in the standard.
The motor cable cross section is chosen for B&R motor cables so that the valid current load capacity for the selected cable cross section is greater than or equal to the thermal equivalent effective value of the motor current (I_q).
If information concerning load torque, inertia and friction are available, the thermal equivalent effective value of the motor current I_q for the motor being used is calculated as follows:

$$I_q[A] = \sqrt{\frac{1}{T_{Zyklus}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

4.2 Motor cables 10 mm²

Order data [1)]

Model number	Short description	Figure
8CM005.12-5	Motor cable, length 5m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM007.12-5	Motor cable, length 7m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM010.12-5	Motor cable, length 10m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM015.12-5	Motor cable, length 15m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM020.12-5	Motor cable, length 20m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	
8CM025.12-5	Motor cable, length 25m, 4 x 10 mm² + 2 x 2 x 1.5 mm², Motor connector 8-pin Intercontec socket, can be used in drag chains, UL/CSA listed	

Table 82: Order data - 10 mm² motor cable

Technical data

Product ID	8CMxxx.12-5
General information	
Cable cross section	4 x 10 mm² + 2 x 2 x 1.5 mm²
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20234, 80°C, 1000 V, E63216 and CSA AWM I/II A/B, 90°C, 1000 V, FT2 LL46064
Lines	
Power lines Wire insulation Wire colors	10 mm², tinned Cu wire Special thermoplastic material Black, brown, blue, yellow/green
Signal lines Wire insulation Wire colors	1.5 mm², tinned Cu wire Special thermoplastic material White, white/red, white/blue, white/green
Cable structure	
Power lines Stranding Shield	 No No
Signal lines Stranding Shield	 White with white/red and white/blue with white/green Separate shielding for pairs, tinned Cu mesh, Optical coverage > 85% and foil banding
Cable stranding	With filler elements and foil banding
Cable shield	Tinned Cu mesh, optical coverage > 85% and wrapped in isolating fabric
Outer sheathing Item Color Labeling	 PUR Orange, similar to RAL 2003 flat BERNECKER + RAINER 4x10.0+2x2x1.5 FLEX

Table 83: Technical data - 10 mm² motor cable

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CMxxx.12-5
Electrical characteristics	
Conductor resistance Power lines Signal lines	 ≤ 2.1 Ω/km ≤ 14 Ω/km
Insulation resistance	> 200 MΩ per km
Test voltage Wire/wire Wire/shield	 1500 VAC 1500 VAC
Max. current loading capacity according to IEC 60364-5-523 depending on the type of installation 1) Installed in conduit or cable duct Mounted on walls Installed in a cable tray	 54.6 A 64.6 A 68.3 A
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +70°C -20°C to +90°C
Outer diameter	20.1 mm ± 0.7 mm
Flex radius	> 150.8 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	0.77 kg/m

Table 83: Technical data - 10 mm² motor cable (cont.)

1) Valid in the following conditions: 40°C ambient temperature and 90°C maximal line temperature.
The maximum current load value in IEC60364-5-523 is for an ambient temperature of 30°C. The values are converted for use at 40°C ambient temperature using the factor k_{Temp} = 0.91 given in the standard.
The motor cable cross section is chosen for B&R motor cables so that the valid current load capacity for the selected cable cross section is greater than or equal to the thermal equivalent effective value of the motor current (I_q).
If information concerning load torque, inertia and friction are available, the thermal equivalent effective value of the motor current I_q for the motor being used is calculated as follows:

$$I_q[A] = \sqrt{\frac{1}{T_{Zyklus}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

4.2 Motor cables 35 mm²

Order data 1)

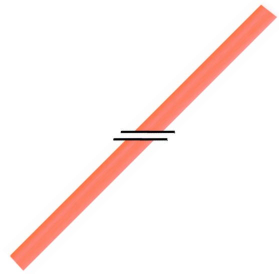
Model number	Short description	Figure
8CM005.12-8	Motor cable, length 5m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	
8CM007.12-8	Motor cable, length 7m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	
8CM010.12-8	Motor cable, length 10m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	
8CM015.12-8	Motor cable, length 15m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	
8CM020.12-8	Motor cable, length 20m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	
8CM025.12-8	Motor cable, length 25m, 4 x 35mm² + 2 x 2 x 1.5mm², can be used in cable drag chains, UL/CSA listed	

Table 84: Order data - 35 mm² motor cable

Technical data

Product ID	8CMxxx.12-8
General information	
Cable cross section	4 x 35 mm² + 2 x 2 x 1.5 mm²
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20234, 80°C, 1000 V, E63216 and CSA AWM I/II A/B, 90°C, 1000 V, FT2 LL46064
Lines	
Power lines	35 mm², tinned Cu wire
Wire insulation Wire colors	Special thermoplastic material Black, brown, blue, yellow/green
Signal lines Wire insulation Wire colors	1.5 mm², tinned Cu wire Special thermoplastic material White, white/red, white/blue, white/green
Cable structure	
Power lines Stranding Shield	 No No
Signal lines Stranding Shield	 White with white/red and white/blue with white/green Separate shielding for pairs, tinned Cu mesh, Optical coverage > 85% and foil banding
Cable stranding	With filler elements and foil banding
Cable shield	Tinned Cu mesh, optical coverage > 85% and wrapped in isolating fabric
Outer sheathing Item Color	 PUR Orange, similar to RAL 2003 flat
Labeling	BERNECKER + RAINER 4x35.0+2x2x1.5 FLEX

Table 85: Technical data - 35 mm² motor cable

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CMxxx.12-8
Electrical characteristics	
Conductor resistance Power lines Signal lines	 ≤ 0.6 Ω/km ≤ 14 Ω/km
Insulation resistance	> 200 MΩ per km
Test voltage Wire/wire Wire/shield	 1500 VAC 1500 VAC
Max. current loading capacity according to IEC 60364-5-523 depending on the type of installation [1)] Installed in conduit or cable duct Mounted on walls Installed in a cable tray	 116.5 A 133.8 A 143.8 A
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +70°C -20°C to +90°C
Outer diameter	32.5 mm ± 1 mm
Flex radius	> 243.8 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	2.2 kg/m

Table 85: Technical data - 35 mm² motor cable (cont.)

1) Valid in the following conditions: 40°C ambient temperature and 90°C maximal line temperature.

The maximum current load value in IEC60364-5-523 is for an ambient temperature of 30°C. The values are converted for use at 40°C ambient temperature using the factor $k_{Temp} = 0.91$ given in the standard.

The motor cable cross section is chosen for B&R motor cables so that the valid current load capacity for the selected cable cross section is greater than or equal to the thermal equivalent effective value of the motor current (I_q).

If information concerning load torque, inertia and friction are available, the thermal equivalent effective value of the motor current I_q for the motor being used is calculated as follows:

$$I_q[A] = \sqrt{\frac{1}{T_{Zyklus}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

4.3 EnDat cables

4.3.1 Order data [1)]

Model number	Model number	Figure
8CE005.12-1	EnDat cable, length 5m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CE007.12-1	EnDat cable, length 7m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CE010.12-1	EnDat cable, length 10m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CE015.12-1	EnDat cable, length 15m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CE020.12-1	EnDat cable, length 20m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CE025.12-1	EnDat cable, length 25m, 10 x 0.14mm² + 2 x 0.5mm², EnDat connector 17-pin Intercontec socket, servo connector 15-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	

Table 86: Order data - EnDat cables

4.3.2 Technical data

Product ID	8CExxx.12-1
General information	
C-UL-US Listed	Yes
Cable cross section	10 x 0.14 mm² + 2 x 0.50 mm²
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20963, 80°C, 30 V, E63216 and CSA AWM I/II A/B, 90°C, 30 V, FT1 LL46064
Lines	
Signal lines Wire insulation Wire colors	0.14 mm², tinned Cu wire Special thermoplastic material Blue, brown, yellow, gray, green, pink, red, black, violet, white
Supply lines Wire insulation Wire colors	0.5 mm², tinned Cu wire Special thermoplastic material White/green, white/red
Cable structure	
Signal lines Stranding Shield	 Green with brown, gray with yellow, white with violet, black with red, pink with blue No

Table 87: Technical data - EnDat cables

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CExxx.12-1
Supply lines Stranding Shield	 White/red with white/green and filler elements No
Cable stranding	With foil banding
Cable shield	Cu mesh, optical coverage > 85% and wrapped in isolating fabric
Outer sheathing Item Color Labeling	 PUR RAL 6018 BERNECKER + RAINER 10x0.14+2x0.50 FLEX
Electrical characteristics	
Conductor resistance Signal lines Supply lines	 ≤ 140 Ω/km ≤ 40 Ω/km
Insulation resistance	> 200 MΩ per km
Test voltage Wire/wire Wire/shield	 1.5 kV 0.8 kV
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +70°C -20°C to +90°C
Outer diameter	7.3 mm ± 0.25 mm
Flex radius	> 55 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	0.08 kg/m

Table 87: Technical data - EnDat cables (cont.)

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4.4 Resolver cables

4.4.1 Order data [1)]

Model number	Short description	Figure
8CR005.12-1	Resolver cable, length 5m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CR007.12-1	Resolver cable, length 7m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CR010.12-1	Resolver cable, length 10m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CR015.12-1	Resolver cable, length 15m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CR020.12-1	Resolver cable, length 20m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	
8CR025.12-1	Resolver cable, length 25m, 3 x 2 x 24 AWG/19, resolver plug 12-pin Intercontec socket, servo plug 9-pin DSUB plug, can be used in cable drag chains, UL/CSA listed	

Table 88: Order data - Resolver cables

4.4.2 Technical data

Product ID	8CRxxx.12-1
General information	
C-UL-US Listed	Yes
Cable cross section	3 x 2 x 24 AWG/19
Durability	Oil resistant according to VDE 0472 part 803, as well as standard hydraulic oil
Certification	UL AWM Style 20671, 90°C, 30 V, E63216 and CSA AWM, 90°C, 30 V, I/II A/B FT1 LL46064
Lines	
Signal lines Wire insulation Wire colors	24 AWG/19, tinned Cu wire Special thermoplastic material White, brown, green, yellow, gray, pink

Table 89: Technical data - Resolver cables

1) Other cable lengths and conduits are available from B&R upon request.

Product ID	8CRxxx.12-1
Cable structure	
Signal lines Stranding Shield	 White with brown, green with yellow, gray with pink No
Cable stranding	The 3 pairs together covered by foil banding
Cable shield	Cu mesh, optical coverage 90% and wrapped in isolating fabric
Outer sheathing Item Color Labeling	 PUR RAL 6018 BERNECKER + RAINER 3x2x24 AWG FLEX
Electrical characteristics	
Conductor resistance 24 AWG	≤ 86 Ω/km
Insulation resistance	> 200 MΩ per km
Cable capacitance	94.8 to 98.8 pF/m
Test voltage Wire/wire Wire/shield	 1.5 kV 0.8 kV
Mechanical characteristics	
Temperature range Moving Static	 -10°C to +80°C -40°C to +90°C
Outer diameter	6.5 mm ± 0.2 mm
Flex radius	50 mm
Movement speed	≤ 4 m/s
Acceleration	< 60 m/s²
Flex cycles	3,000,000
Weight	0.07 kg/m

Table 89: Technical data - Resolver cables (cont.)

5 Plugs

5.1 General information

B&R offers five different motor/encoder connectors for 8MS three-phase synchronous motors. All connectors have IP67 protection. The metallic housing provides a protective ground connection on the housing according to VDE 0627. All plastic used in the connector is UL94/V0 listed. High quality, gold plated cage connector contacts guarantee a high level of contact security even when reinserted many times.

> ## Information:
>
> **Using B&R connectors guarantees that the EMC limits for the connection are not exceeded. Make sure that connectors are put together correctly including a proper shield connection.**

5.2 Motor connectors

5.2.1 Order data

Model number	Short description	Figure
	Cable diameter 9 - 17 mm	 8PM001.00-1  8PM002.00-1
8PM001.00-1	8-pin motor plug Intercontec socket, crimp range 4 x 0.5-2.5mm² + 4 x 0.06-1.0mm², for cable ø 9-14mm, IP67, UL/CSA listed	
8PM002.00-1	8-pin motor plug Intercontec socket, crimp range 4 x 2.5-4.0mm² + 4 x 0.06-1.0mm², for cable ø 14-17mm, IP67, UL/CSA listed	
	Cable diameter 17 - 26 mm	
8PM003.00-1	8-pin motor plug Intercontec socket, crimp range 4 x 1.5-10mm² + 4 x 0.5-2.5mm², for cable ø 17-26mm, IP67, UL/CSA listed	

Table 90: Order data - Motor connectors

5.2 Technical data - 8PM001.00-1 and 8PM002.00-1

Product ID	8PM001.00-1	8PM002.00-1
General information		
Connector size	Size 1	
Contacts	8 (4 power and 4 signal contacts)	
Degree of pollution	3	
Installation altitude	up to 2,000 m	
Insulator	PA 6.6 / PBT, UL94/V0 listed	
Contacts	Gold-plated brass	
Protective ground connection on housing	According to VDE 0627	
Protection according to DIN 40050	IP67 when connected	
Certifications	UL/CSA	
Electrical characteristics		
Overvoltage category	3	
Power contacts Rated current Rated voltage Test voltage (L-L) Contact resistance	 30 A 630 VAC / VDC 6,000 V < 3 mΩ	
Signal contacts Rated current Rated voltage Test voltage (L-L) Contact resistance	 10 A 250 VAC / VDC 2,500 V < 5 mΩ	
Mechanical characteristics		
Temperature range	-20°C to +130°C	
Housing material	Zinc die cast / brass, nickel plated	
Gaskets	FPM / HNBR	
Connection cycles	> 50	
Crimp range	4 x 0.5 - 2.5 mm² + 4 x 0.06 - 1 mm²	4 x 2.5 - 4 mm² + 4 x 0.06 - 1 mm²
Cable ø	9.5 - 14.5 mm	14 - 17 mm
Manufacturer information		
Manufacturer Internet address	INTERCONTEC www.intercontec.biz	
Manufacturer's product ID	BSTA 108 FR 19 58 0036 000	BSTA 108 FR 35 59 0036 000

Table 91: Technical data - Motor connectors 8PM001.00-1 and 8PM002.00-1

5.2 Technical data - 8PM003.00-1

Product ID	8PM003.00-1
General information	
Connector size	Size 1.5
Contacts	8 (4 power and 4 signal contacts)
Degree of pollution	3
Installation altitude	up to 2,000 m
Insulator	PA 6.6 / PBT, UL94/V0 listed
Contacts	Gold-plated brass
Protective ground connection on housing	According to VDE 0627
Protection according to DIN 40050	IP67 when connected
Certifications	UL/CSA
Electrical characteristics	
Overvoltage category	3
Power contacts Rated current Rated voltage Test voltage (L-L) Contact resistance	 75 A 630 VAC / VDC 6,000 V < 1 mΩ
Signal contacts Rated current Rated voltage Test voltage (L-L) Contact resistance	 30 A 630 VAC / VDC 4000 V < 3 mΩ
Mechanical characteristics	
Temperature range	-20°C to +130°C
Housing material	Magnesium die cast / aluminum, nickel plated
Gaskets	FPM / HNBR
Connection cycles	> 50
Crimp range	4 x 1.5 - 10 mm² + 4 x 0.5 - 2.5 mm²
Cable ø	17 - 26 mm
Manufacturer information	
Manufacturer Internet address	INTERCONTEC www.intercontec.biz
Manufacturer's product ID	CSTA 264 FR 48 25 0001 000

Table 92: Technical data - Motor connector 8PM003.00-1

5.3 Encoder connectors

5.3.1 Order data

Model number	Short description	Figure
	EnDat connectors	
8PE001.00-1	17-pin EnDat connector Intercontec socket, crimp range 17 x 0.06-1,0mm², for cable ø 9-12mm, IP67, UL/CSA listed	
	Resolver connectors	
8PR001.00-1	12-pin resolver connector Intercontec socket, crimp range12 x 0.06-1.0mm², for cable ø 5.5-10.5mm, IP67, UL/CSA listed	

Table 93: Order data - Encoder connectors

5.3 Technical data - EnDat connector 8PE001.00-1

Product ID	8PE001.00-1
General information	
Connector size	Size 1
Contacts	17 signal contacts
Degree of pollution	3
Installation altitude	up to 2,000 m
Insulator	PA 6.6 / PBT, UL94/V0 listed
Contacts	Gold-plated brass
Protective ground connection on housing	According to VDE 0627
Protection according to DIN 40050	IP67 when connected
Certifications	UL/CSA
Electrical characteristics	
Overvoltage category	3
Signal contacts Rated current Rated voltage Test voltage (L - L) Contact resistance	 9 A 125 V 2,500 V < 5 mΩ
Mechanical characteristics	
Temperature range	-20°C to +130°C
Housing material	Zinc die cast / brass, nickel plated
Gaskets	FPM / HNBR
Connection cycles	> 50
Crimp range	17 x 0.06 - 1 mm²
Cable ø	5.5 - 10.5 mm
Manufacturer information	
Manufacturer Internet address	INTERCONTEC www.intercontec.biz
Manufacturer's product ID	ASTA 035 FR 11 10 0035 000

Table 94: Technical data - EnDat connector 8PE001.00-1

5.3 Technical data - Resolver connector 8PR001.00-1

Product ID	8PR001.00-1
General information	
Connector size	Size 1
Contacts	12 signal contacts
Degree of pollution	3
Installation altitude	up to 2,000 m
Insulator	PA 6.6 / PBT, UL94/V0 listed
Contacts	Gold-plated brass
Protective ground connection on housing	According to VDE 0627
Protection according to DIN 40050	IP67 when connected
Certifications	UL/CSA
Electrical characteristics	
Overvoltage category	3
Signal contacts Rated current Rated voltage Test voltage (L - L) Contact resistance	 9 A 160 V 2,500 V < 5 mΩ
Mechanical characteristics	
Temperature range	-20°C to +130°C
Housing material	Zinc die cast / brass, nickel plated
Gaskets	FPM / HNBR
Connection cycles	> 50
Crimp range	12 x 0.06 - 1 mm²
Cable ø	5.5 - 10.5 mm
Manufacturer information	
Manufacturer Internet address	INTERCONTEC www.intercontec.biz
Manufacturer's product ID	ASTA 021 FR 11 10 0035 000

Table 95: Technical data - Resolver connector 8PR001.00-1

Chapter 3 • Installation

1. General information

Make sure that installation takes place on a flat surface which is correctly dimensioned. The dimensional diagram lists the number and type of mounting screws to be used.

The eye bolt contained in the delivery can be attached to the device to lift ACOPOS 1640 and ACOPOS 128M drives:

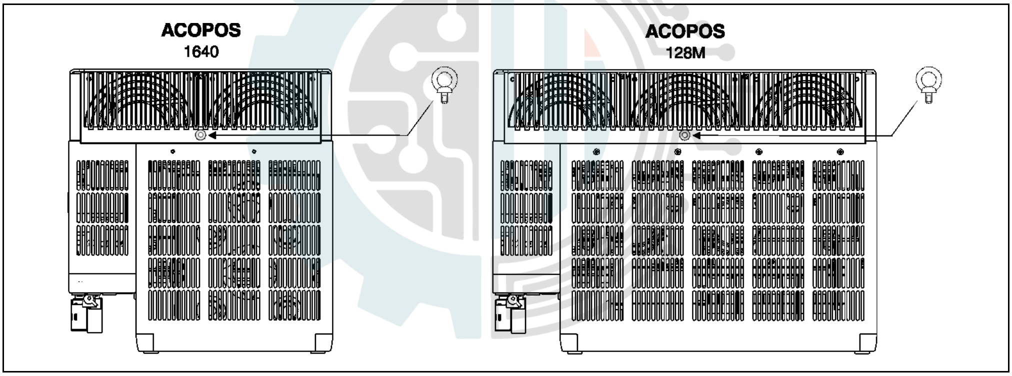


Figure 19: Attaching the eye bolt contained in the delivery to ACOPOS 1640, 128M drives

ACOPOS servo drives must be installed in switching cabinets with at least IP54 protection.

ACOPOS servo drives can only be installed in an environment which corresponds to pollution degree II (non-conductive material). When installing the device, make sure that the specifications for maximum operating temperature and protection level listed in the technical data are met (see section 2 "Technical data", on page 39).

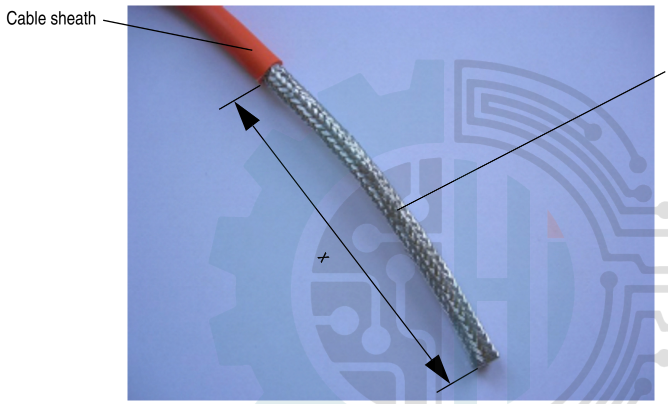
For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive. ACOPOS servo drives can be mounted directly next to each other; the required distance between devices can be found in the respective dimensional diagram.

2 Motor cable

2.1 Assembly example (module-side) of a 1.5 mm² motor cable

1) Shorten motor cable to required length.

2) Strip motor cable on the module-end of cable (make sure not to damage the entire shield mesh)



Motor cable	Length of stripped cable section x
1.5 mm²	75 mm
4 mm²	150 mm
10 mm²	180 mm

Figure 20: Stripped cable end

3) Pull the entire shield back over the cable sheath and cut off the stranding elements

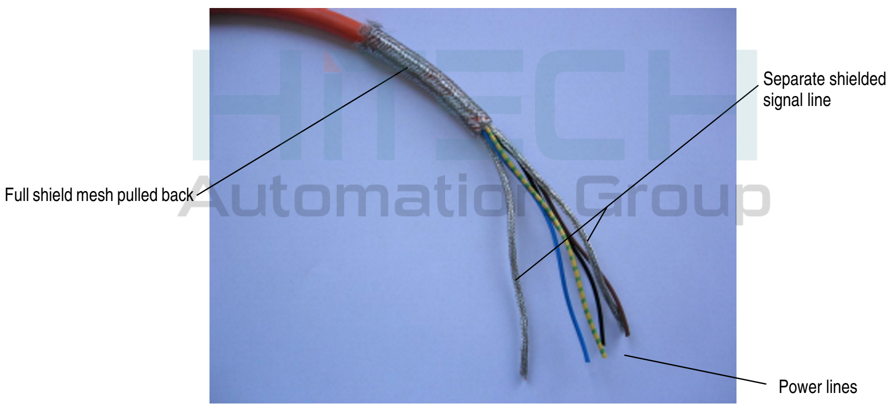


Figure 21: Cable ends with shielding mesh pulled back

4) Pull the separately shielded signal lines (2 x 2 lines) from the shielding mesh.

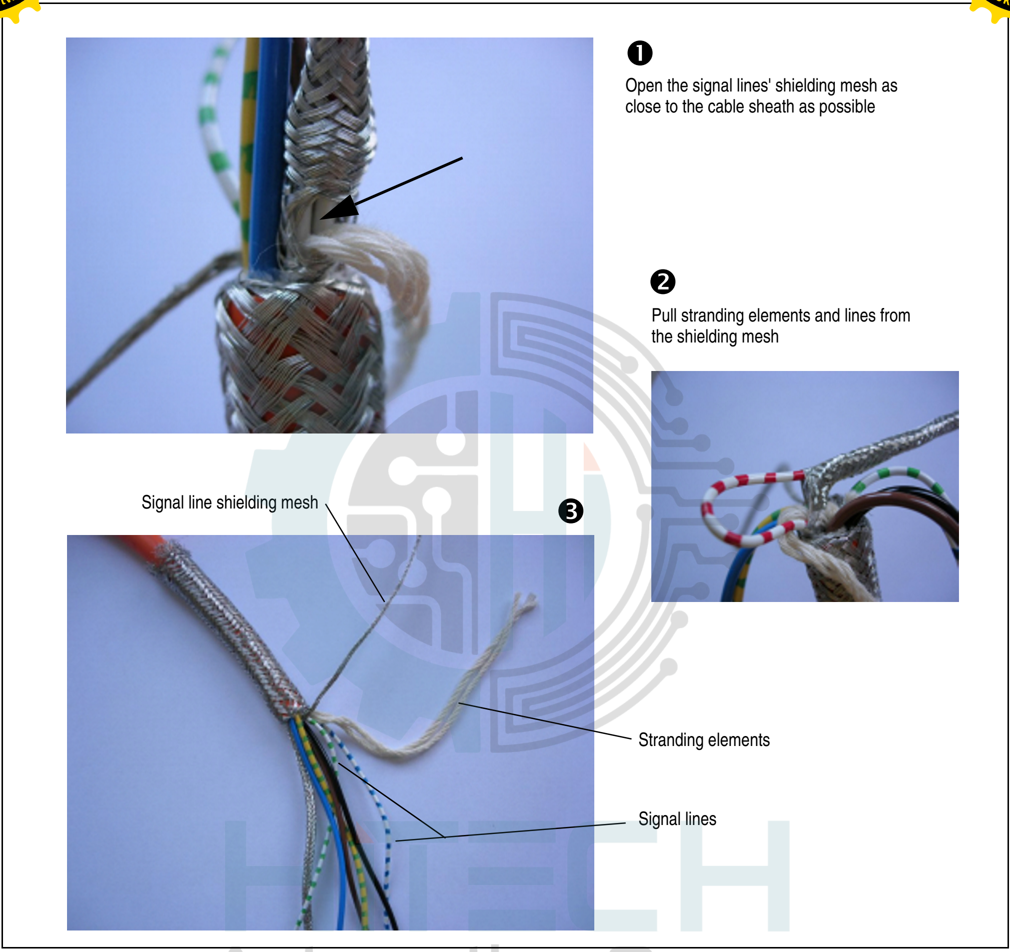


Figure 22: Pulling out the separately shielded signal lines

5) Cut the stranding elements of the separately shielded line.

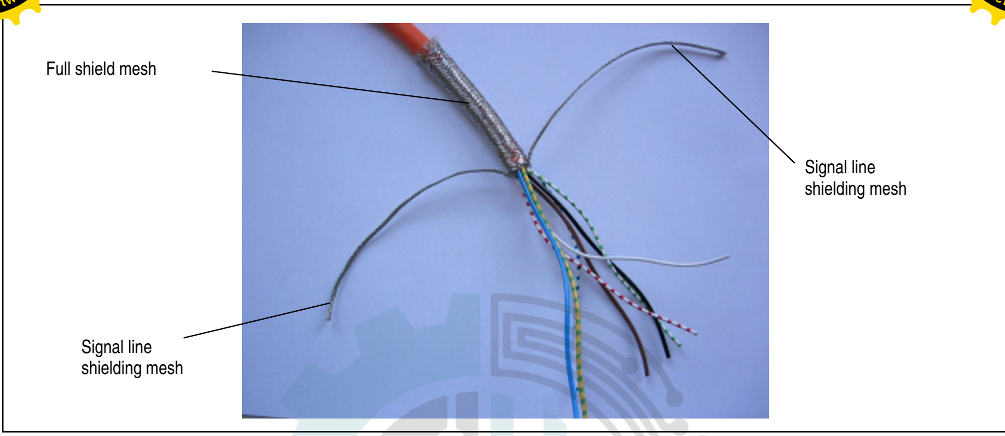


Figure 23: Cable end without stranding elements

6) Shorten the shielding mesh to a length of approximately 40 mm and pull the signal line's shielding mesh over the cable sheath.

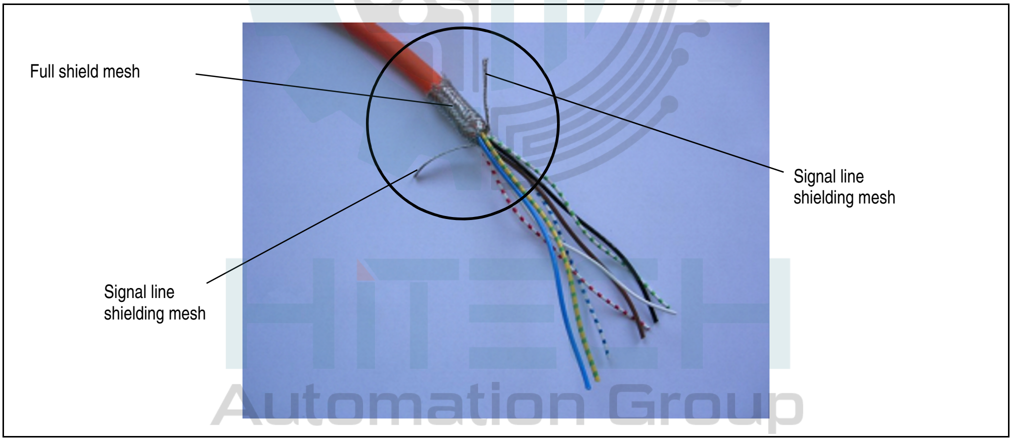


Figure 24: Cable ends with shortened shielding mesh

7) Attach all shielding mesh to the cable sheath using heat shrink tubing (approx. 20 mm ... and leaving some of the shielding mesh free.

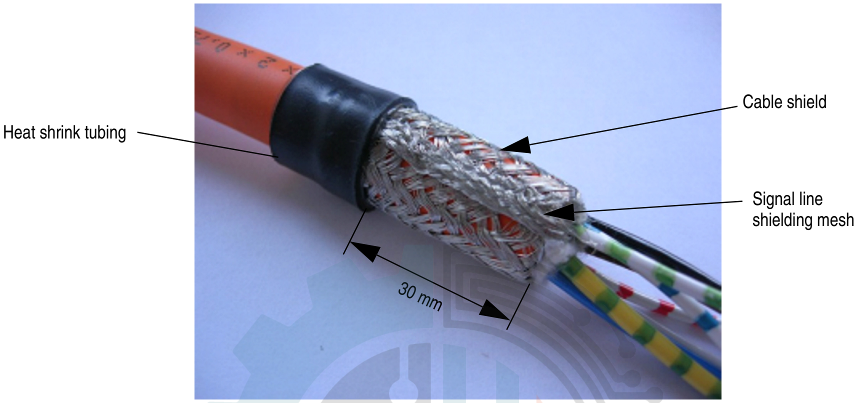
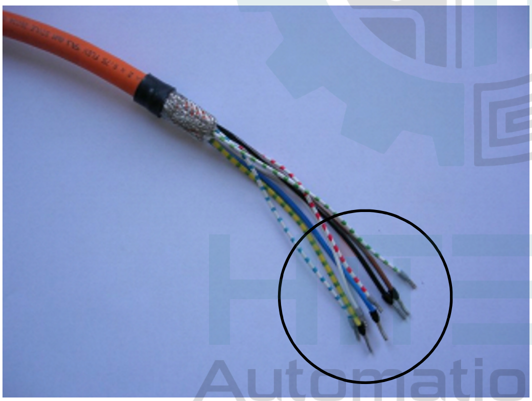


Figure 25: Attaching the shielding mesh

8) Strip wire ends and attach wire tip sleeves.



Motor cable	Stripped lengths	
	Power lines	Signal lines
1.5 mm²	10 mm	8 mm
4 mm²	12 mm	
10 mm²	18 mm	

Motor cable	Wire tip sleeves	
	Power lines	Signal lines
1.5 mm²	1.5 mm²	0.75 mm²
4 mm²	4 mm²	1 mm²
10 mm²	10 mm²	1.5 mm²

Figure 26: Wire ends with wire tip sleeves

3 Dimension diagrams and installation dimensions

3.1 ACOPOS 1010, 1016

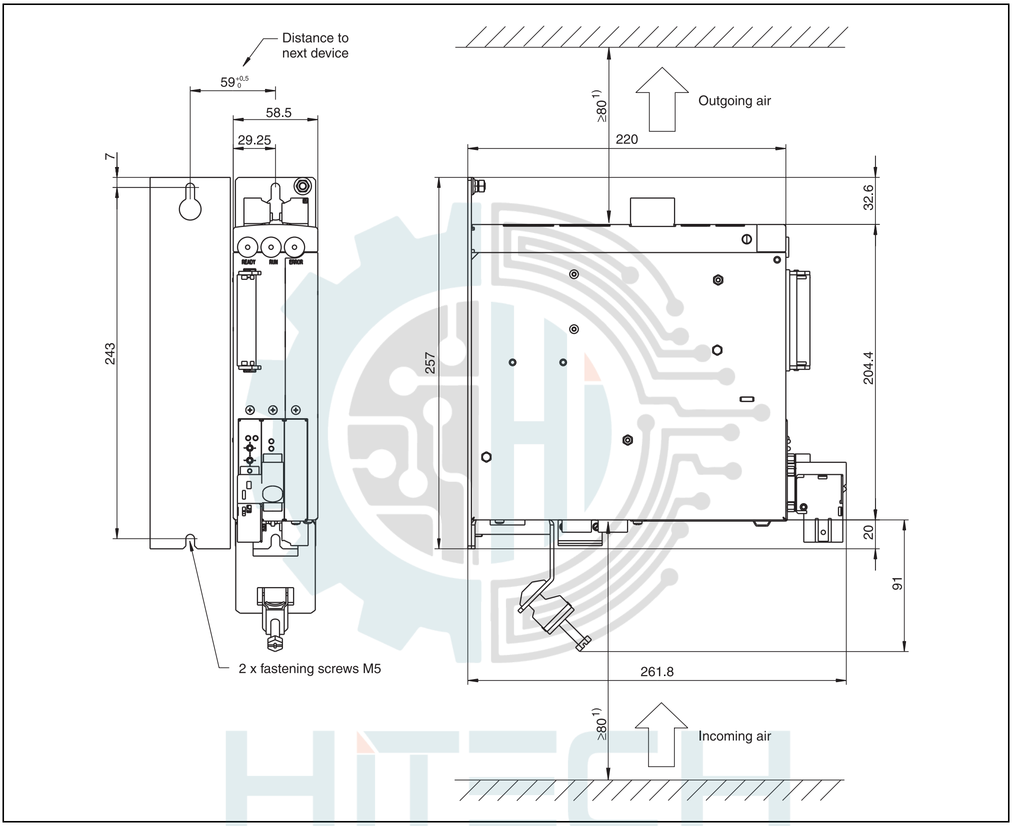


Figure 27: Dimensional diagram and installation dimensions for ACOPOS 1010, 1016

1) For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive. Approximately 100 mm free space is required under the ACOPOS servo drive to prevent cabling problems.

3.2 ACOPOS 1022, 1045, 1090

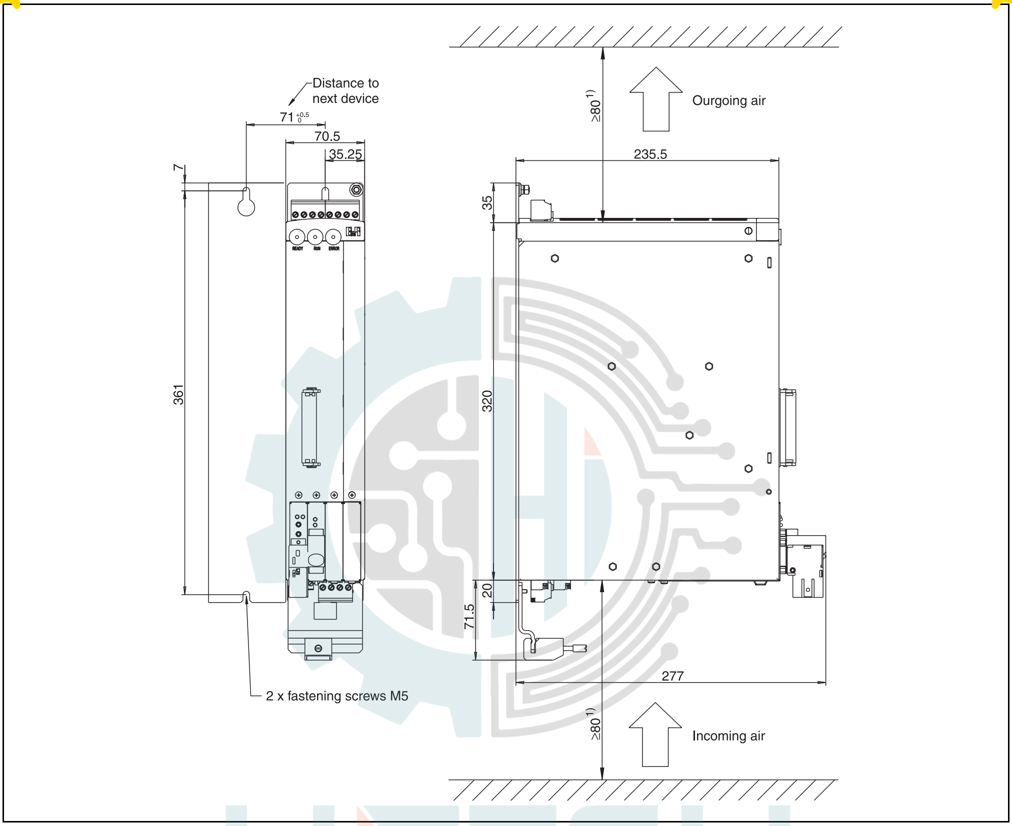


Figure 28: Dimensional diagram and installation dimensions for ACOPOS 1022, 1045, 1090

1) For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive.

3.2 ACOPOS 1180, 1320

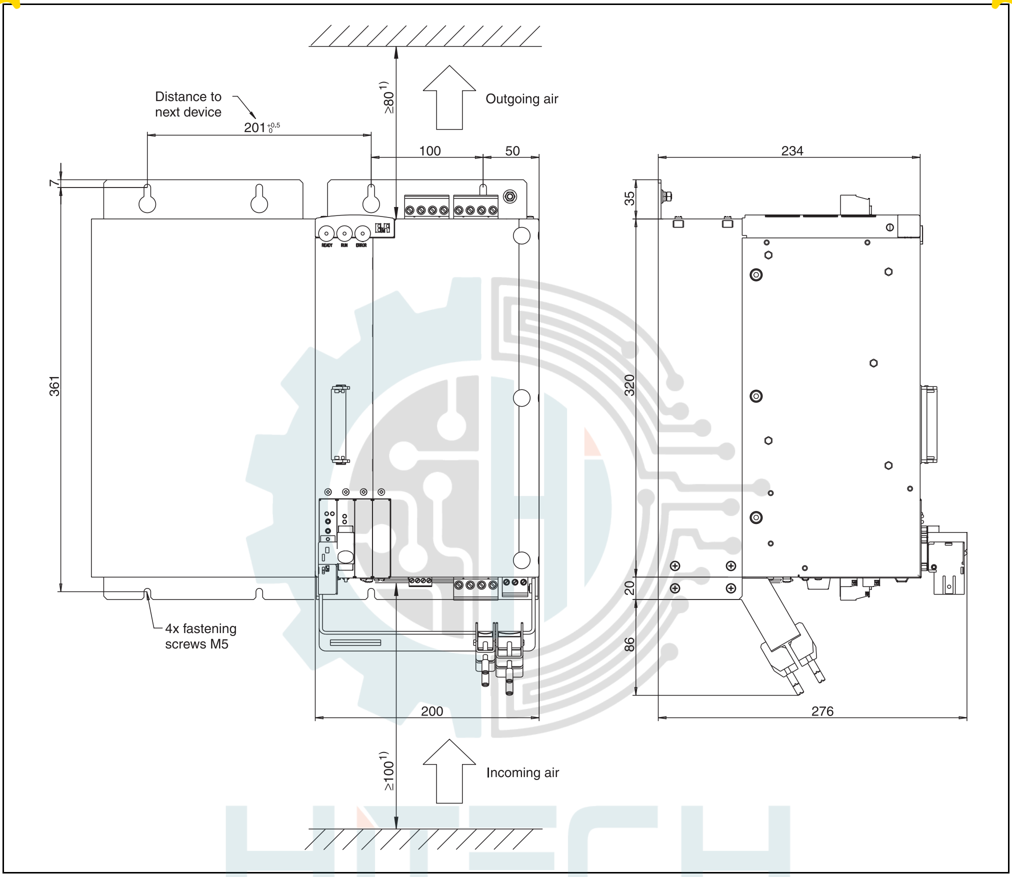


Figure 29: Dimensional diagram and installation dimensions for ACOPOS 1180, 1320

1) For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive. Approximately 100 mm free space is required under the ACOPOS servo drive to prevent cabling problems.

3.4 ACOPOS 1640

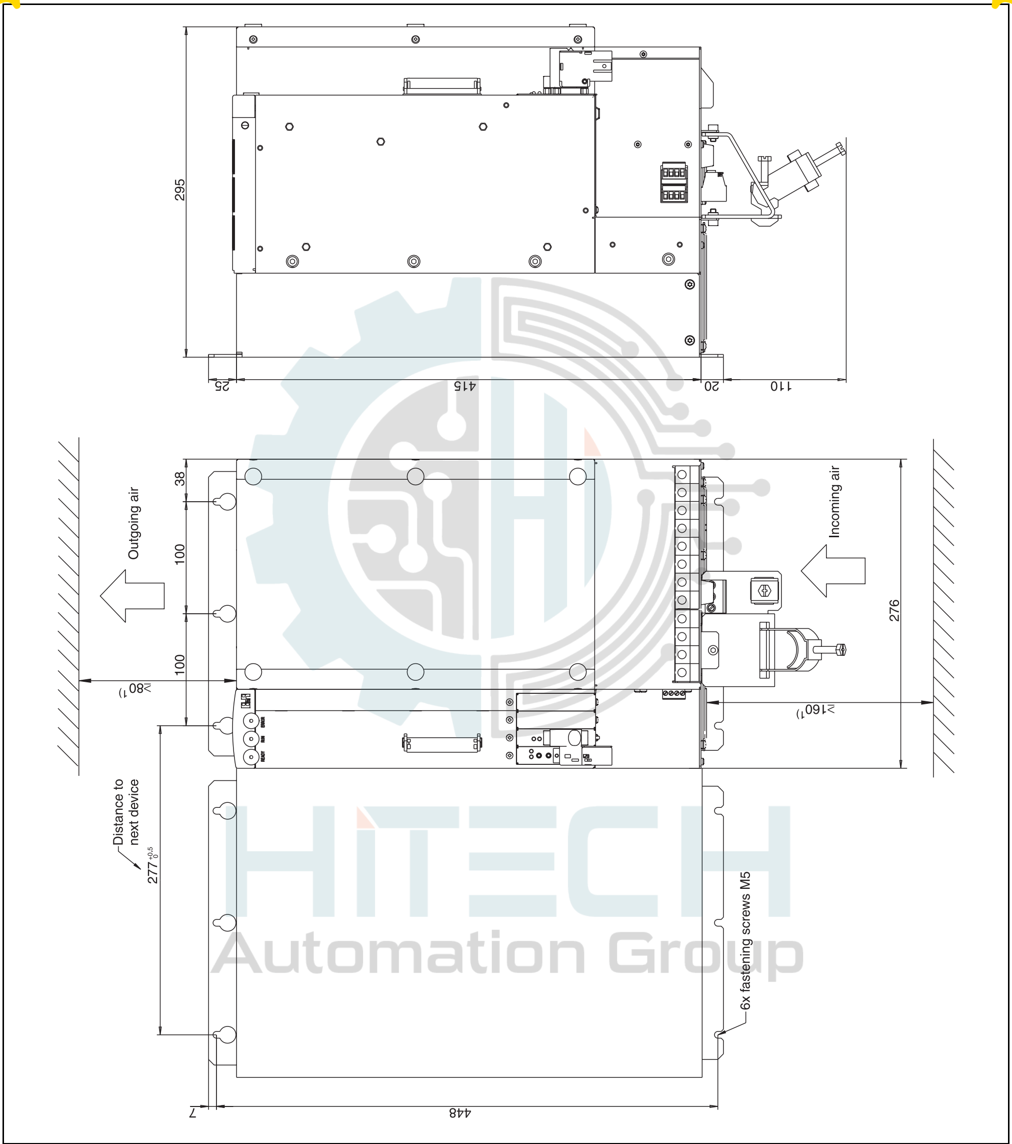


Figure 30: Dimensional diagram and installation dimensions for ACOPOS 1640

1) For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive. Approximately 160 mm free space is required under the ACOPOS servo drive to prevent cabling problems.

3.5 ACOPOS 128M

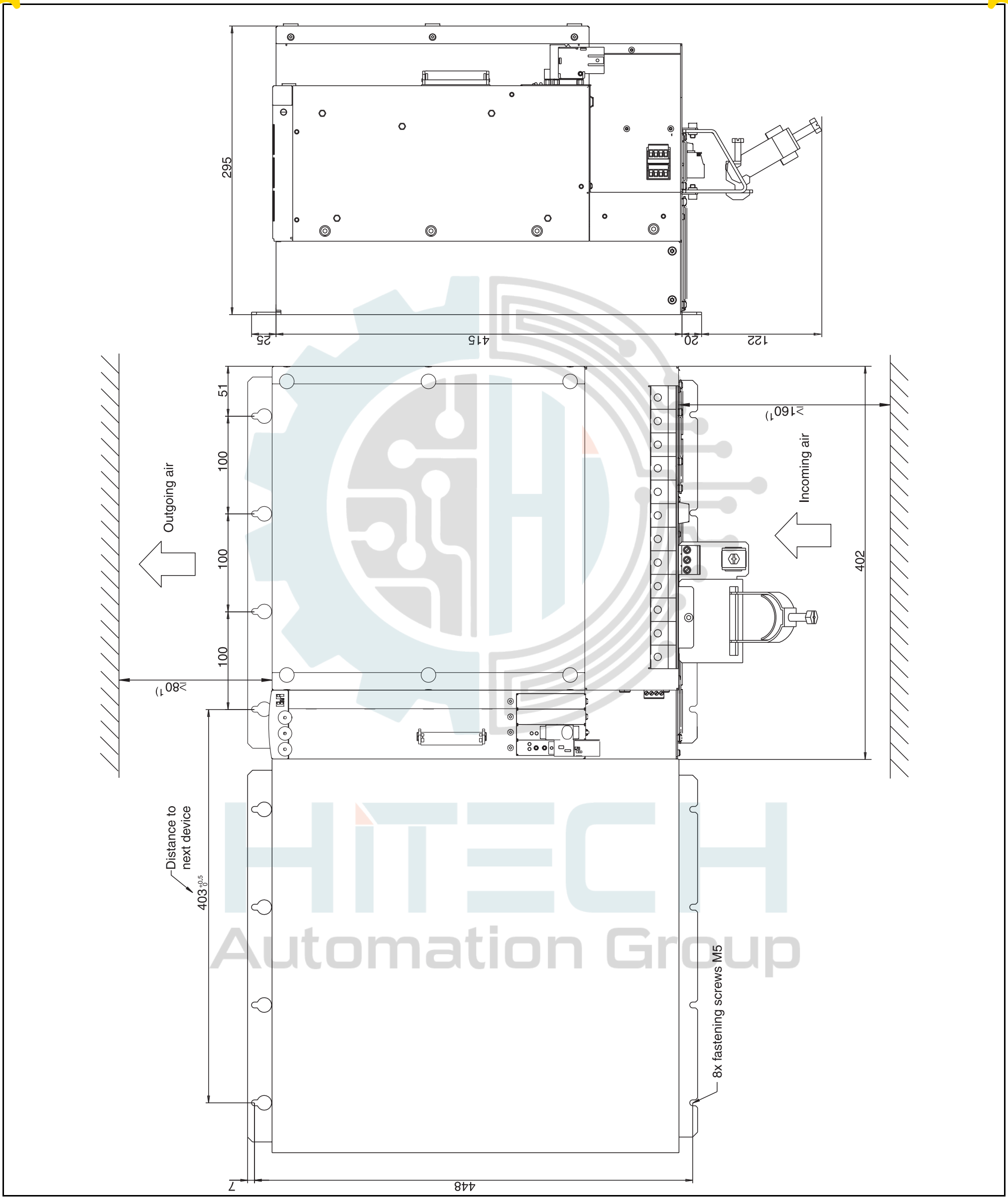


Figure 31: Dimensional diagram and installation dimensions for ACOPOS 128M

1) For proper air circulation, at least 80 mm has to be left free above and below the ACOPOS servo drive. Approximately 160 mm free space is required under the ACOPOS servo drive to prevent cabling problems.

3.6 External braking resistors

3.6.1 8B0W0045H000.001-1, 8B0W0079H000.001-1

	8B0W0045H000.001-1	8B0W0079H000.100-1
L	260±2 mm	460±2 mm
L1	160±2 mm	360±2 mm

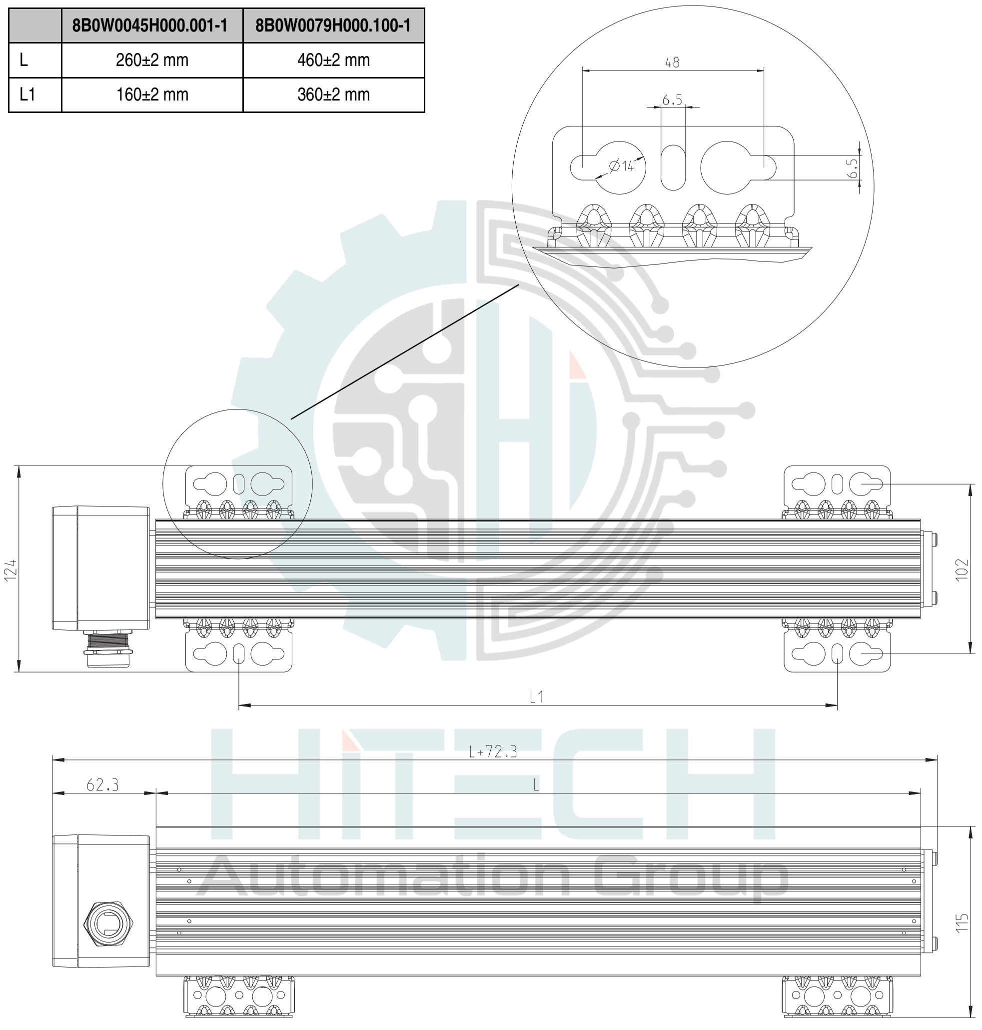


Figure 32: Dimension diagram for 8B0W0045H000.001-1, 8B0W0079H000.001-1

Warning!

8B0W external braking resistors can reach extremely high surface temperatures during operation and after shutting off!

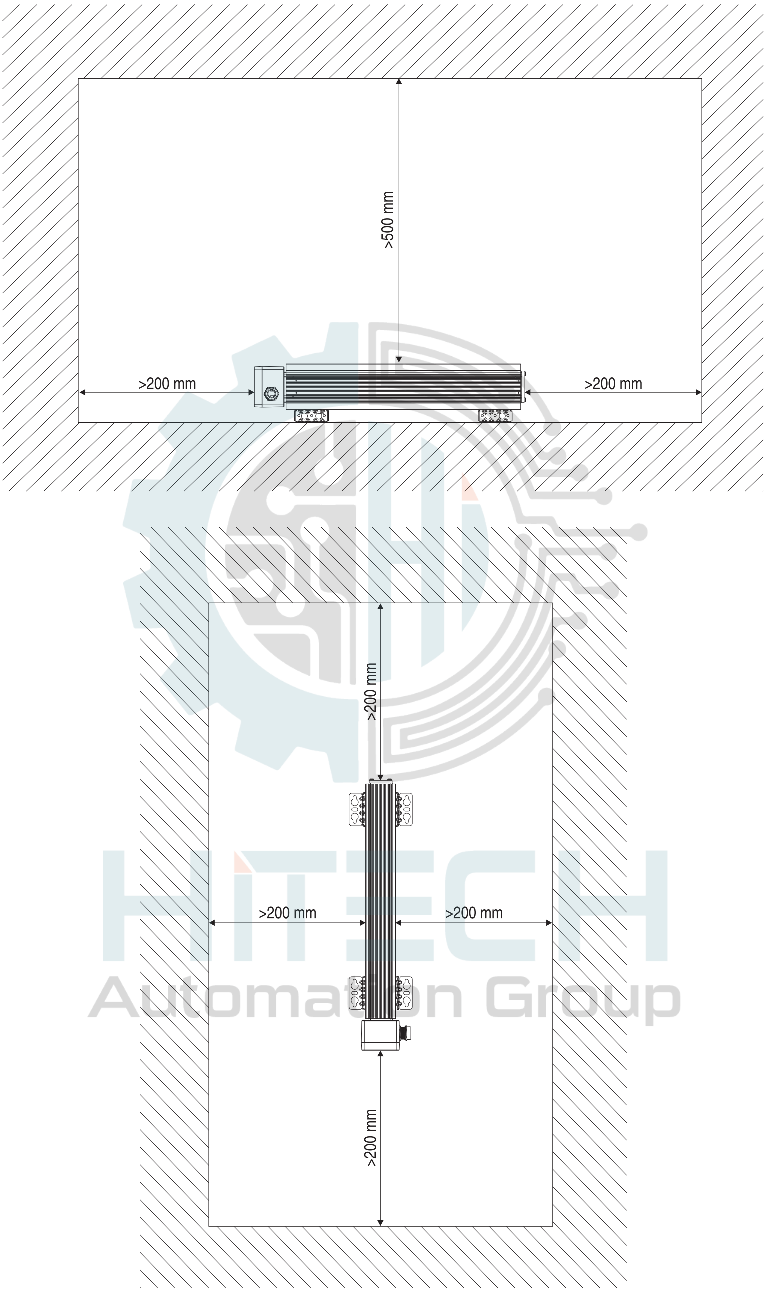


Figure 33: Installation dimensions - 8B0W external braking resistors

4 Installation and removal of plug-in modules

4.1 General information

All ACOPOS servo drives are equipped with three or four slots for plug-in modules depending on the size. At present, the following module arrangements must be used:

Figure	Plug-in module	Operation possible in			
		Slot 1	Slot 2	Slot 3	Slot 4 1)
 1 2 3 4	8AC110.60-2	Yes	No	No	No
	8AC114.60-2	Yes	No	No	No
	8AC120.60-1	No	Yes	Yes	Yes
	8AC121.60-1	No	Yes	Yes	Yes
	8AC122.60-3	No	Yes	Yes	Yes
	8AC123.60-1	No	Yes	Yes	Yes
	8AC130.60-1	No	Yes	Yes	Yes
	8AC131.60-1	No	Yes	Yes	Yes
	8AC140.60-2	Yes 2)		No	No
	8AC140.60-3	Yes 2)		No	No
	8AC140.61-3	Yes 2)		No	No
	8AC141.60-2	Yes 2)		No	No
	8AC141.61-3	Yes 2)		No	No

Table 96: Slot overview for ACOPOS plug-in modules

1) Not available for ACOPOS servo drives 8V1010.xxx-2 and 8V1016.xxx-2.

2) The module uses two slots.

Caution!

For the installation and removal of plug-in modules, the specifications listed in section 4.4 "Protection against electrostatic discharges", on page 33 must be followed!

4.2 Installation

1) Disconnect the ACOPOS servo drive from the power mains and prevent reconnection.

2) Switch off 24 VDC supply voltage.

3) Remove screw from the bottom of the slot cover.

4) Loosen screw on the front side.

5) Remove slot cover.

Figure 34: Installing ACOPOS plug-in modules

6) Insert plug-in module in the free slot (see figure shown above).

7) Fasten the plug-in module with the two screws.

8) Switch on 24 VDC supply voltage.

9) Connect ACOPOS servo drive to the power mains.

4.3 Removal

1) Disconnect the ACOPOS servo drive from the power mains and prevent reconnection.

2) Switch off 24 VDC supply voltage.

3) Remove screw from the bottom of the plug-in module.

4) Loosen the screw on the front side of the plug-in module.

5) Remove plug-in module.

6) Insert slot cover in free slot.

7) Fasten the slot cover with the two screws.

8) Switch on 24 VDC supply voltage.

9) Connect ACOPOS servo drive to the power mains.

5 Installing Various ACOPOS Series Devices Directly Next to Each Other

When installing various ACOPOS series devices directly next to each other, we recommend aligning the vertical position so that the LED displays of the respective devices are lined up.

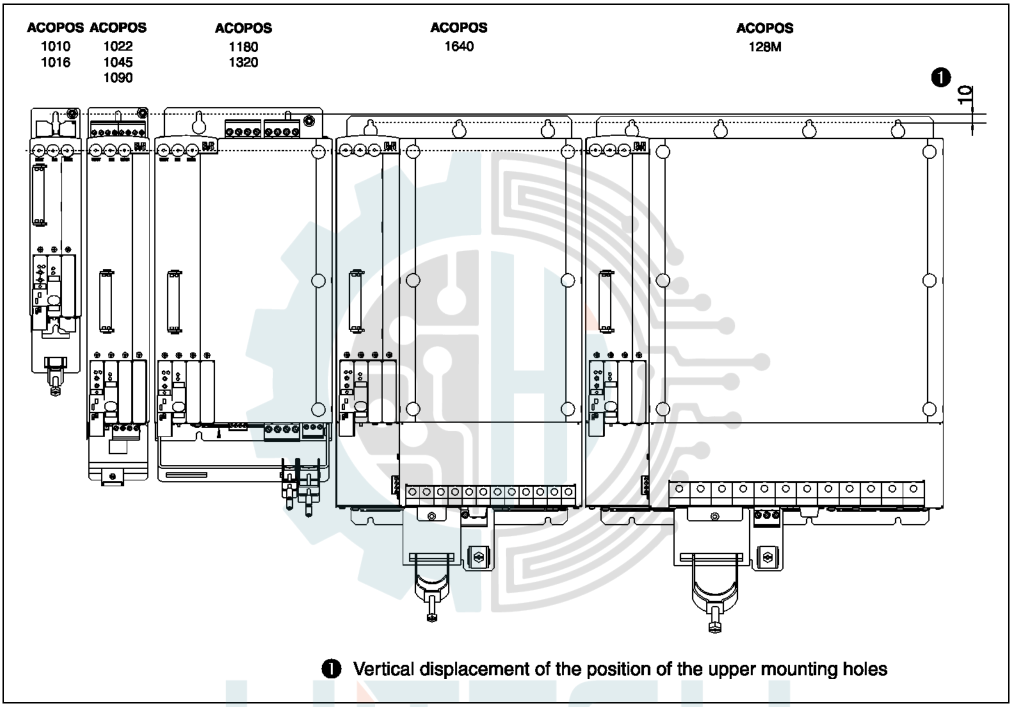


Figure 35: Installing various ACOPOS series devices directly next to each other

You can see from the image above that the vertical offset of the upper mounting holes is 10 mm. The distances for the lower mounting holes and the number and size of the screws required can be taken from the dimensional diagrams for the respective ACOPOS servo drives.

Overview of the vertical offsets:

Installed next to		ACOPOS 1010	1016	1022	1045	1090	1180	1320	1640	128M
ACOPOS	1010	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1016	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1022	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1045	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1090	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1180	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1320	No offset	No offset	No offset	No offset	No offset	No offset	No offset	10 mm	10 mm
ACOPOS	1640	10 mm	10 mm	10 mm	10 mm	10 mm	10 mm	10 mm	No offset	No offset
ACOPOS	128M	10 mm	10 mm	10 mm	10 mm	10 mm	10 mm	10 mm	No offset	No offset

Table 97: Overview of the vertical offsets (ACOPOS - ACOPOS)

6 Using cooling systems in switching cabinets

Cooling systems are generally used to maintain the permissible ambient temperature levels of ACOPOS servo drives in switching cabinets.

For details about dimensioning cooling systems, see the section "Dimensioning cooling systems for cooling switching cabinets", on page 215.

6.1 Natural convection

> ## Warning!
>
> **Make sure that only well-sealed switching cabinets are used because otherwise contaminated ambient air could permeate the switching cabinet.**

6.2 Using filter fans

The filter fans and outlet filters should be arranged on the switching cabinet in such a way that the air is taken in from below and exits above.

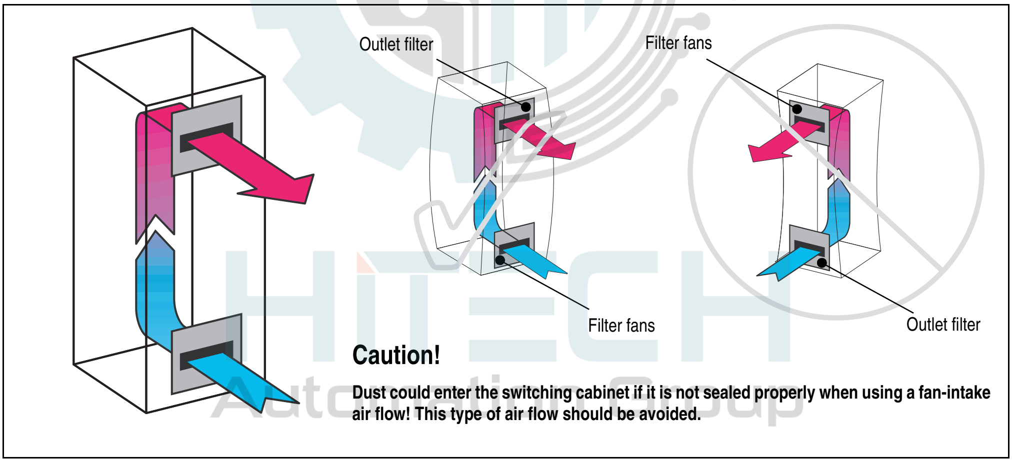


Figure 36: Function diagram of filter fans

> ## Warning!
>
> **Make sure that only well-sealed switching cabinets are used because otherwise contaminated ambient air could permeate the switching cabinet.**

6.2 Using air/air heat exchangers

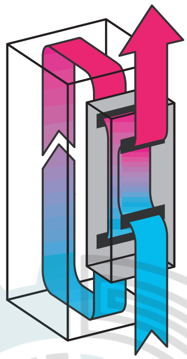


Figure 37: Function diagram of air/air heat exchangers

> **Caution!**
>
> **An even circulation of air must be ensured in the switching cabinet. Air intake openings and outlets for the inner circulation of the air/air heat exchanger must not be covered because this would prevent sufficient air circulation in the switching cabinet.**
>
> **It is recommended to allow for sufficient space (> 200 mm) in front of the air intakes and outlets.**

> **Caution!**
>
> **If any modules or electronic components are used in the switching cabinet which use their own fans, make sure that the direction of air flow does not go against the cooling system's flow of cool air. An air bypass could occur which would prevent sufficient cooling in the switching cabinet.**

> **Warning!**
>
> **Make sure that only well-sealed switching cabinets are used because otherwise contaminated ambient air could permeate the switching cabinet.**

Mounting air/air heat exchangers behind mounting plates should generally be avoided. However if this is necessary, then corresponding air shields must be used. Air intake openings and outlets must also be added to the mounting plate.

6.[illegible] Using air/water heat exchangers

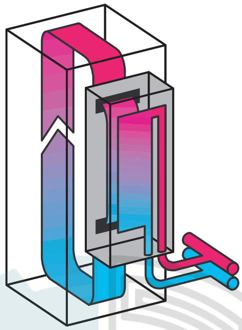


Figure 38: Function diagram of air/water heat exchangers

Caution!

An even circulation of air must be ensured in the switching cabinet. Air intake openings and outlets for the inner circulation of the air/water heat exchanger must not be covered because this would prevent sufficient air circulation in the switching cabinet.

It is recommended to allow for sufficient space (> 200 mm) in front of the air intakes and outlets.

Caution!

If any modules or electronic components are used in the switching cabinet which use their own fans, make sure that the direction of air flow does not go against the cooling system's flow of cool air. An air bypass could occur which would prevent sufficient cooling in the switching cabinet.

Warning!

Make sure that only well-sealed switching cabinets are used because otherwise contaminated ambient air could permeate the switching cabinet.

Mounting air/water heat exchangers behind mounting plates should generally be avoided. However if this is necessary, then corresponding air shields must be used. Air intake openings and outlets must also be added to the mounting plate.

6.5 Using cooling aggregates

6.5.1 General information

Caution!

Incorrect installation of cooling aggregates may cause condensation which can damage the ACOPOS servo drives installed there!

Condensation can enter the ACOPOS servo drives with the cooled air flow!

Warning!

Make sure that only well-sealed switching cabinets are used because otherwise ambient air could penetrate and cause condensation.

During operation with the switching cabinet doors open (e.g. service), the ACOPOS servo drives are not allowed to be cooler than the air in the switching cabinet at any time after the doors are closed.

To keep the temperature of the ACOPOS servo drives and the switching cabinet at the same level, the cooling aggregate must remain in operation even when the system is switched off.

Cooling aggregates must be installed in a way that prevents condensation from dripping into the ACOPOS servo drives. This should be considered when selecting the switching cabinet (special construction for use of cooling aggregates on top of the switching cabinet).

Also make sure that condensed water which forms in the cooling aggregate fan when it is switched off cannot sprinkle into the ACOPOS servo drives.

Make sure the temperature setting of the cooling aggregates is correct! Only set the switching cabinet's internal temperature as low as is necessary.

Be sure to follow the installation guidelines for the cooling aggregate provided in the operating manual!

6.5 Placing a cooling aggregate on top of the switching cabinet

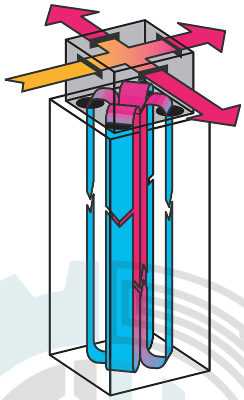


Figure 39: Placing a cooling aggregate on top of the switching cabinet

Caution!

Targeted air flow must be ensured when arranging cooling aggregates on the top of the switching cabinet! The flow of cool air must be directed through air channel systems at the lowest possible point in the switching cabinet (see image above).

Caution!

Make sure that the flow of cool air in the cooling system is not directed against the air flow from the fans in the ACOPOS servo drive. This could cause an air bypass, which would prevent sufficient cooling in the ACOPOS servo drive.

Condensation must be directed off the cooling aggregate according to manufacturer specifications so that it does not end up in the ACOPOS servo drive.

6.5 Placing a cooling aggregate on the front of the switching cabinet

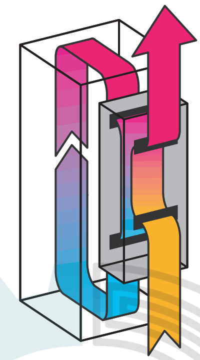


Figure 40: Placing a cooling aggregate on the front of the switching cabinet

Caution!

The flow of cool air from the cooling aggregate must be directed through air channel systems at the lowest possible point in the switching cabinet (see image above).

Caution!

Make sure that the flow of cool air in the cooling system is not directed against the air flow from the fans in the ACOPOS servo drive. This could cause an air bypass, which would prevent sufficient cooling in the ACOPOS servo drive.

Condensation must be directed off the cooling aggregate according to manufacturer specifications so that it does not end up in the ACOPOS servo drive.

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Chapter 4 • Dimensioning

1. Power mains connection

1.1 General information

1.1.1 System configuration

The power mains connection is made using terminals X3 / L1, L2, L3 and PE. The ACOPOS servo drives can be directly connected to TT and TN systems (these are three-phase systems with grounded neutral).

When using ungrounded IT mains (three-phase systems without grounded neutral or with an impedance grounded neutral) or TN-S mains with grounded phase conductor and protective ground conductor, isolation transformers must be used. The secondary neutral must be grounded and connected to the ACOPOS protective ground conductor. In this way, it is possible to prevent overvoltages between external conductors and the ACOPOS housing. Three-phase isolation transformers with the corresponding input and output voltages and a vector group with secondary neutral can be used (e. g. 3 x 400 V / 3 x 400 V, Dyn5).

In the USA, TT and TN systems are among the most common mains systems and are referred to as "Delta / Wye with grounded Wye neutral". TT systems are also known as "systems with ungrounded secondary" and TN-S mains with grounded phase conductor as "Delta / Delta with grounded leg".

> **Danger!**
>
> **The ACOPOS servo drives are only allowed to be operated directly on grounded, three-phase industrial mains (TN, TT systems). When using the servo drives in living areas, shops and small businesses, additional filtering measures must be implemented by the user.**

> **Danger!**
>
> **Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!**

Warning!

ACOPOS servo drives are suitable for power mains which can provide a maximum short circuit current (SCCR) of 10000 A_{eff} at a maximum of 528 V_{eff}.

1.1.2 Supply voltage range

The supply voltage range permitted for ACOPOS servo drives can be found in the following table:

	8V1010.5xx-2 8V1016.5xx-2	8V1010.0xx-2 8V1016.0xx-2	8V1022.0xx-2 8V1045.0xx-2 8V1090.0xx-2	8V1180.0xx-2 8V1320.0xx-2	8V1640.0xx-2 8V128M.0xx-2
Mains input voltage	3 x 110 VAC to 230 VAC ± 10% or 1 x 110 VAC to 230 VAC ± 10%	3 x 400 VAC to 480 VAC ± 10%			

Table 98: Supply voltage range for ACOPOS servo drives

Respective intermediate transformers must be used for other supply voltages. With grounded power mains, autotransformers can also be used to adjust the voltage. Neutral does not have to be connected for this type of transformer.

Warning!

The apparent power from the transformer (intermediate transformer, autotransformer) must be at least 25% of the continuous power from the ACOPOSmulti power supply module being used. Otherwise, parasitic leakage inductances can cause excessive heating of the transformer. In extreme cases, this can cause critical damage to the transformer!

1.1 Protective ground connection (PE)

The following information concerning the protective ground connection corresponds to EN 61800-5-1, Item 4.2.5.4 "Connection elements for the protective ground conductor" and must be followed.

Wire cross section

The wire cross section for the protective ground conductor is oriented to the external conductors and must be selected according to the following table:

Wire cross section for external line A [mm²]	Minimum wire cross section for protective ground connection A_{PE} [mm²] 1)
A ≤ 16	A
16 < A ≤ 35	16
35 < A	A / 2

Table 99: Selection of the protective ground conductor cross section

1) Any protective ground conductor that is not part of a cable must have a minimum wire cross section of 4 mm².

Increased discharge current

ACOPOS servo drives are devices with increased discharge current (larger than 3.5 mA AC or 10 mA DC). Therefore a fixed (immobile) protective ground connection is required on the servo drives.

The following conditions must be fulfilled, depending on the ACOPOS device being used:

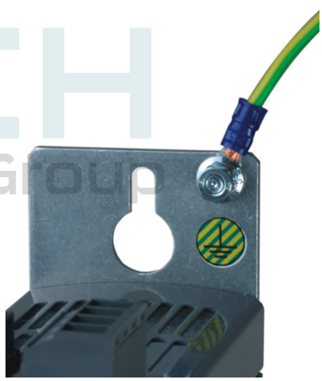
ACOPOS	Condition	Figure
1010 1016	In addition to the connection of the first protective ground conductor on terminal X3 / PE, a second protective ground conductor with the same cross section must be connected on the designated terminal (M5 threaded bolt).	

Table 100: Protective ground conditions according to ACOPOS device

ACOPOS	Condition	Figure
1022 1045 1090	In addition to the connection of the first protective ground conductor on terminal X3 / PE, a second protective ground conductor with the same cross section must be connected on the designated terminal (M5 threaded bolt).	
1180 1320	In addition to the connection of the first protective ground conductor on terminal X3 / PE, a second protective ground conductor with the same cross section must be connected on the designated terminal (M5 threaded bolt).	
1640 128M	The cross section of the protective ground conductor connected to terminal X3 / PE must be at least 10 mm² Cu.	

Table 100: Protective ground conditions according to ACOPOS device (cont.)

1.2 Dimensioning

In general, dimensioning the power mains, the overcurrent protection and the line contactors depends on the structure of the power mains connection. The ACOPOS servo drives can be connected individually (each drive has separate overcurrent protection and, if necessary, a separate line contactor) or together in groups.

1.2.1 Individual ACOPOS Power Mains Connections

The structure of an individual power mains connection with line contactor and circuit breaker can be seen in the following diagram:

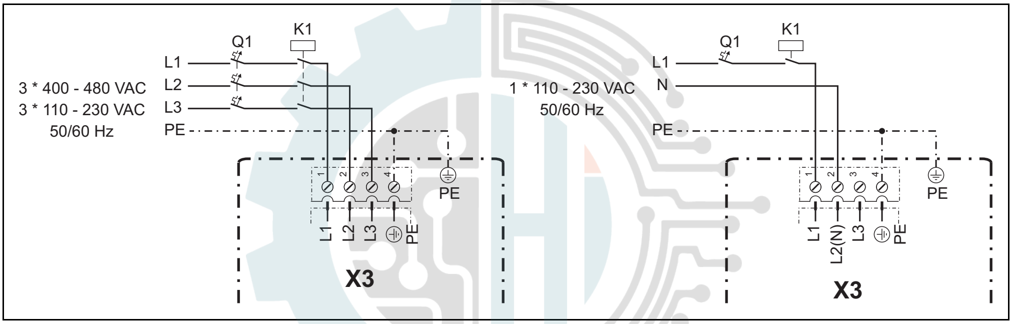


Figure 41: Circuit diagram for ACOPOS X3, individual power mains connection

Dimensioning the Power Mains and Overcurrent Protection

Information:

When choosing a suitable fuse, the user must also account for properties such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. Furthermore, the fuse that is selected must also be able to handle application-specific aspects (e.g. overcurrents that occur in acceleration cycles).

The cross section of the power mains and the rated current for overcurrent protection should be determined based on the average current load to be expected.

The average current load to be expected can be calculated as follows:

$$I_{Mains}[A] = \frac{S[VA]}{\sqrt{3} \cdot U_{Mains}[V]}$$

The apparent power S can be estimated as follows: 1)

$$S[VA] = M_{eff}[Nm] \cdot k \cdot \frac{2 \cdot \pi \cdot n_{aver}[min^{-1}]}{60}$$

The following estimate is valid for linear motors: 1)

$$S[VA] = F_{eff}[N] \cdot k \cdot v_{aver}[m/s]$$

The constant k for each of the various ACOPOS servo drives can be taken from the following table:

Name	ACOPOS								
	1010	1016	1022	1045	1090	1180	1320	1640	128M
Constant k	3		2.8	2.4		2.1	1.9	1.7	1.5

Table 101: Constant k

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183 so that the maximum current load for the cable cross section selected is greater than or equal to the calculated current load.

$$I_Z \geq I_{Mains}$$

The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (see table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183).

$$I_B \leq I_Z$$

1) If information concerning load torque, inertia and friction are available, the effective torque or the effective power is calculated according to the following formulas:

$$M_{eff}[Nm] = \sqrt{\frac{1}{T_{Cycle}[s]} \cdot \sum_i M_i[Nm]^2 \cdot t_i[s]} \qquad F_{eff}[N] = \sqrt{\frac{1}{T_{Cycle}[s]} \cdot \sum_i F_i[N]^2 \cdot t_i[s]}$$

To calculate n_{aver} or v_{aver}, information concerning the positioning cycle must be available.
n_{aver} or v_{aver} is calculated using the following formulas:

$$n_{aver}[min^{-1}] = \frac{1}{T_{Cycle}[s]} \cdot \sum_i n_i[min^{-1}] \cdot t_i[s] \qquad v_{aver}[m/s] = \frac{1}{T_{Cycle}[s]} \cdot \sum_i v_i[m/s] \cdot t_i[s]$$

If the values n_{aver} or v_{aver} become very low, this can cause imprecise results in some situations.
In this case, you should contact B&R regarding the use of different calculation formulas or methods.

The following table shows the maximum current load of PVC insulated three-phase cables (three current-carrying wires) according to IEC 60204-1 at 40°C ambient temperature [1] and 70°C maximum conductor temperature (maximum current load for installation type F and cross sections greater than 35 mm², IEC 60364-5-523 is used for installation types B1 and B2).

Line cross section [mm²]	Maximum current load for the cable cross section I_Z / rated current for the overcurrent protection I_R [A] depending on the type of installation				
	Three individual wires in conduit or cable duct B1	Three-phase cable in conduit or cable duct B2	Three-phase cable on walls C	Three-phase cable in a cable tray E	Three individual wires in a cable tray F
1.5	13.5 / 13	12.2 / 10	15.2 / 13	16.1 / 16	---
2.5	18.3 / 16	16.5 /16	21 / 20	22 / 20	---
4	25 / 25	23 / 20	28 / 25	30 / 25	---
6	32 / 32	29 / 25	36 / 32	37 / 32	---
10	44 / 32	40 / 32	50 / 50	52 / 50	---
16	60 / 50	53 / 50	66 / 63	70 / 63	---
25	77 / 63	67 / 63	84 / 80	88 / 80	96 / 80
35	97 / 80	83 / 80	104 / 100	114 / 100	119 / 100
50	117 / 100	103 / 100	123 / 100	123 / 100	145 / 125
70	149 / 125	130 / 125	155 / 125	155 / 125	188 / 160
95	180 / 160	156 / 125	192 / 160	192 / 160	230 / 200

Table 102: Maximum current load for PVC insulated three-phase cables or individual wires

When determining the cross section for the power mains, make sure that the cross section selected is within the range that can be used with power mains terminal X3 (see section 1.4 "Overview of clampable diameter ranges", on page 236).

Overcurrent protection in the form of a circuit breaker or a fuse is required. Circuit breakers (time lag) with type C tripping characteristics (according to IEC 60898) or fuses (time lag) with type gG tripping characteristics (according to IEC 60269-1) are to be used. [2]

1) The maximum current load value in IEC 60204-1 is for an ambient temperature of 40°C. This reference temperature is 30°C in IEC 60364-5-523. The values in table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183from IEC 60364-5-523 are also converted for use at 40°C with the factor k_{Temp} = 0.87 specified in the standard.
With the specified maximum current load, a reduction factor for groups of cables and individual wires is not taken into consideration. If necessary, they must be taken from the corresponding standards and included in the calculation.

2) Circuit breakers are available on the market with rated currents from 6 A to 63 A.
Outside of this range, fuses must be used.

Section 4 Dimensioning

North America:

Class J fuses according to UL Standard 248-8 can be used (for example fuses of type AJTxx from Ferraz Shawmut (www.ferrazshawmut.com) or type LPJ-xxSP from Bussmann (www.bussmann.com), where xx is the rated current for the respective fuse).

As an alternative. class CC fuses according to UL Standard 248-4 can be used. For example, type LP-CC-xx fuses from Bussmann (www.bussmann.com), where xx is the rated current of the respective fuse; fuses of type LP-CC-xx are available up to a rated current of 30 A.

The fuse must have the following tripping characteristics:

Minimum tripping time [s]	Rated current for the fuse at an average expected current load of			
	12 ... 35 A	50 ... 80 A	100 ... 125 A	160 A
0.2	Approx. 5.1 * I_B	Approx. 4.5 * I_B	Approx. 3.6 * I_B	Approx. 4.0 * I_B
4	Approx. 3.7 * I_B	Approx. 3.3 * I_B	Approx. 2.8 * I_B	Approx. 3.2 * I_B
10	Approx. 2.9 * I_B	Approx. 2.5 * I_B	Approx. 2.0 * I_B	Approx. 2.3 * I_B
240	Approx. 1.7 * I_B	Approx. 1.7 * I_B	Approx. 1.6 * I_B	Approx. 1.8 * I_B

Table 103: Tripping characteristics of the fuse for the power mains connection

Dimensioning the Line Contactor

The rated current of the line contactor is oriented to the overcurrent protection for the power mains connection. The line contactor is set up so that nominal operating current specified by the manufacturer of the line contactor for category AC-1 according to EN 60947-4-1 is approximately 1.3 times the rated current of the overcurrent protection.

1.2 Implementing ACOPOS Power Mains Connections for Drive Groups

The structure of the power mains connection for a drive group with line contactor and circuit breaker can be seen in the following diagram:

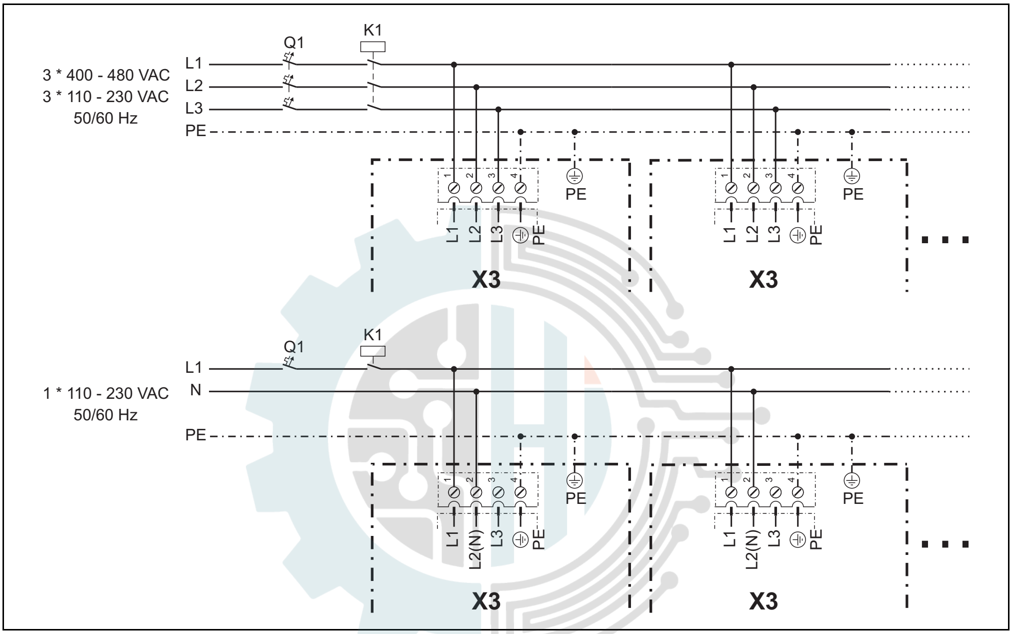


Figure 42: Circuit diagram for ACOPOS X3, power mains connection for a drive group

Section 4
Dimensioning

Dimensioning the Power Mains and Overcurrent Protection

Information:

When choosing a suitable fuse, the user must also account for properties such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. Furthermore, the fuse that is selected must also be able to handle application-specific aspects (e.g. overcurrents that occur in acceleration cycles).

The cross section of the distribution point and all power mains connections are chosen according to table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183 so that the maximum current load for the cable cross section selected [1] is greater than or equal to the sum of the calculated mains current.

$$I_Z \geq \sum I_{Mains}$$

The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (see table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183).

$$I_B \leq I_Z$$

Dimensioning the Line Contactor

The rated current of a common line contactor is oriented to the overcurrent protection for the power mains connection. The line contactor is set up so that nominal operating current specified by the manufacturer of the line contactor for category AC-1 is approximately 1.3 times the rated current of the overcurrent protection.

1) When determining a common cross section for several drives (especially with different sized ACOPOS modules), make sure that the cross section selected is within the range that can be used with the power mains terminals (see section 1.4 "Overview of clampable diameter ranges", on page 236).

1.3 Fault current protection

Fault current protection (RCD - residual current-operated protective device) can be used with ACOPOS servo drives. However the following points must be noted:

ACOPOS servo drives have a power rectifier. If a short-circuit to the frame occurs, a flat DC fault current can be created which prevents an AC current or pulse current sensitive RCD (type A or AC) from being activated, therefore canceling the protective function for all connected devices.

Danger!

If used for protection during direct or indirect contact of the fault current protection (RCD), only a type B RCD (AC-DC sensitive, according to IEC 60755) can be used for the ACOPOS power mains connection. Otherwise additional protective measures must be used, such as neutralization or isolation from the power mains using an isolation transformer.

1.3.1 Rated fault current

On ACOPOS servo drives, fault current protection with a rated fault current [1] of 100 mA can be used. However, errors can occur:

- When connecting servo drives to the power mains (short-term single-phase or two-phase operation because of contact chatter on the line contactor).
- Because of high frequency discharge currents occurring during operation when using long motor cables.
- Because of an extreme unbalance factor for the three-phase system.

1) The rated fault current listed by the manufacturer are maximum values which will definitely trip the protective device. Normally, the protective device is tripped at approximately 60% of the rated fault current.

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1.3.2 Estimating the Discharge Current

Depending on the connection of the ACOPOS servo drive, different discharge currents flow to ground on the protective ground conductor (PE):

Single-phase or two-phase operation (as intermediate state when switching on the line contactor):

$$I_A[A] = \frac{U_{Mains}[V] \cdot 2 \cdot \pi \cdot f_{Mains}[Hz] \cdot C_D[F]}{\sqrt{3}}$$

Single-phase operation with neutral line:

$$I_A[A] = \frac{U_{Mains}[V] \cdot 2 \cdot \pi \cdot f_{Mains}[Hz] \cdot C_D[F]}{2 \cdot \sqrt{3}}$$

The discharge capacitance C_D the various ACOPOS servo drives can be taken from the following table:

Name	ACOPOS								
	1010.0xx-2 1016.0xx-2	1010.5xx-2 1016.5xx-2	1022.0xx-2	1045.0xx-2	1090.0xx-2	1180.0xx-2	1320.0xx-2	1640.0xx-2	128M.0xx-2
Discharge capacitance C_D	550 nF	330 nF	660 nF			3.1 µF		5.4 µF	

Table 104: Discharge capacitance C_D

1.3.3 Manufacturer Used

For example, the AC-DC sensitive, 4-pole fault current protective device F 804 from ABB (fault current: 300 mA; rated current: 63 A) can be used. Using this fault current protective device, approximately 5 ACOPOS 1022 (or 1045, 1090) can be connected in parallel.

2 DC bus

2.1 General information

With ACOPOS servo drives, it is possible to connect several servo drives via the DC bus. This connection allows compensation of braking and drive energy of several axes or the distribution of braking energy to several braking resistors.

The connection is made using terminals X2 / +DC and -DC. The structure of the DC bus connections can be seen in the following diagram:

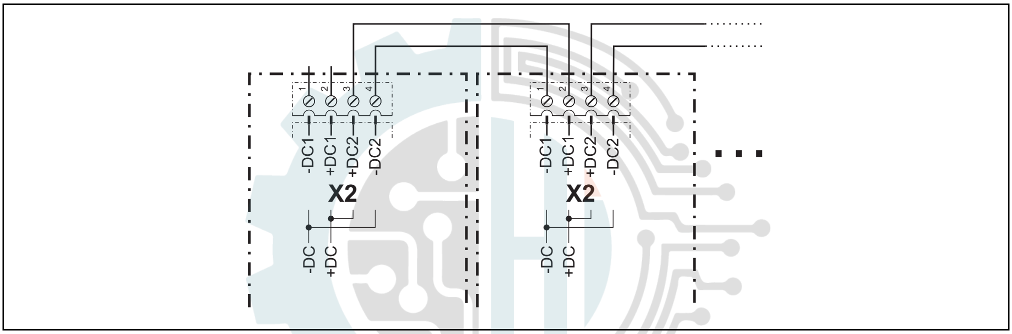


Figure 43: ACOPOS X2 circuit diagram, DC bus connections

Caution!

To prevent excessively high discharge currents from flowing over the individual servo drives, make sure that smaller servo drives are not connected between two larger servo drives.

Warning!

Its only permitted to link DC buses for ACOPOS servo drives with the same supply voltage range (see table 98 "Supply voltage range for ACOPOS servo drives", on page 178).

Therefore, the DC buses for ACOPOS servo drives 8Vxxxx.5xx-2 and 8Vxxxx.0xx-2 are not allowed to be linked! For this reason, the X2 plugs for ACOPOS servo drives 8Vxxxx.5xx-2 and 8Vxxxx.0xx-2 are coded differently.

All ACOPOS servo drives 8Vxxxx.5xx-2 with a single-phase supply that should have their DC buses connected together must be connected to the same phase! If this is not done, the DC bus voltage increases to a level that is not permitted; this caused the devices to be destroyed!

2.2 Wiring

The DC bus connections on the ACOPOS servo drives **do not** have short circuit and ground fault protection and are not protected against reverse polarity. Therefore the DC bus connections must be wired correctly.

> ## Caution!
>
> **The DC bus connections must be wired correctly (no short circuits, ground faults or reverse polarity).**

A suitable measure to ensure that the wiring is secure against short circuits and ground faults [1)] is the use of corresponding cabling. Special rubber-insulated wires with increased resistance to heat (90°C) of types

- NSGAÖU
- NSGAFÖU
- NSGAFCMÖU

with a nominal voltage U_0/U of at least 1.7/3 kV are considered to be secure against short circuits and ground faults in switchgear and distribution systems up to 1000 V [2)] .

2.3 Equal Distribution of the Applied Power via the Power Rectifiers

When creating a DC bus connection between several servo drives, it is possible that the parallel connection of the power rectifiers causes incorrect distribution of the applied power.

> ## Warning!
>
> **Distribution of the supplied power that is not permitted can occur both during operation and when booting the ACOPOS servo drives!**

To prevent this undesired effect, appropriately dimensioned balancing resistors are integrated in the ACOPOS servo drives.

1) Cabling e.g. according to DIN VDE 0100, part 200 "Electrical systems for buildings - terms", item A.7.6.
2) See e.g. DIN VDE 0298, part 3 "Use of cables and insulated wires for high-voltage systems", item 9.2.8.

The following rules must be observed so that the effect of these balancing resistors is cancelled out:

- The length of the DC bus wiring is not allowed to exceed a total length of 3 m and must be within a single switching cabinet.
- Dimensioning the cross section of the ACOPOS servo drive power mains must be done according to section "Dimensioning the Power Mains and Overcurrent Protection", on page 181.
- The cross section of the DC bus wiring [1] on the respective ACOPOS servo drives must be less than or equal to the cross section of the servo drive power mains.
- The selected diameter must be within maximum clampable diameter range for the DC bus connection terminal X2 (see section 1.4 "Overview of clampable diameter ranges", on page 236).

2.4 Equal Distribution of the Brake Power on the Braking Resistors

The braking resistors integrated in the ACOPOS servo drives as well as braking resistors which can be connected externally are controlled using a specially developed procedure. This guarantees that the brake power is optimally and equally distributed on the braking resistors when a DC bus connection is made between several units.

When using the integrated braking resistors, additional configuration is not required.
When using external braking resistors, the corresponding parameters must be defined (see section 4.4 "Setting brake resistor parameters", on page 210).

1) The cross section of the individual segments of the DC bus wiring must be dimensioned for the thermal equivalent effective value of the respective compensation current. If information concerning the flow of the compensation current is available, calculate the thermal equivalent effective value of the compensation current using

$$I_q[A] = \sqrt{\frac{1}{T_{Cycle}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

The cross section of the DC bus connection should then be selected as described in section 1.4 "Overview of clampable diameter ranges", on page 236, so that the maximum current load of the cable cross section is greater than or equal to the thermal equivalent effective value of the compensation current ($I_Z \geq I_q$).

2.5 Connection of external DC bus power supplies

The ACOPOS servo drives recognize a power failure and can immediately initiate active braking of the motor. The brake energy that occurs when braking is returned to the DC bus and the DC bus power supply can use it to create the 24 VDC supply voltage. In this way, the ACOPOS servo drives as well as encoders, sensors and possible safety circuit can be supplied with 24 VDC while braking. [1)]

An external DC bus power supply must be used for ACOPOS servo drives 8V1010 to 8V1090. A DC bus power supply is integrated in ACOPOS servo drives 8V1180 to 8V128M. [2)]

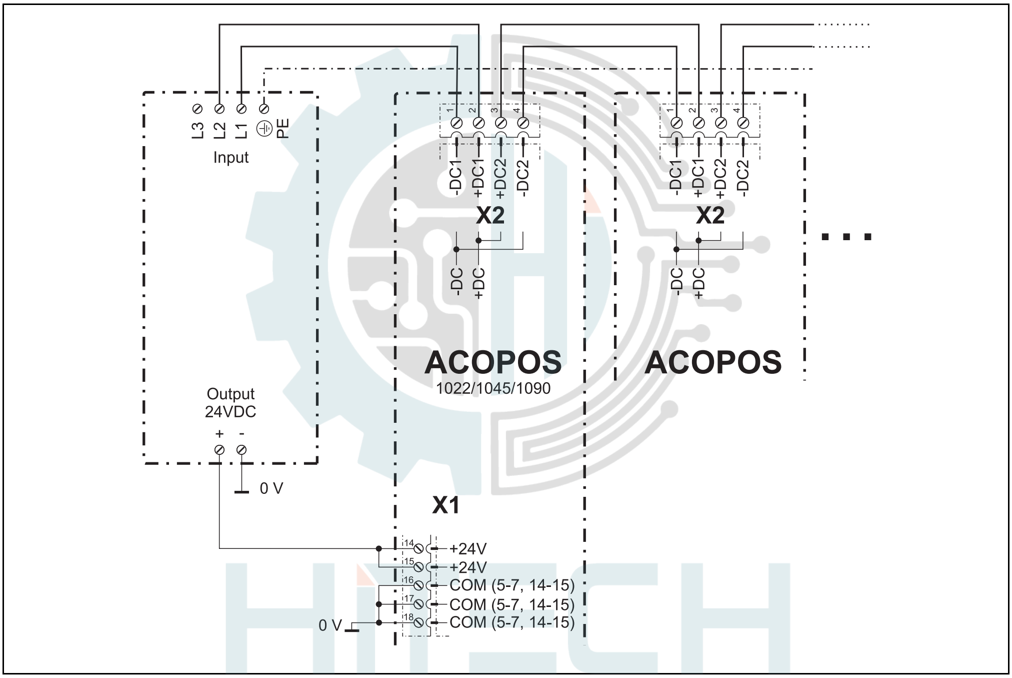


Figure 44: DC bus power supply for ACOPOS servo drives

1) ATTENTION: In some applications, there is not enough brake energy provided to guarantee that the 24 VDC supply voltage remains active until the system is stopped.

2) The SL20.310 DC bus power supply from PULS can be used (www.pulspower.com).

3 Motor connection

On B&R motors, the power connections, the connections for the holding brake and the connections for the motor temperature sensor are all made using the same motor plug.
On the servo drive, the motor connection is made using terminals X5 / U, V, W and PE as well as terminals X4b / B+, B-, T+ and T-. The motor connection must be shielded correctly (see section 1.1 "Electromagnetic compatibility of the installation", on page 227).

The structure of the motor connection can be seen in the following diagram:

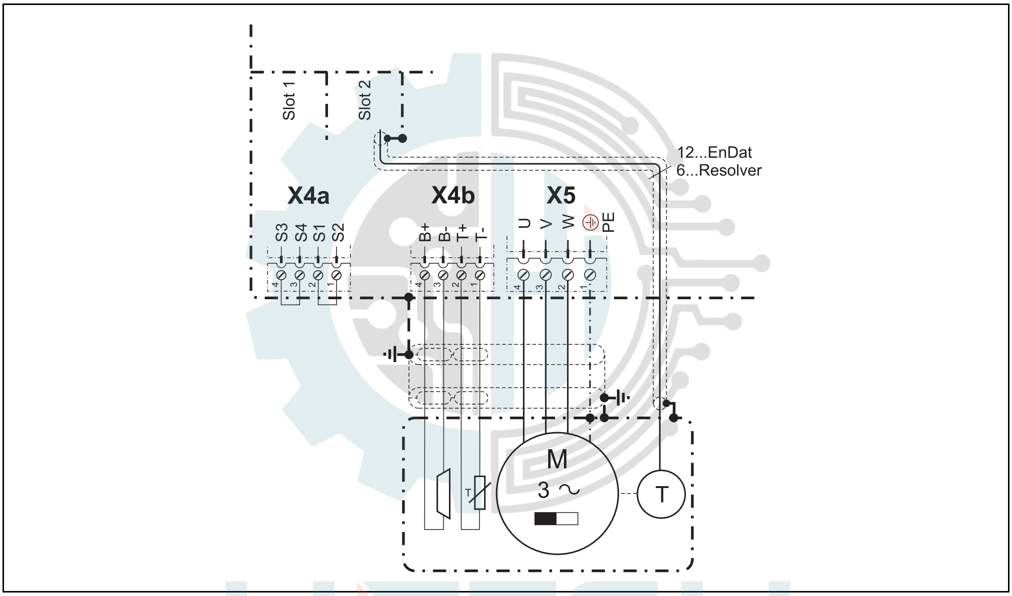


Figure 45: ACOPOS X4/X5 circuit diagram, motor connection

The cross section of the motor cable must be dimensioned for the thermal equivalent effective value of the motor current. 1)

The cross section of the motor cable is chosen for B&R motor cables according to the following table so that the maximum current load for the cable cross section selected is greater than or equal to the thermal equivalent effective value of the motor current:

$$I_Z \geq I_q$$

1) If information concerning load torque, inertia and friction are available, the thermal equivalent effective value for the motor current of the motor used is calculated as follows:

$$I_q[A] = \sqrt{\frac{1}{T_{Cycle}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

The following table shows the maximum current load for special insulated three-phase cables according to IEC 60364-5-523 at 40°C ambient temperature [1] and 90°C maximum cable temperature.

Line cross section [mm²]	Maximum current load on the line I_Z [A] depending on type of installation		
	Three-phase cable in conduit or cable duct B2	Three-phase cable on walls C	Three-phase cable in a cable tray E
1.5	17.8	20	20.9
4	31.9 [1]	36.4 [1]	38.2 [1]
10	54.6	64.6	68.3
35	116.5	133.8	143.8

Table 105: Maximum current load for special insulated three-phase cables

1) The plug pins on the assembled B&R motor cable 8CMxxx.12-3 can only handle a max. load of 30 A (also see section 5.2.2 "Technical data - 8PM001.00-1 and 8PM002.00-1", on page 150).

When determining the cross section for the motor cable, make sure that the cross section selected is within the range that can be used with motor connection terminal X5 (see section 1.4 "Overview of clampable diameter ranges", on page 236).

1) The maximum current load value in IEC 60364-5-523 is for an ambient temperature of 30°C. The values in table 105 "Maximum current load for special insulated three-phase cables", on page 194 are converted for use at 40°C ambient temperature using the factor k_{Temp} = 0.91 given in the standard.
With the specified maximum current load, a reduction factor for groups of cables and individual wires is not taken into consideration. If necessary, they must be taken from the corresponding standards and included in the calculation.

4 Braking resistor

4.1 General information

When braking servo motors, power is returned to the ACOPOS servo drive. This causes the capacitors in the DC bus to be charged to higher voltages. Starting with a DC bus voltage of approx. 800 V, the ACOPOS servo drive links the braking resistor to the DC bus using the brake chopper and converts the braking energy to heat.

For ACOPOS servo drives, braking resistors are integrated for this purpose or external braking resistors can be connected. The different features can be looked up in the following table:

Name	ACOPOS								
	1010	1016	1022	1045	1090	1180	1320	1640	128M
Integrated brake chopper	Yes								
Internal braking resistor Continuous power Maximum Power	Yes 130 W 2 kW 1) 1.9 kW 2)		Yes 130 W 3.5 kW	Yes 200 W 7 kW		Yes 400 W 14 kW		Yes 3) 200 W 7 kW	Yes 3) 240 W 8.5 kW
Connection of External Braking Resistor Possible 4) Continuous power (P_{BRmax}) Maximum power (P_{BRmax}) Minimum braking resistance (R_{Brmin}) Rated current for the built-in fuse ($I_{BRServo}$) 5)	No 6) --- --- --- ---					Yes --- 7) 40 kW 15 Ω 10 A (fast-acting)		Yes --- 7) 250 kW 2.5 Ω 30 A (fast-acting)	

Table 106: Braking resistors for ACOPOS servo drives

1) For 8V1010.0xx-2 and 8V1016.0xx-2.
2) For 8V1010.5xx-2 and 8V1016.5xx-2.
3) The braking resistor integrated in the ACOPOS servo drives 1640 and 128M is dimensioned so that it is possible to brake to a stop (in a typical drive situation).
4) The ACOPOS servo drives are designed so that either the integrated braking resistor **or** the external braking resistor can be activated. Braking with both braking resistors at the same time is not possible.
Switching takes place using the software and is only possible during the ACOPOS servo drive initialization phase:

ParID 398: Setting for an internal / external braking resistor

0 ... internal (default)
1 ... external
5) The fuses used must be fast-acting fuses ∅10 x 38 mm for 600 VAC/VDC.
For example, type KLKD0xx (xx is the rated current of the fuse in amperes e. g. KLKD030) from Littelfuse (www.littelfuse.com) can be used.
6) The braking resistors integrated in ACOPOS servo drives 1010, 1016, 1022, 1045 and 1090 are optimally dimensioned for the respective sizes.
7) Application-dependent (see Section "Determining braking resistor data", on page 199).

4.2 External braking resistor connection

The external braking resistors are connected using terminals X6 / RB+, RB- and PE. The structure of the external braking resistor connection can be seen in the following diagram:

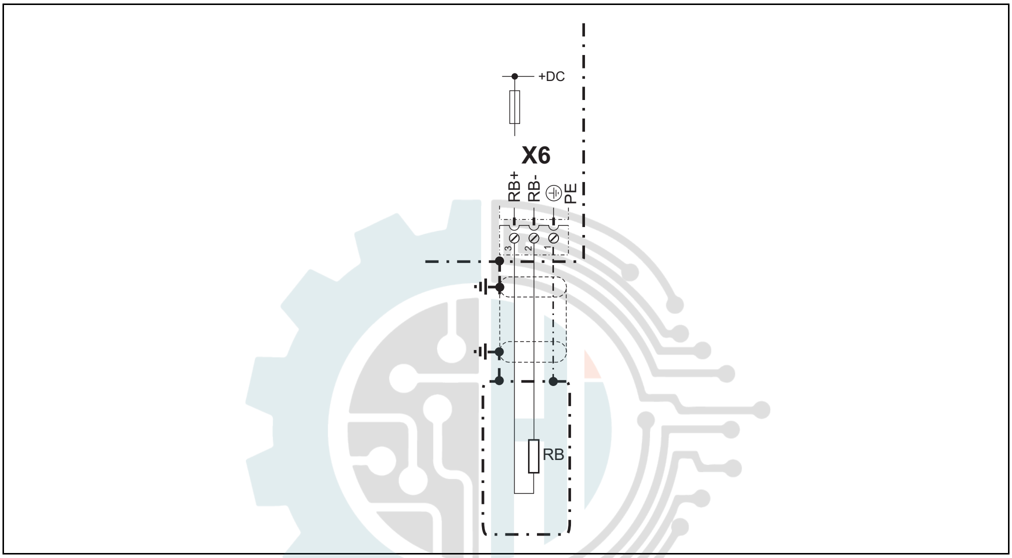


Figure 46: Circuit diagram for ACOPOS X6, external braking resistor on ACOPOS 1180/1320/1640/128M

When determining the diameter [1)] for wiring the external braking resistor, make sure that the selected diameter is within the range that can be used with braking resistor connection terminal X6 (see section 1.4 "Overview of clampable diameter ranges", on page 236).

1) The cross section of the braking resistor cable must be dimensioned for the thermal equivalent effective value of the respective brake current. If information concerning the flow of the brake current is available, calculate the thermal equivalent effective value of the brake current using

$$I_q[A] = \sqrt{\frac{1}{T_{Cycle}[s]} \cdot \sum_i I_i[A]^2 \cdot t_i[s]}$$

The cross section of the braking resistor connection should then be selected as described in table 102 "Maximum current load for PVC insulated three-phase cables or individual wires", on page 183, so that the maximum current load of the cable cross section is greater than or equal to the thermal equivalent effective value of the brake current ($I_Z \geq I_q$).

4.2 Fuse protection

To protect the external braking resistor connection, a fuse is built into the bottom of the ACOPOS servo drive. [1)]

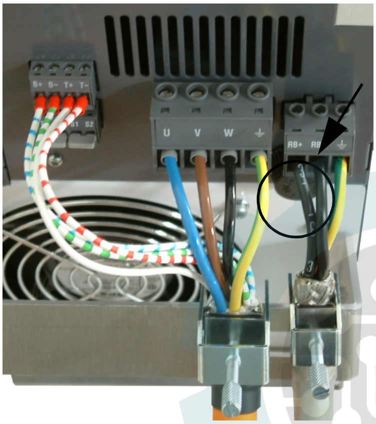
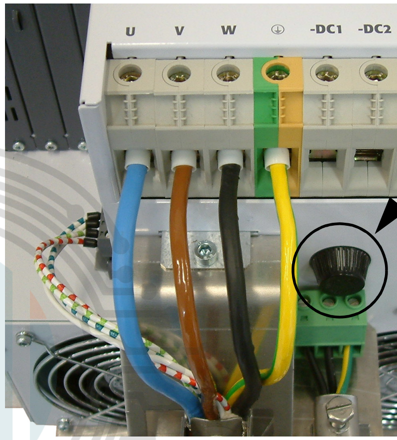
ACOPOS 1180, 1320	ACOPOS 1640, 128M
	

Table 107: The location where the fuse for the external braking resistor connection is installed

The relevant data for the fuses that are to be used can be found on the sticker close to the fuse holder.

1) External braking resistors can only be connected to ACOPOS 8V1180.0xx-2, 8V1320.0xx-2, 8V1640.0xx-2 and 8V128M.0xx-2 devices. The fuses used must be fast-acting fuses ∅10 x 38 mm for 600 VAC/VDC.
For example, type KLKD0xx (xx is the rated current of the fuse in amperes e. g. KLKD030) from Littelfuse (www.littelfuse.com) can be used.

4.3 Sizing the braking resistor

4.3.1 Calculation basics

An external braking resistor can be dimensioned based on a movement and load profile (for each axis in the corresponding application):

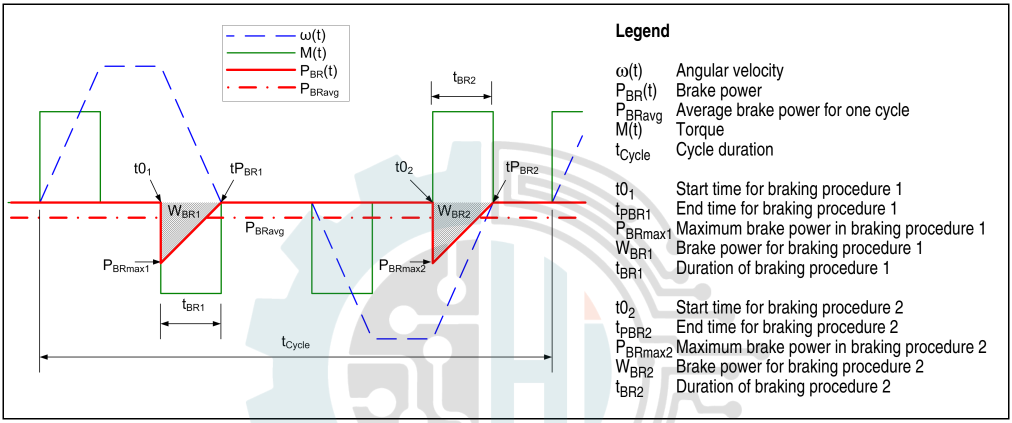


Figure 47: Movement and load profile for one axis in a sample application

<u>Power calculation</u>

$$P(t) = M(t) \cdot \omega(t)$$

All P(t) < 0 will be labeled as brake power ratings $P_{BR}(t)$.

<u>Braking energy per braking procedure (responsible for heating up the braking resistor during a braking procedure)</u>

$$W_{BR_i} = \int_{t0_i}^{tP_{BR_i}} P_{BR_i}(t)dt \qquad P_{BR_i} < 0$$

<u>Braking energy for one cycle (responsible for average heating of the braking resistor)</u>

$$W_{BRtotal} = \sum_{i=1}^{N} W_{BR_i}$$

Maximum brake power within one cycle (determinant variable for selecting the braking resistor value)

$$P_{BRmaxAPPL} = Max(P_{Brmax_i})$$

Average brake power for one cycle (determinant variable for the required continuous power of the braking resistor)

$$P_{BRavgAPPL} = \frac{|W_{BRtotal}|}{t_{Cycle}}$$

Total braking time within one cycle (determinant variable for determining the duty cycle ratio)

$$t = \sum_{0}^{t_{Cycle}} t_{BRi}$$

Determining braking resistor data

The following parameters must be determined for an external braking resistor according to the application:

- Resistor value (R_{BR})
- Rated continuous power (P_{BRN})

Further parameters for external braking resistors can be taken from the manufacturer's data sheet:

- Thermal capacity (c_{th})
- Thermal resistance (R_{th})
- Maximum over-temperature of the braking resistor (ΔT_{BRmax}) 2)
  or absorbed heat up to ΔT_{BRmax} (Q_{BRmax})

Data for B&R 8B0W braking resistors

Model number	Mounting orientation	R_{BR} [Ω]	ΔT_{BRmax} [°C] 1) 2)	R_{th} [K/W]	c_{th} [J/K]	Q_{BRmax} [J] 1) 2)	P_{BRavg} [W] 1) 2)
8B0W0045H000.00x-1	Vertical	50	682	1.517	16.3	10465	450
	Horizontal	50	682	1.897	16.3	10465	360
8B0W0079H000.00x-1	Vertical	33	673	0.852	22.6	14306	790
	Horizontal	33	673	1.065	22.6	14306	632

Table 108: Overview of 8B0W braking resistor data

1) ΔT_{BRmax} can be reduced by application-related limitations (contact protection, warming of neighboring components, maximum warming of the switching cabinet, installation position, etc.). In this case, the values for Q_{BRmax} and P_{BRN} will also change; these must be recalculated for the maximum value of T_{BRmax} permitted in the application!

2) Values for an ambient temperature T_{amb} = 40°C.

Series and parallel connection of braking resistors

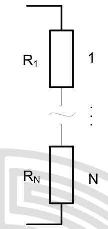
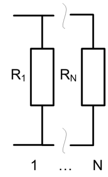
Parameter	Serial connection		Parallel operation	
Resistance value	$R_{ges} = \sum_{i=1}^{N} R_i$		$\frac{1}{R_{ges}} = \sum_{i=1}^{N} \frac{1}{R_i}$	
Thermal resistance	$\frac{1}{R_{thges}} = \sum_{i=1}^{N} \frac{1}{R_{th_i}}$		$\frac{1}{R_{thges}} = \sum_{i=1}^{N} \frac{1}{R_{th_i}}$	
Thermal capacity	$C_{th} = \sum_{i=1}^{N} C_{th_i}$		$C_{th} = \sum_{i=1}^{N} C_{th_i}$	
Max. permissible temperature	$T_{max} = T_{max}$		$T_{max} = T_{max}$	
Absorbed heat up to T_{max}	$Q_{maxges} = \sum_{i=1}^{N} Q_{max_i}$		$Q_{maxges} = \sum_{i=1}^{N} Q_{max_i}$	

Table 109: Series and parallel connection of braking resistors

Maximum heat that can be absorbed by the braking resistor

$$Q_{BRmax} = \Delta T_{BRmax} \cdot c_{th}$$

Average over-temperature in continuous operation

$$\Delta T_{cont} = P_{avg} \cdot R_{th}$$

Temperature increase caused by the braking procedures for one cycle

$$\Delta T_{BR} = \frac{W_{BRtotal}}{c_{th}}$$

Thermal time constant of the braking resistor

$$\tau = R_{th} \cdot c_{th}$$

4.3 Example

Scenario

An axis has the following movement and load profile:

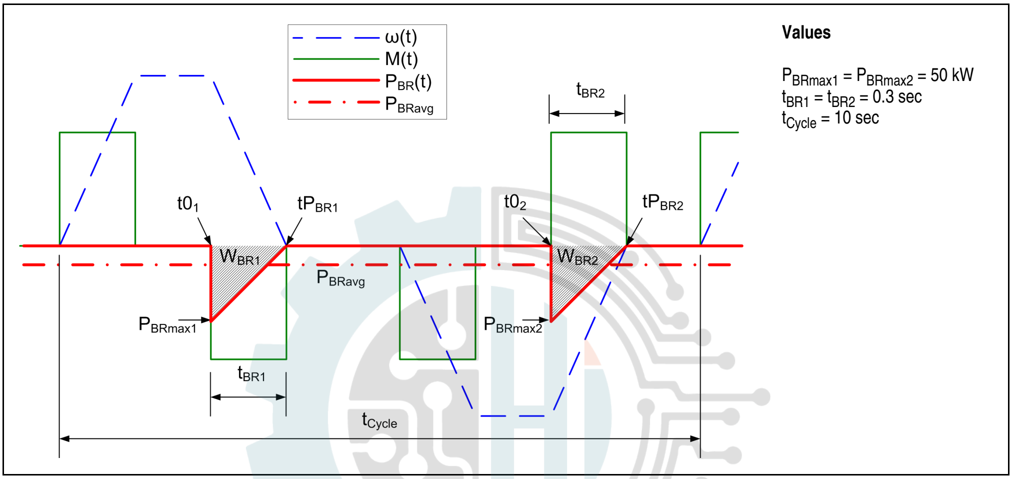


Figure 48: Example: Movement and load profile of one axis

- The ambient temperature is 40°C.
- There are no application-related limitations for the maximum surface temperature of the braking resistor.

Section 4
Dimensioning

Calculation

Step 1) Determine maximum brake power within one cycle

$$P_{BRmaxAPPL} = P_{BRmax1} = P_{BRmax2} = 50kW$$

Step 2) Determine average brake power for one cycle

$$W_{BRall} = \frac{P_{BRmax1} \cdot t_{BR1}}{2} + \frac{P_{BRmax2} \cdot t_{BR2}}{2} = \frac{50kW \cdot 0,3s}{2} + \frac{50kW \cdot 0,3s}{2} = 15kJ$$

$$P_{BRavgAPPL} = \frac{W_{BRtotal}}{t_{Cycle}} = \frac{15kJ}{10s} = 1,5kW$$

Step 3) Determine the right ACOPOS servo drive

The following criteria must be met:

$$P_{maxServo} \geq P_{BRmaxAPPL} \Rightarrow P_{maxServo} \geq 50kW$$

$$I_{BRServo} \geq \frac{\sqrt{P_{BRavgAPPL} \cdot P_{BRmaxAPPL}}}{U_{DC}} \Rightarrow I_{BRServo} \geq \frac{\sqrt{1500W \cdot 50000W}}{800V} \Rightarrow I_{BRServo} \geq 10,83A$$

The ACOPOS servo drive 8V1640.00-2 meets these criteria (see table 106 "Braking resistors for ACOPOS servo drives", on page 195):

- $P_{maxServo} = 250kW \geq 50kW$
- $I_{BRServo} = 30A \geq 10,83A$

Ca[illegible]e selected ACOPOS servo drive conduct the peak power for the required braking du[illegible] each individual braking procedure within the cycle?

This can be checked using the following diagrams:

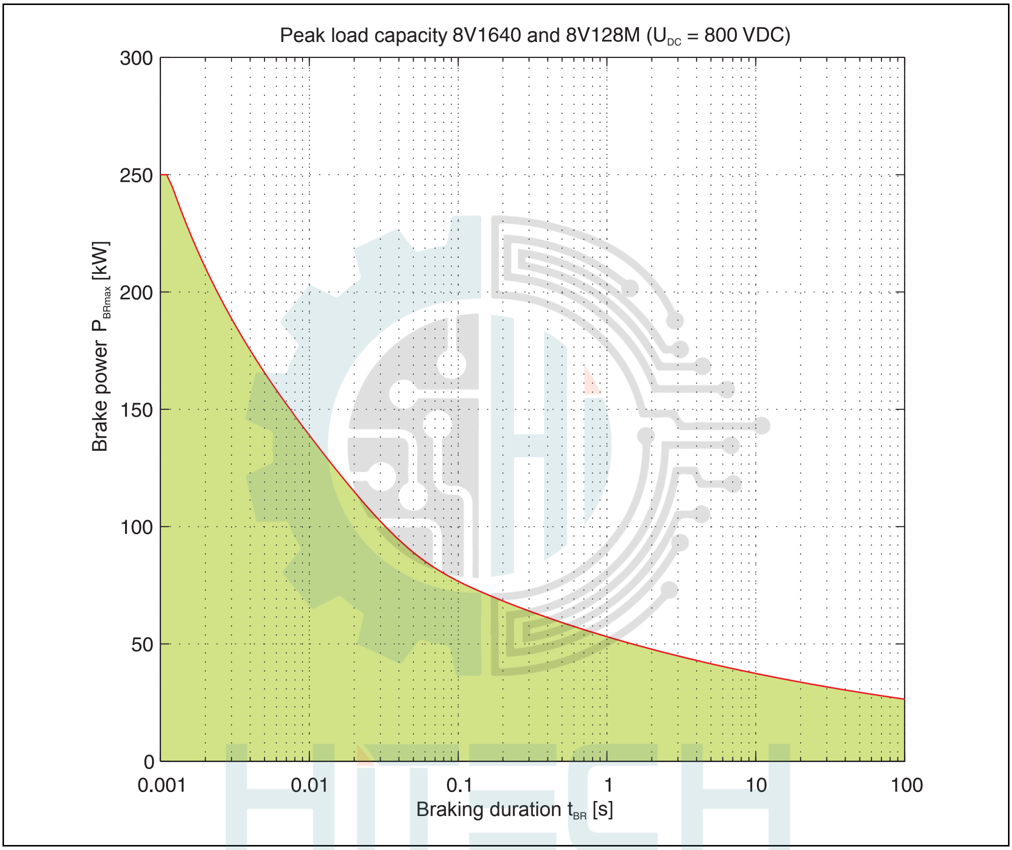


Figure 49: Peak load capacity - 8V1180 / 8V1320

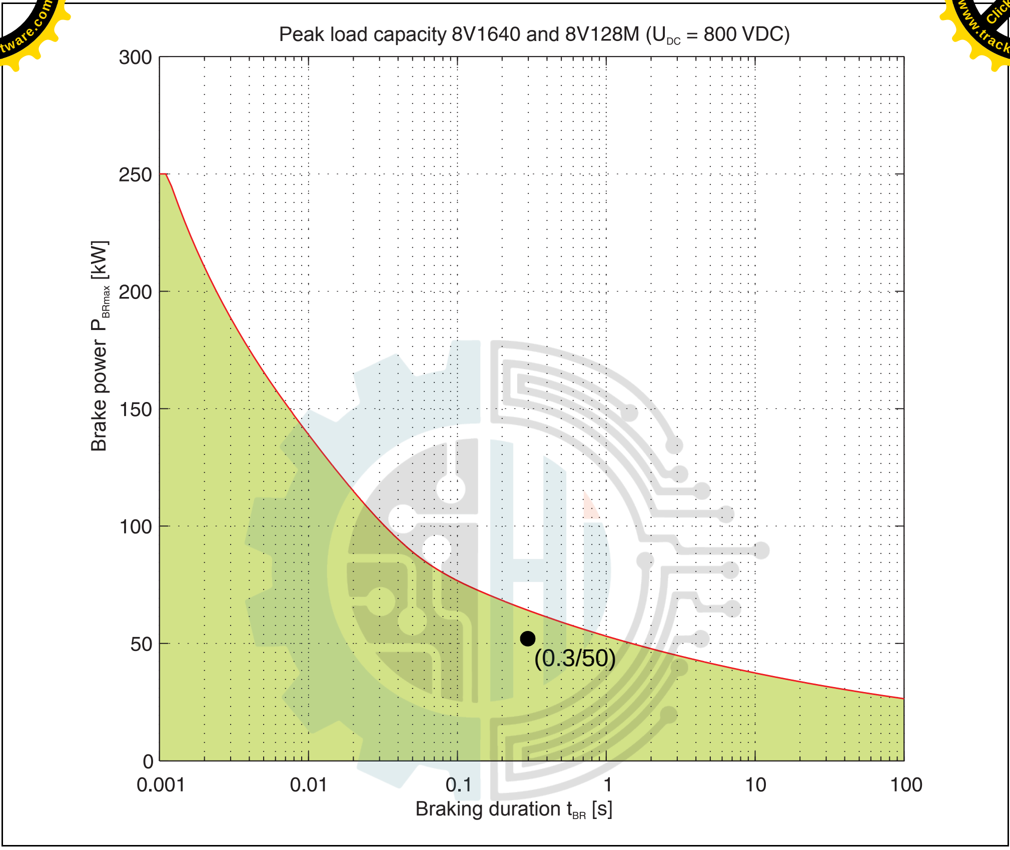


Figure 50: Peak load capacity - 8V1640 / 8V128M

The individual braking procedures within one cycle are entered in the diagram as points with the coordinates (t_{BR}/P_{BRmax}) and must all be within the permissible range (marked green). If this is not the case, then a different ACOPOS servo drive must be selected!

Figure 50 "Peak load capacity - 8V1640 / 8V128M" contains the individual braking procedures from the sample application (t_{BR} = 0.3 sec, P_{BRmax} = 50 kW). These are within the permissible range, which indicates that the selected ACOPOS servo drive is suitable for the peak power of each individual braking procedure in the application.

Step 3) Determine value of the required external braking resistor

Maximum permissible braking resistor for the application:

$$R_{BRmaxAPPL} = \frac{U_{DCmax}^2}{P_{BRmaxAPPL}} = \frac{800V^2}{50000W} = 12,8\Omega$$

The value of the external braking resistor must meet the following criteria:

- $R_{BR} \geq R_{minServo} \Rightarrow R_{BR} \geq 2,5\Omega$
- $R_{BR} \geq \frac{P_{BRavgAPPL}}{I_{BRServo}^2} \Rightarrow R_{BR} \geq \frac{1500W}{30A^2} \Rightarrow R_{BR} \geq 1,67\Omega$
- $R_{BR} \leq R_{BRmaxAPPL} \Rightarrow R_{BR} \leq 12,8\Omega$

Therefore, a braking resistor or a combination of braking resistors must be selected with a resistance value between 2.5 Ω and 12.8 Ω.

Step 4) Select external braking resistor

Caution!

If a resistance less than the minimum resistance is used, the brake chopper built into the device could be destroyed!

Danger!

During braking, voltages up to 900 VDC can occur on the external braking resistor. The external braking resistor must be able to handle these voltages.

Information:

We recommend choosing braking resistor value so that its resistance value R_{BR} is as close as possible to the maximum value permissible for the application R_{BRmax}, in order to keep the current low through the fuse on the ACOPOS servo drive's braking resistor connection.

This can require a parallel or series connection of individual braking resistors.

These braking resistors 8B0W0079H000.001-1 (R_{BR} = 33 Ω) will be connected in parallel to obtain a resistance value that is right for the application (for technical data, see table "Overview of 8B0W braking resistor data", on page 199):

- Resistance value: $\frac{1}{R_{BR}} = \sum_{i=1}^{N} \frac{1}{R_{BR_i}} \Rightarrow R_{BR} = 11\Omega \leq 12{,}8\Omega$
- Thermal capacity: $c_{th} = \sum_{i=1}^{N} c_{th_i} \Rightarrow c_{th} = 77{,}8\,\frac{J}{K}$

The continuous power P_{BRN} and the thermal resistance R_{th} of the selected combination of braking resistors depends on the installation position:

- Horizontal installation:

$$\frac{1}{R_{th}} = \sum_{i=1}^{N} \frac{1}{R_{th_i}} \Rightarrow R_{th} = 0{,}355\frac{K}{W} \qquad P_{BRN} = \sum_{i=1}^{N} P_{BRN} \Rightarrow P_{BRN} = 1896W$$

- Vertical installation:

$$\frac{1}{R_{th}} = \sum_{i=1}^{N} \frac{1}{R_{th_i}} \Rightarrow R_{th} = 0{,}284\frac{K}{W} \qquad P_{BRN} = \sum_{i=1}^{N} P_{BRN} \Rightarrow P_{BRN} = 2370W$$

Information:

The rated continuous power P_{BRN} of a braking resistor depends on the ambient temperature and the braking resistor's maximum permissible temperature.

The braking resistor's rated power will be decreased if, for application reasons, the ambient temperature is increased and/or the braking resistor's maximum permissible temperature is limited (contact protection, warming of neighboring components, maximum warming of the switching cabinet, installation position, etc.)!

Only for ACOPOS servo drives in the DC bus network!

The braking resistors integrated in the ACOPOS servo drives as well as braking resistors which can be connected externally are controlled using a specially developed procedure. This guarantees that the brake power is optimally and equally distributed on the braking resistors when the DC bus connection of ACOPOS servo drives is made between several units.

The following condition must be met for the external braking resistor in order for this occur: $P_{BRN} \geq \frac{U_{DC}^{2}}{30 \cdot R_{BR}}$

This condition must be checked for all permissible installation positions:

- Horizontal installation: $P_{BRN} \geq \frac{U_{DC}^{2}}{30 \cdot R_{BR}} \Rightarrow 1896W \geq \frac{800V^2}{30 \cdot 11\Omega} \Rightarrow 1896W \geq 1939W$ --> Condition not met!
- Vertical installation: $P_{BRN} \geq \frac{U_{DC}^{2}}{30 \cdot R_{BR}} \Rightarrow 2370W \geq \frac{800V^2}{30 \cdot 11\Omega} \Rightarrow 2370W \geq 1939W$ --> Condition met.

Is the rated continuous power P_{BRN} of the selected braking resistor combination sufficient for the application's average brake power $P_{BRavgAPPL}$?

The following condition must be met:

$$P_{BRN} \geq P_{BRavgAPPL}$$

This condition must be checked for all permissible installation positions:

- Horizontal installation:
  $P_{BRN} \geq P_{BRavgAPPL} \Rightarrow 1896W > 1500W$ --> Rated continuous power P_{BRN} is sufficient
- Vertical installation:
  $P_{BRN} \geq P_{BRavgAPPL} \Rightarrow 2370W > 1500W$ --> Rated continuous power P_{BRN} is sufficient

Can the selected braking resistor conduct the incidental braking energy without exceeding the maximum braking resistor temperature for the application?

The following condition must be met for this to happen: $P_{BRN} \geq \frac{W_{Br_i}}{t_i} \cdot k$

The peak load factor k for any braking resistor can be visually determined using the following diagram:

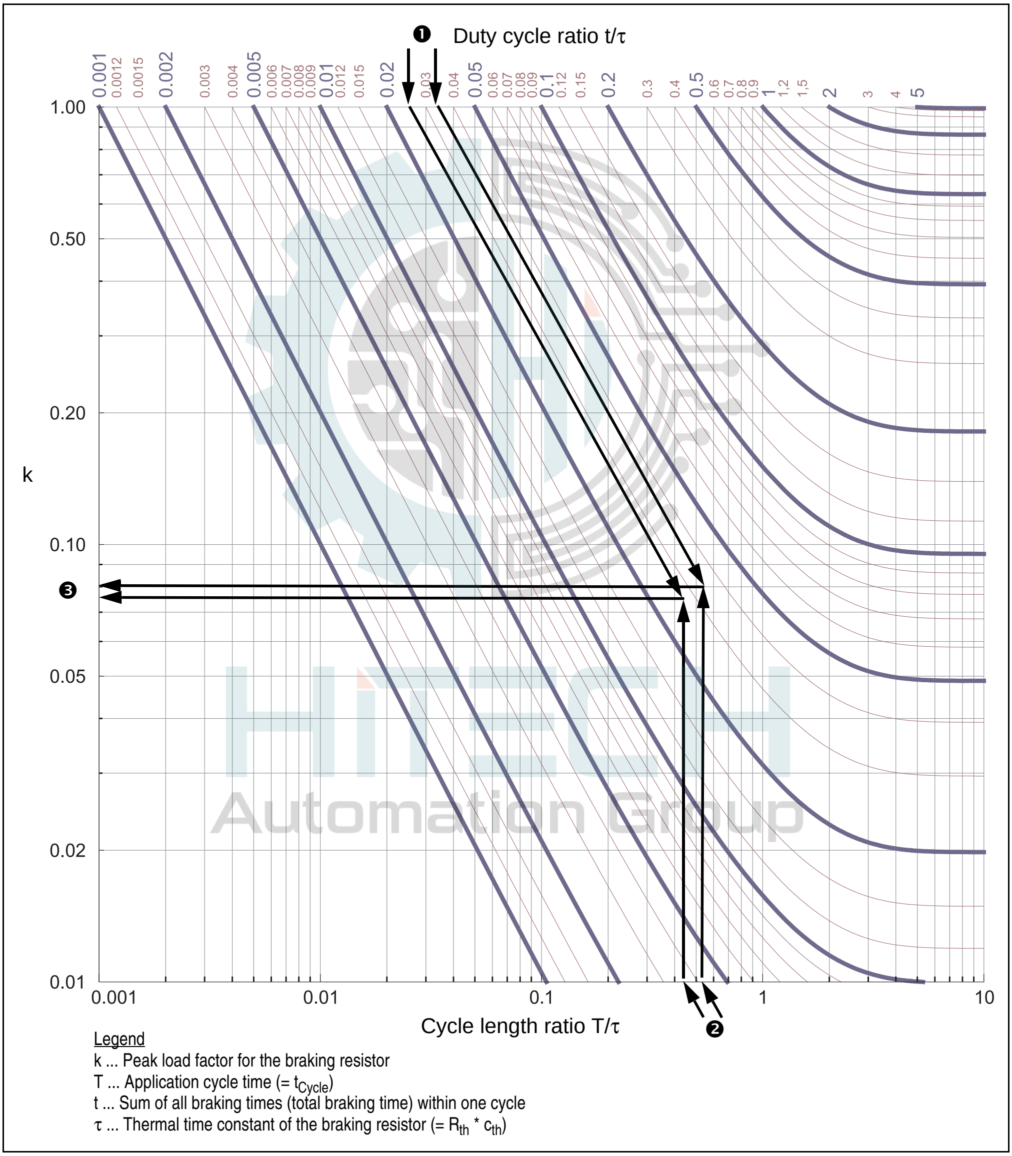


Figure 51: Determining the peak load factor k

❶ Calculation of the duty cycle ratio

- Horizontal installation: $\frac{t}{\tau} = \frac{t_{BR1} + t_{BR2}}{R_{th} \cdot c_{th}} = \frac{0,3 + 0,3}{0,355 \cdot 67,8} = 0,025$
- Vertical installation: $\frac{t}{\tau} = \frac{t_{BR1} + t_{BR2}}{R_{th} \cdot c_{th}} = \frac{0,3 + 0,3}{0,284 \cdot 67,8} = 0,031$

❷ Calculation of the cycle length ratio

- Horizontal installation: $\frac{T}{\tau} = \frac{t_{Cycle}}{R_{th} \cdot c_{th}} = \frac{10}{0,355 \cdot 67,8} = 0,415$
- Vertical installation: $\frac{T}{\tau} = \frac{t_{Cycle}}{R_{th} \cdot c_{th}} = \frac{10}{0,284 \cdot 67,8} = 0,519$

❸ Reading the peak load factor k based on the values from ❶ and ❷ in figure 51 "Determining the peak load factor k"

- Horizontal installation: k = 0.075
- Vertical installation: k = 0.08

This condition must be checked for all permissible installation positions:

- Horizontal installation:

  $$P_{BRN} \geq \frac{W_{BR_i}}{t_i} \cdot k \Rightarrow 1896W \geq \frac{7500J}{0,3s} \cdot 0,075 \Rightarrow 1896W \geq 1875W$$

  --> The rated power P_{BRN} of the braking resistor is barely sufficient for the application - <u>no reserves! Therefore, horizontal installation is not recommended!</u>

- Vertical installation:

  $$P_{BRN} \geq \frac{W_{BR_i}}{t_i} \cdot k \Rightarrow 2370W \geq \frac{7500J}{0,3s} \cdot 0,08 \Rightarrow 2370W \geq 2000W$$

  --> The rated power P_{BRN} of the braking resistor is sufficient for the application

Result

Three B&R braking resistors 8B0W0079H000.001-1 connected in parallel and installed vertically on an ACOPOS servo drive 8V1640.00-2 power supply module meet the requirements of the application.

4.4 Setting brake resistor parameters

The braking resistors, which are integrated in B&R drive systems and which can be connected externally, are controlled by a specially developed procedure. This guarantees that the brake power is optimally and equally distributed on the braking resistors when a DC bus connection is made between several units.

4.4.1 Using the Integrated Braking Resistors

No settings or configuration is required by the user.

4.4.2 Using external braking resistors

When using external braking resistors, the following parameters must be set on the drive system using B&R Automation Studio:

ParID	Name	Formula symbols	Units
10	Ohmic resistance	R_{BR}	[Ω]
11	Maximum over-temperature on the external braking resistor	ΔT_{BRmax}	[°C]
12	Thermal resistance between braking resistor and the environment	R_{th}	[K/W]
13	Heat capacitance of the filament	c_{th}	[Ws/°C]
398	Setting for an internal / external braking resistor 0 ... internal (default) 1 ... external **Information:** **Switching is only possible during the ACOPOSservo drive initialization phase.**	---	---

Table 110: ParIDs for setting external braking resistor parameters

The parameters can normally be found on the data sheet from the respective manufacturer. [1]

1) An example of reliable braking resistors are Σ SIGMA type braking resistors (www.danotherm.com).

The parameters are based on the following thermal equivalent circuit for the external braking resistor:

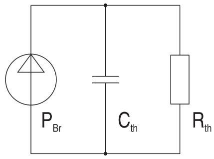


Figure 52: Thermal equivalent circuit for the external braking resistor

If a value for the maximum over-temperature ΔT_{BRmax} of the external braking resistor is not given, it can be determined using the following formula:

$$\Delta T_{BRmax} = P_{BRN} \cdot R_{th}$$

5 Configuration of ACOPOS Servo Drives

The plug-in modules for ACOPOS servo drives allow each servo drive to be individually configured according to the requirements of the application. When putting together plug-in module combinations, the power consumption must be checked. This then results in the current requirements of the ACOPOS servo drive configuration.

5.1 Maximum power output for all slots on the ACOPOS servo drive

The maximum power output for all slots (P_{max}) depends on the size of the ACOPOS servo drive:

Name	ACOPOS								
	1010	1016	1022	1045	1090	1180	1320	1640	128M
P_{max}	Max. 16 W		Max. 22 W						

Table 111: Maximum power output for all slots depending on the ACOPOS servo drive

The total power consumption for all plug-in modules must be less than or equal to the ACOPOS servo drive's maximum power output:

$$\sum P_{Module}[W] \leq P_{max}[W]$$

The power consumption of the individual plug-in modules can be found in table 112 "Power consumption Pmodule of ACOPOS plug-in modules" or the technical data for the modules (see chapter 2 "Technical data"):

Plug-in module	Power consumption P_{module}
8AC110.60-2	Max. 0.7 W
8AC114.60-2	Max. 3 W
8AC120.60-1 E0 ... EnDat single-turn, 512 lines E1 ... EnDat multi-turn, 512 lines E2 ... EnDat single-turn, 32 lines (inductive) E3 ... EnDat multi-turn, 32 lines (inductive) E4 ... EnDat single-turn, 512 lines E5 ... EnDat multi-turn, 512 lines	Depends on the EnDat encoder connected Max. 2.3 W Max. 3.1 W Max. 3.1 W Max. 3.1 W Max. 2.4 W Max. 2.7 W
8AC121.60-1 With encoder current requirement of 0 mA With encoder current requirement of 100 mA With encoder current requirement of 170 mA	 0.35 W 1.4 W 2.1 W
8AC122.60-3	Max. 2.5 W
8AC123.60-1	Max. 7.5 W Depends on the current requirements for the encoder connected 1)
8AC125.60-1	In preparation
8AC130.60-1	Max. 0.8 W

Table 112: Power consumption P_{module} of ACOPOS plug-in modules

Plug-in module	Power consumption P_{module}
8AC131.60-1	Max. 1 W
8AC140.60-2, 8AC140.60-3, 8AC140.61-3	Max. 4.5 W
8AC141.60-2, 8AC141.61-3	Max. 4.5 W

Table 112: Power consumption P_{module} of ACOPOS plug-in modules (cont.)

1) The power consumption of the plug-in module can be approximated using the following formula:

$P_{module}\,[W] = P_{encoder}\,[W] \cdot k + 0.6\,W$

The power consumed by the encoder $P_{Encoder}$ is calculated from the selected encoder supply voltage (5 V / 15 V) and the current required:

$P_{Encoder}\,[W] = U_{Encoder}\,[V] \cdot I_{Encoder}\,[A]$

The following values must be used for k:

k = 1.2 (for 15 V encoder supply)
k = 1.75 (for 5 V encoder supply)

5.2 24 VDC current requirements for the ACOPOS servo drive

The 24 VDC current requirements (I_{24VDC}) must be regarded differently depending on the size of the ACOPOS servo drive.

- The following estimation can always be used for the ACOPOS 1010, 1016, 1022, 1045 and 1090:

$$I_{24VDC}[A] = I_{24VDC_{max}}[A] - \frac{1,1}{24V \cdot k} \cdot \left(P_{max} - \sum P_{Module}[W]\right)$$

- This estimation can also be used for the ACOPOS 1180, 1320, 1640 and 128M as long as a mains input voltage is not applied. As soon as a mains input voltage is applied to these servo drives, the 24 VDC supply voltage is created via the integrated DC bus power supply; the 24 VDC current requirements (I_{24VDC}) is then reduced to 0.

The 24 VDC maximum current requirements for the ACOPOS servo drives can be found in table 113 "Maximum current requirements and constant k" or the technical data for the ACOPOSservo drives (see chapter 2 "Technical data") .

Name	ACOPOS								
	1010	1016	1022	1045	1090	1180	1320	1640	128M
$I_{24VDC_{max}}$	1.47 A		2.5 A			2.8 A		4.6 A	5.7 A
k	0.73		0.64			0.63		0.58	

Table 113: Maximum current requirements and constant k

The 24 VDC total current consumption for the ACOPOS servo drive is made up of the 24 VDC current requirements, the current on the 24 VDC output (only for ACOPOS 1180/1320/1640/128M) and the current for the motor holding brake (if used):

$$I_{24VDC_{total}} = I_{24VDC} + I_{24VDC_{out}} + I_{Br}$$

In this case, make sure that the 24 VDC total current consumption does not exceed the maximum current load for the connection terminals.

6 Dimensioning cooling systems for cooling switching cabinets

6.1 General dimensioning criteria

- What are the environmental conditions where the switching cabinet will be located (ambient temperature T_A, humidity, installation altitude above sea level)?
- How is the air circulation (intake and outlet) where the switching cabinet will be located? Particularly small spaces can become significantly warmer due to the heat dissipation from a cooling device.
- Is the ambient air clean or contaminated with dust, oil, etc?
- Which type of switching cabinet installation is intended according to DIN 57660 part 500?
- Is the switching cabinet open (allowing air flow) or closed (no air flow)?
  Switching cabinets that are closed (no air flow) can only dissipate power loss via the switching cabinet walls.
- What kind of material are the switching cabinet walls made of (specification of the heat transfer coefficient k)?
- What is the switching cabinet's minimum required level of protection according to EN 60529?
- How high is the specified internal temperature T_{Iset} of the switching cabinet?
  This value must be lower than the lowest permissible ambient temperature of all components used in the switching cabinet.
- Is a coolant circulation available where the switching cabinet is located?
- Is the maximum ambient temperature T_{Amax} lower than the desired internal temperature $_{TIset}$ of the switching cabinet?

6.1.1 Basic selection of the cooling system

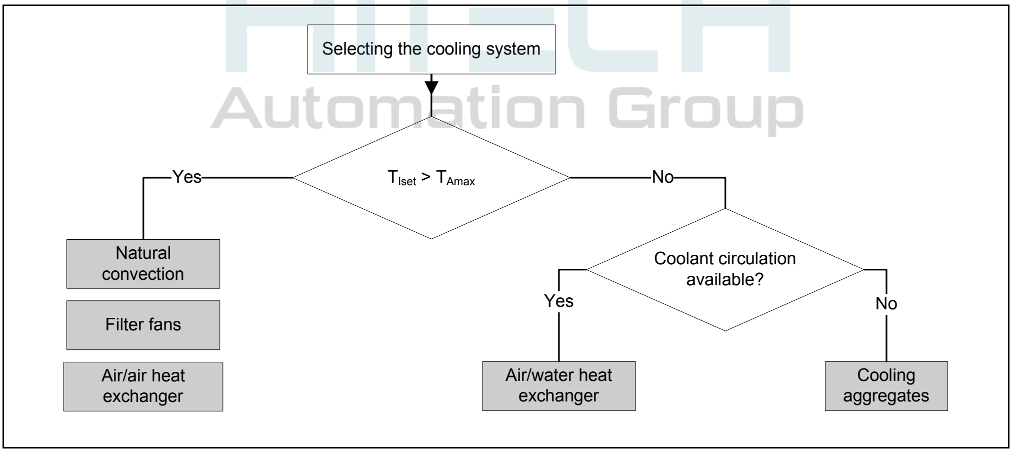


Figure 53: Basic selection of the cooling system

Section 4
Dimensioning

6.2 Natural convection

The power loss is emitted outwards via the switching cabinet walls.

> **Information:**
>
> **The ambient temperature T_A must be considerably lower than the internal temperature T_I of the switching cabinet.**

The heat capacity emitted from the switching cabinet to the environment depends decisively on the location where the switching cabinet is installed: A housing located in an open space can emit more heat to its environment than a housing that is mounted to a wall or built into a recess.

The calculation of the effective switching cabinet surface A depending on the type of switching cabinet installation is determined in DIN VDE 57 660 part 500 or IEC 890 (and VDE 0660 part 890):

Mounting arrangement according to IEC 890	Formula for calculating A [m²] 1)
Detached single cabinet, free-standing on all sides	A = 1.8 x H x (B + T) + 1.4 x B x T
Single cabinet, against a wall	A = 1.4 x W x (H + D) + 1.8 x D x H
First or last cabinet, detached on three sides	A = 1.4 x D x (H + W) + 1.8 x W x H
First or last cabinet, against a wall	A = 1.4 x H x (B + T) + 1.4 x B x T
Middle cabinet, detached on two sides	A = 1.8 x B x H + 1.4 x B x T + T x H
Middle cabinet, against a wall	A = 1.4 x W x (H + D) + D x H
Middle cabinet, against a wall, with covered roof	A = 1.4 x B x H + 0.7 x B x T + T x H

Table 114: Calculation of the effective switching cabinet surface A (DIN VDE 57 660 part 500 or IEC 890)

1) B ... Switching cabinet width [m]; H ... Switching cabinet height [m]; D ... Switching cabinet depth [m].

6.2.1 Dimensioning

1) Determining the power loss Q_V of all devices in the switching cabinet

2) Calculating the effective switching cabinet surface A

3) Calculating the switching cabinet's maximum internal temperature T_{Imax}: 1)

$$T_{Imax} = \frac{Q_V}{k \cdot A} + T_A$$

The switching cabinet's maximum internal temperature T_{Imax} must be lower than the maximum ambient temperature of the components used inside the switching cabinet.

1) k ... Heat transfer coefficient [W/m²K]; for steel panel: k = 5.5
If the power loss Q_V in the switching cabinet is unknown, the actual power loss can be calculated by measuring T_A and T_I:

$$Q_V = A \cdot k \cdot (T_{Imax} - T_A)$$

6.2 Example

Two ACOPOS 8V1320.00-2 units and an ACOPOS 8V1640.00-2 are built into a switching cabinet. The power loss from the braking resistors was determined over one machine cycle and is on average 800 W. The power loss from all other active devices in the switching cabinet is 500 W.

The steel switching cabinet is 1 m wide, 2 m high, 0.5 m deep and is free-standing on all sides. The internal temperature of the switching cabinet should not exceed 40 °C. The ambient temperature is 30 °C.

Now determine whether the power loss occurring in the switching cabinet can be dissipated by its own natural convection.

Determining the power loss of all devices in the switching cabinet

Components in the switching cabinet	Amount	Power loss per component [W]	Total power loss [W]
8V1320.00-2	2	800 1)	1600
8V1640.00-2	1	1600 1)	1600
Braking resistors	---	800 (average value over one machine cycle)	800
All other active devices	---	500	500
		Sum:	**4500**

Table 115: Determining the power loss in the switching cabinet

1) The power loss for ACOPOS servo drives is specified in chapter 2 "Technical data".

Calculating the effective switching cabinet surface

A = 1.8 x H x (W + D) + 1.4 x W x D = 1.8 x 2 x (1+0.5) + 1.4 x 2+0.5 = 6.1 m²

Calculating the switching cabinet's internal temperature T_I

$$T_I = \frac{Q_V}{k \cdot A} + T_A = \frac{4500}{5{,}5 \cdot 6{,}1} + 30 = 104\,^\circ\mathrm{C}$$

The switching cabinet's calculated internal temperature considerably exceeds the desired internal temperature of 40 °C. Therefore, the power loss occurring inside the switching cabinet cannot be dissipated by its own natural convection. Another method must be used for cooling the switching cabinet.

6.3 Filter fans

Filter fans are also a simple type of switching cabinet cooling. The power loss is dissipated by adding the circulation of ambient air and simultaneously allowing the heated air inside the switching cabinet to flow out.

> ## Information:
>
> **The ambient temperature T_A must be lower than the internal temperature T_I of the switching cabinet in order to use filter fans.**

6.3.1 Dimensioning

1) Determining the power loss Q_V of all devices in the switching cabinet

2) Determining the switching cabinet's maximum internal temperature T_{Imax} at nominal load or from the maximum ambient temperature of the components being used

3) Specification of the switching cabinet's ambient temperature T_A

4) Specification of the switching cabinet's installation altitude h above sea level. Depending on the switching cabinet's installation altitude, a compensation factor f might be required, which can be found in the following table:

Installation altitude h [m]	Compensation factor f [m³K/Wh]
0 ≤ h ≤ 100	3.1
100 < h ≤ 250	3.2
250 < h ≤ 500	3.3
500 < h ≤ 750	3.4
750 < h ≤ 1000	3.5

Table 116: Compensation factor f depending on the switching cabinet's installation altitude

5) Calculation of the air flow volume V:

$$V[m^3/h] = f \cdot \frac{Q_V}{T_{Imax} - T_A}$$

The correct filter fan can now be selected based on the calculated air flow volume V.

> ## Information:
>
> **The required protection level of the switching cabinet according to EN 60529 must also be taken into consideration when selecting a filter fan.**

6.3 Example

Two ACOPOS 8V1320.00-2 units and an ACOPOS 8V1640.00-2 are built into a switching cabinet. The power loss from the braking resistors was determined over one machine cycle and is on average 800 W. The power loss from all other active devices in the switching cabinet is 500 W.

The internal temperature of the switching cabinet should not exceed 40 °C. The ambient temperature is 30 °C. The switching cabinet should be installed at 800 m above sea level.

The right filter fan must be selected for this switching cabinet.

Determining the power loss of all devices in the switching cabinet

Components in the switching cabinet	Amount	Power loss per component [W]	Total power loss [W]
8V1320.00-2	2	800 [1)]	1600
8V1640.00-2	1	1600 [1)]	1600
Braking resistors	---	800 (average value over one machine cycle)	800
All other active devices	---	500	500
		Sum:	**4500**

Table 117: Determining the power loss in the switching cabinet

1) The power loss for ACOPOS servo drives is specified in chapter 2 "Technical data".

Calculation of the air flow volume V

The compensation factor f can be taken from table 116 "Compensation factor f depending on the switching cabinet's installation altitude", on page 218 and is equal to 3.5 m³K/Wh.

This results in an air flow volume of

$$V = f \cdot \frac{Q_V}{T_{Imax} - T_A} = 3{,}5 \cdot \frac{4500}{40 - 30} = 1575 m^3 / h$$

The correct filter fan can now be selected based on the determined air flow volume.

6.4 Air/air heat exchanger

Air/air heat exchangers dissipate the power loss from the switching cabinet using two hermetically isolated air currents in the opposing current principle. This prevents dust, oil and other (aggressive) materials in the ambient air from penetrating the switching cabinet.

> **Information:**
>
> **The ambient temperature T_A must be lower than the internal temperature T_I of the switching cabinet in order to use air/air heat exchangers.**

6.4.1 Dimensioning

1) Determining the power loss Q_V of all devices in the switching cabinet
2) Determining the switching cabinet's maximum internal temperature T_{Imax} at nominal load or from the maximum ambient temperature of the components being used
3) Specification of the switching cabinet's ambient temperature T_A
4) Calculating the effective switching cabinet surface A
5) Calculating the specific heat capacity q_W: [1)]

$$q_W\left[\frac{W}{K}\right] = \frac{Q_V - (A \cdot (T_{Imax} - T_A) \cdot k)}{T_{Imax} - T_A}$$

The right air/air heat exchanger can be selected based on the specific heat capacity q_W.

> **Information:**
>
> **The required protection level of the switching cabinet according to EN 60529 must also be taken into consideration when selecting an air/air heat exchanger.**

1) k ... Heat transfer coefficient [W/m²K]; for steel panel: k = 5.5

6.4 Example

Two ACOPOS 8V1320.00-2 units and an ACOPOS 8V1640.00-2 are built into a switching cabinet. The power loss from the braking resistors was determined over one machine cycle and is on average 800 W. The power loss from all other active devices in the switching cabinet is 500 W.

The steel switching cabinet is 1 m wide, 2 m high, 0.5 m deep and is free-standing on all sides. The internal temperature of the switching cabinet should not exceed 40 °C. The ambient temperature is 30 °C.

The right air/air heat exchanger must be selected for this switching cabinet.

Determining the power loss of all devices in the switching cabinet

Components in the switching cabinet	Amount	Power loss per component [W]	Total power loss [W]
8V1320.00-2	2	800 1)	1600
8V1640.00-2	1	1600 1)	1600
Braking resistors	---	800 (average value over one machine cycle)	800
All other active devices	---	500	500
		Sum:	**4500**

Table 118: Determining the power loss in the switching cabinet

1) The power loss for ACOPOS servo drives is specified in chapter 2 "Technical data".

Calculating the effective switching cabinet surface

A = 1.8 x H x (W + D) + 1.4 x W x D = 1.8 x 2 x (1 + 0.5) + 1.4 x 2 + 0.5 = 6.1 m²

Calculating the specific heat capacity

The heat transfer coefficient k for steel panels is 5.5 W/m²K.

This results in a specific heat capacity q_W of

$$q_W = \frac{Q_v - (A \cdot (T_{Imax} - T_A) \cdot k)}{T_{Imax} - T_A} = \frac{4500 - (6{,}1 \cdot (40 - 30) \cdot 5{,}5)}{40 - 30} = 416{,}45\ \frac{W}{K}$$

The right air/air heat exchanger can be selected based on the determined specific heat capacity q_W.

6.5 Air/water heat exchanger, cooling aggregates

Air/water heat exchangers and cooling aggregates dissipate the power loss via a cooling circulation system. This prevents dust, oil and other (aggressive) materials in the ambient air from penetrating the switching cabinet.

6.5.1 Dimensioning

1) Determining the power loss Q_v of all devices in the switching cabinet
2) Determining the switching cabinet's maximum internal temperature T_{Imax} at nominal load or from the maximum ambient temperature of the components being used
3) Specification of the switching cabinet's ambient temperature T_A
4) Calculating the effective switching cabinet surface A
5) Calculation of the required cooling capacity Q_E: [1)]

$$Q_E[W] = Q_v - (A \cdot (T_{Imax} - T_A) \cdot k)$$

The right air/water heat exchanger or cooling aggregate can now be selected based on the required cooling capacity Q_E.

Information:

The required protection level of the switching cabinet according to EN 60529 must also be taken into consideration when selecting an air/water heat exchanger or cooling aggregate.

1) k ... Heat transfer coefficient [W/m²K]; for steel panel: k = 5.5

6.5 Example

Scenario

Two ACOPOS 8V1320.00-2 units and an ACOPOS 8V1640.00-2 are built into a switching cabinet. The power loss from the braking resistors was determined over one machine cycle and is on average 800 W. The power loss from all other active devices in the switching cabinet is 500 W.

The steel switching cabinet is 1 m wide, 2 m high, 0.5 m deep and is free-standing on all sides. The internal temperature of the switching cabinet should not exceed 40 °C. The ambient temperature is 30 °C.

The right air/water heat exchanger or cooling aggregate must be selected for this switching cabinet.

Determining the power loss in the switching cabinet

Components in the switching cabinet	Amount	Power loss per component [W]	Total power loss [W]
ACOPOS 8V1320.00-2	2	800 1)	1600
ACOPOS 8V1640.00-2	1	1600 1)	1600
Braking resistors	---	800 (average value over one machine cycle)	800
All other active devices	---	500	500
		Sum:	**4500**

Table 119: Determining the power loss in the switching cabinet

1) The power loss for ACOPOS servo drives is specified in chapter 2 "Technical data".

Calculating the effective switching cabinet surface

A = 1.8 x H x (W + D) + 1.4 x W x D = 1.8 x 2 x (1 + 0.5) + 1.4 x 2 + 0.5 = 6.1 m²

Calculation of the required cooling capacity

The heat transfer coefficient k for steel panels is 5.5 W/m²K.

This results in a required cooling capacity Q_E of

$$Q_E = Q_v - (A \cdot (T_{Imax} - T_A) \cdot k) = 4500 - (6{,}1 \cdot (40 - 30) \cdot 5{,}5) = 4164{,}5W$$

The right air/water heat exchanger or cooling aggregate can now be selected based on the determined required cooling capacity Q_E.

7 Formula Variables Used

Character	Units	Name
A	m²	Effective, power radiating switching cabinet surface according to DIN 57660 section 500
C_A	F	Discharge capacitance
$C_{Br_{Th}}$	Ws/°C	Heat capacitance of the filament
k	---	General constants
f_{mains}	Hz	Mains frequency
I_{24VDC}	A	24 VDC current requirements
$I_{24VDC_{max}}$	A	24 VDC maximum current requirements
$I_{24VDC_{total}}$	A	24 VDC Total Current Consumption
$I_{24VDC_{out}}$	A	Current on 24 VDC Output of the ACOPOS Servo Drive (max. 0.5 A)
I_A	A	Discharge current via protective ground conductor (PE)
I_B	A	Rated current for overcurrent protection
I_{mains}	A	Mains current (phase current)
I_q	A	Thermal equivalent current effective value
I_Z	A	Maximum current load on a cable
k	W/m²K	Heat transfer coefficient (for steel: k = 5.5 W/m²K)
M	Nm	Torque (general)
M_{eff}	Nm	Effective load torque for one cycle
n	min^{-1}	Speed (general)
n_{aver}	min^{-1}	Average speed for one cycle
ω	rad/s	Angular velocity
P	W	Power or true power (general)
P_{Br}	W	Brake power
$P_{Br_{max}}$	W	Maximum brake power
$P_{Br_{aver}}$	W	Average brake power
$P_{R_{Br_{max}}}$	W	Maximum load on the external braking resistor
$P_{R_{Br_N}}$	W	Nominal power of the external braking resistor
P_{max}	W	Maximum power output for all slots
P_{module}	W	Power consumption of the ACOPOS plug-in modules
π	---	Pi (3.1415)
Q_v	W	Sum of the power loss in the switching cabinet
Q_S	W	Power that is radiated through the switching cabinet surface ($Q_S > 0$: Radiation; $Q_S < 0$: irradiation into the switching cabinet)
q_W	W/K	Specific heat output of a heat exchanger
V	m³/h	Air flow volume of a filter fan that is required in order to ensure that the maximum temperature difference between the intake and the exiting air is not exceeded
R_{Br}	Ω	Braking resistor
$R_{Br_{min}}$	Ω	Minimum braking resistance
$R_{Br_{Th}}$	°C/W	Thermal resistance between braking resistor and the environment

Table 120: Formula variables used

Character	Units	Name
S	VA	Apparent power
t	s	Time (general)
t_{Br}	s	Braking time
$T_{Br_{max}}$	°C	Maximum over-temperature of the resistor
T_{Imax}	°C	Maximum temperature permitted inside the switching cabinet
T_{amb}	°C	Ambient temperature of the switching cabinet
T_{cycle}	s	Cycle time
U_{DC}	V	DC bus voltage
U_{mains}	V	Supply voltage (phase to phase)

Table 120: Formula variables used (cont.)

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Chapter 5 • Wiring

1. General information

1.1 Electromagnetic compatibility of the installation

1.1.1 General information

If the directives for elecromagnetic compatibility of the installation are followed, ACOPOS servo drives meet EMC directives 2004/108/CE and low-voltage directives 2006/95/CE. They meet the requirements for harmonized EMC product standard IEC 61800-3:2004 for industry (second environment).

Additional EMC measures must be implemented by the manufacturer of machines or systems if the product standards for the machine has lower limits or if the machine should conform to generic standard IEC 61000-6-4. Additional EMC measures may also be needed for machines with a large number of ACOPOS servo drives. The installation of a central line filter is mostly sufficient in such cases. Proof of conformity to the necessary limits must be provided according to the documentation for use of the EMC directives from the manufacturer or distributor of the machine or system.

Additional EMC measures are needed when operating ACOPOS servo drives in living area or when connecting ACOPOS servo drives to a low voltage system which supplies buildings in living areas without an intermediate transformer (first environment).

1.1 Installation notes

1) The switching cabinet or the system must be constructed appropriately.

2) To prevent the effects of disturbances, the following lines must be properly shielded:

- Motor cables
- Encoder cables
- Control cables
- Data cables

3) Inductive switching elements such as contactors or relays are to be equipped with corresponding suppressor elements such as varistors, RC elements or damping diodes.

4) All electrical connections are to be kept as short as possible.

5) Cable shields are to be attached to the designated shield terminals and the plug housing.

6) Shielded cables with copper mesh or tinned copper mesh are to be used. Twisting or extending the protective mesh using single conductors is not allowed.

7) Unused cable conductors are to be grounded on both sides if possible.

The ground connections and shield connections have to be made as illustrated in the following diagram.

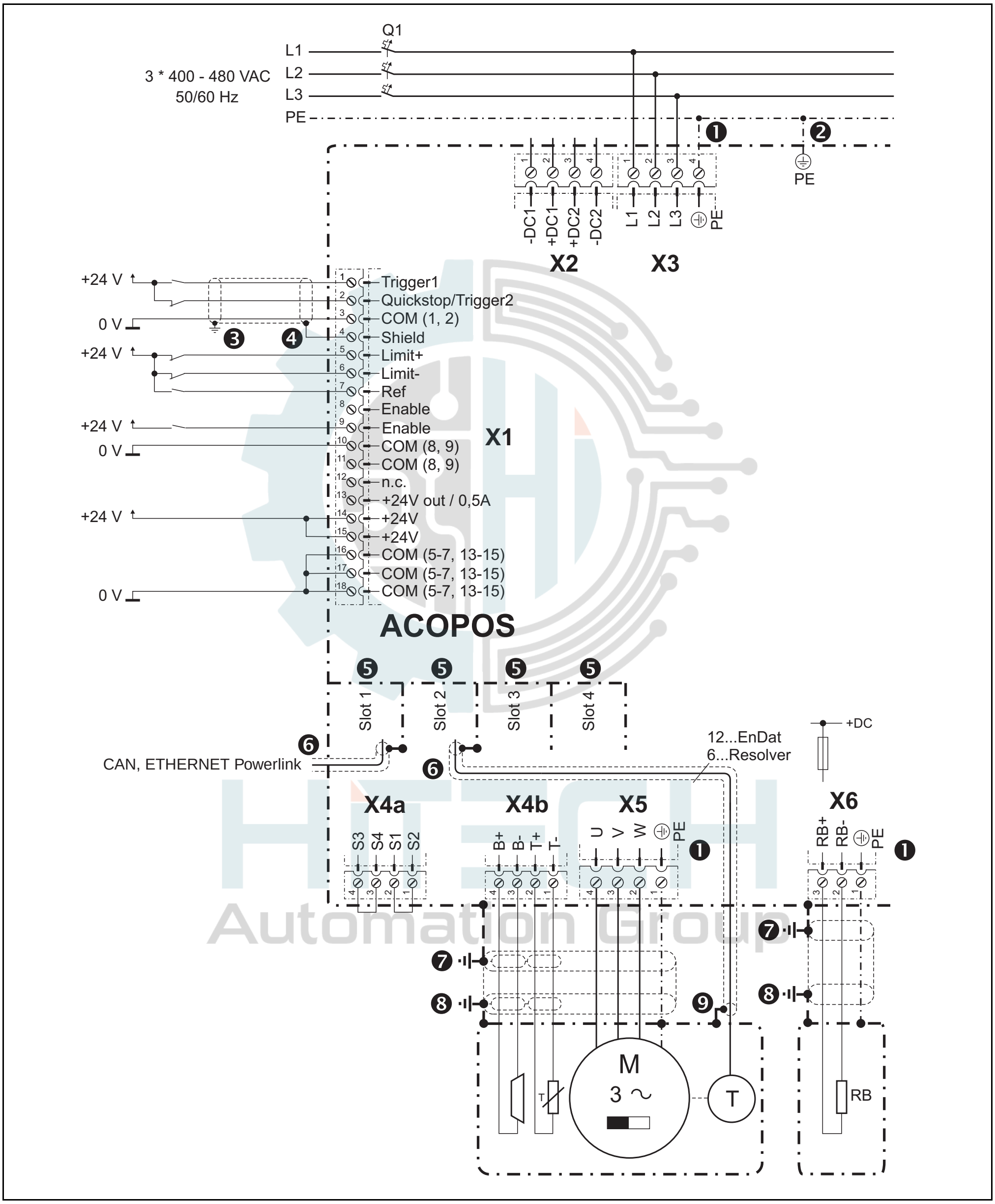


Figure 54: Connection diagram for ground and shield connections

❶ The protective ground conductors (PE) for the power mains, the motor lines and external braking resistor connection are internally connected with the housing of the ACOPOS servo drive.

❷ The second protective ground conductor connection is required because of the increased discharge current (> 3.5 mA) on ACOPOS servo drives 1022, 1045, 1090, 1180 and 1320. The same cross section as the power mains protective ground conductor must be used.

❸ Both trigger inputs are only filtered internally with approx. 50 µs. Make sure the cable shield is grounded properly.

❹ The cable shield must be attached to the shield connector.

❺ On all plug-in modules, the two screws used to fasten the module must be tightened so that the mounting bracket is connected to ground.

❻ Cable connection via DSUB plug:
The cable shield must be sufficiently connected using the designated clamp in the metallic or metal-plated DSUB plug housing. The DSUB plug fastening screws must be tightened.

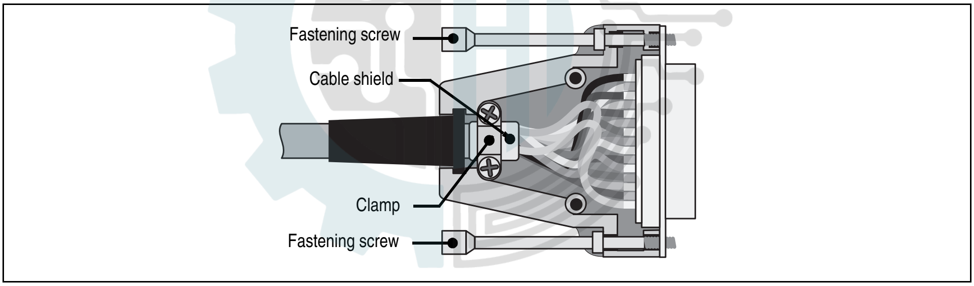


Figure 55: Cable shielding in DSUB housing

Cable connection via terminals:
The cable shield must be attached to the shield connection terminal.

Cable connection via RJ45 plug:
Grounding the cable shield as well provides an improvement in EMC properties. Grounding should take place on both sides, extensively and near to the connector.

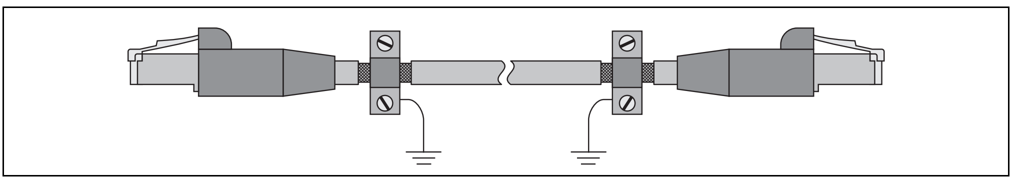


Figure 56: Grounding the POWERLINK cable shielding

Information:

When cabling POWERLINK networks with B&R POWERLINK cables, <u>no</u> additional grounding of the cable shield is required to ensure resistance to disturbances in accordance with EN 61800-3!

❼ The cable shield for the motor line or the connection cable for the external braking resistor is connected with the housing of the ACOPOS servo drive via the grounding plate using the grounding clamp provided:

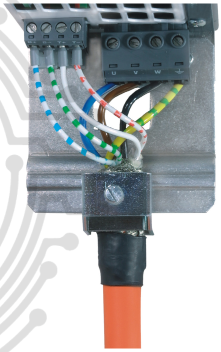
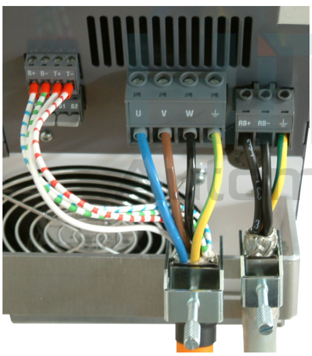
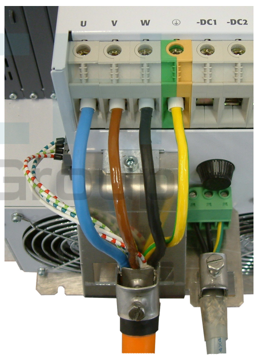
Shield connection for the motor cable using grounding clamps	
ACOPOS 1010, 1016	ACOPOS 1022, 1045, 1090
	
ACOPOS 1180, 1320	ACOPOS 1640, 128M
	

Table 121: Grounding of the motor cable on the ACOPOS servo drive

Section 5
Wiring

❽ On the motor side, the cable shield for the motor line is connected to the motor housing using the motor plug and connected to ground via the machine.
The cable shield on the connection cable for the external braking resistor must be connected with the housing of the braking resistor.

❾ On the motor side, the encoder cable shield must be connected to the motor housing using the encoder plug and connected to ground via the machine.

For external encoders, the cable shield of the encoder cable must be connected (on the encoder side) with the machine and therefore with ground using the encoder plug.

1.2 Insulation and high-voltage test

1.2.1 Insulation resistance according to EN 60204

According to EN 60204, the insulation resistance of electrical equipment is measured with 500 V DC voltage between the main circuit conductors and the protective ground conductor system and is not permitted to be below a value of 1 MΩ. Testing individual sections of the system is permitted.

ACOPOS servo drive power mains connection (X3)

The insulation resistance test can be carried out on the ACOPOS servo drive power mains connection (X3) as described above; however, values > 1 MΩ are not expected because of the overvoltage protection circuit of the power mains.[1)] The 50 kΩ minimum value required by the EN 60204 section 18.3 standard is exceeded.

ACOPOS servo drive motor connection (X5)

> **Warning!**
>
> **An insulation test is not permitted to be carried out on the ACOPOS servo drive motor connection (X5) because that would destroy the ACOPOS servo drive!**
>
> **The motor cable must be removed from the ACOPOS servo drive motor connection (X5) before the insulation resistance is measured!**

B&R motors and B&R motor cables

In principle, an insulation resistance measurement can be carried out on B&R motor cables and B&R motors. However, the insulation resistance can be lower than 1 MΩ depending on the motor that is connected. The 50 kΩ minimum value required by the EN 60204 section 18.3 standard is exceeded.

> **Warning!**
>
> **An insulation test is not permitted to be carried out on the ACOPOS servo drive motor connection (X5) because that would destroy the ACOPOS servo drive!**
>
> **The motor cable must be removed from the ACOPOS servo drive motor connection (X5) before the insulation resistance is measured!**

Section 5 Wiring

1) Typical values are: 8V1010/1016: 880 kΩ; 8V1022/1045/1090: 820 kΩ; 8V1180/1320: 750 kΩ; 8V1640/128M: 820 kΩ.

1.2 High voltage test

According to EN 60204, the electrical equipment must be able to withstand a test voltage connected between the conductors of all circuits and the protective ground conductor system for at least 1 s (exception: all circuits with a voltage < PELV voltage). The test voltage must be twice the rated voltage for the equipment, and at least 1000 VAC (50 / 60 Hz). Components that cannot handle this test voltage must be disconnected before carrying out the high voltage test.

ACOPOS servo drive power mains connection (X3)

Warning!

A high voltage test cannot be carried out on the ACOPOS servo drive power mains connection (X3) because sparks can occur that are caused by the internal wiring.

ACOPOS servo drive motor connection (X5)

Warning!

A high voltage test is not permitted to be carried out on the ACOPOS servo drive motor connection (X5) because that would destroy the ACOPOS servo drive!

B&R motors and B&R motor cables

In principle, a high voltage test can be carried out on B&R motor cables and B&R motors. Depending on the size of the motor and length of the motor cable, increased measurement currents can occur because of capacitive coupling.

Warning!

A high voltage test is not permitted to be carried out on the ACOPOS servo drive motor connection (X5) because that would destroy the ACOPOS servo drive!

The motor cable must be removed from the ACOPOS servo drive motor connection (X5) before the high voltage measurement!

1.2 Connecting cables to plug-in modules

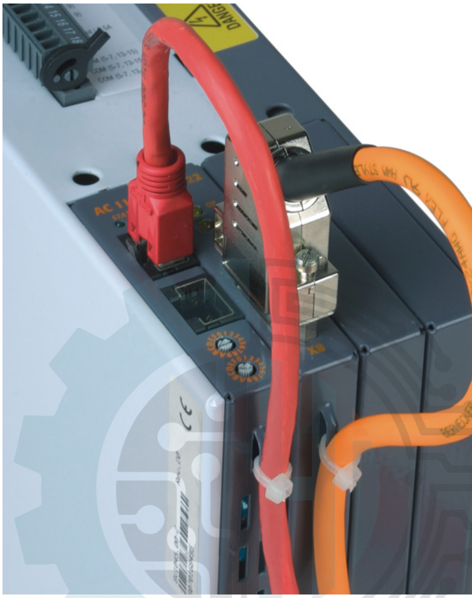


Figure 57: Connecting cables to plug-in modules

Stress relief for the cable is implemented using a cable tie. The cable tie is to be run through the eye on the bottom of the plug-in module.

Make sure that the ventilation slots on the bottom of the ACOPOS drive are not blocked.

1.[illegible] Overview of clampable diameter ranges 1)

Connection	Wire types Approbation data	8V1010.0xx-2 8V1010.5xx-2 8V1016.0xx-2 8V1016.5xx-2 [mm²]	[AWG]	8V1022.0xx-2 8V1045.0xx-2 8V1090.0xx-2 [mm²]	[AWG]	8V1180.0xx-2 8V1320.0xx-2 [mm²]	[AWG]	8V1640.0xx-2 [mm²]	[AWG]	8V128M.0xx-2 [mm²]	[AWG]
X1	Solid core / multiple conductor lines	0.5 - 1.5	20 - 14	0.5 - 1.5	20 - 14	0.5 - 1.5	20 - 14	0.5 - 1.5	20 - 14	0.5 - 1.5	20 - 14
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	0.5 - 1.5 0.5 - 1.5	20 - 14 20 - 14	0.5 - 1.5 0.5 - 1.5	20 - 14 20 - 14	0.5 - 1.5 0.5 - 1.5	20 - 14 20 - 14	0.5 - 1.5 0.5 - 1.5	20 - 14 20 - 14	0.5 - 1.5 0.5 - 1.5	20 - 14 20 - 14
	Approbation data UL/C-UL-US CSA	--- ---	26 - 14 26 - 14	--- ---	26 - 14 26 - 14	--- ---	26 - 14 26 - 14	--- ---	26 - 14 26 - 14	--- ---	26 - 14 26 - 14
Holding torque for the terminal screws [Nm]		0.2 ... 0.25		0.2 ... 0.25		0.2 ... 0.25		0.2 ... 0.25		0.2 ... 0.25	
X2 DC bus	Solid core / multiple conductor lines	0.2 - 4	24–10	0.2 - 4	24–10	0.5–10	20 - 7	10 - 50	7 - 0	16 - 95	6 - 3/0
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	0.2 - 4 0.25 - 4	24–10 23–10	0.2 - 4 0.25 - 4	24–10 23–10	0.5 - 6 0.5 - 6	20 - 9 20 - 9	10 - 35 10 - 35	7 - 2 7 - 2	10 - 70 10 - 70	7 - 2/0 7 - 2/0
	Approbation data UL/C-UL-US CSA	--- ---	30–10 28–10	--- ---	30–10 28–10	--- ---	20 - 8 20 - 8	--- ---	10 - 2 12 - 2	--- ---	6 - 2/0 6 - 2/0
Holding torque for the terminal screws [Nm]		0.5 ... 0.6		0.5 ... 0.6		1.2 ... 1.5		3 ... 4		6 ... 10	
X3 Network	Solid core / multiple conductor lines	0.2 - 4	24–10	0.2 - 4	24–10	0.5–10	20 - 7	10 - 50	7 - 0	16 - 95	6 - 3/0
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	0.2 - 4 0.25 - 4	24–10 23–10	0.2 - 4 0.25 - 4	24–10 23–10	0.5 - 6 0.5 - 6	20 - 9 20 - 9	10 - 35 10 - 35	7 - 2 7 - 2	10 - 70 10 - 70	7 - 2/0 7 - 2/0
	Approbation data UL/C-UL-US CSA	--- ---	30–10 28–10	--- ---	30–10 28–10	--- ---	20 - 8 20 - 8	--- ---	10 - 2 12 - 2	--- ---	6 - 2/0 6 - 2/0
Holding torque for the terminal screws [Nm]		0.5 ... 0.6		0.5 ... 0.6		1.2 ... 1.5		3 ... 4		6 ... 10	
X4a, X4b Motor (holdingbrake, Temperature sensor)	Solid core / multiple conductor lines	0.2 - 2.5	24 - 12	0.2 - 2.5	24 - 12	0.2 - 2.5	24 - 12	0.2 - 2.5	24 - 12	0.2 - 2.5	24 - 12
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	0.2 - 2.5 0.25 - 2.5	24 - 12 23 - 12	0.2 - 2.5 0.25 - 2.5	24 - 12 23 - 12	0.2 - 2.5 0.25 - 2.5	24 - 12 23 - 12	0.2 - 2.5 0.25 - 2.5	24 - 12 23 - 12	0.2 - 2.5 0.25 - 2.5	24 - 12 23 - 12
	Approbation data UL/C-UL-US CSA	--- ---	30 - 12 28 - 12	--- ---	30 - 12 28 - 12	--- ---	30 - 12 28 - 12	--- ---	30 - 12 28 - 12	--- ---	30 - 12 28 - 12
Holding torque for the terminal screws [Nm]		0.5 ... 0.6		0.5 ... 0.6		0.5 ... 0.6		0.5 ... 0.6		0.5 ... 0.6	
X5 Motor (power)	Solid core / multiple conductor lines	0.2 - 4	24–10	0.2 - 4	24–10	0.5–10	20 - 7	10 - 50	7 - 0	16 - 95	6 - 3/0
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	0.2 - 4 0.25 - 4	24–10 23–10	0.2 - 4 0.25 - 4	24–10 23–10	0.5 - 6 0.5 - 6	20 - 9 20 - 9	10 - 35 10 - 35	7 - 2 7 - 2	10 - 70 10 - 70	7 - 2/0 7 - 2/0
	Approbation data UL/C-UL-US CSA	--- ---	30–10 28–10	--- ---	30–10 28–10	--- ---	20 - 8 20 - 8	--- ---	10 - 2 12 - 2	--- ---	6 - 2/0 6 - 2/0
Holding torque for the terminal screws [Nm]		0.5 ... 0.6		0.5 ... 0.6		1.2 ... 1.5		3 ... 4		6 ... 10	
X6 External Brake resistor	Solid core / multiple conductor lines	---	---	---	---	0.2 - 4	24–10	0.5–10	20 - 7	0.5–10	20 - 7
	Flexible and fine wire lines without Wire Tip Sleeves with Wire Tip Sleeves	--- ---	--- ---	--- ---	--- ---	0.2 - 4 0.25 - 4	24–10 23–10	0.5 - 6 0.5 - 6	20 - 9 20 - 9	0.5 - 6 0.5 - 6	20 - 9 20 - 9
	Approbation data UL/C-UL-US CSA	--- ---	--- ---	--- ---	--- ---	--- ---	30–10 28–10	--- ---	20 - 8 20 - 8	--- ---	20 - 8 20 - 8
Holding torque for the terminal screws [Nm]		---		---		0.5 ... 0.6		1.2 ... 1.5		1.2 ... 1.5	

Table 122: Terminal cross sections for ACOPOS servo drives

1) ACOPOS 1022/1045/1090 revision I0 and higher; ACOPOS 1180/1320 revision F0 and higher; ACOPOS 1640 revision K0 and higher; ACOPOS 128M revision C0 and higher.

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2 Pin assignments ACOPOS 1010, 1016

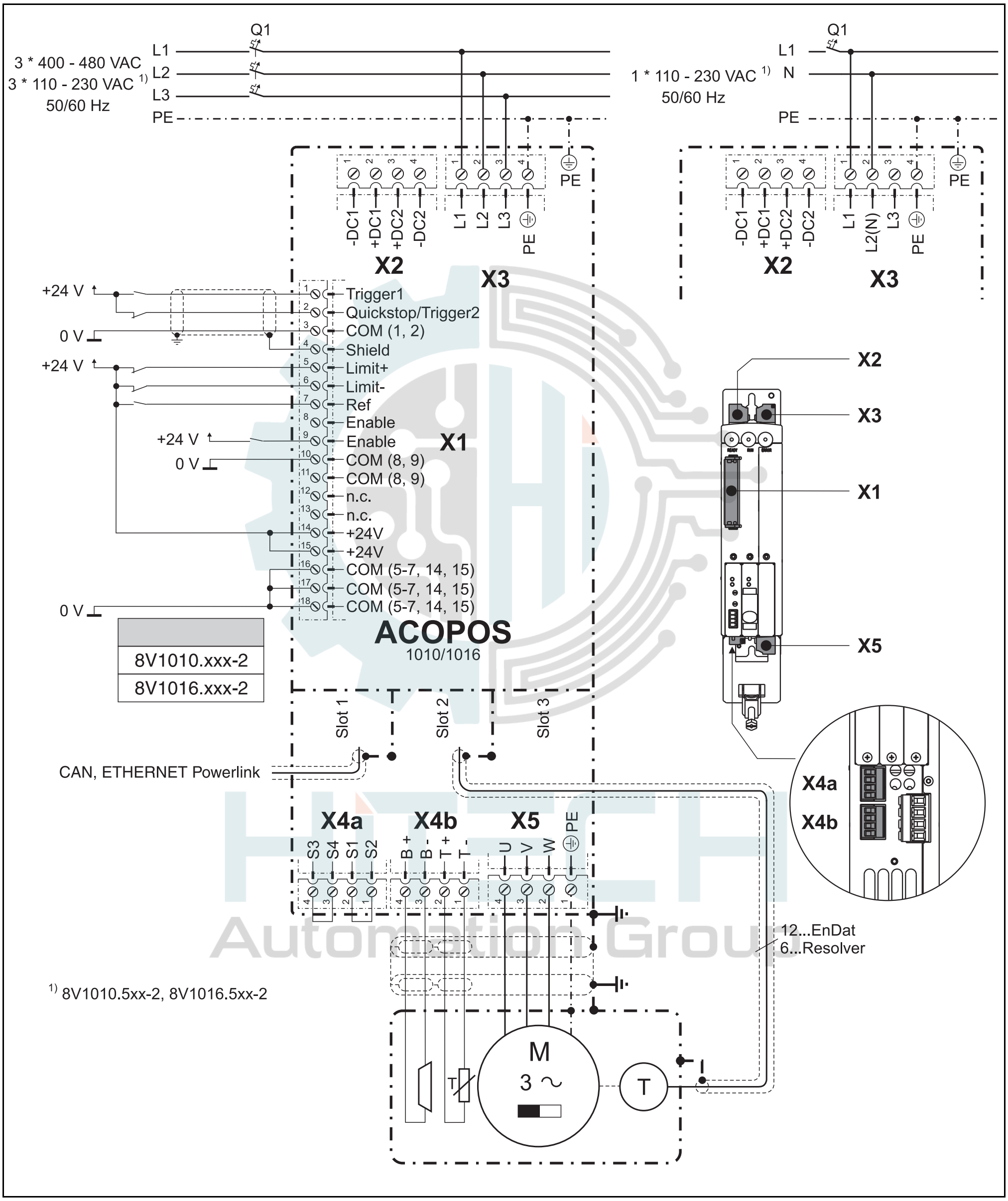
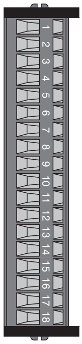


Figure 58: Overview of pin assignments ACOPOS 1010, 1016

Section 5
Wiring

2.[illegible] Pin assignments for X1 plug



X1	Pin	Name	Function
	1	Trigger1	Trigger 1
	2	Quickstop/Trigger2	Quickstop/Trigger 2
	3	COM (1, 2)	Trigger 1, Quickstop/Trigger 2 0 V
	4	Shield	Shield
	5	Limit+	Positive HW limit
	6	Limit-	Negative HW limit
	7	Ref	Reference switch
	8	Enable	Enable
	9	Enable	Enable
	10	COM (8, 9)	Enable 0 V
	11	COM (8, 9)	Enable 0 V
	12	---	---
	13	---	---
	14	+24V	+24 V supply
	15	+24V	+24 V supply
	16	COM (5-7, 14, 15)	0 V supply
	17	COM (5-7, 14, 15)	0 V supply
	18	COM (5-7, 14, 15)	0 V supply

The following connections are linked with each other internally in the device:

- Pin 8 --> Pin 9 (Enable)
- Pin 10 --> Pin 11 (Enable 0 V)
- Pin 14 --> Pin 15 (Supply +24 V)
- Pin 16 --> Pin 17 --> Pin 18 (Supply 0 V)

Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236

Table 123: Pin assignments for plug X1 ACOPOS 1010, 1016

2.2 Pin assignments - X2 plug

2.2.1 8V1010.0xx-2, 8V1016.0xx-2

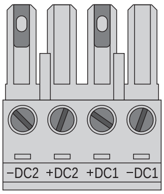
X2	Pin	Name	Function
	1	-DC1	U DC bus -
	2	+DC1	U DC bus +
	3	+DC2	U DC bus +
	4	-DC2	U DC bus -
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 124: Pin assignments for plug X2 ACOPOS 8V1010.00-2, 8V1016.00-2

2.2.2 8V1010.5xx-2, 8V1016.5xx-2

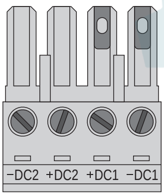
X2	Pin	Name	Function
	1	-DC1	U DC bus -
	2	+DC1	U DC bus +
	3	+DC2	U DC bus +
	4	-DC2	U DC bus -
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 125: Pin assignments for plug X2 ACOPOS 8V1010.50-2, 8V1016.50-2

Warning!

Its only permitted to link DC buses for ACOPOS servo drives with the same supply voltage range (see table 98 "Supply voltage range for ACOPOS servo drives", on page 178).

Therefore, the DC buses for ACOPOS servo drives 8Vxxxx.5xx-2 and 8Vxxxx.0xx-2 are not allowed to be linked! For this reason, the X2 plugs for ACOPOS servo drives 8Vxxxx.5xx-2 and 8Vxxxx.0xx-2 are coded differently.

All ACOPOS servo drives 8Vxxxx.5xx-2 with a single-phase supply that should have their DC buses connected together must be connected to the same phase! If this is not done, the DC bus voltage increases to a level that is not permitted; this caused the devices to be destroyed!

2.3 Pin assignments - X3 plug

Danger!

Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!

2.3.1 8V1010.0xx-2, 8V1016.0xx-2

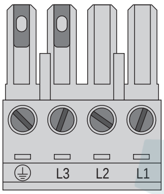
X3	Pin	Name	Function
	1	L1	Power mains connection L1
	2	L2	Power mains connection L2
	3	L3	Power mains connection L3
	4	PE	Protective ground conductor
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 126: Pin assignments for plug X3 ACOPOS 8V1010.00-2, 8V1016.00-2

2.3.2 8V1010.5xx-2, 8V1016.5xx-2

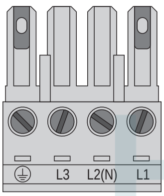
X3	Pin	Name	Function
	1	L1	Power mains connection L1
	2	L2(N)	Power mains connection N
	3	L3	---
	4	PE	Protective ground conductor
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 127: Pin assignments for plug X3 ACOPOS 8V1010.50-2, 8V1016.50-2

2.[illegible] Pin assignments for plugs X4a, X4b

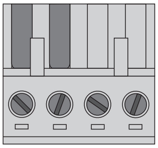
X4a	Pin	Name	Function
	1	S2 1)	Activation, supply for the external holding brake (+)
	2	S1 1)	Activation for the external holding brake (+)
	3	S4	Activation, supply for the external holding brake (-)
	4	S3	Activation for the external holding brake (-)
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 128: Pin assignments for plug X4a ACOPOS 1010, 1016

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

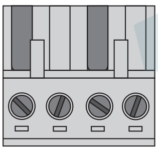
X4b	Pin	Name	Function
	1	T-	Temperature sensor -
	2	T+	Temperature sensor +
	3	B- 1)	Brake -
	4	B+ 1)	Brake +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 129: Pin assignments for plug X4b ACOPOS 1010, 1016

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

Danger!

The connections for the motor temperature sensors and the motor holding brake are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Caution!

If B+ and B are swapped when connecting the permanent magnet holding brakes, then the brakes cannot be opened! ACOPOS servo drives cannot determine if a holding brake is connected with reverse polarity.

2.4 Wiring the output for the motor holding brake

The supply, activation and monitoring of the output for the motor holding brake can take place via the the X4a connector in three different ways:

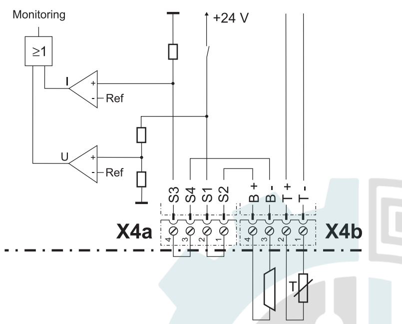
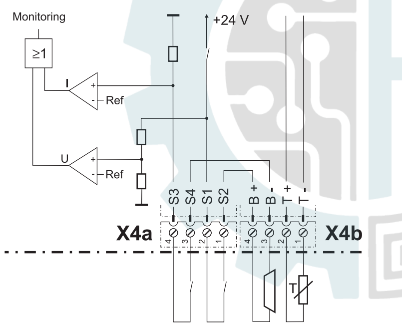
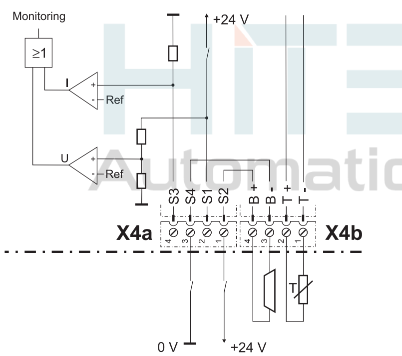
	Figure	Description
1		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive • **Monitoring:** Internally by the ACOPOS servo drive A jumper must be placed between S1 and S2 as well as S3 and S4 on the X4a connector. 1)
2		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive and also possible externally using potential free contacts 2) • **Monitoring:** Internally by the ACOPOS servo drive **Information:** **The parameters for ACOPOS internal monitoring must be set according to the requirements of the application.** 3)
3		• **Supply:** External • **Activation:** External • **Monitoring:** External **Information:** **ACOPOS internal monitoring cannot be used here; therefore it must be deactivated using software.** 4)

Table 130: Activation for the external holding brake

1) Both jumpers are already on the X4a connector delivered with the ACOPOS servo drives.
2) External potential free contacts can be connected between S1 and S2 as well as between S3 and S4. This makes it possible to activate the holding brake using an external safety circuit independent of the control integrated in the ACOPOS servo drive.
3) The parameters are set using ParID 90 (1 ... internal monitoring active; 5 ... internal monitoring not active).
4) Deactivation takes place using ParID 90 (5 ... internal monitoring not active).

2.5 Pin Assignments for Plug X5

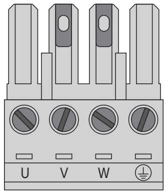
X5	Pin	Name	Function
	1	PE	Protective ground conductor
	2	W	Motor connection W
	3	V	Motor connection V
	4	U	Motor connection U
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 131: Pin assignments for plug X5 ACOPOS 1010, 1016

2.6 Additional protective ground connection (PE)

The protective ground conductor is connected to the M5 threaded bolt provided using a cable lug. For information concerning dimensioning see section 1.1.3 "Protective ground connection (PE)", on page 179.

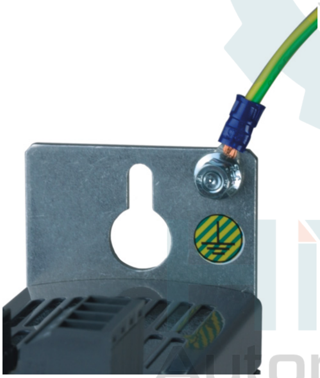
Figure	Pin	Name	Function
	---	PE	Protective ground conductor
Terminal cross sections		**[mm²]**	**AWG**
Cable lug for M5 threaded bolt		0.25 - 16	23 - 5

Table 132: Protective ground conductor (PE) ACOPOS 1010, 1016

Danger!

Before turning on the servo drive, make sure that the housing is properly connected to ground (PE rail). The ground connection must be made, even when testing the servo drive or when operating it for a short time!

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2.7 Input/output circuit diagram

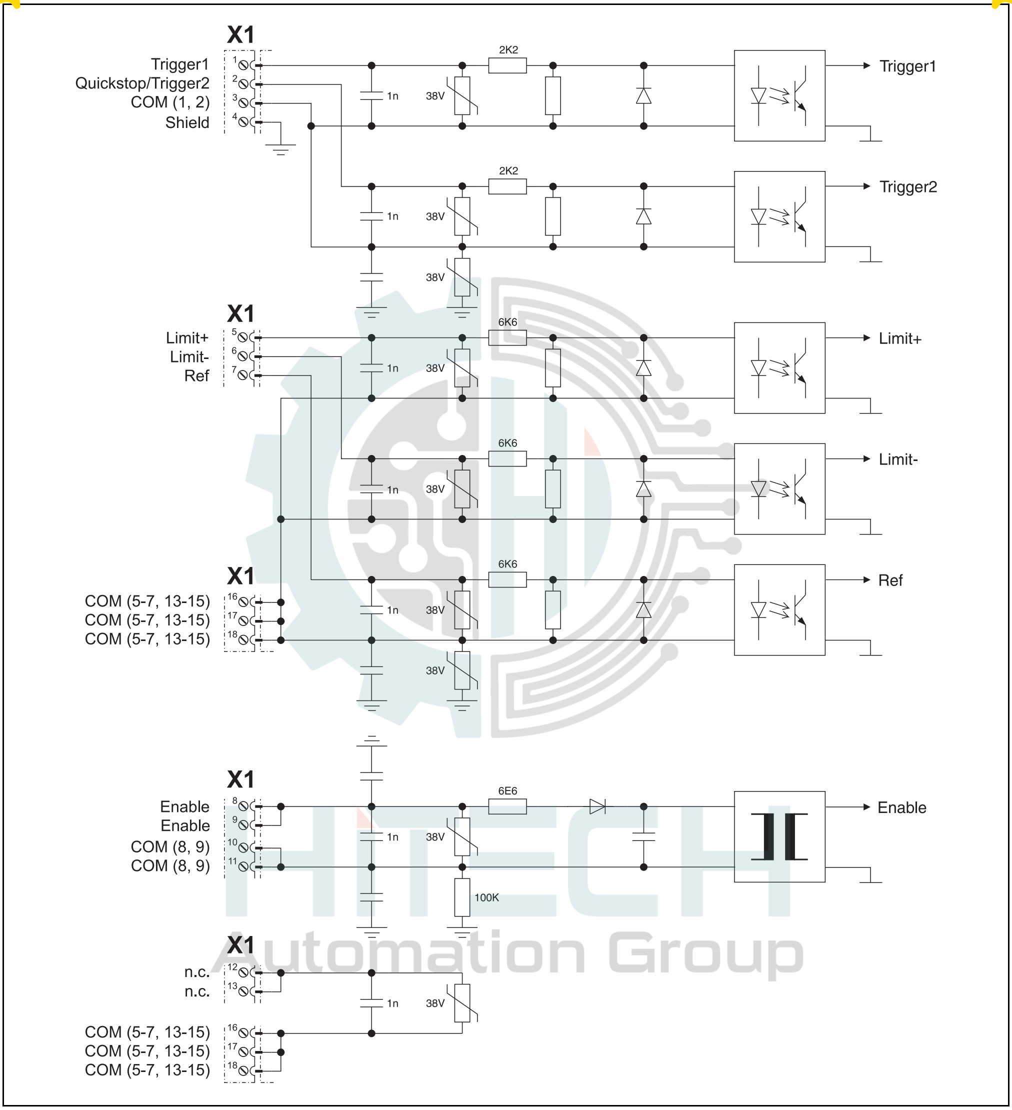


Figure 59: Input/output circuit diagram - ACOPOS 1010, 1016

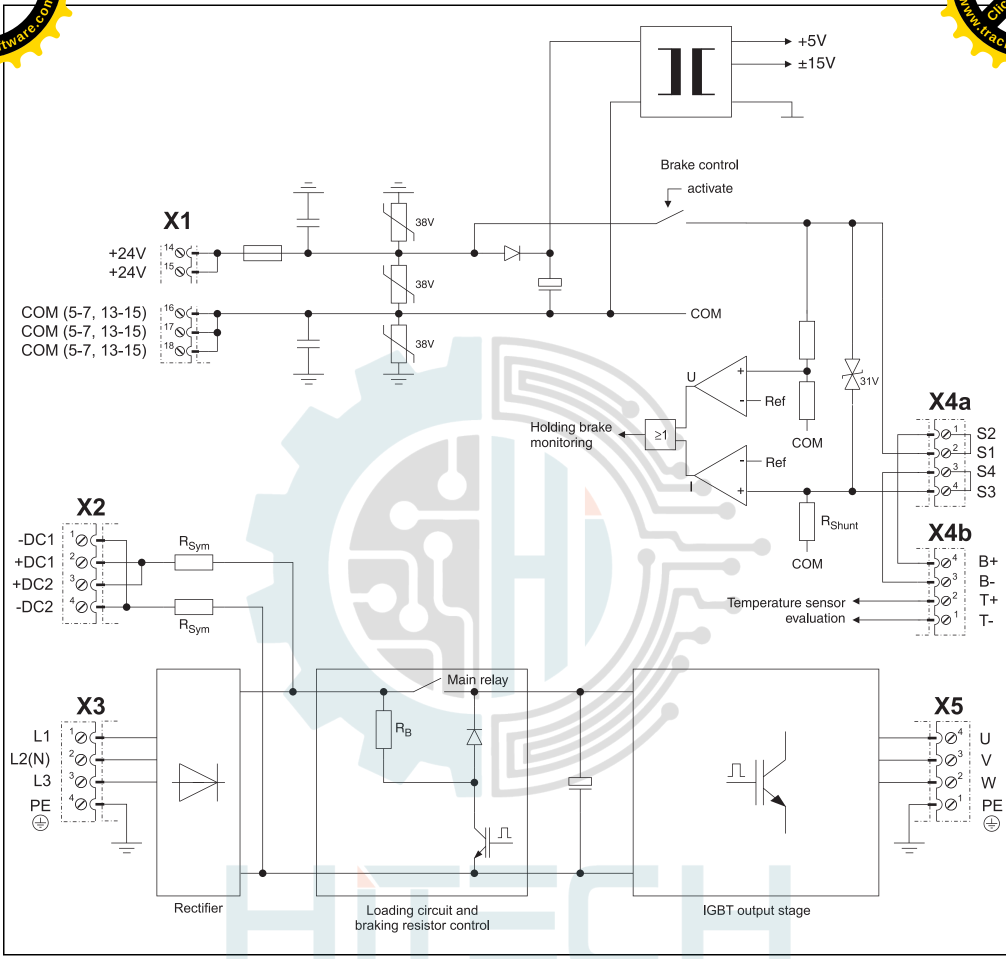


Figure 59: Input/output circuit diagram - ACOPOS 1010, 1016 (cont.)

3 Pin assignments ACOPOS 1022, 1045, 1090 [1)]

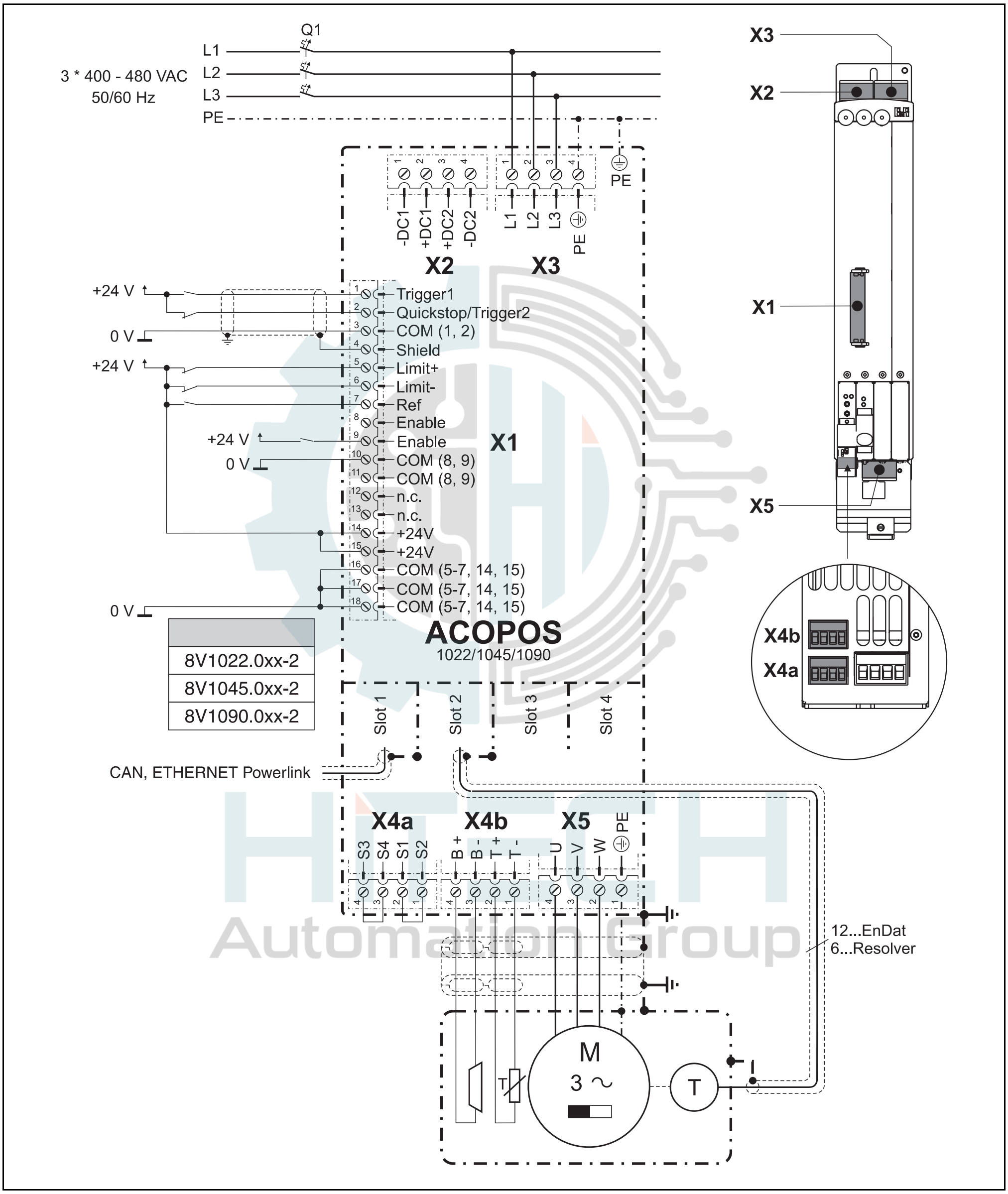
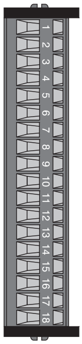


Figure 60: Overview of pin assignments ACOPOS 1022, 1045, 1090

1) Starting with revision I0.

3.2 Pin assignments for X1 plug

X1



Pin	Name	Function
1	Trigger1	Trigger 1
2	Quickstop/Trigger2	Quickstop/Trigger 2
3	COM (1, 2)	Trigger 1, Quickstop/Trigger 2 0 V
4	Shield	Shield
5	Limit+	Positive HW limit
6	Limit-	Negative HW limit
7	Ref	Reference switch
8	Enable	Enable
9	Enable	Enable
10	COM (8, 9)	Enable 0 V
11	COM (8, 9)	Enable 0 V
12	---	---
13	---	---
14	+24V	+24 V supply
15	+24V	+24 V supply
16	COM (5-7, 14, 15)	0 V supply
17	COM (5-7, 14, 15)	0 V supply
18	COM (5-7, 14, 15)	0 V supply

The following connections are linked with each other internally in the device:

- Pin 8 --> Pin 9 (Enable)
- Pin 10 --> Pin 11 (Enable 0 V)
- Pin 14 --> Pin 15 (Supply +24 V)
- Pin 16 --> Pin 17 --> Pin 18 (Supply 0 V)

Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236

Table 133: Pin assignments for plug X1 ACOPOS 1022, 1045, 1090

Section 5
Wiring

3.2 Pin assignments - X2 plug

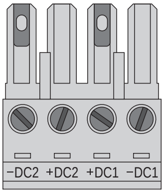
X2	Pin	Name	Function
	1	-DC1	U DC bus -
	2	+DC1	U DC bus +
	3	+DC2	U DC bus +
	4	-DC2	U DC bus -
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 134: Pin assignments for plug X2 ACOPOS 1022, 1045, 1090

3.3 Pin assignments - X3 plug

Danger!

Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!

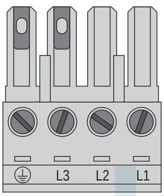
X3	Pin	Name	Function
	1	L1	Power mains connection L1
	2	L2	Power mains connection L2
	3	L3	Power mains connection L3
	4	PE	Protective ground conductor
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 135: Pin assignments for plug X3 ACOPOS 1022, 1045, 1090

3.[illegible] Pin assignments for plugs X4a, X4b

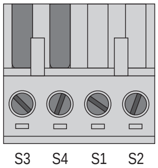
X4a	Pin	Name	Function
	1	S2 1)	Activation, supply for the external holding brake (+)
	2	S1 1)	Activation for the external holding brake (+)
	3	S4	Activation, supply for the external holding brake (-)
	4	S3	Activation for the external holding brake (-)
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 136: Pin assignments for plug X4a ACOPOS 1022, 1045, 1090

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

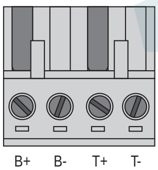
X4b	Pin	Name	Function
	1	T-	Temperature sensor -
	2	T+	Temperature sensor +
	3	B- 1)	Brake -
	4	B+ 1)	Brake +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 137: Pin assignments for plug X4b ACOPOS 1022, 1045, 1090

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

Danger!

The connections for the motor temperature sensors and the motor holding brake are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Caution!

If B+ and B are swapped when connecting the permanent magnet holding brakes, then the brakes cannot be opened! ACOPOS servo drives cannot determine if a holding brake is connected with reverse polarity!

3.4 Wiring the output for the motor holding brake

The supply, activation and monitoring of the output for the motor holding brake can take place via the the X4a connector in three different ways:

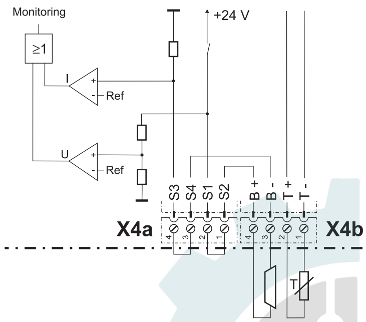
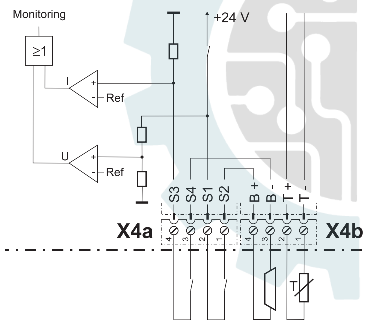
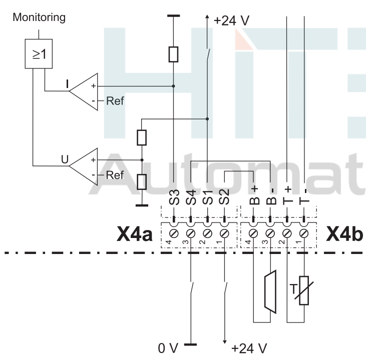
	Figure	Description
1		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive • **Monitoring:** Internally by the ACOPOS servo drive A jumper must be placed between S1 and S2 as well as S3 and S4 on the X4a connector. 1)
2		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive and also possible externally using potential free contacts 2) • **Monitoring:** Internally by the ACOPOS servo drive **Information:** **The parameters for ACOPOS internal monitoring must be set according to the requirements of the application. 3)**
3		• **Supply:** External • **Activation:** External • **Monitoring:** External **Information:** **ACOPOS internal monitoring cannot be used here; therefore it must be deactivated using software. 4)**

Table 138: Activation for the external holding brake

1) Both jumpers are already on the X4a connector delivered with the ACOPOS servo drives.
2) External potential free contacts can be connected between S1 and S2 as well as between S3 and S4. This makes it possible to activate the holding brake using an external safety circuit independent of the control integrated in the ACOPOS servo drive.
3) The parameters are set using ParID 90 (1 ... internal monitoring active; 5 ... internal monitoring not active).
4) Deactivation takes place using ParID 90 (5 ... internal monitoring not active).

3.5 Pin Assignments for Plug X5

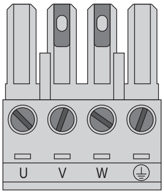
X5	Pin	Name	Function
	1	PE	Protective ground conductor
	2	W	Motor connection W
	3	V	Motor connection V
	4	U	Motor connection U
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 139: Pin assignments for plug X5 ACOPOS 1022, 1045, 1090

3.6 Additional protective ground connection (PE)

The protective ground conductor is connected to the M5 threaded bolt provided using a cable lug. For information concerning dimensioning see section 1.1.3 "Protective ground connection (PE)", on page 179.

Figure	Pin	Name	Function
	---	PE	Protective ground conductor
Terminal cross sections		**[mm²]**	**AWG**
Cable lug for M5 threaded bolt		0.25 - 16	23 - 5

Table 140: Protective ground conductor (PE) ACOPOS 1022, 1045, 1090

Danger!

Before turning on the servo drive, make sure that the housing is properly connected to ground (PE rail). The ground connection must be made, even when testing the servo drive or when operating it for a short time!

3.7 Input/output circuit diagram

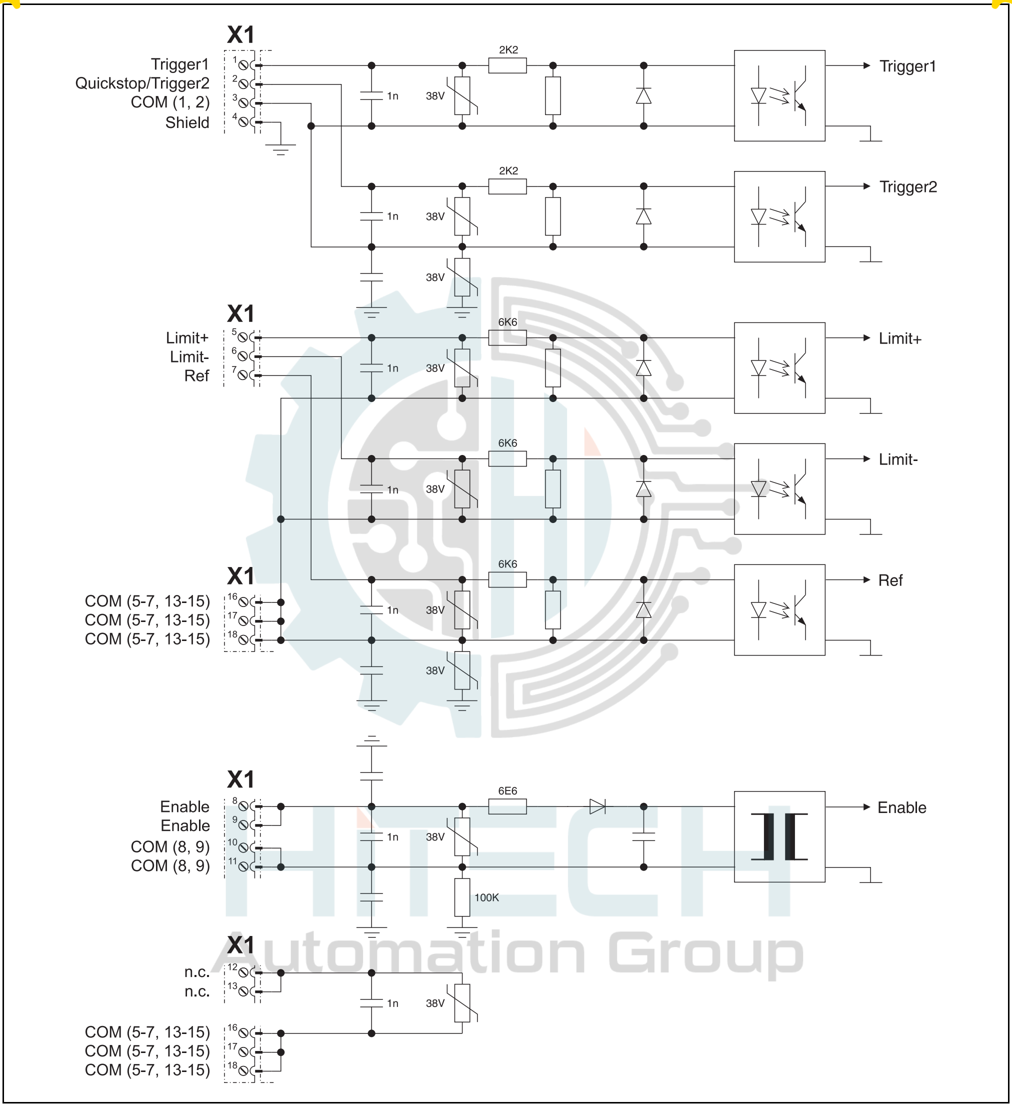


Figure 61: Input/output circuit diagram - ACOPOS 1022, 1045, 1090

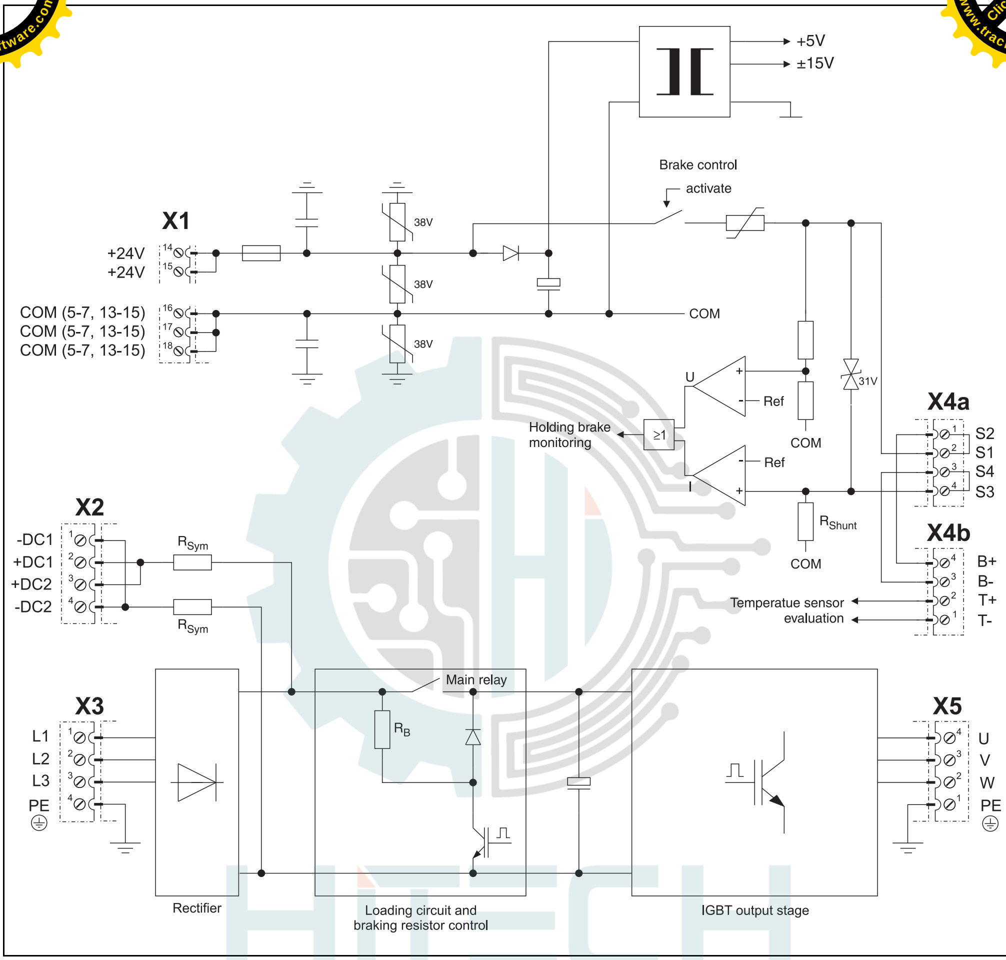


Figure 61: Input/output circuit diagram - ACOPOS 1022, 1045, 1090 (cont.)

4 ...n Assignments ACOPOS 1180, 1320 1)

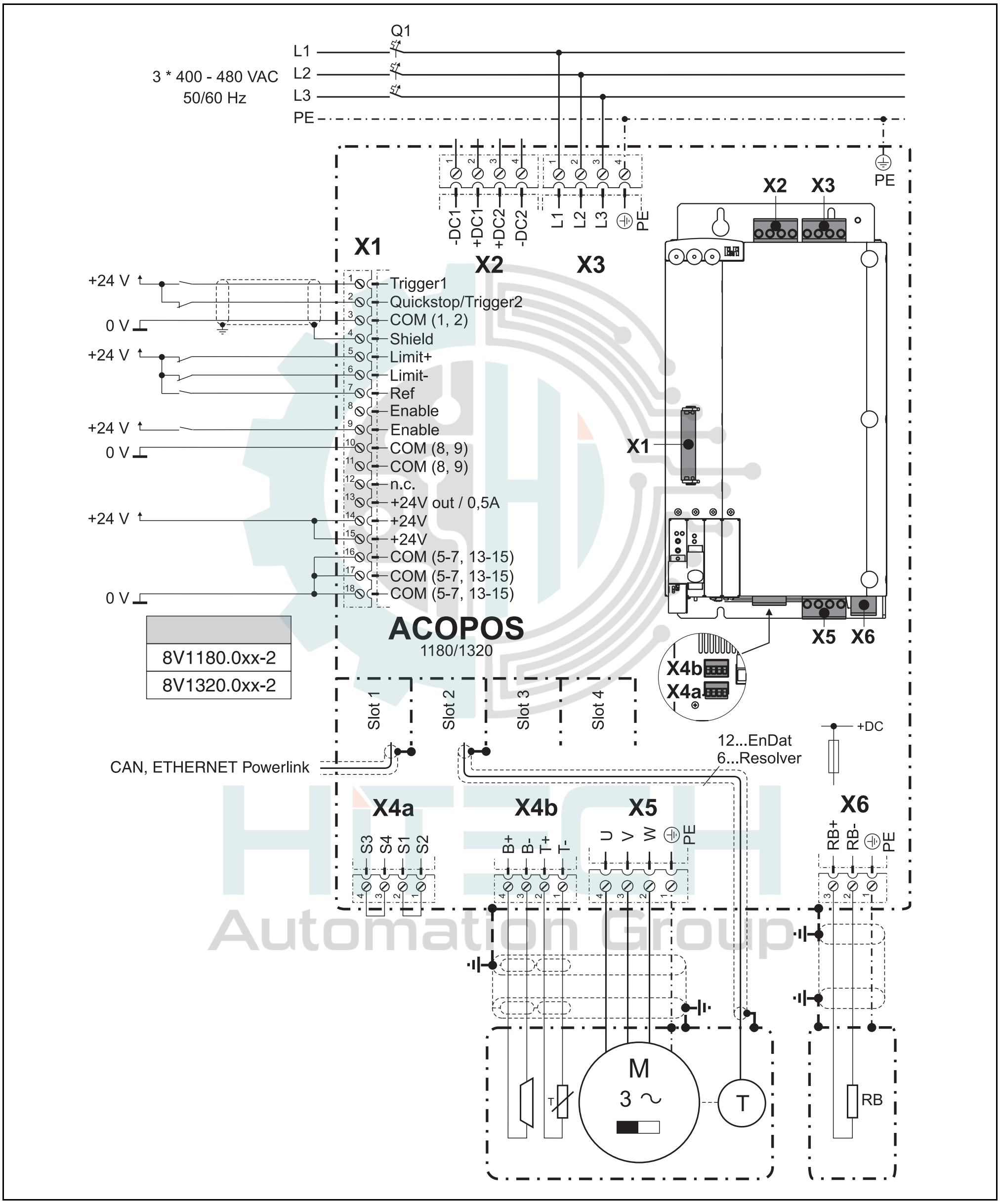
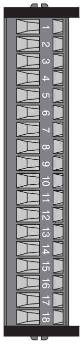


Figure 62: Overview of pin assignments ACOPOS 1180, 1320

1) Starting with revision F0.

4.2 Pin assignments for X1 plug



X1	Pin	Name	Function
	1	Trigger1	Trigger 1
	2	Quickstop/Trigger2	Quickstop/Trigger 2
	3	COM (1, 2)	Trigger 1, Quickstop/Trigger 2 0 V
	4	Shield	Shield
	5	Limit+	Positive HW limit
	6	Limit-	Negative HW limit
	7	Ref	Reference switch
	8	Enable	Enable
	9	Enable	Enable
	10	COM (8, 9)	Enable 0 V
	11	COM (8, 9)	Enable 0 V
	12	---	---
	13	+24V out / 0.5A	+24 V output / 0.5 A
	14	+24V	+24 V supply
	15	+24V	+24 V supply
	16	COM (5-7, 13-15)	0 V supply
	17	COM (5-7, 13-15)	0 V supply
	18	COM (5-7, 13-15)	0 V supply

The following connections are linked with each other internally in the device:

- Pin 8 --> Pin 9 (Enable)
- Pin 10 --> Pin 11 (Enable 0 V)
- Pin 14 --> Pin 15 (Supply +24 V)
- Pin 16 --> Pin 17 --> Pin 18 (Supply 0 V)

Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236

Table 141: Pin assignments for plug X1 ACOPOS 1180, 1320

4.2 Pin assignments - X2 plug

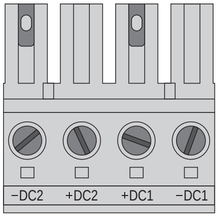
X2	Pin	Name	Function
	1	-DC1	U DC bus -
	2	+DC1	U DC bus +
	3	+DC2	U DC bus +
	4	-DC2	U DC bus -
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 142: Pin assignments for plug X2 ACOPOS 1180, 1320

4.3 Pin assignments - X3 plug

Danger!

Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!

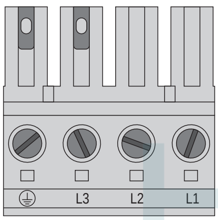
X3	Pin	Name	Function
	1	L1	Power mains connection L1
	2	L2	Power mains connection L2
	3	L3	Power mains connection L3
	4	PE	Protective ground conductor
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 143: Pin assignments for plug X3 ACOPOS 1180, 1320

4.[illegible] Pin assignments for plugs X4a, X4b

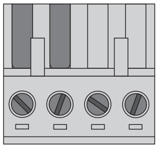
X4a	Pin	Name	Function
 S3 S4 S1 S2	1	S2 1)	Activation, supply for the external holding brake (+)
	2	S1 1)	Activation for the external holding brake (+)
	3	S4	Activation, supply for the external holding brake (-)
	4	S3	Activation for the external holding brake (-)
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 144: Pin assignments for plug X4a ACOPOS 1180, 1320

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

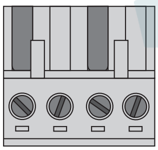
X4b	Pin	Name	Function
 B+ B- T+ T-	1	T-	Temperature sensor -
	2	T+	Temperature sensor +
	3	B- 1)	Brake -
	4	B+ 1)	Brake +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 145: Pin assignments for plug X4b ACOPOS 1180, 1320

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

Danger!

The connections for the motor temperature sensors and the motor holding brake are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Caution!

If B+ and B are swapped when connecting the permanent magnet holding brakes, then the brakes cannot be opened! ACOPOS servo drives cannot determine if a holding brake is connected with reverse polarity!

4.4 Wiring the output for the motor holding brake

The supply, activation and monitoring of the output for the motor holding brake can take place via the the X4a connector in three different ways:

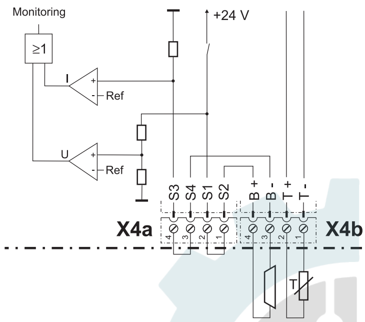
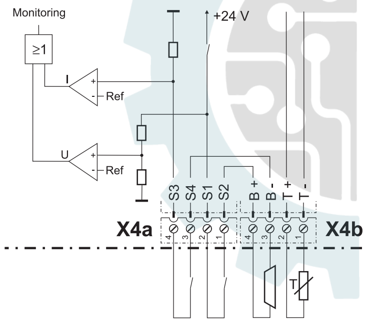
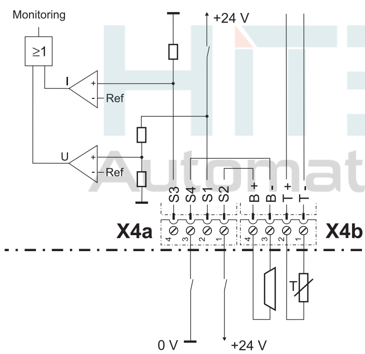
	Figure	Description
1		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive • **Monitoring:** Internally by the ACOPOS servo drive A jumper must be placed between S1 and S2 as well as S3 and S4 on the X4a connector. 1)
2		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive and also possible externally using potential free contacts 2) • **Monitoring:** Internally by the ACOPOS servo drive **Information:** **The parameters for ACOPOS internal monitoring must be set according to the requirements of the application. 3)**
3		• **Supply:** External • **Activation:** External • **Monitoring:** External **Information:** **ACOPOS internal monitoring cannot be used here; therefore it must be deactivated using software. 4)**

Table 146: Activation for the external holding brake

1) Both jumpers are already on the X4a connector delivered with the ACOPOS servo drives.
2) External potential free contacts can be connected between S1 and S2 as well as between S3 and S4. This makes it possible to activate the holding brake using an external safety circuit independent of the control integrated in the ACOPOS servo drive.
3) The parameters are set using ParID 90 (1 ... internal monitoring active; 5 ... internal monitoring not active).
4) Deactivation takes place using ParID 90 (5 ... internal monitoring not active).

4.5 Pin Assignments for Plug X5

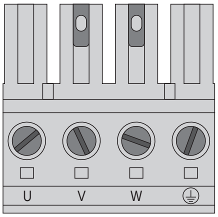
X5	Pin	Name	Function
	1	PE	Protective ground conductor
	2	W	Motor connection W
	3	V	Motor connection V
	4	U	Motor connection U
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 147: Pin assignments for plug X5 ACOPOS 1180, 1320

4.6 Pin Assignments for Plug X6

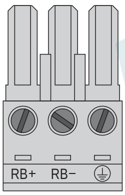
X6	Pin	Name	Function
	1	PE	Protective ground conductor
	2	RB-	Braking resistor -
	3	RB+	Brake resistor +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 148: Pin assignments for plug X6 ACOPOS 1180, 1320

4.7 Additional protective ground connection (PE)

The protective ground conductor is connected to the M5 threaded bolt provided using a cable lug. For information concerning dimensioning see section 1.1.3 "Protective ground connection (PE)", on page 179.

Figure	Pin	Name	Function
	---	PE	Protective ground conductor
Terminal cross sections	**[mm²]**		**AWG**
Cable lug for M5 threaded bolt	0.25 - 16		23 - 5

Table 149: Protective ground conductor (PE) ACOPOS 1180, 1320

Danger!

Before turning on the servo drive, make sure that the housing is properly connected to ground (PE rail). The ground connection must be made, even when testing the servo drive or when operating it for a short time!

4. Input/output circuit diagram

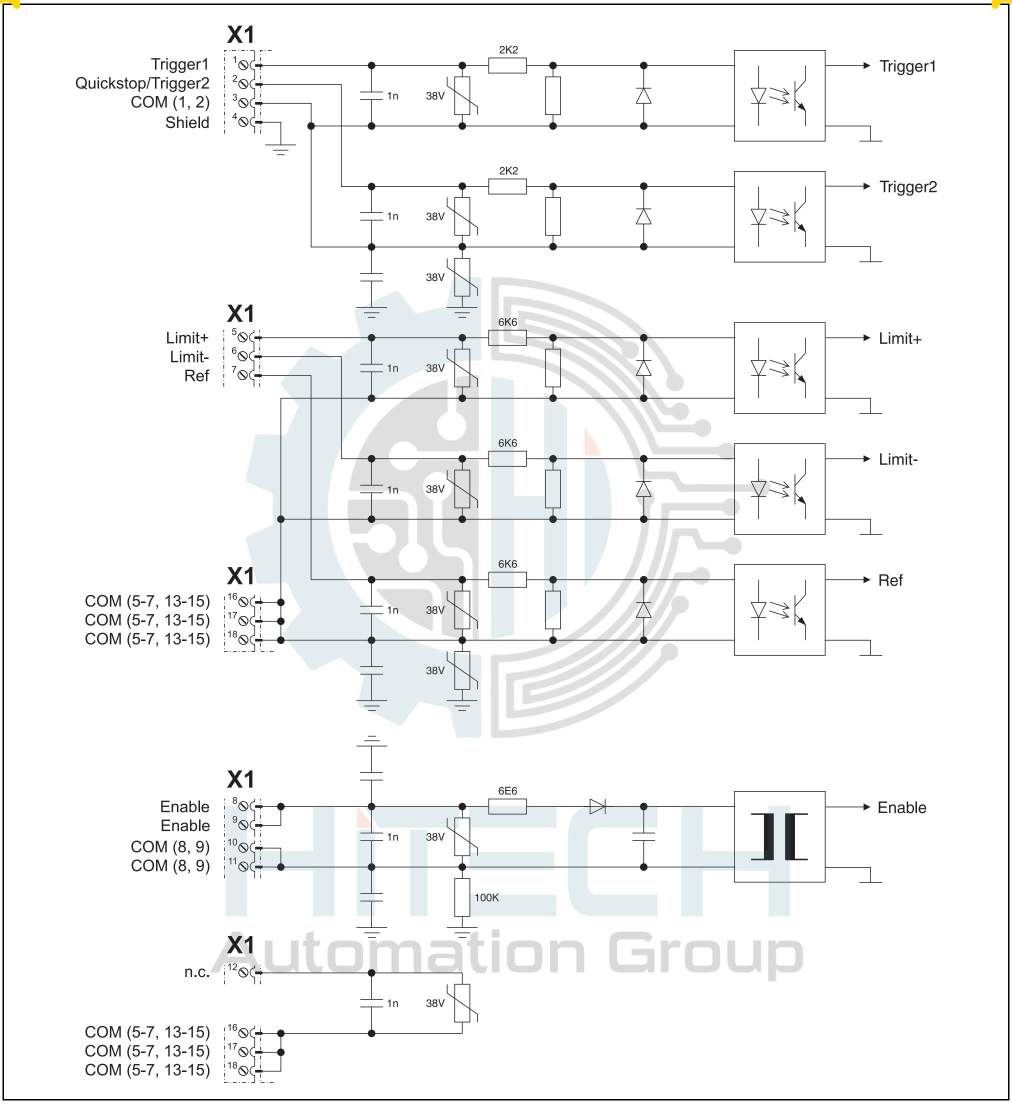


Figure 63: Input/output circuit diagram - ACOPOS 1180, 1320

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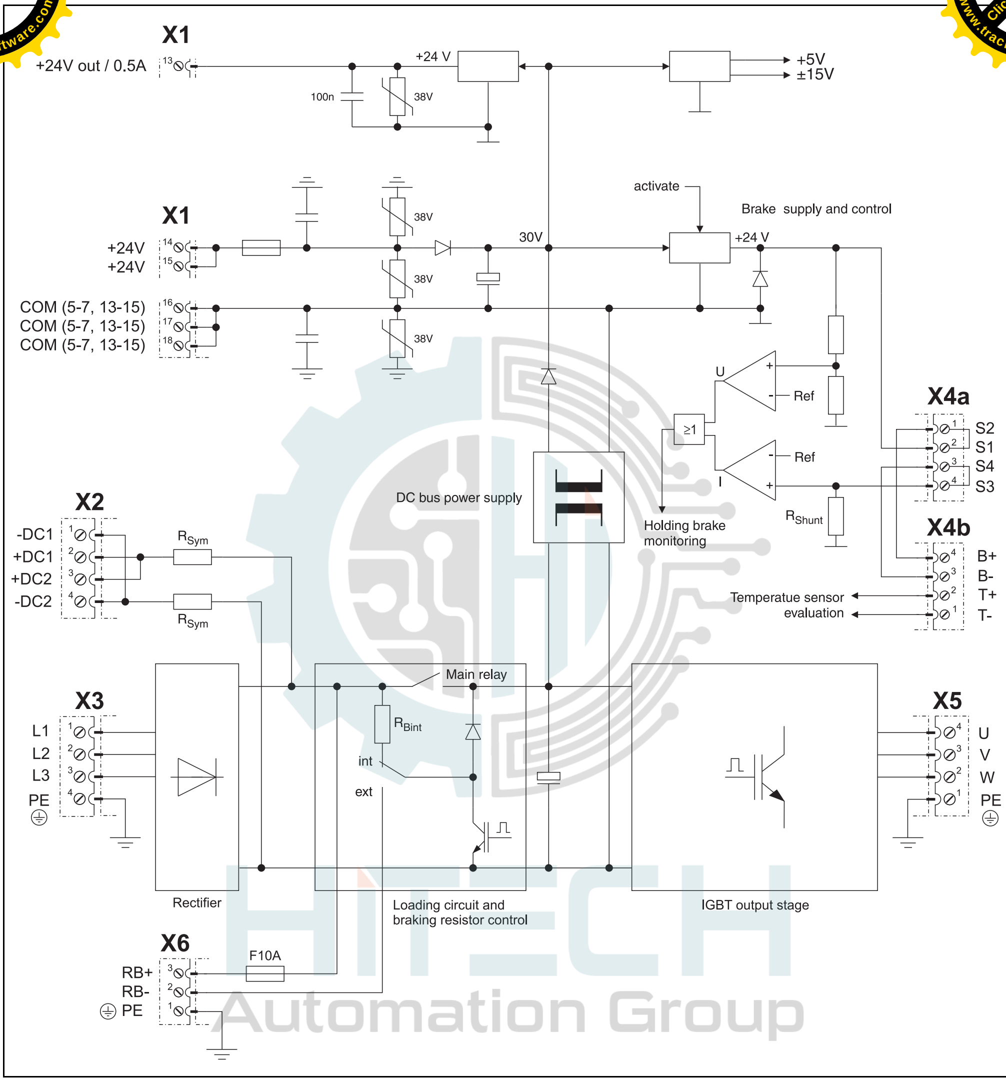
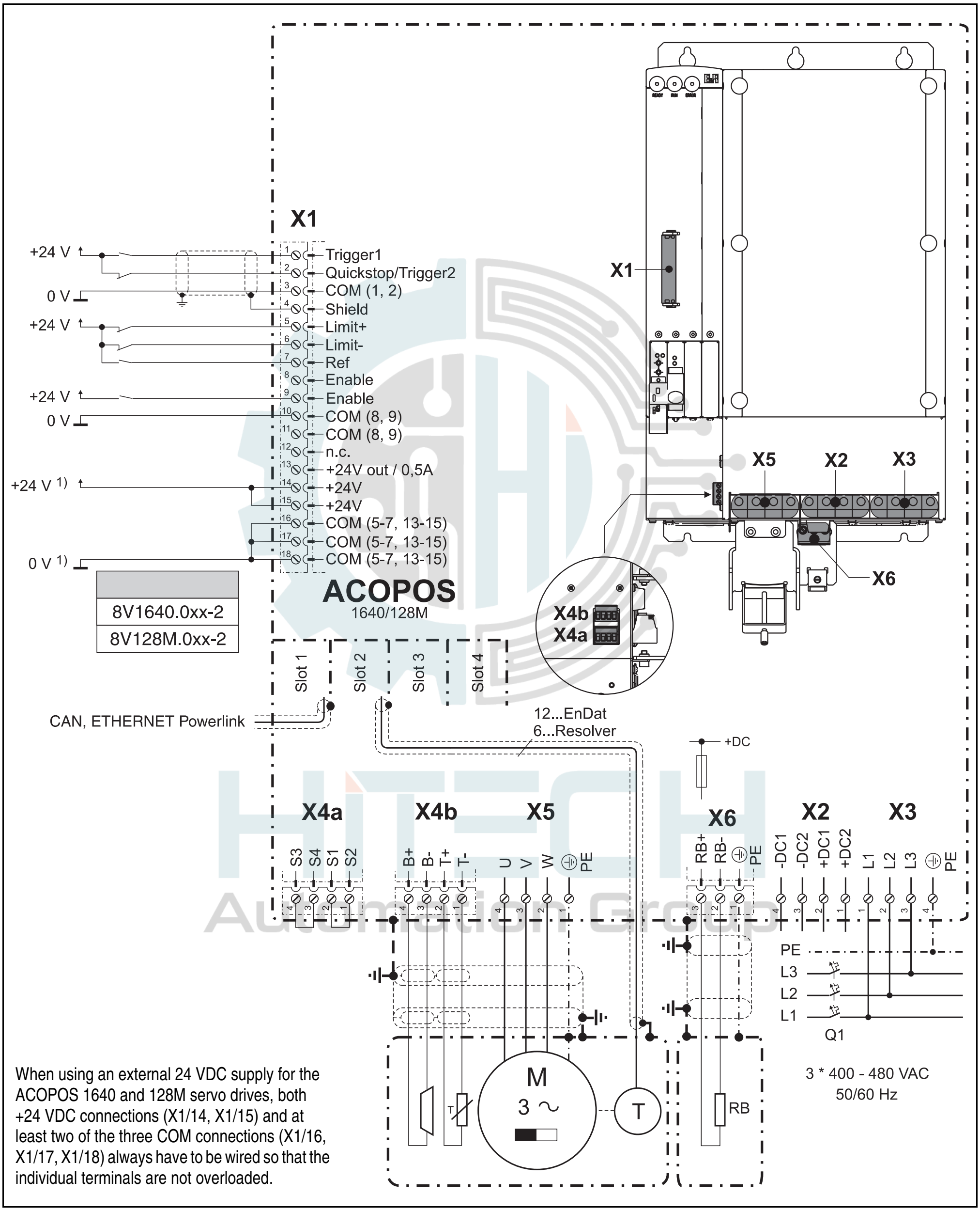


Figure 63: Input/output circuit diagram - ACOPOS 1180, 1320 (cont.)

5 in assignments ACOPOS 1640, 128M 1)



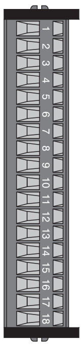
When using an external 24 VDC supply for the ACOPOS 1640 and 128M servo drives, both +24 VDC connections (X1/14, X1/15) and at least two of the three COM connections (X1/16, X1/17, X1/18) always have to be wired so that the individual terminals are not overloaded.

Figure 64: Overview of pin assignments ACOPOS 1640, 128M

1) Starting with revision K0

Section 5
Wiring

5.2 Pin assignments for X1 plug

X1	Pin	Name	Function
	1	Trigger1	Trigger 1
	2	Quickstop/Trigger2	Quickstop/Trigger 2
	3	COM (1, 2)	Trigger 1, Quickstop/Trigger 2 0 V
	4	Shield	Shield
	5	Limit+	Positive HW limit
	6	Limit-	Negative HW limit
	7	Ref	Reference switch
	8	Enable	Enable
	9	Enable	Enable
	10	COM (8, 9)	Enable 0 V
	11	COM (8, 9)	Enable 0 V
	12	---	---
	13	+24V out / 0.5A	+24 V output / 0.5 A
	14	+24V	+24 V supply 1)
	15	+24V	+24 V supply 1)
	16	COM (5-7, 13-15)	0 V supply 1)
	17	COM (5-7, 13-15)	0 V supply 1)
	18	COM (5-7, 13-15)	0 V supply 1)

The following connections are linked with each other internally in the device:

- Pin 8 --> Pin 9 (Enable)
- Pin 10 --> Pin 11 (Enable 0 V)
- Pin 14 --> Pin 15 (Supply +24 V)
- Pin 16 --> Pin 17 --> Pin 18 (Supply 0 V)

Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236

Table 150: Pin assignments for plug X1 ACOPOS 1640, 128M

1) When using an external 24 VDC supply for the ACOPOS 1640 and 128M servo drives, both +24 VDC connections (X1/14, X1/15) and at least two of the three COM connections (X1/16, X1/17, X1/18) always have to be wired so that the individual terminals are not overloaded.

5.2 Pin assignments - X2

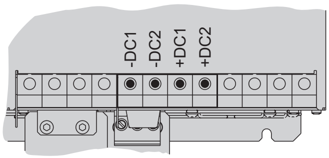
X2	Pin	Name	Function
	1	+DC2	U DC bus +
	2	+DC1	U DC bus +
	3	-DC2	U DC bus -
	4	-DC1	U DC bus -
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 151: Pin assignments for X2 ACOPOS 1640, 128M

5.3 Pin assignments - X3

Danger!

Servo drives are not permitted to be operated directly on IT and TN-S mains with a grounded phase conductor and protective ground conductor!

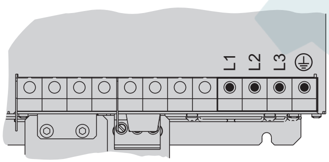
X3	Pin	Name	Function
	1	L1	Power mains connection L1
	2	L2	Power mains connection L2
	3	L3	Power mains connection L3
	4	⏚	Protective ground conductor
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 152: Pin assignments for X3 ACOPOS 1640, 128M

Section 5
Wiring

5.? Pin assignments for plugs X4a, X4b

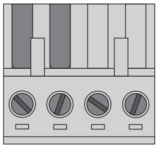
X4a	Pin	Name	Function
	1	S2 1)	Activation, supply for the external holding brake (+)
	2	S1 1)	Activation for the external holding brake (+)
	3	S4	Activation, supply for the external holding brake (-)
	4	S3	Activation for the external holding brake (-)
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 153: Pin assignments for plug X4a ACOPOS 1640, 128M

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

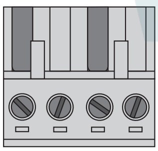
X4b	Pin	Name	Function
	1	T-	Temperature sensor -
	2	T+	Temperature sensor +
	3	B- 1)	Brake -
	4	B+ 1)	Brake +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 154: Pin assignments for plug X4b ACOPOS 1640, 128M

1) If the holding brake is connected via an additional external relay contact (ground-in e.g. via the connections S1/S2) instead of via the internal transistor, then the internal quenching circuit has no effect! In this case, the customer must make sure that neither the relay contact nor the braking coil are damaged when switching off the brake. This can be done by interconnecting the coil or - better still - interconnecting the contact with a quenching circuit.

Danger!

The connections for the motor temperature sensors and the motor holding brake are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Caution!

If B+ and B are swapped when connecting the permanent magnet holding brakes, then the brakes cannot be opened! ACOPOS servo drives cannot determine if a holding brake is connected with reverse polarity!

5.4 Wiring the output for the motor holding brake

The supply, activation and monitoring of the output for the motor holding brake can take place via the the X4a connector in three different ways:

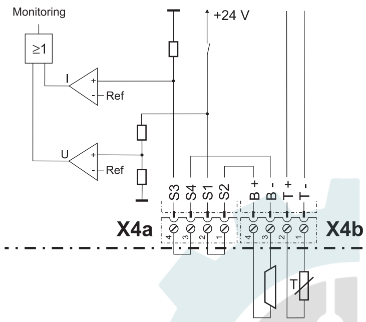
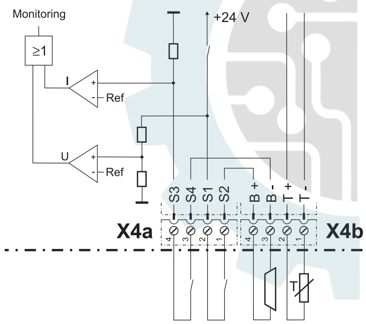
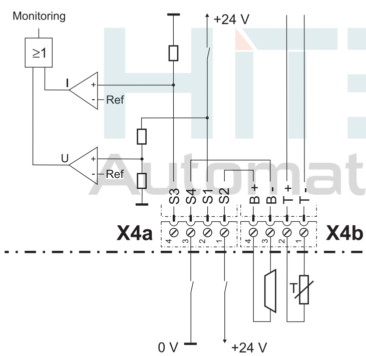
	Figure	Description
1		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive • **Monitoring:** Internally by the ACOPOS servo drive A jumper must be placed between S1 and S2 as well as S3 and S4 on the X4a connector. 1)
2		• **Supply:** Internally by the ACOPOS servo drive • **Activation:** Internally by the ACOPOS servo drive and also possible externally using potential free contacts 2) • **Monitoring:** Internally by the ACOPOS servo drive **Information:** **The parameters for ACOPOS internal monitoring must be set according to the requirements of the application. 3)**
3		• **Supply:** External • **Activation:** External • **Monitoring:** External **Information:** **ACOPOS internal monitoring cannot be used here; therefore it must be deactivated using software. 4)**

Table 155: Activation for the external holding brake

1) Both jumpers are already on the X4a connector delivered with the ACOPOS servo drives.
2) External potential free contacts can be connected between S1 and S2 as well as between S3 and S4. This makes it possible to activate the holding brake using an external safety circuit independent of the control integrated in the ACOPOS servo drive.
3) The parameters are set using ParID 90 (1 ... internal monitoring active; 5 ... internal monitoring not active).
4) Deactivation takes place using ParID 90 (5 ... internal monitoring not active).

5.5 Pin assignments X5

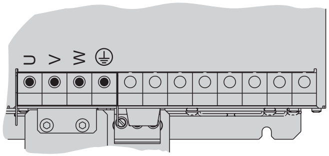
X5	Pin	Name	Function
	1	⏚	Protective ground conductor
	2	W	Motor connection W
	3	V	Motor connection V
	4	U	Motor connection U
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 156: Pin assignments for X5 ACOPOS 1640, 128M

5.6 Pin assignments X6

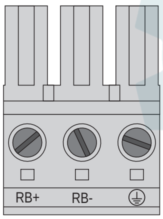
X6	Pin	Name	Function
	1	PE	Protective ground conductor
	2	RB-	Braking resistor -
	3	RB+	Brake resistor +
	Terminal cross sections see section 1.4 "Overview of clampable diameter ranges", on page 236		

Table 157: Pin assignments for X6 ACOPOS 1640, 128M

5.7 Input/output circuit diagram

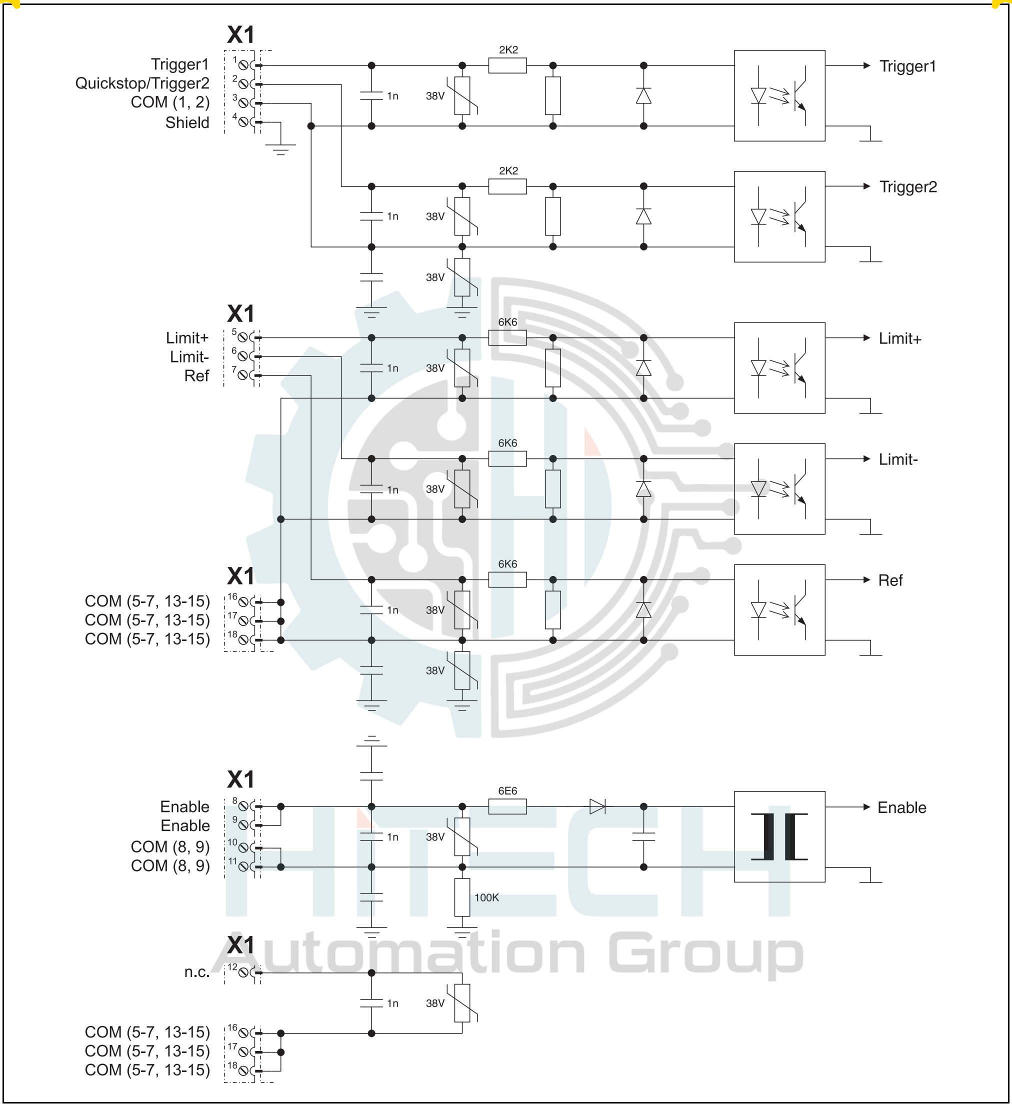


Figure 65: Input/output circuit diagram - ACOPOS 1640, 128M

Section 5
Wiring

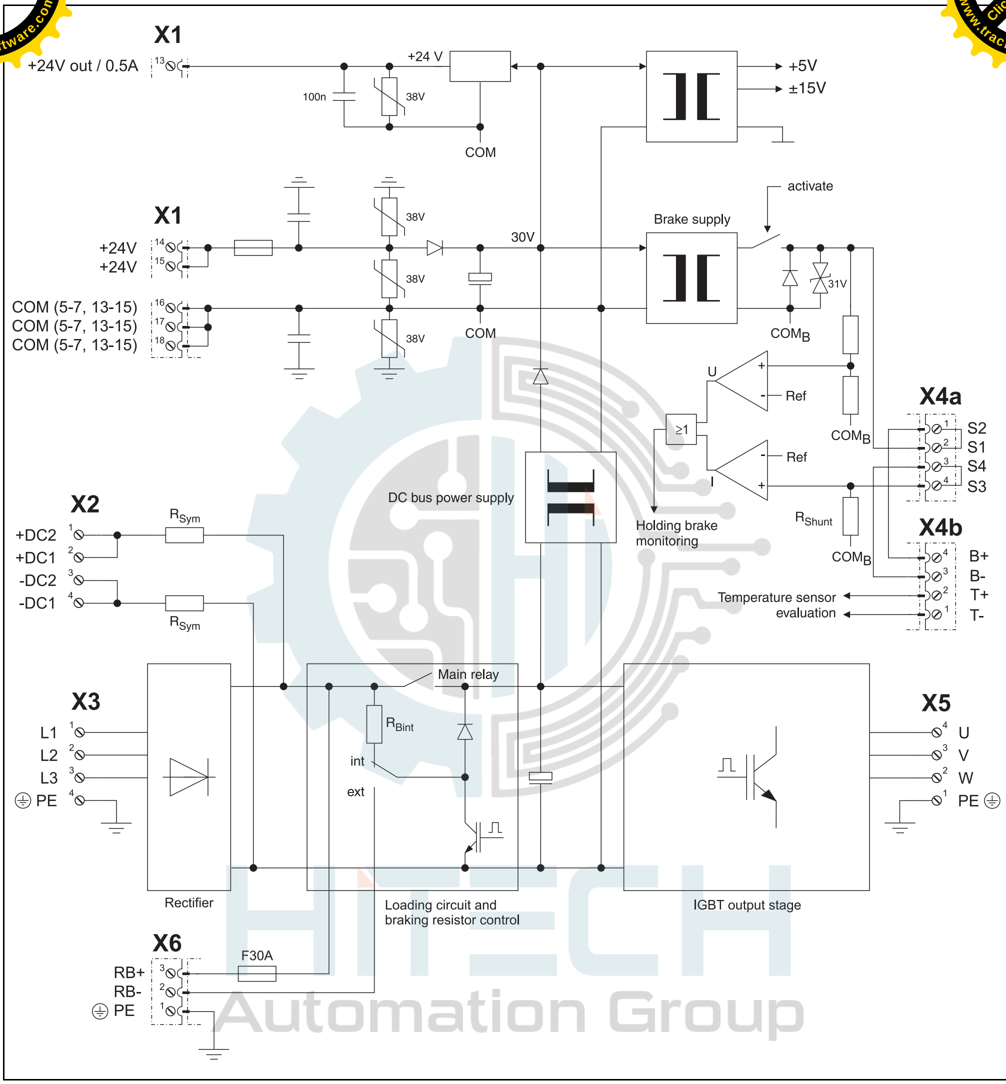


Figure 65: Input/output circuit diagram - ACOPOS 1640, 128M (cont.)

6. Pin assignments - 8B0W braking resistors

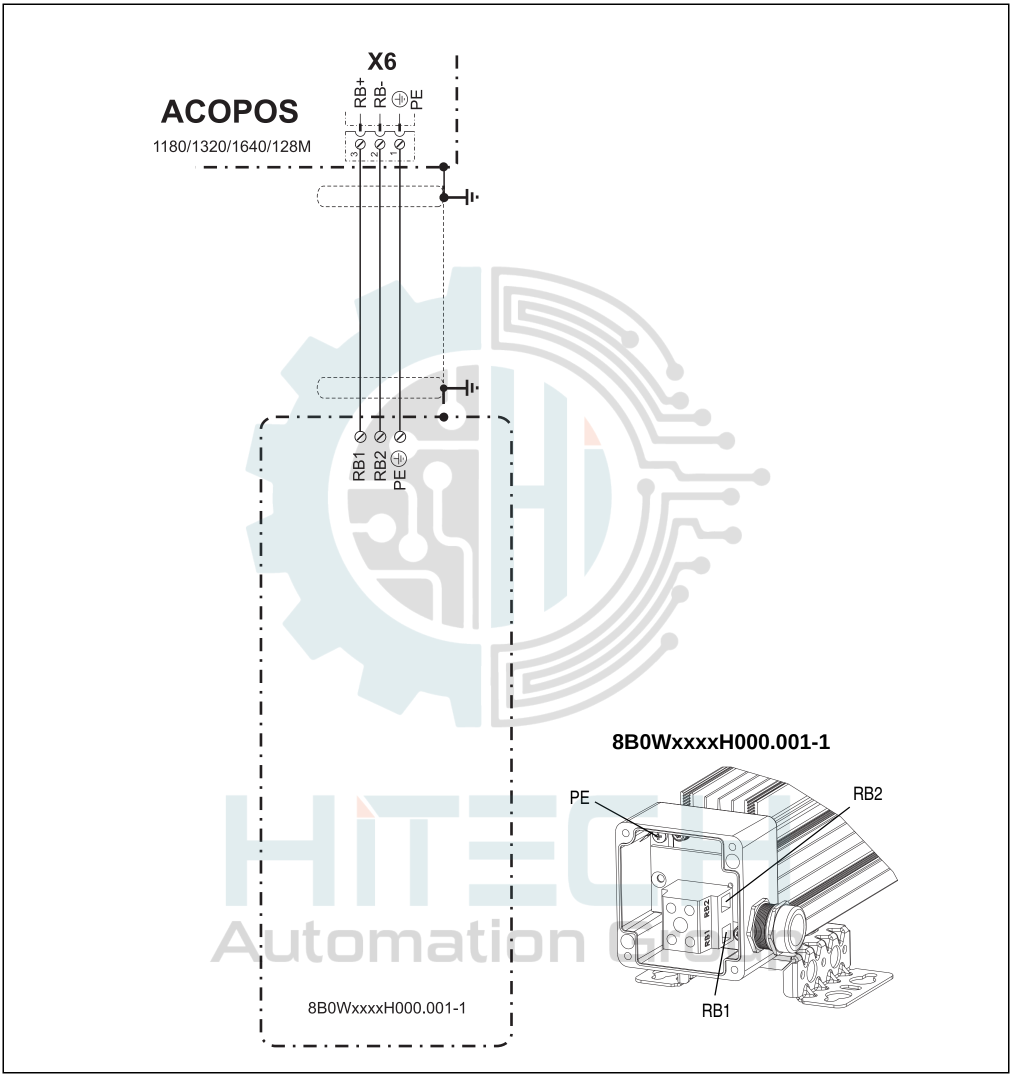


Figure 66: Overview of pin assignments - 8B0W

Information:

8B0W external braking resistors must be wired using connection cables that are suited for maximum line temperatures > 90°C.

Shielded cables must be used for wiring!

7 Pin Assignments - Plug-in modules

7.1 AC110 - CAN interface

7.1.1 Pin assignments

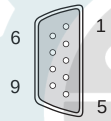
Figure	X11	Pin	Name	Function
		1	---	---
		2	CAN_L	CAN low
		3	COM (2, 7)	CAN 0 V
		4	---	---
		5	---	---
		6	---	---
		7	CAN_H	CAN high
		8	---	---
		9	---	---

Table 158: Pin assignments for AC110 - CAN interface

7.1.2 Input/output circuit diagram

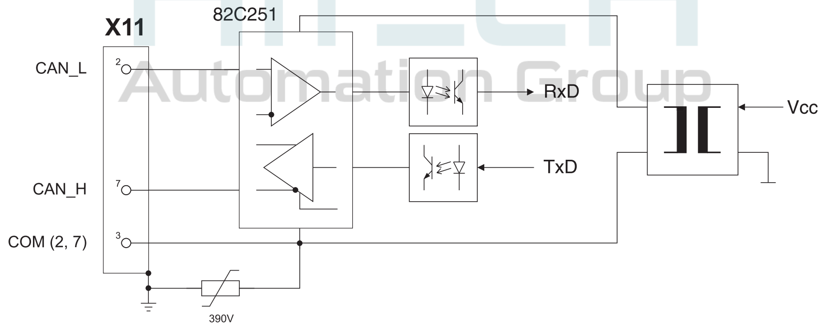


Figure 67: Input/output circuit diagram - AC110

7.2 AC114 - POWERLINK V2 interface

7.2.1 Pin assignments

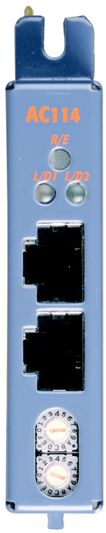
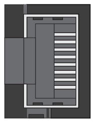
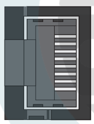
Figure	X11	Pin	Name	Function
	 1	1	RXD	Receive signal
		2	RXD\	Receive signal inverted
		3	TXD	Transmit signal
		4	Shield	Shield
		5	Shield	Shield
		6	TXD\	Transmit signal inverted
		7	Shield	Shield
		8	Shield	Shield
	X12	**Pin**	**Name**	**Function**
	 1	1	RXD	Receive signal
		2	RXD\	Receive signal inverted
		3	TXD	Transmit signal
		4	Shield	Shield
		5	Shield	Shield
		6	TXD\	Transmit signal inverted
		7	Shield	Shield
		8	Shield	Shield

Table 159: Pin assignments for AC114 - POWERLINK V2 interface

Information:

In general, crossover Ethernet cables must be used for POWERLINK connections!

Take care when plugging the cable in and out because otherwise the shield connection could break between the RJ45 plug and the cable shield which could then cause connection disturbances!

7.2 Input/output circuit diagram

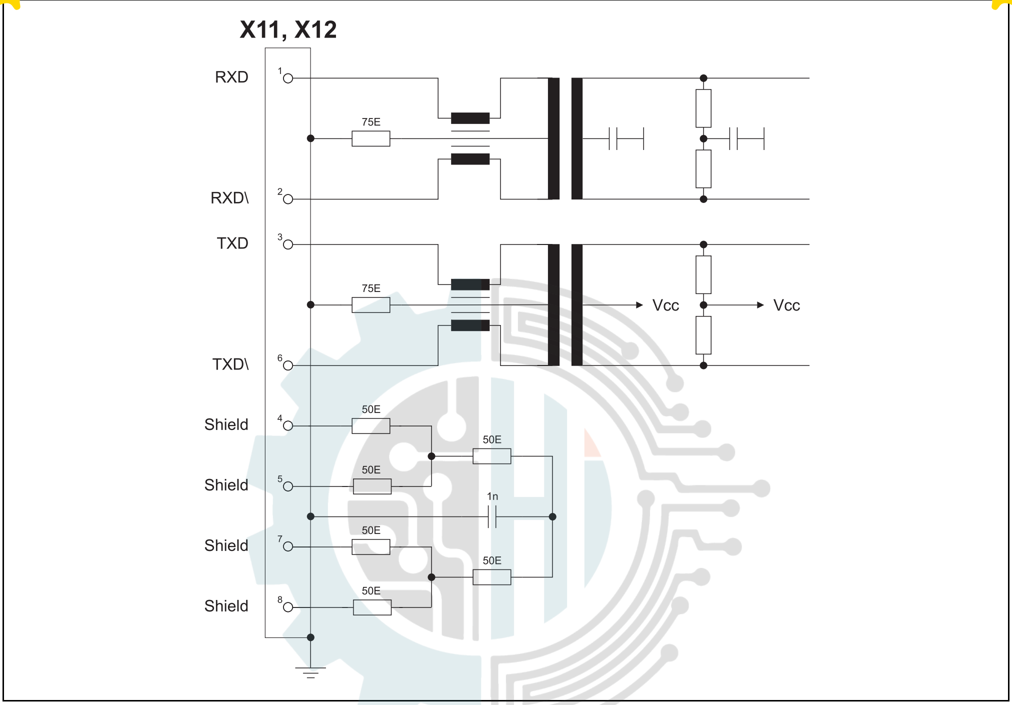


Figure 68: Input/output circuit diagram - AC114

7.3 AC120 - EnDat encoder interface

7.3.1 Pin assignments

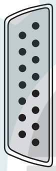
Figure	X11	Pin	Name	Function	
				EnDat mode	Incremental mode
	 15 8 9 1	1	A	Channel A	
		2	COM (1, 3 - 9, 11, 13 - 15)	Encoder supply 0 V	
		3	B	Channel B	
		4	+5V out / 0.25A	Encoder supply +5 V	
		5	D	Data input	---
		6	---	---	
		7	R\	---	Reference pulse Inverted
		8	T	Clock output	---
		9	A\	Channel A inverted	
		10	Sense COM	Sense input 0 V	
		11	B\	Channel B inverted	
		12	Sense +5V	Sense input +5 V	
		13	D\	Data Inverted	---
		14	R	---	Reference pulse
		15	T\	Clock output Inverted	---

Table 160: Pin assignments for AC120 - EnDat Encoder Interface

Danger!

The connections for the encoders are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Section 5
Wiring

7.3 Input/output circuit diagram

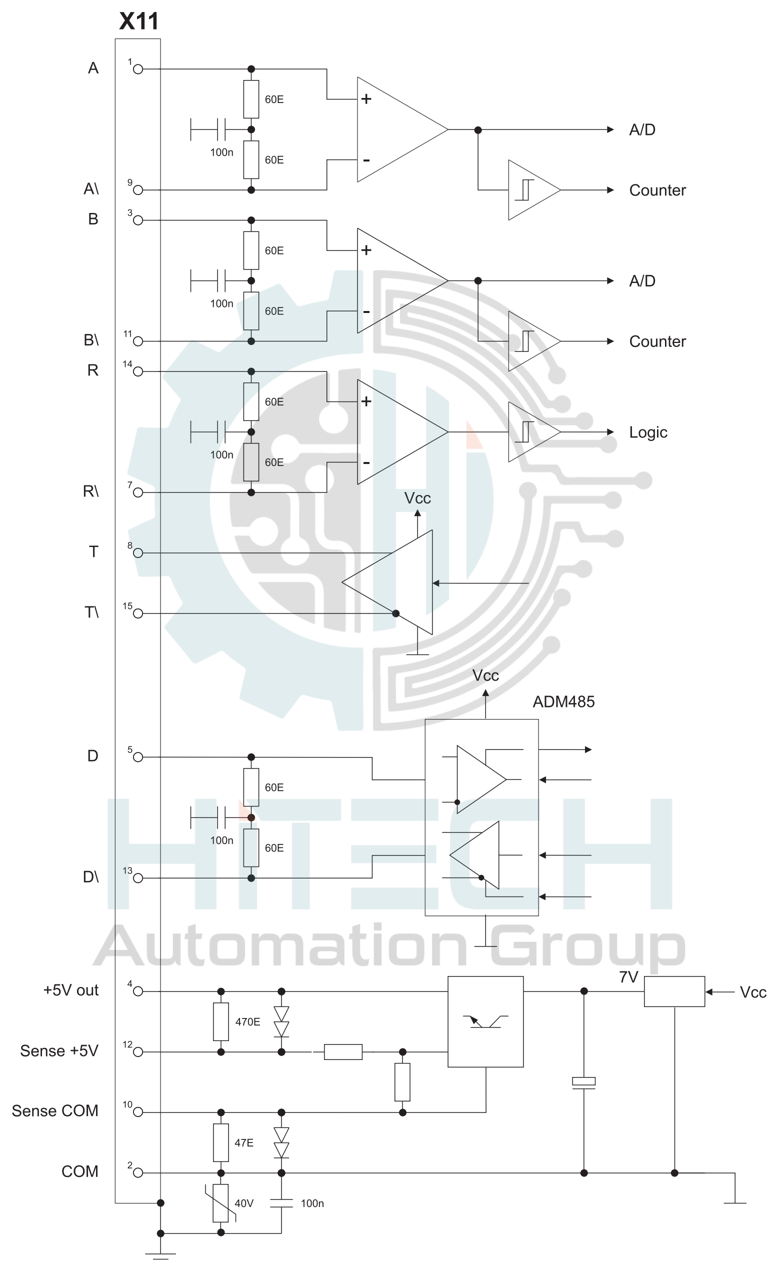


Figure 69: Input/output circuit diagram - AC120

7.4 AC121 - HIPERFACE encoder interface

7.4.1 Pin assignments

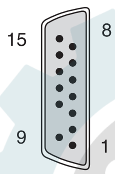
Figure	X11	Pin	Name	Function
		1	SIN	Channel SIN
		2	COM (1, 3 - 5, 9, 11, 13)	Encoder supply 0 V
		3	COS	Channel COS
		4	+8V out / 0.15A	Encoder supply +8 V
		5	D	Data
		6	---	---
		7	---	---
		8	---	--- 1)
		9	REF SIN	Reference for SIN
		10	---	--- 1)
		11	REF COS	Reference for COS
		12	---	---
		13	D\	Data inverted
		14	---	---
		15	---	---

Table 161: Pin assignments for AC121 - HIPERFACE encoder interface

1) Pins 8 and 10 are closed with plastic plugs. This prevents the accidental connection of a B&R EnDat cable.

Danger!

The connections for the encoders are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

7.4 Input/output circuit diagram

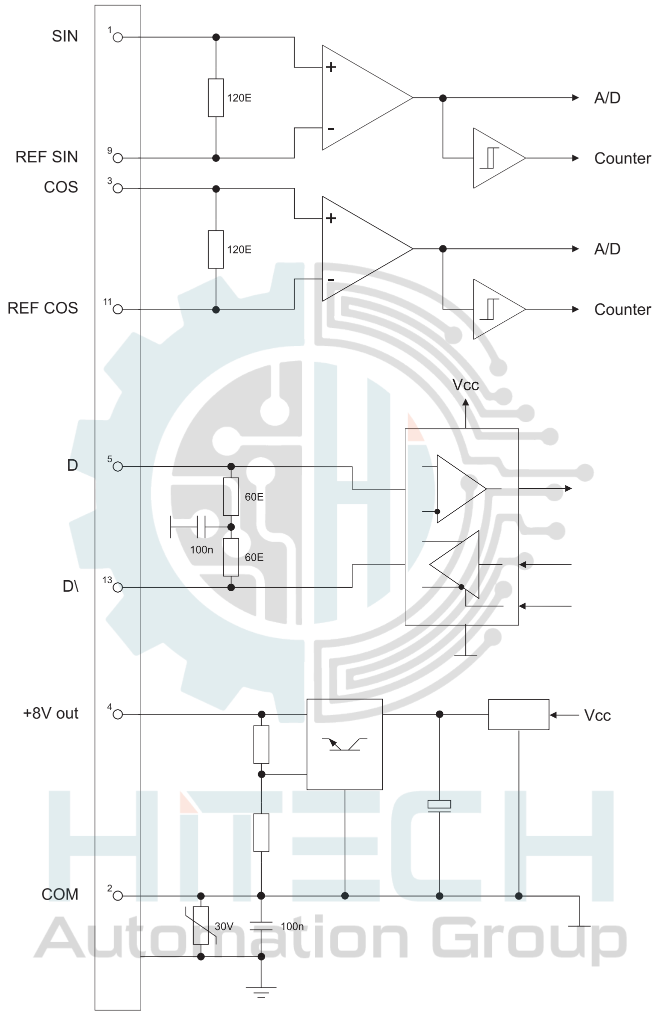


Figure 70: Input/output circuit diagram - AC121

7.5 AC122 - Resolver interface

7.5.1 Pin assignments

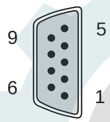
Figure	X11	Pin	Name	Function	Typical wire colors for the resolver
		1	---	---	---
		2	---	---	---
		3	S4	Sine input +	Blue
		4	S1	Cosine input -	Red
		5	R2	Reference output +	black/white (or yellow/white)
		6	---	---	---
		7	S2	Sine input -	Yellow
		8	S3	Cosine input +	Black
		9	R1	Reference output -	red/white

Table 162: Pin assignments for AC122 - Resolver interface

Danger!

The connections for the encoders are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

7.5 Input/output circuit diagram

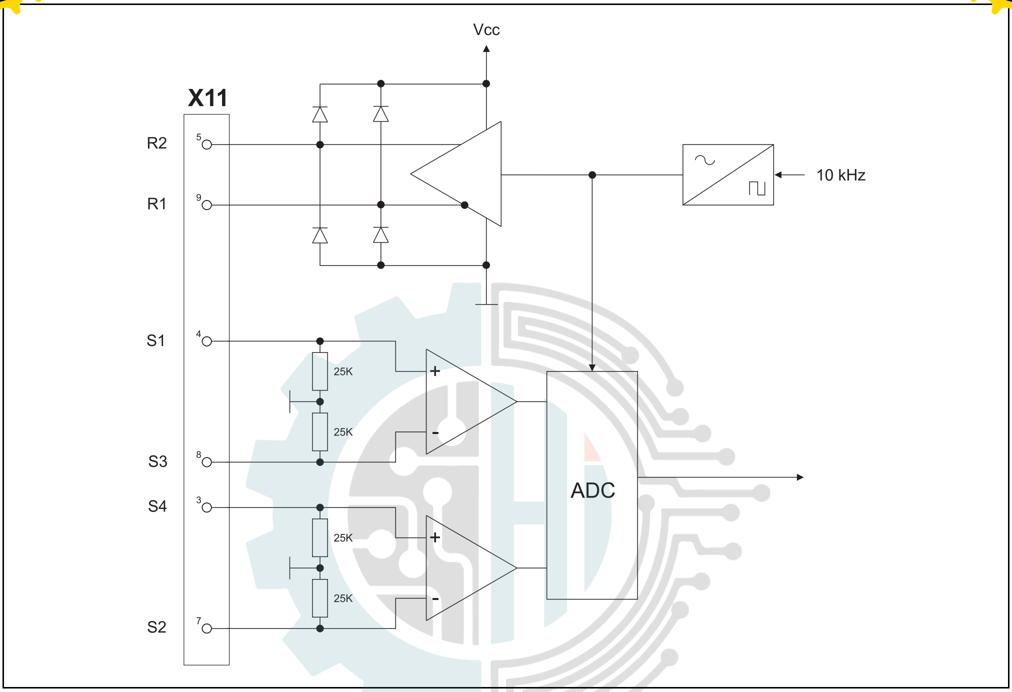


Figure 71: Input/output circuit diagram - AC122

7.6 AC123 - Incremental encoder and SSI absolute encoder interface

7.6.1 Pin assignments

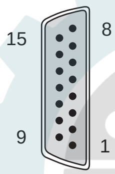
Figure	X11	Pin	Name	Function	
				Incremental mode	SSI mode
		1	A	Channel A	---
		2	A\	Channel A inverted	---
		3	B	Channel B	---
		4	B\	Channel B inverted	---
		5	RD	Reference pulse	Data input
		6	RD\	Reference pulse Inverted	Data input Inverted
		7	T	---	Clock output
		8	T\	---	Clock output Inverted
		9	+5V out / 0.35A	Encoder supply +5 V	
		10	Sense +5V	Sense +5 V	
		11	Sense COM	Sense 0 V	
		12	COM (7 - 9, 13)	Encoder supply 0 V	
		13	+15V out / 0.35A	Encoder supply +15 V	
		14	A1	Activate encoder supply [1)]	
		15	A2	Activate encoder supply [1)]	

Table 163: Pin assignments AC123 - Incremental encoder and SSI absolute encoder interface

1) To activate the encoder supply, pins 14 and 15 must be connected in the encoder cable plug.
Caution: To read from SSI encoders, the encoder supply also has to be activated if the encoder is supplied externally!

Danger!

The connections for the encoders are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

Section 5
Wiring

Input/output circuit diagram

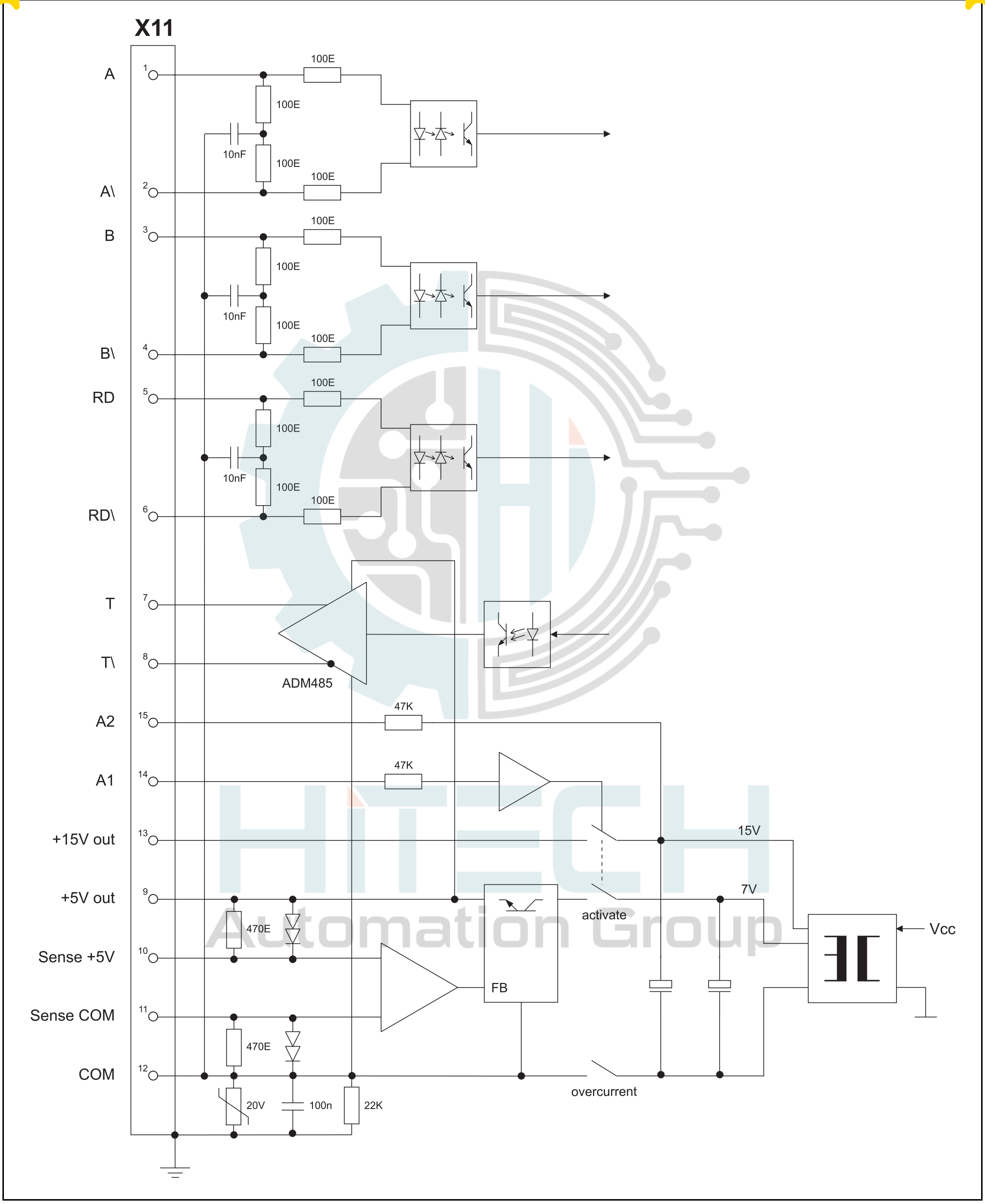


Figure 72: Input/output circuit diagram - AC123

7.7 AC125 - BiSS encoder interface

7.7.1 Pin assignments

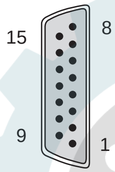
Figure	X11	Pin	Name	Function
		1	A	Channel A
		2	COM (1, 3 - 9, 11, 13 - 15)	Encoder supply 0 V
		3	B	Channel B
		4	+5V out / 0.25A	Encoder supply +5 V
		5	D	Data input
		6	---	---
		7	R\	---
		8	T	Clock output
		9	A\	Channel A inverted
		10	---	---
		11	B\	Channel B inverted
		12	---	---
		13	D\	Data inverted
		14	R	---
		15	T\	Clock output inverted

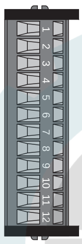
Table 164: Pin assignments for AC125 - BISS encoder interface

Danger!

The connections for the encoders are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

7.8 AC130 - Digital mixed module

7.8.1 Pin assignments

Figure	X11	Pin	Name	Function
		1	Digital I/O 1	Digital input/ouput 1
		2	Digital I/O 2	Digital input/ouput 2
		3	Digital I/O 3	Digital input/ouput 3
		4	Digital I/O 4	Digital input/ouput 4
		5	Digital I/O 5	Digital input/ouput 5
		6	Digital I/O 6	Digital input/ouput 6
		7	Digital I/O 7	Digital input/ouput 7
		8	Digital I/O 8	Digital input/ouput 8
		9	Digital O 9	Digital output 9
		10	Digital O 10	Digital output 10
		11	+24V	+24 V supply
		12	COM (1 - 11)	0 V supply

Terminal cross sections	[mm²]	[AWG]
Solid core / multiple conductor lines	0.5 - 1.5	20 - 14
Flexible, multiple wire line without Wire Tip Sleeves with Wire Tip Sleeves	 0.5 - 1.5 0.5 - 1.5	 20 - 14 20 - 14
Approbation Data (UL/C-UL-US- and CSA) UL/C-UL-US CSA	 --- ---	 26 - 14 26 - 14
Holding torque for the terminal screws [Nm]	0.2 ... 0.25	

Table 165: Pin assignments for AC130 - digital mixed module

Danger!

The digital inputs are isolated circuits. Therefore, these connections are only allowed to be connected to devices or components with at least safe isolation according to IEC 60364-4-41 or EN 61800-5-1.

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7.8 Input/output circuit diagram

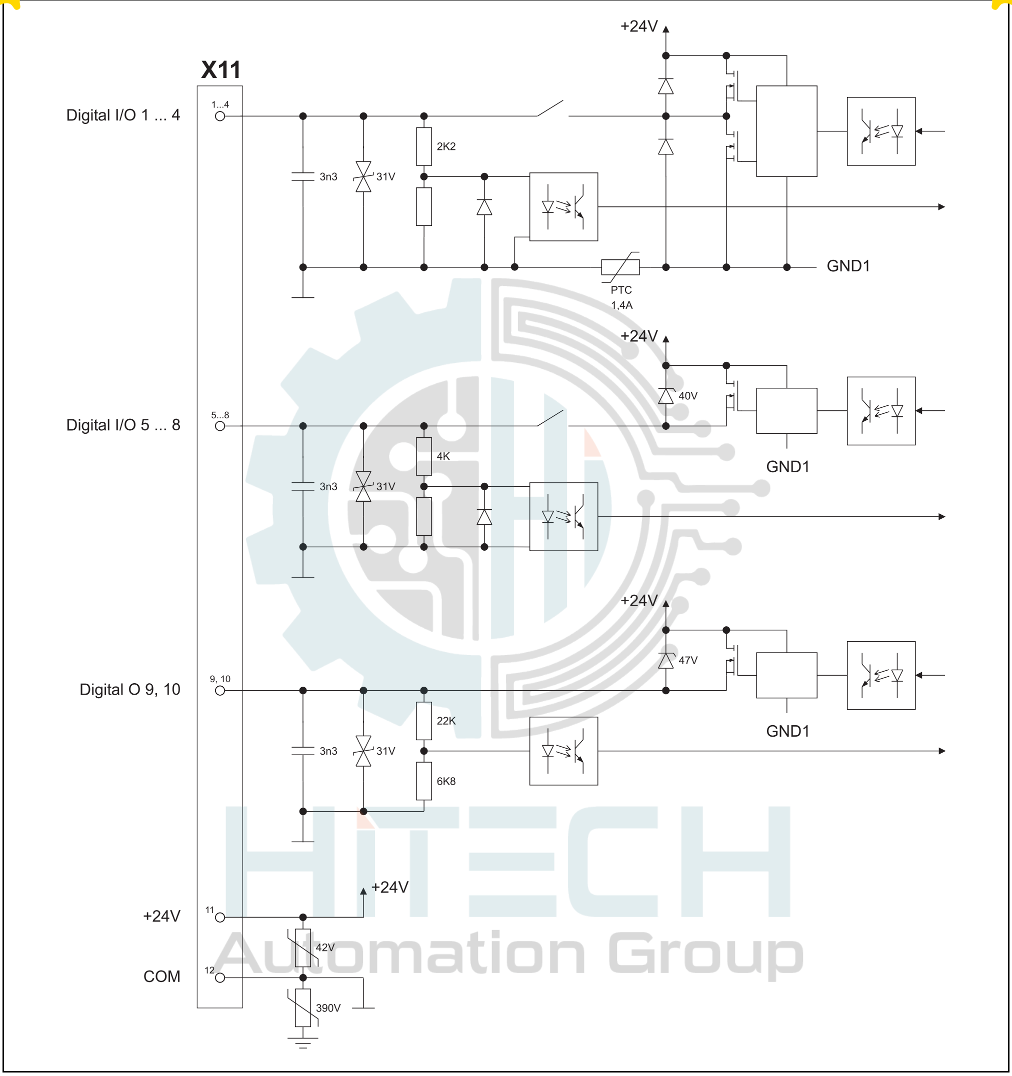
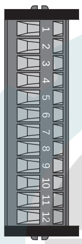


Figure 73: Input/output circuit diagram - AC130

7.9 AC131 - Mixed module

7.9.1 Pin assignments

Figure	X11	Pin	Name	Function
		1	Analog I 1 +	Analog input 1 plus
		2	Analog I 1 -	Analog input 1 minus
		3	COM (1, 2, 5, 6)	0 V analog input
		4	Shield	Shield
		5	Analog I 2 +	Analog input 2 plus
		6	Analog I 2 -	Analog input 2 minus
		7	COM (1, 2, 5, 6)	0 V analog input
		8	Shield	Shield
		9	Digital I/O 1	Digital input/ouput 1
		10	Digital I/O 2	Digital input/ouput 2
		11	+24V	+24 V supply
		12	COM (9 - 11)	0 V supply

Terminal cross sections	[mm²]	[AWG]
Solid core / multiple conductor lines	0.5 - 1.5	20 - 14
Flexible, multiple wire line without Wire Tip Sleeves with Wire Tip Sleeves	 0.5 - 1.5 0.5 - 1.5	 20 - 14 20 - 14
Approbation Data (UL/C-UL-US- and CSA) UL/C-UL-US CSA	 --- ---	 26 - 14 26 - 14
Holding torque for the terminal screws [Nm]	0.2 ... 0.25	

Table 166: Pin assignments AC131 - mixed module

7.9 Input/output circuit diagram

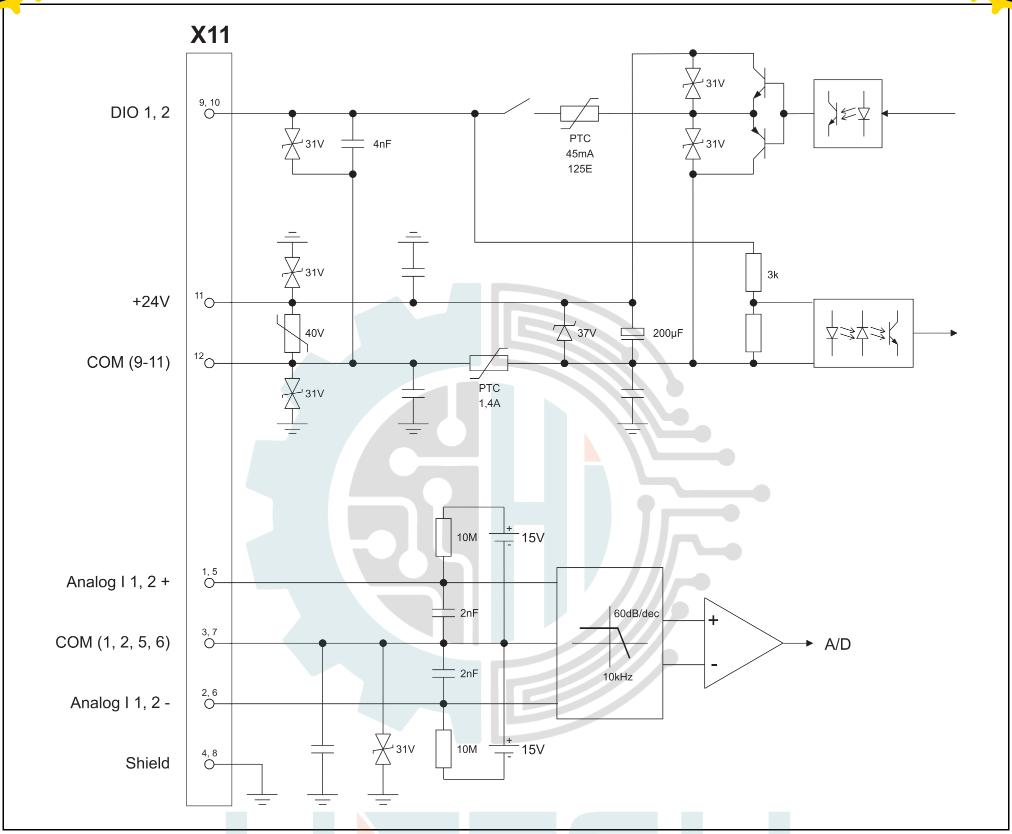


Figure 74: Input/output circuit diagram - AC131

7.2 AC140 - CPU module

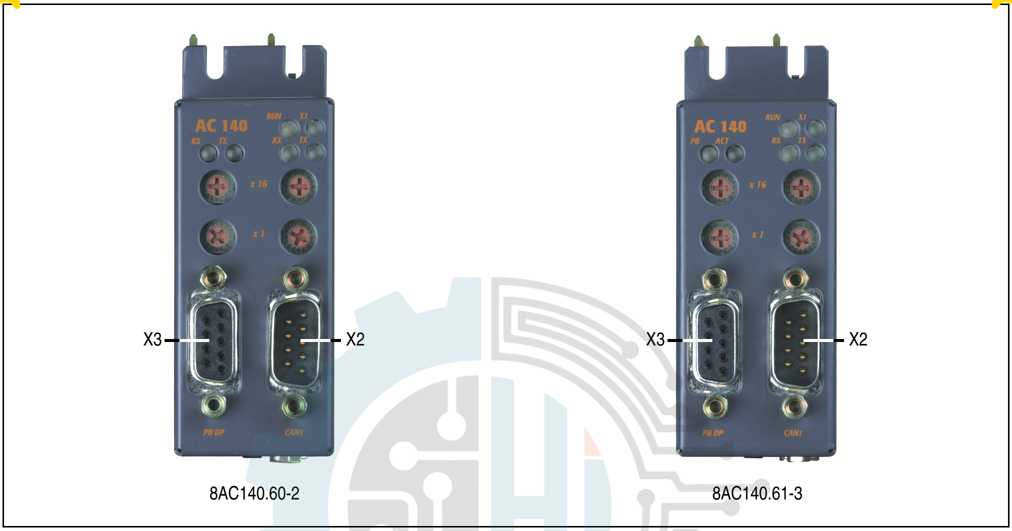


Figure 75: Overview of AC140 connections (view from front)

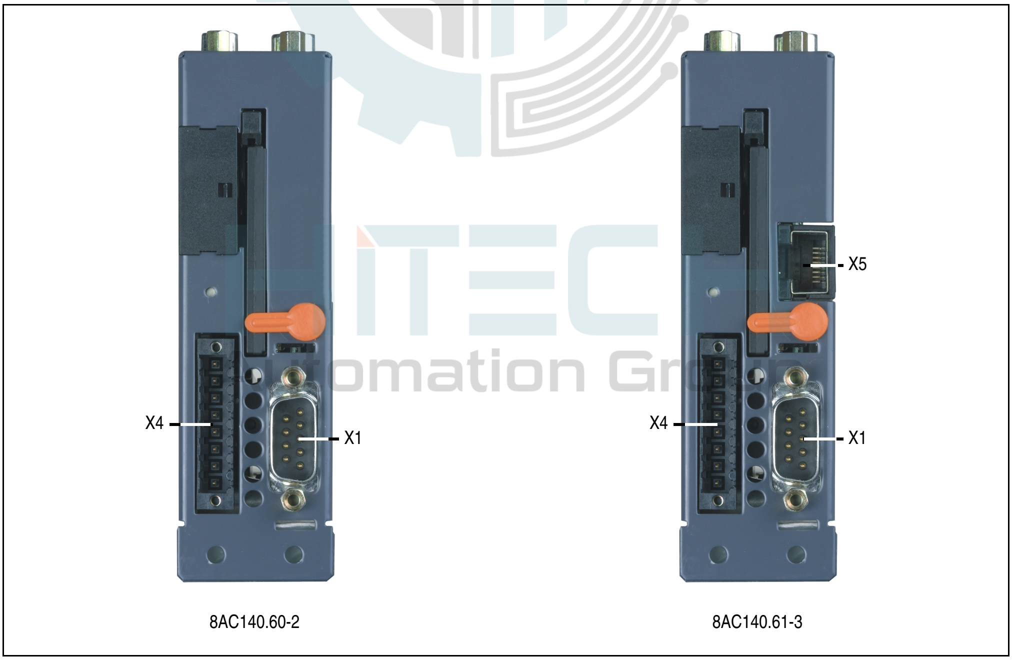
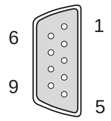


Figure 76: Overview of AC140 connections (view from below)

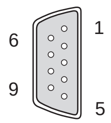
7.10.1 Application interface IF1 (RS232)



X1	Pin	Name	Function
	1	DCD	Data Carrier Detect
	2	RXD	Receive signal
	3	TXD	Transmit signal
	4	DTR	Data Terminal Ready
	5	GND	Ground
	6	DSR	Data Set Ready
	7	RTS	Request To Send
	8	CTS	Clear To Send
	9	RIN	Ring indicator

Table 167: Pin assignments - X1 (RS232)

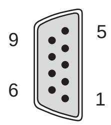
7.10.2 Application interface IF2 (CAN)



X2	Pin	Name	Function
	1	---	---
	2	CAN_L	CAN low
	3	CAN_GND	CAN 0 V
	4	---	---
	5	---	---
	6	---	---
	7	CAN_H	CAN high
	8	---	---
	9	---	---

Table 168: Pin assignments - X2 (CAN)

7.10.3 Application interface - IF3 (PROFIBUS)



X3	Pin	Name	Function
	1	---	---
	2	---	---
	3	DATA	Data
	4	CNTRL	Transmit enable
	5	PROFIBUS_GND	PROFIBUS GND (electrically isolated)
	6	+5V / 50mA	+5 V supply / 50 mA (electrically isolated)
	7	---	---
	8	DATA\	Data\
	9	CNTRL\	Transmit enable\

Table 169: Pin assignments - X3 (PROFIBUS)

7.10.4 X4 connector (inputs/outputs)

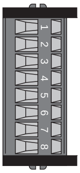
X4	Pin	Name	Function in Incremental counter Mode	Function in Period/gate measurement mode	Function in Stepper motor counter mode
	1	GND	GND		
	2	+24 VDC	Dig. supply I/O +24V 1)		
	3	Digital I/O 1	A	Counter input	
	4	Digital I/O 2	B	---	Counting direction
	5	Digital I/O 3	R	External clock	---
	6	Shield	Shield		
	7	Analog I +	Analog Input +		
	8	Analog I -	Analog Input -		

Table 170: Pin assignments - X4 (inputs/outputs)

1) The +24 V supply is only necessary for digital I/O 1 .. 3.

7.10.5 Application interface IF6 (Ethernet) 1)

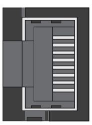
X6	Pin	Name	Function
 1	1	RXD	Receive signal
	2	RXD\	Receive signal inverted
	3	TXD	Transmit signal
	4	Termination	Termination
	5	Termination	Termination
	6	TXD\	Transmit signal inverted
	7	Termination	Termination
	8	Termination	Termination

Table 171: Pin assignments - X6 (Ethernet)

1) This interface is only available for 8AC140.61-3.

7.2 AC141 - CPU module

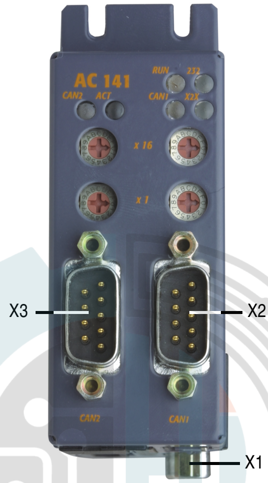


Figure 77: Overview of AC141 connections (view from front)

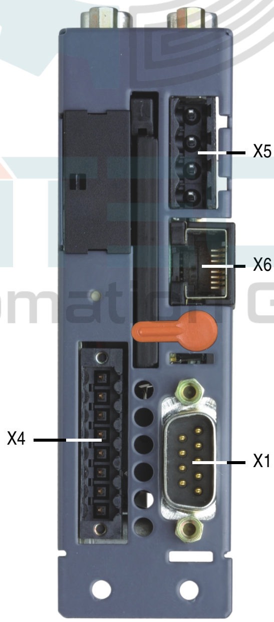


Figure 78: Overview of AC141 connections (view from below)

7.11.1 Application interface IF1 (RS232)

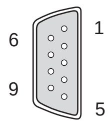
X1	Pin	Name	Function
	1	DCD	Data Carrier Detect
	2	RXD	Receive signal
	3	TXD	Transmit signal
	4	DTR	Data Terminal Ready
	5	GND	Ground
	6	DSR	Data Set Ready
	7	RTS	Request To Send
	8	CTS	Clear To Send
	9	RIN	Ring indicator

Table 172: Pin assignments - X1 (RS232)

7.11.2 Application interface IF2 (CAN1)

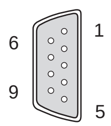
X2	Pin	Name	Function
	1	---	---
	2	CAN_L	CAN low
	3	CAN_GND	CAN 0 V
	4	---	---
	5	---	---
	6	---	---
	7	CAN_H	CAN high
	8	---	---
	9	---	---

Table 173: Pin assignments - X2 (CAN1)

7.11.3 Application interface IF3 (CAN2)

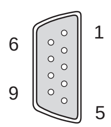
X3	Pin	Name	Function
	1	---	---
	2	CAN_L	CAN low
	3	CAN_GND	CAN 0 V
	4	---	---
	5	---	---
	6	---	---
	7	CAN_H	CAN high
	8	---	---
	9	---	---

Table 174: Pin assignments - X3 (CAN2)

7.11.4 X4 connector (inputs/outputs)

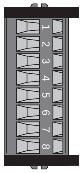
X4	Pin	Name	Function in Incremental counter Mode	Function in Period/gate measurement Mode	Function in Stepper motor counter mode
	1	GND	GND		
	2	+24 VDC	Dig. supply I/O +24V [1)]		
	3	Digital I/O 1	A	Counter input	
	4	Digital I/O 2	B	---	Counting direction
	5	Digital I/O 3	R	External clock	---
	6	Shield	Shield		
	7	Analog I +	Analog Input +		
	8	Analog I -	Analog Input -		

Table 175: Pin assignments - X4 (inputs/outputs)

1) The +24 V supply is only necessary for digital I/O 1 .. 3.

7.11.5 Application interface IF4 (X2X)

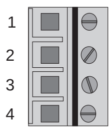
X5	Pin	Name	Function
	1	X2X	X2X data
	2	X2X⊥	X2X ground
	3	X2X\	X2X data inverted
	4	SHLD	Shield

Table 176: Pin assignments - X5 (X2X)

7.11.6 Application interface IF6 (Ethernet)

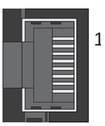
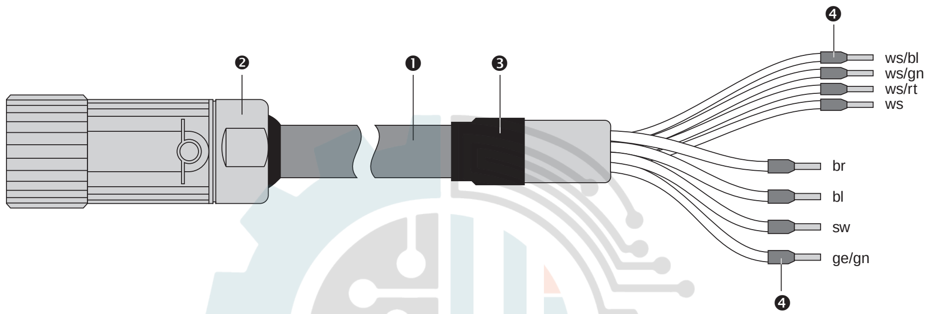
X6	Pin	Name	Function
	1	RXD	Receive signal
	2	RXD\	Receive signal inverted
	3	TXD	Transmit signal
	4	Termination	Termination
	5	Termination	Termination
	6	TXD\	Transmit signal inverted
	7	Termination	Termination
	8	Termination	Termination

Table 177: Pin assignments - X6 (Ethernet)

8 Cables

8.1 Motor cables

8.1.1 Motor cable construction



Pos.	pieces	Name	Note
1	1	Motor lines	4 x 1.5 mm² + 2 x 2 x 0.75 mm² 4 x 4 mm² + 2 x 2 x 1 mm² 4 x 10 mm² + 2 x 2 x 1.5 mm² 4 x 35 mm² + 2 x 2 x 1.5 mm² (not assembled)
2	1	Circular plug	BSTA 108 FR 19 58 0036 000 (for 8CMxxx.12-1) BSTA 108 FR 35 59 0036 000 (for 8CMxxx.12-3) CSTA 264 FR 48 25 0001 000 (for 8CMxxx.12-5)
3	1	Heat shrink tubing	
4	8	Wire tip sleeve	

Table 178: Motor cable construction

8.1.2 Pin assignments for 8CMxxx.12-1, 8CMxxx.12-3

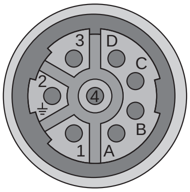
Circular plug	Pin	Name	Function
	1	U	Motor connection U
	4	V	Motor connection V
	3	W	Motor connection W
	2	PE	Protective ground conductor
	A	T+	Temperature +
	B	T-	Temperature -
	C	B+	Brake +
	D	B-	Brake -

Table 179: Pin assignments for motor cable 8CMxxx.12-1, 8CMxxx.12-3

8.1.3 Cable schematic for 8CMxxx.12-1, 8CMxxx.12-3

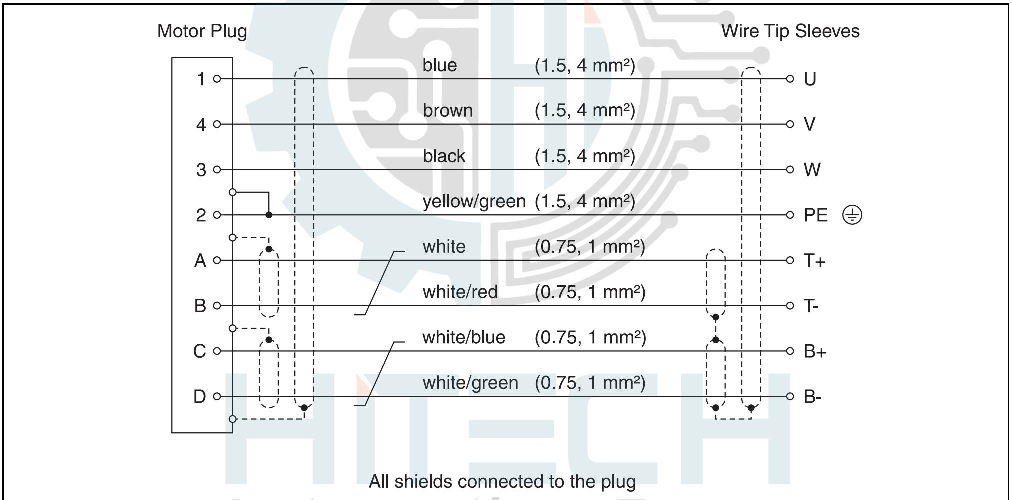


Figure 79: Cable schematic for motor cables 8CMxxx.12-1, 8CMxxx.12-3

Section 5
Wiring

8.1.4 Pin assignments for 8CMxxx.12-5

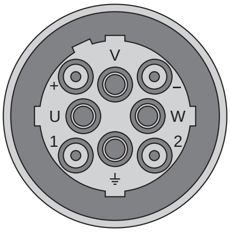
Circular plug	Pin	Name	Function
	U	U	Motor connection U
	V	V	Motor connection V
	W	W	Motor connection W
	⏚	PE	Protective ground conductor
	1	T+	Temperature +
	2	T-	Temperature -
	+	B+	Brake +
	-	B-	Brake -

Table 180: Pin assignments for motor cables 8CMxxx.12-5

8.1.5 Cable schematic for 8CMxxx.12-5

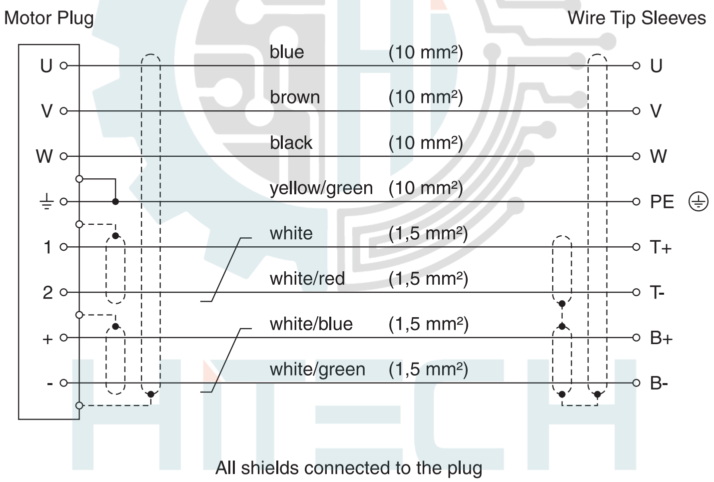
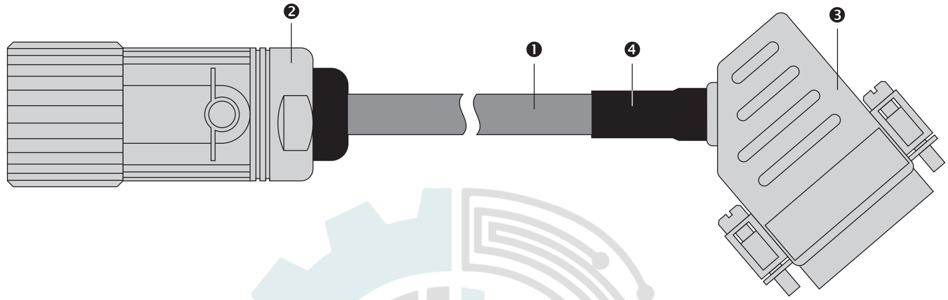


Figure 80: Cable schematic for motor cables 8CMxxx.12-5

8.2 EnDat encoder cables

8.2.1 EnDat Encoder Cable Construction

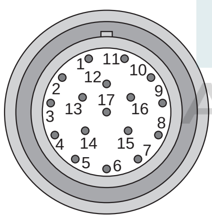


Pos.	pieces	Name	Note
1	1	Encoder cable	10 x 0.14 mm² + 2 x 0.50 mm²
2	1	Circular plug, 17-pin socket	ASTA 035 FR 11 10 0035 000
3	1	DSUB housing 45°, metal plated, 15-pin plug	
4	1	Heat shrink tubing	

Table 181: EnDat encoder cable construction

8.2.2 Pin assignments

Circular plug	Pin	Name	Function	Pin	DSUB plug
	15	A	Channel A	1	
	10	COM (1, 3 - 9, 11, 13 - 15)	Encoder supply 0 V	2	
	12	B	Channel B	3	
	7	+5V out / 0.25A	Encoder supply +5 V	4	
	14	D	Data input	5	
	8	T	Clock output	8	
	16	A\	Channel A inverted	9	
	4	Sense COM	Sense input 0 V	10	
	13	B\	Channel B inverted	11	
	1	Sense +5V	Sense input +5 V	12	
	17	D\	Data inverted	13	
	9	T\	Clock output inverted	15	



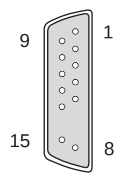


Table 182: Pin assignments for EnDat encoder cables

Section 5
Wiring

8.2 Cable schematic

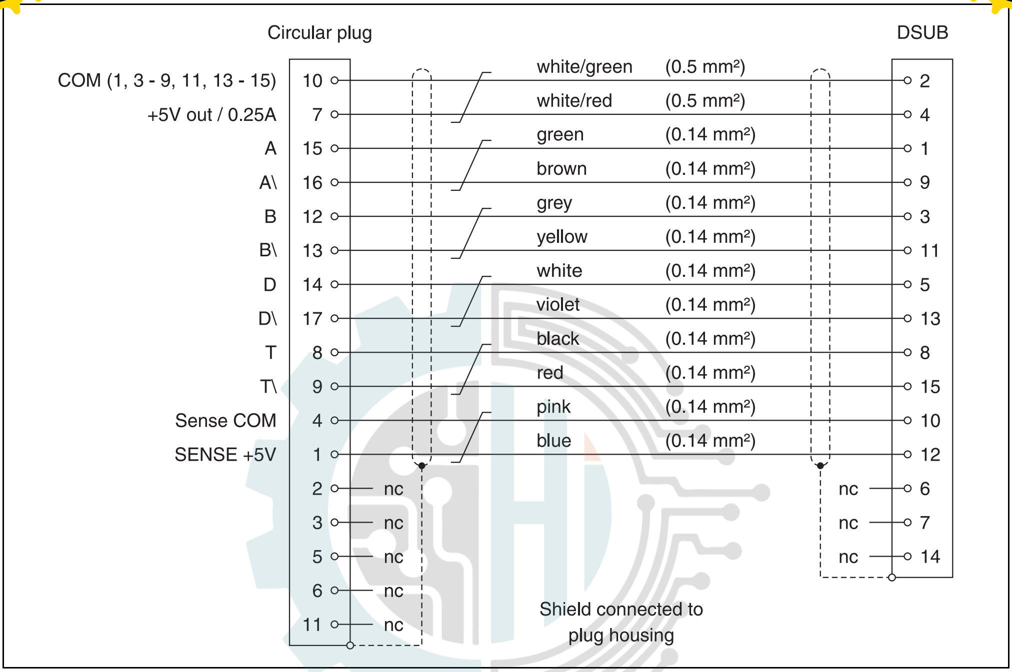
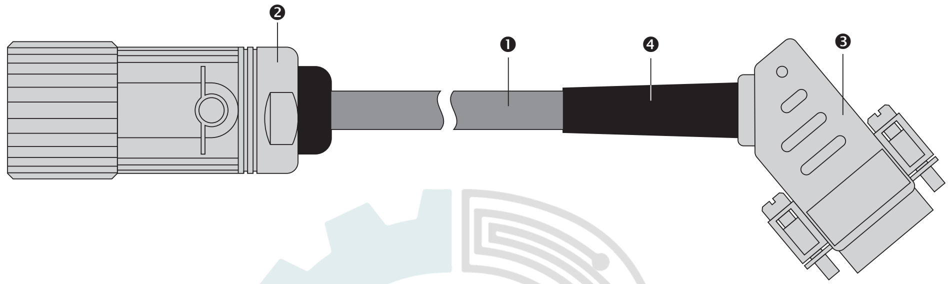


Figure 81: Cable schematic for EnDat encoder cables

8.3 Resolver cables

8.3.1 Resolver cable construction



Pos.	pieces	Name	Note
1	1	Encoder cable	3 x 2 x 24 AWG/19
2	1	Circular plug, 12-pin socket	ASTA 021 FR 11 10 0035 000
3	1	DSUB housing 45°, metal plated, 9-pin plug	
4	1	Kink protection	

Table 183: Resolver cable construction

8.3.2 Pin assignments

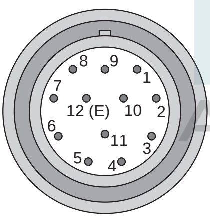
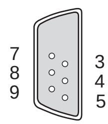
Circular plug	Pin	Name	Function	Pin	DSUB plug
	1	---			
	2	---			
	3	S4	Sine input +	3	
	4	S1	Cosine input -	4	
	5	R2	Reference output +	5	
	6	---			
	7	S2	Sine input -	7	
	8	S3	Cosine input +	8	
	9	R1	Reference output -	9	
	10	---			
	11	---			
	12	---			

Table 184: Pin assignments for resolver cable

8.3 Cable schematic

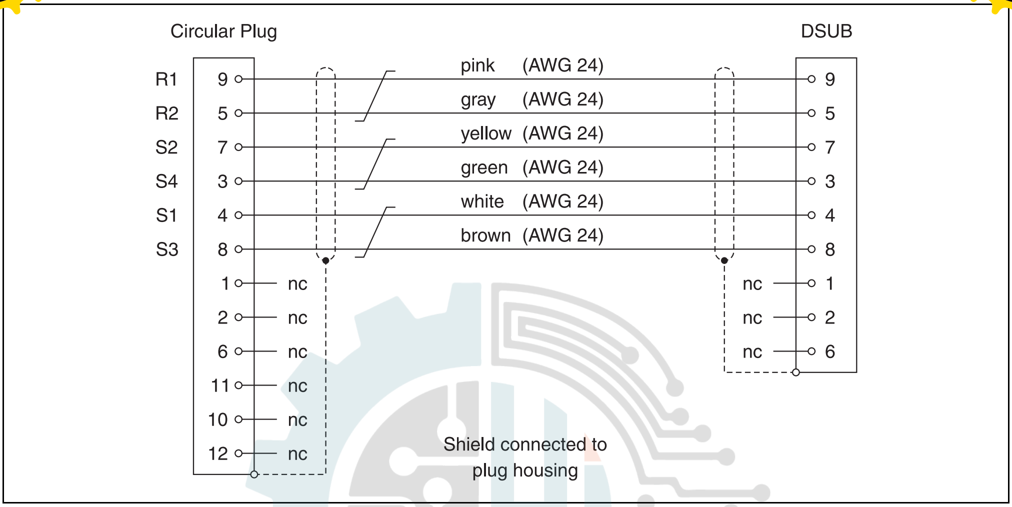


Figure 82: Cable schematic for resolver cables

Chapter 6 • Safety technology

1. Standard safety technology ("Wired safety technology")

Danger!

Especially in the area of safety technology, always consult the latest version of the User's Manual on the B&R homepage (www.br-automation.com) for the valid specifications. Specifications in previous versions are not necessarily up-to-date. Users should verify the correctness of the data before implementing any safety functions.

1.1 General information

ACOPOS servo drives use integrated safe pulse disabling for secure shutdown and to prevent unwanted startup. This is designed to meet the following safety classifications depending on the external circuit: 1)

Criteria	Characteristic value
Maximum safety category according to EN ISO 13849 or EN 954-1 1)	KAT 3
Maximum performance level acc. EN ISO 13849	PL d
Maximum safety integrity level acc. IEC 62061	SIL 2
Maximum safety integrity level acc. IEC 61508	SIL 2
PFH (Probability of dangerous Failure per Hour)	$< 4 * 10^{-9}$
PFD (Probability of dangerous Failure on demand)	$< 4 * 10^{-4}$ at a proof test interval of 10 years $< 7 * 10^{-4}$ at a proof test interval of 20 years
PT (Proof Test Interval) 2)	Max. 20 years
DC (Diagnostic Coverage)	99 %
MTTFd (Mean Time To Failure - dangerous)	> 140 years

Table 1: Safety classifications, criteria and characteristics for safe pulse disabling

1) EN 954-1 is no longer valid and has been replaced by EN ISO 13849.
2) Corresponds to the service life of the module.

1) A detailed explanation of the standards and safety functions can be found in chapter 7, "Standards and Certifications".

The following table provides an overview of the individual safety functions that can be implemented:

Label according to standard		Short description
EN 61800-5-2	EN 60204-1	
STO (Safe Torque Off)	Stop Category 0	Power supply cut off
SS1 (Safe Stop 1)	Stop Category 1	Introduction of active braking and activation of the STO function after a defined amount of time has expired
SS2 (Safe Stop 2)	Stop Category 2	Introduction of active braking and activation of the SOS function after a defined amount of time has expired
SLS (Safely-Limited Speed)	---	Protection against exceeding a defined limit speed
SOS (Safe Operating Stop)	---	Protection against impermissible position deviation

Table 2: Overview of safety functions according to standard

Safe pulse disabling interrupts the power supply to the motor by preventing the pulses to the IGBTs over one channel. In this way, a rotating field can no longer be created in synchronous and induction motors controlled by the ACOPOS servo drives.

Therefore, integrated safe pulse disabling meets the requirements for preventing unwanted startup in accordance to EN 1037 as well as the requirements in regard to Category 0 and 1 stop functions in accordance with EN 60204-1. Both stop functions require the supply to the machine drives to be switched off (immediately for Category 0 and after reaching standstill for Category 1). The requirements in regard to the safety functions STO, SS1, SS2, SLS and SOS are also met in accordance to EN 61800-5-2.

Subsequently, the nomenclature of EN 61800-5-2 (STO, SS1, SS2, SLS, SOS) will always be taken into consideration.

1.2 Principle - Implementing the safety function

Secure pulse disabling is obtained by removing the IGBT driver supply in the ACOPOS servo drives. Terminals X1 / Enable and X1 / COM (8, 9) are used to supply an integrated DC-DC converter with 24 VDC. The converter creates the supply voltage for the IGBT driver from this voltage.

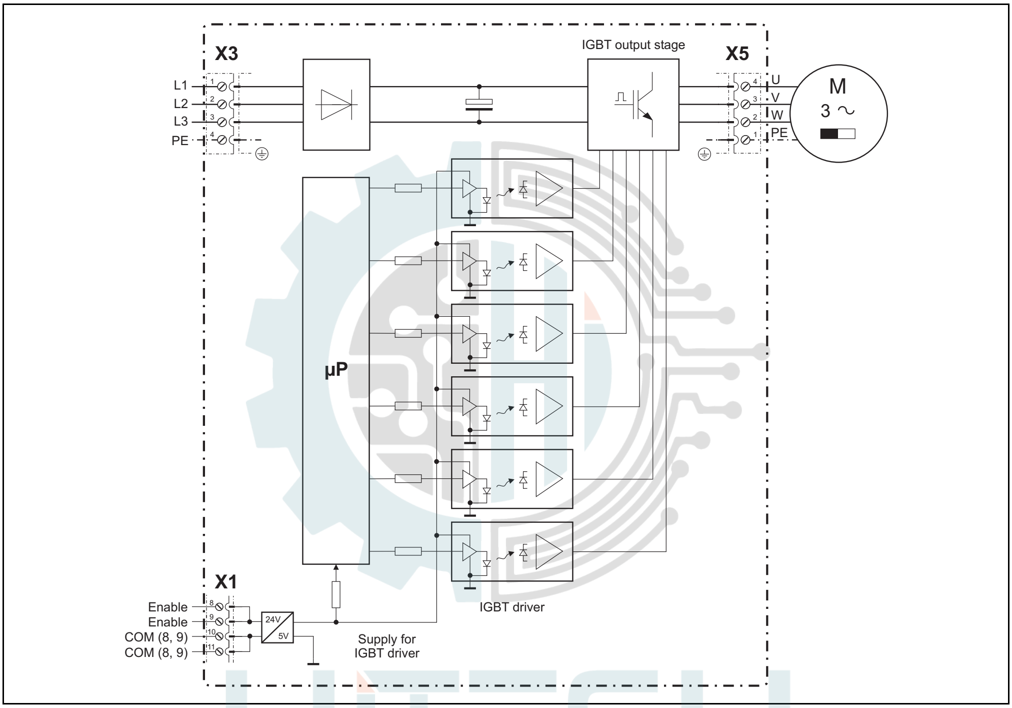


Figure 1: Block diagram of secure pulse disabling

If the 24 VDC voltage supply for the DC-DC converter is interrupted, the IGBT driver is also no longer supplied. It is then no longer possible to transfer the modulation pattern needed to generate the rotating field on the IGBT output stage. The supply of power to the motor is cut off.

1.2 Additional function

The availability of the DC-DC converter's output voltage is requested from the microprocessor. If voltage is not present on the output of the DC-DC converter, then generation of the modulation pattern is suppressed by the microprocessor.

Danger!

After activating safe pulse disabling using terminals X1 / Enable and X1 / COM(8, 9), the motor is de-energized and therefore torque-free. If the motor was moving before activation of safe pulse disabling, it is only stopped by a safe operational brake (available under certain conditions) or from the friction of the entire system. Therefore, the motor is not able to hold hanging loads. Holding brakes must be used for this purpose.

For applications where this can be dangerous, the desired level of protection cannot be obtained.

Danger!

Keep in mind the turn-off time for the enable input, since this has a considerable effect on the response time of the safety functions and therefore the remaining distances and times. In order to calculate the total safety response time, the user must validate the lag-time over the entire system.

The turn-off time for the enable input can be found in the technical data for the respective ACOPOS inverter module.

Danger!

Activation of safe pulse disabling via the terminals X1 / Enable1 and X1 / COM (8, 9) is not sufficient for achieving a voltage-free drive and therefore does not provide sufficient protection against electrical shock!

Danger!

Depending on the application, it is possible for the drive to startup again after deactivating safe pulse disabling.

Danger!

The brake controller integrated in the ACOPOS servo drives and the holding brake integrated in the B&R standard motors are sufficient for the maximum category B in accordance to EN ISO 13849-1.

Additional measures must be taken to achieve higher safety categories.

Danger!

The respective C-standards for the applications must be adhered to!

Information:

Take note that multiple errors in the IGBT bridge can cause a short forward movement. The maximum rotary angle φ of the forward movement on the motor shaft depends on the motor used. For permanently excited synchronous motors, $\varphi = 360°/2p$ (for B&R standard motors, $p = 3$ and the angle is therefore 60°). For three-phase asynchronous motors, there is a relatively small angle of rotation (between 5° and 15°).

For applications where this can be dangerous, the desired level of protection cannot be obtained.

1.3 Enable input connected according to Safety Category 3 / SIL 2 / PL d

In the example of the STO safety function, different circuit variations for the Enable inputs on ACOPOS servo drives are displayed according to the Safety Category 3 / SIL / PL d.

Danger!

All errors (e.g. cross circuit) that are not detected can lead to a loss of safety functioning.

Suitable measures that justify a faulty connection for the error must be taken. In accordance with EN ISO 13849-2, appendix D.5, errors caused by short-circuit between any two conductors that are

- **permanently wired and protected against external damage, e.g. via cable duct, armored conduit, or**
- **in different sheathed cables, or**
- **within an area for electrical equipment [1), or]**
- **which are each individually protected via ground connection**

can be ruled out. [2)]

To achieve Safety Category 3 / SIL 2 / PL d, it must be ensured that a single error does not lead to a loss of safety functioning.

1) This requires that the lines as well as the area for electrical equipment meet the respective requirements (see IEC 60204-1).

2) For more exclusions of errors, see EN ISO 13849-2, appendix D.5.

1.3.1 STO, Category 3 / SIL 2 / PL d (Variant A)

The input X1 / Enable and X1 / COM (8, 9) of the ACOPOS servo drive are supplied via a safe digital output (Out1+, Out1-). If the safety function is requested, then the safe digital output separates input X1 / Enable and X1 / COM (8, 9).

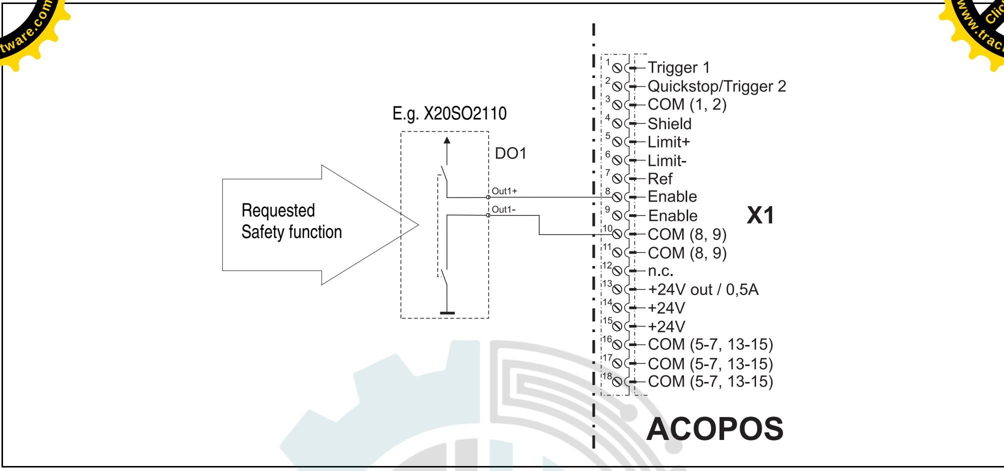


Figure 2: STO, Category 3 / SIL 2 / PL d (Variant a)

Danger!

At least one safe digital output module with the Category 3 / SIL 2 / PL d must be used for the displayed DO1 digital output.

The instructions in the safe digital output module's user documentation must be followed!

The test signals on the safe digital output module must be turned off.

1.3 STO, Category 3 / SIL 2 / PL d (Variant B)

When an E-stop button is pressed, the Enable input on the ACOPOS servo drive is separated by a switch from the +24 V supply, thereby cutting off the motor's power supply.

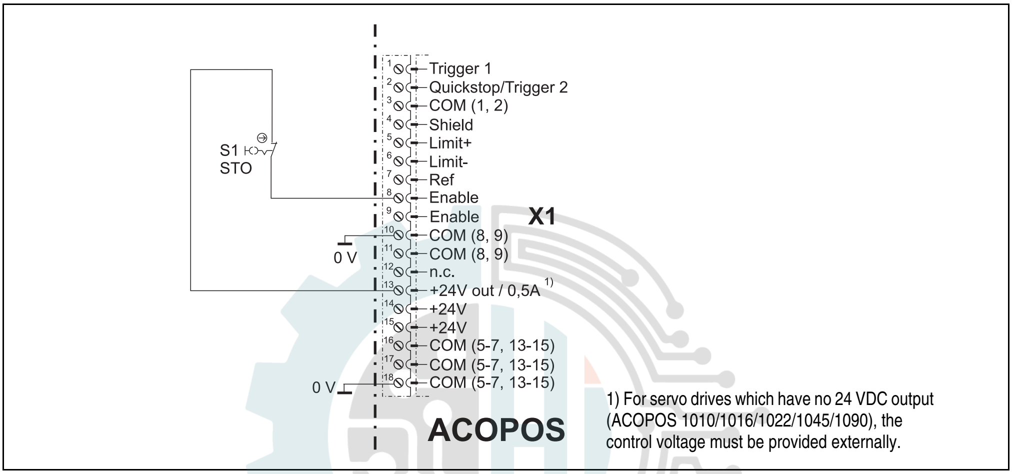


Figure 3: STO, Category 3 / SIL 2 / PL d (Variant B)

Danger!

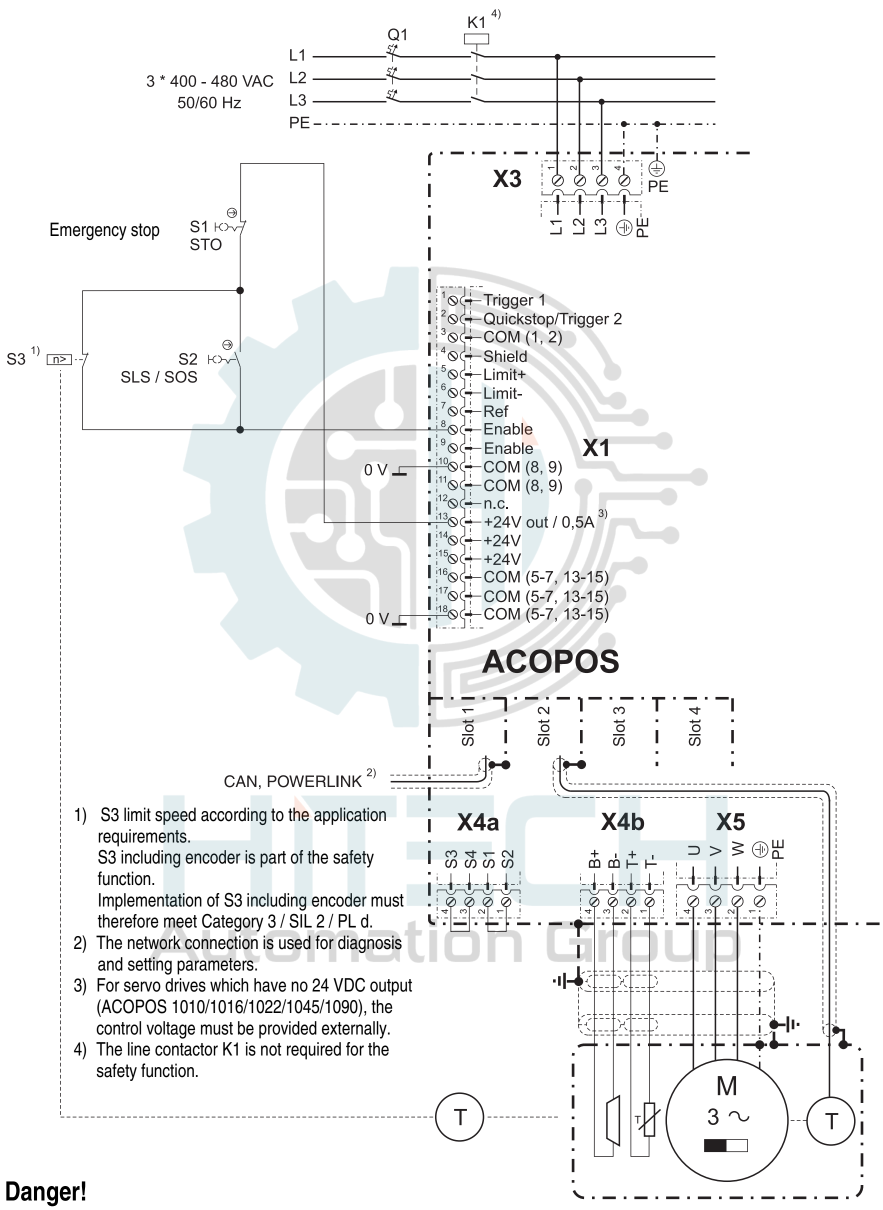
The S1 switch displayed requires the use of a one-pin switching device (Category 3 / SIL 2 / PL d) with a positive opening contact according to EN 60947-5-1.

The instructions in the switching device's user documentation must be followed!

1.4 Enable input circuits according to Safety Category 3 / SIL 2 / PL d and functionality (STO, SS1, SS2, SLS, SOS)

The following illustrates exemplary wiring suggestions for the external circuit of the Enable input on ACOPOS servo drives. The examples vary by safety classification in accordance to EN 60204-1, ISO 13849 and EN 61800-5-2 and according to the safety function (STO, SS1, SS2, SLS, SOS).

1.4 STO, SLS, SOS - Safety category 3 / SIL 2 / PL d



1) S3 limit speed according to the application requirements.
S3 including encoder is part of the safety function.
Implementation of S3 including encoder must therefore meet Category 3 / SIL 2 / PL d.
2) The network connection is used for diagnosis and setting parameters.
3) For servo drives which have no 24 VDC output (ACOPOS 1010/1016/1022/1045/1090), the control voltage must be provided externally.
4) The line contactor K1 is not required for the safety function.

Danger!

The brake shown in this image as well as the brake control from the ACOPOS servo drive are not part of the safety function!

Figure 4: STO, SLS, SOS - Safety category 3 / SIL 2 / PL d

Description

STO:

The Enable input on the ACOPOS servo drive is separated by pressing the S1 E-stop button. As a result, the supply of power to the motor is cut off.

This guarantees that the supply of power to the motor is immediately cut off.

Secure restart inhibit:

If you open and lock E-stop switch S1, unexpected startup is prevented.

SLS:

The SLS safety function is activated by opening the S2 switch. The switching contact of the S3 rotation speed monitor is opened when the limit speed set on the rotation speed monitor is exceeded. This separates the Enable input of the ACOPOS servo drive. As a result, the supply of power to the motor is cut off.

This guarantees that the supply of power to the motor is immediately cut off when the limit speed set on the S3 rotation speed monitor is exceeded.

SOS:

The SOS safety function is activated by opening the S2 switch. The switching contact of the rotation speed monitor is opened when the S3 standstill monitor is activated. This separates the Enable input of the ACOPOS servo drive. As a result, the supply of power to the motor is cut off.

This guarantees that the supply of power to the motor is immediately cut off when the S3 standstill monitor is activated.

Information about SLS and SOS:

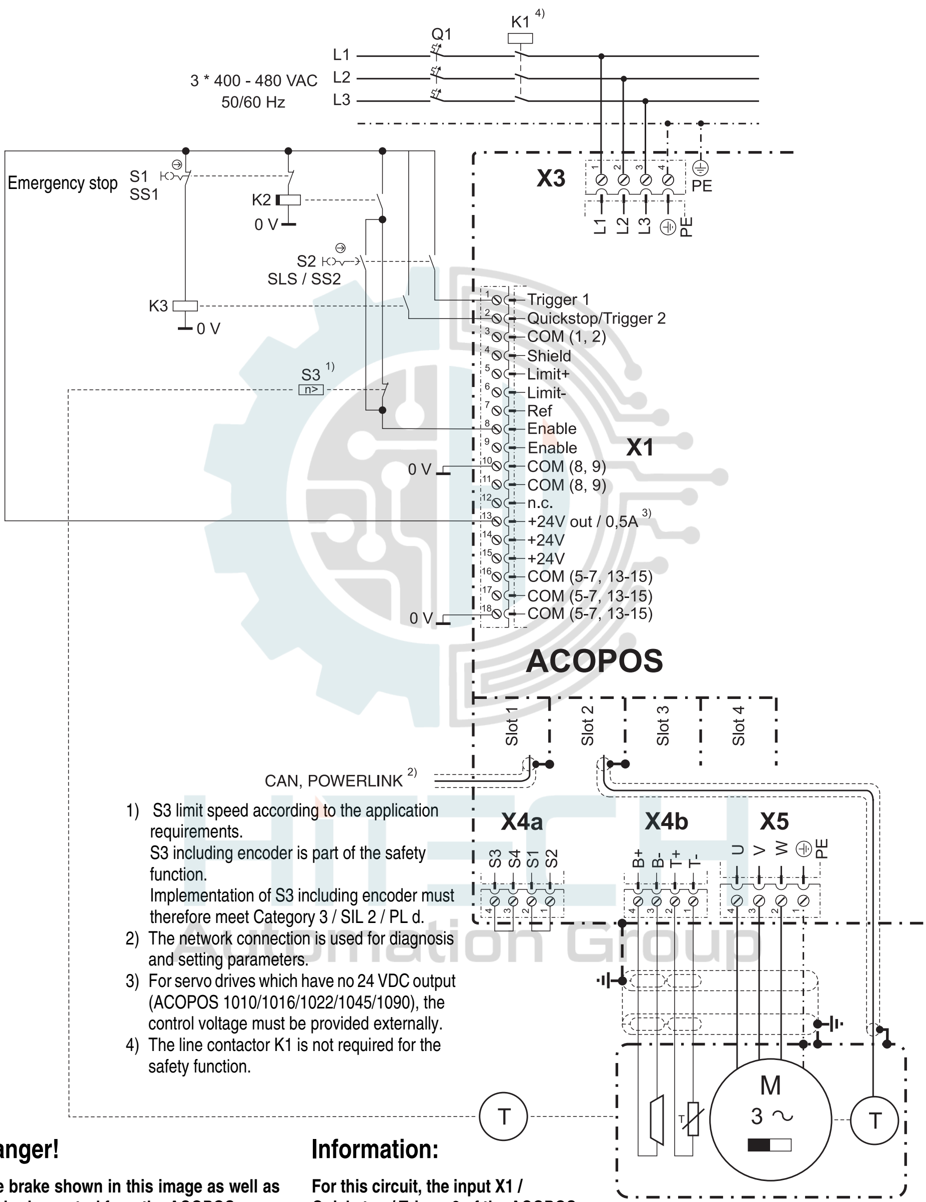
The SLS safety function or the SOS safety function can be implemented depending on the function of the S3 switching device (rotation speed monitor or standstill monitor).

Danger!

The S1 and S2 switches displayed require the use of a one-pin switching device (Category 3 / SIL 2 / PL d) with a positive opening contact according to EN 60947-5-1. A one-pin switching device (Category 3 / SIL 2 / PL d) must be used for the displayed S3 switching device.

The instructions in the switching device's user documentation must be followed!

1.4 SS1, SLS, SS2 - Safety Category 3 / SIL 2 / PL d (Variant A)



1) S3 limit speed according to the application requirements.
S3 including encoder is part of the safety function.
Implementation of S3 including encoder must therefore meet Category 3 / SIL 2 / PL d.
2) The network connection is used for diagnosis and setting parameters.
3) For servo drives which have no 24 VDC output (ACOPOS 1010/1016/1022/1045/1090), the control voltage must be provided externally.
4) The line contactor K1 is not required for the safety function.

Danger!

The brake shown in this image as well as the brake control from the ACOPOS servo drive are not part of the safety function!

Information:

For this circuit, the input X1 / Quickstop / Trigger2 of the ACOPOS servo drive must be configured as a quickstop for this connection.

Figure 5: SS1, SLS, SS2 - Safety Category 3 / SIL 2 / PL d (Variant A)

Section 6
Safety technology

Description

SS1:

Pressing e-stop switch S1 causes relay K3 to be released. As a result, an active braking procedure is triggered via the input X1 / Quickstop / Trigger2 of the ACOPOS servo drive.

The K2 auxiliary relay with drop-out time is released after a defined amount of time. This separates the Enable input of the ACOPOS servo drive. As a result, the supply of power to the motor is cut off.

This guarantees that the supply of power to the motor is cut off after a defined amount of time.

Secure restart inhibit:

If you open and lock E-stop switch S1, unexpected startup is prevented.

SLS:

Opening the switch S2 will activate the SLS safety function and trigger an active braking procedure via the input X1 / Trigger1 of the ACOPOS servo drive. After a defined amount of time, speed monitoring will be activated on the speed monitor S3. If the defined limit speed is exceeded, then the enable input of the ACOPOS servo drive is cleared via the switching contact of the speed monitor S3.

This guarantees that the supply of power to the motor is immediately cut off when the limit speed set on the rotation speed monitor S3 is exceeded.

SS2:

Opening the switch S2 will activate the SS2 safety function and trigger an active braking procedure via the input X1 / Trigger1 of the ACOPOS servo drive. After a defined amount of time, standstill monitoring will be activated on the standstill monitor S3. If the defined tolerance limit is exceeded (standstill monitor S3 is activated), then the enable input of the ACOPOS servo drive is cleared via the switching contact of the standstill monitor S3.

This guarantees that the supply of power to the motor is immediately cut off when the standstill monitor S3 is activated.

Information about SLS and SS2:

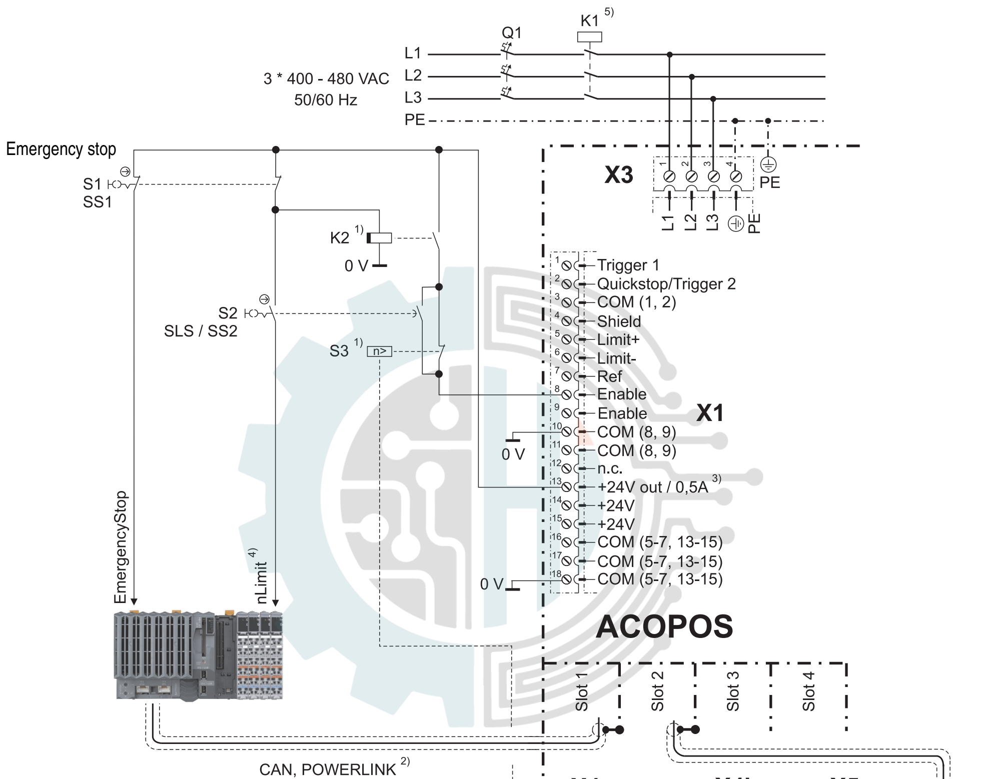
The SLS safety function or the SS2 safety function can be implemented depending on the function of the S3 switching device (rotation speed monitor or standstill monitor).

Danger!

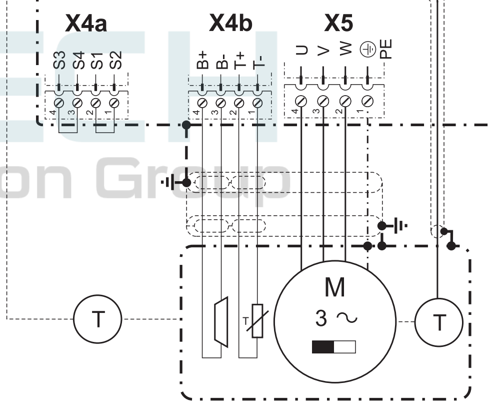
The S1 and S2 switches displayed require the use of a one-pin switching device (Category 3 / SIL 2 / PL d) with a positive opening contact according to EN 60947-5-1. A one-pin switching device (Category 3 / SIL 2 / PL d) must be used for the displayed K2 relay and the S3 switching device.

The instructions in the switching device's user documentation must be followed!

1.4 SS1, SLS, SS2 - Safety Category 3 / SIL 2 / PL d (Variant B)



1) Drop-out time lag of K2 and limit speed of S3 according to the application requirements. The K2 auxiliary relay with drop-out time lag and the S3 (including encoder) are part of the safety function. Implementation of K2 and S3 including encoder must therefore meet Category 3 / SIL 2 / PL d.
2) The network connection is used to transfer the interruption command for active braking, for diagnosis and setting parameters.
3) For servo drives that have no 24 VDC output (ACOPOS 1010/1016/1022/1045/1090), the control voltage must be provided externally.
4) Information about the status of the "EmergencyStop" digital input is also contained in the status of the "nLimit" digital input.
5) The line contactor K1 is not required for the safety function.



Danger!

The brake shown in this image as well as the brake control from the ACOPOS servo drive are not part of the safety function!

Figure 6: SS1, SLS, SS2 - Safety Category3 / SIL 2 / PL d (Variant B)

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Description

SS1:

When the e-stop switch S1 is pressed, the "EmergencyStop" digital input on the controller triggers active braking (see "Code example", on page 317).

The K2 auxiliary relay with drop-out time is released after a defined amount of time. This separates the Enable input of the ACOPOS servo drive. As a result, the supply of power to the motor is cut off.

This guarantees that the supply of power to the motor is cut off after a defined amount of time.

Secure restart inhibit:

If you open and lock E-stop switch S1, unexpected startup is prevented.

SLS:

Opening the switch S2 will activate the safety function SLS and trigger an active braking procedure via the digital input "nLimit" on the controller (see "Code example", on page 317). After a defined amount of time, speed monitoring will be activated on the speed monitor S3. If the defined limit speed is exceeded, then the enable input of the ACOPOS servo drive is cleared via the switching contact of the speed monitor S3.

This guarantees that the supply of power to the motor is immediately cut off when the limit speed set on the rotation speed monitor S3 is exceeded.

SS2:

Opening the switch S2 will activate the safety function SS2 and trigger an active braking procedure via the digital input "nLimit" on the controller (see "Code example", on page 317). After a defined amount of time, standstill monitoring will be activated on the standstill monitor S3. If the defined tolerance limit is exceeded (standstill monitor S3 is activated), then the enable input of the ACOPOS servo drive is cleared via the switching contact of the standstill monitor S3.

This guarantees that the supply of power to the motor is immediately cut off when the standstill monitor S3 is activated.

Information about SLS and SS2:

The SLS safety function or the SS2 safety function can be implemented depending on the function of the S3 switching device (rotation speed monitor or standstill monitor).

Danger!

The S1 and S2 switches displayed require the use of two or one-pin switching devices (Category 3 / SIL 2 / PL d) with a positive opening contact according to EN 60947-5-1. A one-pin switching device (Category 3 / SIL 2 / PL d) must be used for the displayed K2 relay and the S3 switching device.

The instructions in the switching device's user documentation must be followed!

Code example

Trigger the stop command (via CAN bus or POWERLINK).

```
if ( ! stop_active )
{
/* Movement stop not active: Test stop inputs */
    if ( EmergencyStop == ncLOW )
    {
    /* Activate movement stop with parameter set for "emergency stop" */
       stop_index = E_STOP_INDEX;
       step = MOV_STOP;
       stop_active = 1;
    }
    else if ( nLimit == ncLOW )
    {
    /* Activate movement stop with parameter set for
       "low speed" */
       stop_index = NLIMIT_INDEX;
       step = MOV_STOP;
       stop_active = 1;
    }
}
else
{
/* Movement stop was activated */
    if ( EmergencyStop == ncHIGH && nLimit == ncHIGH
          && step!= W_MOVE_STOP)
    {
    /* Movement stop completed */
       stop_active = 0;
    }
}

switch (step)
{
    ...
    case MOV_STOP:
    /* Call NC action for movement stop */
        p_ax_dat->move.stop.index.command = stop_index;

        action_status = ncaction(ax_obj,ncMOVE,ncSTOP);
        if ( action_status == ncOK )
        {
            step = W_MOVE_STOP;
        }
        break;

    case W_MOVE_STOP:
    /* Wait for completion of movement stop */
        if (p_ax_dat->move.mode == ncOFF)
        {
        /* Movement stop completed */
            step = <NEXT_STEP>
        }
        break;
    ...
}
```

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Chapter 7 • Standards and certifications

1. Applicable European directives

- EMC directive 2004/108/CE
- Low-voltage directive 2006/95/CE
- Machine directive 2006/42/EG [1]

2. Applicable standards

Standard	Description
IEC/EN 61800-2	Adjustable speed electrical power drive systems • Part 2: General requirements; Rating specifications for low voltage adjustable frequency AC power drive systems
IEC/EN 61800-3	Adjustable speed electrical power drive systems • Part 3: EMC product standard including specific test methods
IEC 61800-5-1	Electrical drive systems with adjustable speed • Part 5-1: Safety requirements - Electrical, thermal and power requirements (IEC 61800-5-1:2003)
EN 61800-5-2	Adjustable speed electrical power drive systems • Part 5-2: Safety requirements - Functional requirements
IEC/EN 61131-2	Programmable logic controllers • Part 2: Equipment requirements and tests
EN 60204-1	Safety of machinery - Electrical equipment on machines • Part 1: General requirements
EN 1037	Safety of machinery - Prevention of unexpected start-up
IEC 61508	Functional safety of electrical / electronic / programmable electronic safety-related systems
EN 50178-1	Electronic equipment for high voltage systems
EN 954-1 [1]	Safety of machinery - Safety-related parts of control systems • Part 1: General design principles
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems • Part 1: General design principles
EN 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
UL 508C	Power conversion equipment

Table 3: Applicable standards for ACOPOS servo drives

1) Replaced by EN ISO 13849-1.

1) This machine directive only applies to logic units for safety functions that are for the first time being placed on the market by B&R for sale or use.

The limit values specified in the following section (3 "Environmental limits" to 6 "Environmental limit values according to IEC 61800-2") are taken from the product standard EN 61800 (and IEC 61800) for servo drives in industrial environments (Category C3 [1]). Stricter test procedures and limit values are used during the type tests for ACOPOS servo drives. Additional information is available from B&R.

1) Limit values from CISPR11, group 2, class A (second environment).

3 Environmental limits

3.1 Mechanical conditions according to EN 61800-2

3.1.1 Operation

IEC 60721-3-3, class 3M1	
	EN 61800-2
Vibration during operation 2 ≤ f < 9 Hz 9 ≤ f < 200 Hz	 0.3 mm amplitude 1 m/s² acceleration

Table 4: Mechanical conditions during operation

3.1.2 Transport

IEC 60721-3-2, class 2M1	
	EN 61800-2
Vibration during transport 2 ≤ f < 9 Hz 9 ≤ f < 200 Hz 200 ≤ f < 500 Hz	 3.5 mm amplitude 10 m/s² acceleration 15 m/s² acceleration

Table 5: Mechanical conditions during transport

3.2 Climate conditions according to IEC 61800-2

3.2.1 Operation

IEC 60721-3-3, class 3K3	
	EN 61800-2
Ambient temperature during operation	5 to 40°C
Relative humidity during operation	5 - 85%, non-condensing

Table 6: Climate conditions during operation

3.2.2 Bearings

IEC 60721-3-1, class 1K4	
	EN 61800-2
Storage temperature	-25 to +55°C

Table 7: Climate conditions (temperature) during storage

IEC 60721-3-1, class 1K3	
	EN 61800-2
Relative humidity during storage	5 - 95%, non-condensing

Table 8: Climate conditions (humidity) during storage

3.2 Transport

IEC 60721-3-2, class 2K3	
	EN 61800-2
Transport temperature	-25 to +70°C
Relative humidity during transport	95% at +40°C

Table 9: Climate conditions during transport

4 Requirements for immunity to disturbances (EMC)

4.1 Evaluation criteria (performance criteria)

Criteria A ...... Test object not influenced during test.

Criteria B ...... Test object only temporarily influenced during test.

Criteria C ...... The system does not reboot automatically (reset required).

4.2 Low frequency disturbances according to EN 61800-3

The following limit values are applicable for industrial environments (category C3). [1)]

4.2.1 Power mains harmonics and commutation notches / voltage distortions

IEC 61000-2-4, class 3		
	EN 61800-3	Performance criteria
Hharmonics	THD = 10%	A
Short harmonics (< 15 s)	1.5x continuous level	B

Table 10: Limits for power mains harmonics

IEC 60146-1-1, class 3		
	EN 61800-3	Performance criteria
Commutation notches	Depth = 40%, Total area = 250% x degree	A

Table 11: Limit values for commutation notches / voltage distortions

4.2.2 Voltage changes, fluctuations, drops and short-term interruptions

IEC 61000-2-4, class 3		
	EN 61800-3	Performance criteria
Voltage changes and fluctuations	± 10%	A
Voltage changes and fluctuations (< 1 min)	+ 10% to - 15%	

Table 12: Limit values for voltage changes and fluctuations

IEC 61000-2-1		
	EN 61800-3	Performance criteria
Voltage dips and short-term interruptions	10% to 100%	C

Table 13: Limit values for voltage dips and short-term interruptions

1) Limit values from CISPR11, group 2, class A (second environment).

4.2 Asymmetric voltage und frequency changes

IEC 61000-2-4, class 3		
	EN 61800-3	Performance criteria
Asymmetric voltages	3% negative component	A
Frequency change and change rate	± 2%, 1%/s (+-4%, 2%/s if the power supply is isolated from general power mains)	

Table 14: Limit values for asymmetric voltages and frequency changes

4.3 High frequency disturbances according to EN 61800-3

These immunity tests are valid for industry (category C3). [1)]

4.3.1 Electrostatic discharge

Tests according to EN 61000-4-2		
	EN 61800-3	Performance criteria
Contact discharge to powder-coated and bare metal housing parts	6 kV	B
Discharge through the air to plastic housing parts	8 kV	

Table 15: Limits for electrical discharge

4.3.2 Electromagnetic fields

Tests according to EN 61000-4-3		
	EN 61800-3	Performance criteria
Housing, completely wired	80 MHz - 1 GHz, 10 V/m, 80% amplitude modulation at 1 kHz	A

Table 16: Limits for electromagnetic fields

4.3.3 Burst

Tests according to EN 61000-4-4		
	EN 61800-3	Performance criteria
Power connection	2 kV, 1 min, direct coupling	B
Lines for measurement and control functions in the process environment	2 kV, 1 min	
Signal interfaces, other lines	1 kV, 1 min	

Table 17: Limits for burst

1) Limit values from CISPR11, group 2, class A (second environment).

4.3.4 Surge

Tests according to EN 61000-4-5		
	EN 61800-3	**Performance criteria**
Power connection	1 kV (2 Ω) [1)], DM, symmetrical 2 kV (12 Ω) [1)], CM, unsymmetrical	B

Table 18: Limits for surge

1) The impedance was added from EN 61000-4-5 because it is not defined in EN 61800-3.

4.3.5 High frequency conducted disturbances

Tests according to EN 61000-4-6		
	EN 61800-3	**Performance criteria**
Power connection	0.15 - 80 MHz, 10 V, 80% amplitude modulation at 1 kHz	A
Lines for measurement and control functions in the process environment		
Signal interfaces, other lines		

Table 19: Limits for conducted disturbances (radio frequency)

5 Requirements for emissions (EMC)

5.1 High frequency emissions according to EN 61800-3

These emission tests are valid for industry (category C3). [1]

5.1.1 Conducted emissions on the power connections

Tests according to EN 55011			
Continuous current on motor	**Frequency range [MHz]**	**Quasi-peak value**	**Average**
I ≤ 100 A	0.15 ≤ f < 0.5	100 dB (µV)	90 dB (µV)
	0.5 ≤ f < 5	86 dB (µV)	76 dB (µV)
	5 ≤ f < 30	90 dB (µV) Decreases with the logarithm of the frequency up to 70	80 dB (µV) Decreases with the logarithm of the frequency up to 60
100 A < I	0.15 ≤ f < 0.5	130 dB (µV)	120 dB (µV)
	0.5 ≤ f < 5	125 dB (µV)	115 dB (µV)
	5 ≤ f < 30	115 dB (µV)	105 dB (µV)

Table 20: Limits for conducted emissions on the power connections

5.1.2 Electromagnetic emissions

Tests according to EN 55011	
Frequency range [MHz]	**Quasi-peak value**
30 ≤ f ≤ 230	40 dB (µV/m), measured at distance of 30 m [1]
230 < f ≤ 1000	50 dB (µV/m), measured at distance of 30 m [1]

Table 21: Limit values for electro-magnetic emissions

1) The limit values were increased by 10 dB (µV/m) when measuring from distances of 10 m.

1) Limit values from CISPR11, group 2, class A (second environment).

6 Other environmental limit values according to IEC 61800-2

	EN 61800-2
Degree of pollution according to IEC 61800-2, 4.1.2.1.	2 (non-conductive pollution)
Overvoltage cat. according to IEC 60364-4-443:1999	II
Protection according to IEC 60529	IP20
Reduction of the continuous current at installation altitudes over 500 m above sea level	10% per 1,000 m
Maximum installation altitude	2,000 m [1)]

Table 22: Additional environmental limits

1) Additional requirements are to be arranged with B&R.

7 International certifications

B&R products and services comply with applicable standards. They are international standards from organizations such as ISO, IEC and CENELEC, as well as national standards from organizations such as UL, CSA, FCC, VDE, ÖVE, etc. We give special consideration to the reliability of our products in an industrial environment.

Certifications	
USA and Canada	All important B&R products are tested and listed by Underwriters Laboratories and checked quarterly by a UL inspector. This mark is valid for the USA and Canada and simplifies certification of your machines and systems in these areas.
Europe	All harmonized EN standards for the applicable directives are met.
Russian Federation	GOST-R certification is available for the export of all B&R ACOPOS servo drives to the Russian Federation.

Table 23: International Certifications

8 Standards & definitions for safety techniques

Stop Functions according to IEC 60204-1/2006 (electrical equipment for machines, part 1: general requirements)

The following three stop function categories exist:

Category	Description
0	Stop by immediately switching off the power to the machine drive elements (i.e. uncontrolled stop).
1	A controlled stop, the power to the machine drive elements remains on until the stop procedure is completed. The power is switched off after the stop is complete.
2	A controlled stop, the power to the machine drive elements is not switched off.

Table 24: Overview of stop function categories

The necessary stop functions must be determined based on a risk evaluation for the machine. Stop functions in category 0 and category 1 must be able to function regardless of the operating mode. A category 0 stop must have priority. Stop functions must have priority over assigned start functions. Resetting the stop function is not permitted to cause a dangerous state.

Emergency stops according to IEC 60204-1/2006 (electrical equipment for machines, part 1: general requirements)

The following requirements are valid for emergency stops in addition to the requirements for the stop functions:

- It must have priority over all other functions and operations in all operating modes.
- The power to the machine drive elements which can cause a dangerous state must be switched off as quickly as possible without creating other dangers.
- Resetting is not permitted to cause a restart.

Emergency stops must be category 0 or category 1 stop functions. The necessary stop function must be determined based on a risk evaluation for the machine.

For emergency stop function in stop category 0, only hard wired, electromechanical equipment can be used. Additionally, the function is not permitted to depend on electronic switching logic (hardware or software) or the transfer of commands via a communication network or data connection.

When using a category 1 stop function for the emergency stop function, it must be guaranteed that the power to the machine drive elements is completely switched off. These elements must be switched off using electromechanical equipment.

Performance Levels (PL) according to EN ISO 13849-1 (Safety of machinery – Safety-related parts of control systems, Part 1: General design principles)

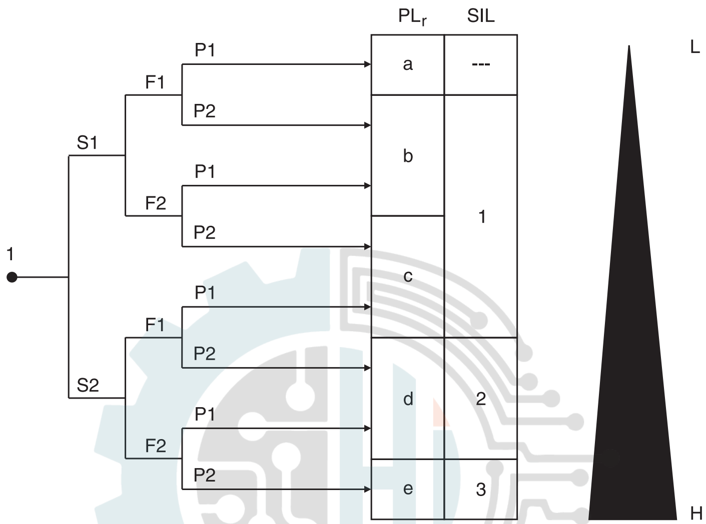
The safety related parts of control systems must meet one or more of the requirements for five defined Performance Levels. The Performance Levels define the required behavior of safety related controller parts regarding their resistance to errors.

Performance Level (in accordance with EN ISO 13849-1)	Safety integrity level - SIL (in accordance with IEC 61508-2)	Short description	System behavior
a	---	Safety related parts must be designed and built so that they can meet the expected operational requirements. (No specific safety measures are implemented.)	**Caution!** **An error can cause the safety function to fail.**
b	1	Safety related parts must be designed and built so that only reliable components and safety principles are used. (e. g. preventing short circuits by using sufficient distances, reducing the probability of errors caused by using oversized components, defining the failure route - bias current fail-safe, etc.)	**Caution!** **An error can cause the safety function to fail.**
c	1	Safety related parts must be designed so that their safety functions are checked in suitable intervals by the machine controller. (e. g. automatic or manual check during start-up)	**Caution!** **An error between checks can cause the safety function to fail. If the safety function fails, it will be recognized during the check.**
d	2	Safety related parts must be designed so that individual errors do not cause the safety function to fail. Individual errors should - if possible - be recognized the next time (or before) the safety function is required.	**Caution!** **The safety function remains active when an error occurs. Some, but not all errors are recognized. A buildup of errors can cause the safety function to fail.**
e	3	Safety related parts must be designed so that individual errors do not cause the safety function to fail. Individual errors must be recognized the next time (or before) the safety function is required. If this type of recognition is not possible, a buildup of errors is not permitted to cause the safety function to fail.	**Information:** **The safety function remains active when an error occurs. Errors are recognized in time to prevent the safety function from failing.**

Table 25: Overview of Performance Levels (PL)

The suitable performance level must be selected separately for each drive system (or for each axis) based on a risk evaluation. This risk evaluation is a part of the total risk evaluation for the machine.

Th following risk graph (according to EN ISO 13849-1, Appendix A) provides a simp cedure for risk evaluation:



Legend

1 Starting point for evaluating the impact on risk reduction
L ow impact on risk reduction
H igh impact on risk reduction

PL$_r$ required Performance Level
SIL Safety Integrity Level according to IEC 61508-2

Risk parameters

S Severity of injury
S1 Slight (usually reversible) injury
S2 Serious (usually irreversible) injury including death

F Frequency and/or duration of exposure to danger
F1 Seldom-to-less-often and/or exposure time is short
F2 Frequent-to-continuous and/or exposure time is long

P Possibility of avoiding hazard or limiting harm
P1 Possible under specific conditions
P2 Scarcely possible

Figure 7: Risk graph for determining the PL$_r$ for each safety function in accordance with EN ISO 13849-1, Appendix A

Begin at the starting point shown and follow the risk parameters S, F and P to the performance level to be used.

Restart inhibit according to EN 1037/04.96 (Safety of machinery - prevention of unexpected start-up)

Keeping a machine in an idle state when people are working in the danger zone is one of the most important requirements for safe operation of machines.

Starting refers to the transition of a machine or its parts from an idle state to moving state. Any start is unexpected if it is caused by:

- A start command sent because of a controller failure or because of external influences on the controller.
- A start command sent because of incorrect operation of a start element or another part of the machine.
- Restoration of power supply after an interruption.
- External/internal influences on parts of the machine.

To prevent unexpected starting of machines or parts of machines, power should be removed and dissipated. If this is not practical (e. g. frequent, short work in danger zone), other measures must be taken:

- Measures to prevent random start commands.
- Measures to prevent that random start commands cause unexpected starting.
- Measures to automatically stop dangerous parts of the machine before a dangerous situation can be caused by unexpected starting.

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Model number index

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MAACP2-ENG